Draft Minutes
High-Energy Physics Advisory Panel
June 3–4, 2010
Palomar Hotel, Washington, DC

HEPAP members present:

- Hiroaki Aihara
- Daniel Akerib
- Marina Artuso
- Edward Blucher
- Raymond Brock
- Patricia Burchat
- Andrew Cohen
- Lance Dixon
- Bonnie Fleming
- Graciela Gelmini
- Douglas Glenzinski
- Stuart Henderson
- Steven Kettell
- Daniel Marlow
- Ann Nelson
- Regina Rameika
- Ian Shipsey
- Paris Sphicas
- Kate Scholberg
- Melvyn Shochet, Chair
- William Trischuk
- Herman White

HEPAP members absent:

- Donald Hartill
- Wim Leemans
- Henry Sobel

Also participating:

- Charles Baltay, Departments of Physics and Astronomy, Yale University
- Roberto Battiston, Physics Department, University of Perugia
- Glen Crawford, HEPAP Designated Federal Officer, Office of High Energy Physics, Office of Science, Department of Energy
- Joseph Dehmer, Director, Division of Physics, National Science Foundation
- Paul DeLuca, Jr., Provost and Vice Chancellor for Academic Affairs, University of Wisconsin–Madison
- Robert Diebold, Diebold Consulting
- Marvin Goldberg, Program Director, Division of Physics, National Science Foundation
- Alfred Goshaw, Department of Physics, Duke University
- Nicholas Hadley, Physics Department, University of Maryland
- Young-Kee Kim, Deputy Director, Fermi National Accelerator Laboratory
- John Kogut, HEPAP Executive Secretary, Office of High Energy Physics, Office of Science, Department of Energy
- Dennis Kovar, Associate Director, Office of High Energy Physics, Office of Science, Department of Energy
- Kevin Lesko, Nuclear Science Division, Lawrence Berkeley National Laboratory
- Marsha Marsden, Office of High Energy Physics, Office of Science, Department of Energy
- John O'Fallon, Director (Ret.), Office of High Energy Physics, Office of Science, Department of Energy
- Frederick M. O'Hara, Jr., HEPAP Recording Secretary, Oak Ridge Institute for Science and Education
- Moishe Pripstein, Program Director, Division of Physics, National Science Foundation
- Michael Procario, Program Manager, Office of High Energy Physics, Office of Science, Department of Energy
- Helen Quinn, Emeritus Professor, Stanford Linear Accelerator Center, Stanford University
- James Strait, Head, Particle Physics Division, Fermi National Accelerator Laboratory

Vigdor Teplitz, Physicist, Goddard Space Flight Center, National Aeronautics and Space Administration
Maury Tigner, Director, Laboratory of Nuclear Studies, Cornell University
Samuel Ting, Department of Physics, Massachusetts Institute of Technology
Kathleen Turner, Research and Technology Division, Office of High Energy Physics, Office of Science, Department of Energy
Andreene Witt, Oak Ridge Institute for Science and Education

About 120 others were present in the course of the two-day meeting.

Thursday, June 3, 2010
Morning Session

Chairman **Melvyn Shochet** called the meeting to order at 8:59 a.m. He introduced **Dennis Kovar** to present an update on the activities of the DOE Office of High Energy Physics (HEP).

His perspective on high-energy physics was that scientists have been looking forward to the tera-electron-volt (TeV) scale, because of expectations of physics beyond the Standard Model, and the high-energy-physics community is poised to exploit them. It has been found that the universe is expanding, and that 75% of it is in dark energy. The scientific community is poised to get insight into it. It is now possible to look back in the history of the universe. It has been discovered that neutrinos have mass; but not much is known about it. We are living in extraordinary times.

Science has become very big with next-generation detectors that are getting bigger and more costly. Efforts will have to be coordinated internationally, and resources will have to be leveraged. This is a wealthy nation and is expected to contribute proportionately. Energy, climate change, and economic competitiveness are important goals of this administration. The Office of Science (SC) has to contribute to those goals. A plan is needed to deliver science. The next generation of enabling technology needs to be developed, and a case needs to be made that those investments will change the trend of downsizing the HEP program in the face of other pressing national needs.

The Office is using the guidance received from its Advisory Committee. There has been no congressional action on the FY11 budget. The FY12 budget is under review; it will go to DOE upper management during the week following this meeting with passback at Thanksgiving.

The program has been optimized over the next 10 years in four funding scenarios similar to the P5 [Particle Physics Project Prioritization Panel] funding scenarios. The prioritization criteria used for particle astrophysics were that (1) the science addressed by the project must be necessary, (2) particle-physicist participation must be necessary, and (3) scale matters (particularly at the boundary between particle physics and astrophysics). Priorities are generally aligned with the recommendations for the cosmic frontier in the 2008 HEPAP (P5) report; the advice that came out of that was that dark matter and dark energy both remain high priorities.

The guidance that came out of the Particle Astrophysics Scientific Assessment Group (PASAG) report is that dark energy funding (recommended for largest budget portion) should not significantly compromise U.S. leadership in dark matter, where a discovery could be imminent. Dark energy and dark matter together should not completely zero out other important activities. HEP [along with the National Aeronautics and Space Administration (NASA) and NSF] awaits the Astro2010 report before making decisions on proposed major projects.

Some believed that there was a strong case to operate the Tevatron to 2014, but it is currently slated for shutdown in 2012.

The Large Hadron Collider (LHC) is now colliding and recording data at 7 TeV. The United States is planning to participate in the LHC program. Participation includes detector and accelerator upgrades. The present U.S.–CERN [Conseil Européen pour la Recherche Nucléaire] memorandum of understanding (MOU) lasts until 2017. CERN activities and plans for the LHC are driving discussions of global projects.

Discussions of a next-generation lepton collider are ongoing. A decision about the next-generation lepton collider awaits results from the LHC and commitments of interested participants. That decision was envisioned to happen in FY12 but is now expected somewhat later. DOE is working with Americas Research Team to define a U.S. ILC R&D program for FY12–15. The American team has been asked to develop a plan for 2013. HEP is working to establish a 5-year national muon-accelerator R&D plan. Fermilab has been charged to organize this national effort in August. Investments are being made in plasma Wakefield acceleration demonstration projects.

NSF and DOE have established a Deep Underground Science and Engineering Laboratory (DUSEL) Physics Joint Oversight Group (JOG) to coordinate and oversee the DUSEL experimental physics program. The agencies are collaborating in defining the DUSEL physics program and have agreed on DUSEL stewardship roles and a core research program. An interagency MOU will define the roles and responsibilities in more detail. The MOU is expected to be signed before the end of 2010. There are hiccups in this project.

The Office is looking for guidance from Astro2010, the findings and recommendations of which will influence the opportunities for HEP participation and inform HEP on scientific/technical aspects of particle astrophysics. DOE and NASA continue to work to identify the path forward on a Joint Dark Energy Mission, and several mission concepts have been developed. The Dark Energy Cosmology Survey (DECS) and the Observatory for Multi-Epoch Gravitational-lens Astrophysics (OMEGA) were presented to Astro2010 in June 2009. The Interim Science Working Group is looking at a new $650-million-capped mission concept. The European Space Agency (ESA) has expressed an interest in a partnership on their proposed dark-energy mission. DOE has had discussions with NASA and with NSF on how to respond to Astro2010 guidance. DOE and NSF have worked to coordinate planned activities. DOE and NSF requested the HEPAP PASAG report and have held discussion on a strategy for dark-matter experiments.

The Office has received a report from the Stanford Linear Accelerator Center (SLAC) on possible U.S. options in SuperB (in Italy). SLAC's assessment has raised three options:

- The provision of reusable PEP-II [Positron Electron Project] and BABAR [B B-bar Detector] components
- Plus additional funding for U.S. participation in detector program
- Plus additional funding for U.S. participation in accelerator program

The Office expects to get a proposal for participation in Belle-II at SuperKEKB (at the High-Energy Accelerator Research Oganization in Japan) for participation in detector subsystems. It also expects to get a proposal for implementing the g-2 experiment at Fermilab that uses existing Fermilab infrastructure and planned upgrades and Brookhaven National Laboratory (BNL) design and development. The Office will conduct peer reviews of these scientific opportunities.

An accelerator workshop has been held, and the Office has received guidance on the needs of federal programs and the private sector. The workshop report is out, and the Office has considered what initiatives might be undertaken. The report offers a new cut on the issues with opportunities in accelerator-driven systems in the treatment of flue gases, waste, and water; isotope generation and heavy-ion therapy; defense, cargo interrogation, and monitoring; and next-generation discovery-science machines. There are some policy issues and liabilities.

In budgets, HEP has still not made the turn (there is a 2.3% increase in the FY11 budget). The American Recovery and Reinvestment Act (ARRA) funds are significant and will be obligated by the end of the year and then costed. The FY11 budget is tight for Fermilab. SLAC is where it will be for the next 5 years. Elementary particle physics looks like a good increase.

The HEPAP Committee of Visitors (COV) that is to examine and evaluate the operations of the Office will happen in October. HEP laboratory reviews are being held on electron-accelerator-based physics and nonaccelerator physics. Fermilab and BNL will have HEP peer-reviews, and Argonne National Laboratory (ANL), Lawrence Berkeley National Laboratory (LBNL), and SLAC will have HEP Office reviews. These reviews serve different purposes and are working well.

There have been two recent appointments in instrumentation and nonaccelerator physics. There are three vacancies and a need for Intergovernmental Personnel Act (IPA) staff and detailees.

Information needs to be collected on demographics. HEP gathers demographics information from two sources: from surveys of university principal investigators (PIs) and other laboratories and from ANL, BNL, Fermilab, LBNL, and SLAC spreadsheets submitted during annual budget briefings. The information collected includes the actual number of full-time-equivalent employees (FTEs) for FY09 by job classification and research activity and estimates for 2010. This information provides a snapshot of HEP's workforce and where the budget is going. It will show how many people are being supported.

Shochet asked about the dark-energy-side possible problem with the new National Research Council (NRC) study. Kovar replied that the Office has been talking with the Decadal Survey and informed them of the evaluations, costs, and cross-agency interest. The Survey now realizes that things are changing. It is hoped that its guidance will allow the high-energy community to make decisions relevant to the new circumstances.

Trischuk asked what the 2015 decision on lepton colliders meant. Kovar replied that, by 2015, it will be known what the LHC will do, options will be better understood, and a manufacturing capability will have been developed. Power consumption by next-generation accelerators will be a big climate-change issue. Big breakthroughs in technology will be needed.

Joseph Dehmer was asked to present an update on the activities of the Division of Physics of the NSF.

Ed Seidel has been appointed Assistant Director for Mathematical and Physical Sciences (MPS). As an aside, Dehmer expressed the deep gratitude for the scientific community's unstinting willingness to serve as ad hoc and panel reviewers, the demand for and importance of which are both increasing.

The FY11 Physics Division budget request was up 2.8%, which was below the rate for the NSF overall, because of the budget cut in the planning for the DUSEL. That cut has been actively discussed. A new budget model has been developed and proposed, increasing the DUSEL budget from $18.7 million to $42.0 million. There are still some difficulties (dewatering costs and a new shaft for safety). This increase is likely to happen, putting the project back on track; but the execution parameters of DUSEL are changed slightly.

DUSEL is being envisioned as a unique, dedicated international underground education and research center that would support a set of potentially transformational experiments in multiple disciplines. The U.S. particle, nuclear, and astrophysics communities have selected DUSEL as central to their national programs. The engineering, geology, and biology communities are proactively engaged. The intellectual footprint is enormous. The facility will host a variety of physics and biology–geology–engineering (BGE) experiments. The major research equipment and facilities construction (MREFC) will include the facility construction and will reserve a fixed amount of dollars for the integrated suite of experiments. By the time of the MREFC submission, the scope of the experimental program will be defined; however, no specific experiments need to have been selected. The concept is a flexible two-phase project. The preliminary design report (PDR) will provide a facility design that is able to accommodate a "generic" suite of experiments. Experiments will be approved as they reached the right level of maturity. Funding in the MREFC will be for the facility and the NSF share of experiments.

There have been many NSF reviews of the project, and there are more coming up. NSF reviewed the project with DOE in February and April. The design team is lean but of proven high quality. Progress on the PDR remains good, and the schedule remains aggressive. The response to safety concerns is good and must continue. The budgetary constraints imply a lean but scientifically sound program. The issues that came out of this review were that immediate shaft maintenance is needed for safe access to complete work related to design. Scheduled maintenance support by South Dakota is expected to end in FY11 (i.e., dewatering and continued access to mine), and costs are being shifted to NSF; and guidance on the cost structure was modified after the April review.

Converting the commercial mine up to a scientific laboratory is very costly; $50 million has been shifted from the scientific program to cover these costs. The rest of the $750 million total budget is being "scrubbed" for cost savings. The proposed costs will exceed the $750 million budget cap.

NSF and DOE agreed to establish the DUSEL Physics JOG immediately after the release of the P5 report. It will jointly coordinate and oversee the DUSEL experimental physics program. Smaller physics experiments have been added to the program's elements. An MOU is being written and will be completed by the end of the summer. The JOG is being populated and is meeting monthly.

The agencies have agreed on DUSEL stewardship roles and a core research program. Key DUSEL milestones have been set for the various experiments of the different agencies. The issues that HEPAP should be aware of are the needs for FY11–13 support for DUSEL planning; a solid, value-optimized PDR; safety (a culture-change issue); the National Environmental Policy Act (NEPA) requirements; a National Research Council (NRC) study of DUSEL science, which is due next spring; integration and design for the science program; and international participation. DUSEL is intended to be a globally open infrastructure.

Fleming asked him to comment on funding for DUSEL beyond FY11. Dehmer replied that, because of the funding-cut scare, the budgeting was discussed for a longer term, producing a 3-year plan, leading to a decision.

Dixon asked what new information would come out of the NRC study. Dehmer replied that the National Science Board (NSB) requested the NRC review. It is important. There has been a lot of deliberation; what is new is an assessment of the scientifically broad DUSEL program. That will provide a lot of leverage, and it will be independent. The agencies are happy that it is happening.

A break was declared at 10:12 a.m. The meeting was called back into session at 10:44 a.m. **Kevin Lesko** was asked to present an overview of the NSF DUSEL project.

The motivation for DUSEL is broad and well documented. It is being approached as discovery science at the intensity frontier (neutrinos, dark matter, dark life, natural resources engineering, and education and outreach).

DUSEL will be a MREFC project that includes the facility with NSF stewardship and a suite of high-energy-physics experiments with DOE and NSF stewardship. DOE granted CD-0 in January 2010 for the Long-Baseline Neutrino Experiment (LBNE). The proposal and conceptual design report (CDR) championed an early implementation program that requires an operational Environment, Safety, and Health (EH&S) Program while DUSEL's full programs are being crafted. The project is working closely with the state of South Dakota to realize this goal.

The intention is to develop a world-class facility with campuses at the surface (about 27,000 m^2), at the 4850 Level (about 25,000 m2), at the 7400 Level (about 5000 m2), and on other levels and ramps. There will be dual access to the research campuses with best-practices life safety systems and programs, experimental support, and a design that enables future expansion. Coupled with this is a suite of transformational scientific experiments. The surface campus will host two installations. At the 4850 Level, there is planned one large cavity and space for four or five physics experiments plus Earth science experiments. The 7400 Level will host two physics experiments and additional Earth science experiments. Other locations will also host experiments.

A draft suite of scientific experiments has been produced; a facility to support those experiments has been developed and will be further developed with science collaborators and agency reviews; the science is recognized to require additional support. The $750 million cost includes $125 million for LBNE science.

The DUSEL organization is almost complete with about 55 staff members, with several working on science-requirements integration. The design is progressing well in excavation design, outfitting, and geology/geo-technology access. The 4850 Level mapping is complete, the geology model has been developed, coring and logging have been completed, and in situ and laboratory testing has been completed. The news is good. The rock is very good and strong, and there is very little water down there.

A construction-management team came on board in April. They are fully engaged with the project. A milestone schedule has been developed for completing the preliminary design. The PDR is to be delivered to the agencies late in December.

The State of South Dakota has extended its pumping activities an extra 6 months. That activity is being transferred to the DOE contractor (the University of California at Berkeley).

The LBNE organization is being integrated with the DUSEL organization. A high-level milestone schedule for DUSEL through the 5-year construction period has been developed. The schedule has not been optimized but has identified the review dates for the critical decision points, CD-1, CD-2, and CD-3. There is implementation of science during construction.

A Program Advisory Committee has been established and appointed. It has a physics side and an Earth science side.

The end of 2009 and early 2010 saw several incidents involving contractors at the site. A review of the infrastructure highlighted deferred-maintenance issues in the Ross Shaft, and NSF's reviews highlighted the need to focus on establishing an appropriate "culture of safety." A factor-of-100 improvement in ES&H is needed. Excellent progress has been made. Executive orders were issued restricting underground access to essential personnel and providing increased oversight of contractors. The NSF reviewed the safety plans and infrastructure improvements at the end of February. The project reported its progress and plans to the NSF and DOE in May. A safety review is scheduled for June 21–22. In the shaft, the furnishings are being rehabilitated. (Maintenance on these components was ended when commercial production ceased.) The focus in access is maintaining the pumping so that geotechnical, electrical, and other staff can get down there and so that assessments can be conducted (e.g., background radiation, cultural vibrations and noise, blast vibration effects, and hydrology).

The Sanford Laboratory (Sanford Underground Scientific and Engineering Laboratory, SUSEL) is currently conducting physics, biology, geology, engineering, and other research with about 17 groups of researchers plus support staff. The Large Underground Xenon (LUX-350) Experiment has 52 researchers from 10 institutions. It had an ES&H review in March 2010; its readiness review will be in August 2010; an MOU is being developed; its insurance is not yet determined. The Majorana Demonstrator (for neutrinoless double-beta decay) has about 93 researchers and involves 18 institutions plus the Sanford laboratory. Lead and copper were moved onsite in June 2009, and temporary-clean-room work began in December 2009. EH&S. work has begun, DOE pre-readiness was granted in October 2009, the readiness review was held in January 2010, a DOE review was held in May 2010, the MOU was also signed in May. The Davis campus of SUSEL will be used to support both LUX and the Majorana Demonstrator.

On May 6, the congressional delegations from South Dakota, California, and Illinois requested a briefing from Office of Science and Technology Policy (OSTP), NSF, and DOE. FY11 funding for DUSEL and continued good interagency cooperation were discussed at length during the briefing. The project remains confident that the NSF will work with the Office of Management and Budget (OMB) and OSTP to obtain an adequate level of funding in FY11 and to understand the project needs beyond this period. Following the recommendations from the February and April NSF reviews, the project has prepared a proposal to provide bridge funding between April 2011 and May 2012. The proposal will fund continued activities including (1) critical design activities, (2) continued experimental integration, and (3) ensured safe access underground for design and pumping activities.

In summary, building the health and safety program is a principal focus for the project. The preliminary design and integrating activities are being aggressively advanced. There is progress in establishing good relationships with the LBNE. The project is on schedule for completing the PDR by the end of 2010.

Shipsey asked how many MREFCs there could be at one time at NSF. Dehmer replied that there are normally 3 to 6 across the Foundation, most in MPS and Geology; $100 million is the average amount. The limit is $250 million, but that may be increased. They overlap chronologically, with some ramping up as others roll off.

Henderson asked if there were scope contingencies in mind if other cost cutting is not sufficient. Lesko replied that infrastructure is being heavily invested in; sharing could lower the capacity needed.

White asked if all the NEPA processes were integrated. Lesko replied, yes. A series of engagements are being conducted with the public. The major public review period will be this summer. It is a combined action of DOE and NSF, focusing on the Homestead Site.

James Strait was asked to review the LBNE, which originates in Illinois and ends in Lead, South Dakota. The collaboration is growing rapidly and is slowly accreting non-U.S. collaborators. It now has 244 scientists and engineers from 54 institutions.

It is to measure ν_μ–ν_e oscillations at a sensitivity that is much greater than that measured by the NuMI Off-Axis ν_e Appearance (NOvA) experiment or the Tokai-to-Kamioka (T2K) experiment. The goal is to (1) determine the mass hierarchy (i.e., are ν_1 and ν_2 lighter or heavier than ν_3); (2) to search for charge-parity (CP) violation in the neutrino sector (i.e., to determine why there is matter but almost no anti-matter in the universe); and (3) to extend the sensitivity for the above measurements down to a $\sin^2 (2\theta_{13})$ of about 0.01. θ_{13} must be determined before the LBNE can work. It needs massive detectors well underground, which can be used for other purposes (proton decay, neutrinos from nearby supernovae, diffuse supernovae neutrino flux, atmospheric neutrinos, and solar neutrinos).

The scope starts with a new beamline at Fermilab, designed to accommodate power upgrades. The near detector will measure the beam before it goes to South Dakota. The far detector would be equivalent to a 200-kt water equivalent detector with 100-kt water-Cherenkov *or* 20-kt liquid-argon modules. The goal is to choose a detector configuration that gives the best science within the cost, schedule, and technical-risk constraints. There will be conventional facilities at the far and near sites. There will be significant underground and surface facilities at the near and far sites. Significant underground and surface civil engineering will be required on the Fermilab site for the beam and near detector. Underground and surface civil engineering will be required for the LBNE-specific facilities at the DUSEL site. The LBNE team is working with DUSEL to define precise boundaries of responsibility between DUSEL and LBNE and to define the management of “LBNE’s” cavern and surface construction within the overall DUSEL construction project. Fermilab is the overall lead laboratory; BNL is the lead for the water detector; Los Alamos National Laboratory (LANL) is the lead for the near detector; and Fermilab is the lead for the far detector. There is coordination between the collaboration and the agencies and within the agencies. The LBNE project organization is still being filled out. Active searches are being conducted for open positions.

A budgetary exercise has recently been completed to determine where the CD-1, CD-2, and CD-3 funding profiles should be set. Low, medium, and high profiles were defined, with the medium profile having an additional \$5 million in R&D. The high scenario has an additional \$10 million in FY12 for the CD-2 effort. The project’s timeline depends on which of these profiles is adopted and on the success of the CD-1 review. The guess is that the project will be complete sometime after 2020. A detailed outline of the CDR was completed on May 10. An intermediate draft CDR will be completed by June 25. An internal review will be conducted during the third week of July. The final draft CDR is expected in mid-September with the CD -1 review being conducted December 7–9, 2010.

A big accomplishment will be to determine what LBNE is, a water detector or an argon detector. Trade-offs (in dollars) among the beam design, the near detector capability, and the far-detector mass need to be considered. There are other trade-offs to be determined (depth, beam power, etc.). The general approach will be to build an experimental complex to deliver the best possible science.

CD-1 is not a baseline; some options can be left open. The simpler the list of options for achieving CD-1, the better. However, enough information to make good decisions must be gathered. Options left open must be covered by the cost range and schedule range presented for CD-1. There could be two water detectors, two argon detectors, detectors at great depth, or detectors near the surface. One must understand what the science is.

For DOE, the primary mission is long-baseline neutrino oscillations. Proton decay and neutrino astrophysics are important secondary goals. For NSF, LBNE represents two of the four physics experiments that "must" be part of the initial experimental program (the long-baseline neutrino oscillations and proton decay). Other physics enabled by the large detectors are important secondary goals. Neutrino oscillations and proton decay should be most strongly considered in choosing the configuration for the best possible science.

In making configuration decisions, one must determine and compare the sensitivity for each physics topic for each configuration, which requires simulations or other studies to determine (or improve the determination of) the detection efficiency and background rejection for each detector technology and for each relevant physics process along with the uncertainties in these quantities. One must conduct a complete risk analysis (technical, cost and schedule) for each detector technology and far-detector depth and estimate the CD-1 cost of each configuration, including the contingency required by risks, the required R&D, and the specific impact of the far-detector choice on beam requirements. The same thing has to be done for schedules. For the far detectors, one must normalize the detector mass in each configuration to common cost (including contingency). Then the physics reach can be estimated for each configuration. A mechanism is needed to evaluate the "input data," weigh the relative importance of the inputs, and come to a consensus concerning the configuration of the experimental complex.

Formally, the configuration decision is the responsibility of the LBNE project, which is the organization that is responsible to the funding agencies, and through them the taxpayers, for how their money is spent. Strong input from the collaboration is required because the project is building the experiment for the collaboration to do the science. This will be done by constituting the Collaboration Executive Committee as an advisory committee. The charge to the Committee would be to develop a set of issues to be addressed, not just a request for a recommendation about the configuration. "Too early to decide" is a possible outcome for some choices.

The LBNE is working in partnership with DUSEL. This is a cost-effective way to do business. This cooperation is going well. There are weekly meetings, and one small MOU is in place to funnel money to DUSEL to do analyses. DUSEL and LBNE are also holding monthly "integration week" meetings. The rules of engagement will be codified in a DUSEL–LBNE MOU, which is actively being worked on. Issues currently being debated include:

- Defining boundaries between DUSEL and LBNE project responsibilities.
- Organizations and procedures to manage the civil construction of LBNE facilities within DUSEL.
- How NSF and DOE funding can be managed to support LBNE civil construction at DUSEL, LBNE detector construction, and LBNE beam and civil construction at Fermilab.
- The need to understand how to "normalize" the DUSEL vs. LBNE project development schedules.

In summary, the LBNE project is making good progress towards a CD-1 review, currently scheduled for this coming December. A strong project team is functioning well; active searches are under way to fill out the remaining key openings. Making decisions about experimental configurations will be an important process. And the DUSEL and LBNE projects are developing a good partnership.

Dixon asked about the timescale for determining θ_{13}. Strait replied that there is an estimate of that progress by projects under way. Daya Bay has great reach but great uncertainty because it is still under construction. By 2016, there is a good shot at knowing if θ_{13} is greater than or less than 0.01. Without knowing the value of θ_{13}, one would not know what experiment to do and could not ask for CD-3.

Gelmini asked if one could do the neutrino experiment on the surface. Strait replied, not with the water detector. It could possibly be done with the liquid argon detector. Gelmini asked if a larger experiment were needed because of shielding. Straight answered that, at the surface, one has lots of cosmic rays, but shielding can be limited to critical regions.

Kim commented that all of the participants have been spending time together to make sure that there is a good understanding of what is going on.

A break for lunch was declared at 12:35 p.m.

Thursday, June 3, 2010
Afternoon Session

The meeting was called back into session at 1:45 p.m. **Charles Baltay** was asked to report on the panel charged to provide scientific assistance on the Joint Dark Energy Mission (JDEM) during its Phase-A activities.

The first phase of the Interim Science Working Group (ISWG) process (through Spring 2010) was to develop one or two best designs for JDEM with the fiscal constraint of $650 million plus launch costs. This phase has been completed, and a final report was presented to NASA and DOE on May 4.

New information can be expected during the next few months on costing, from the report of the Decadal Survey, on the status of plans for new ground-based programs, as input from the broader scientific community, in a re-examination of the JDEM mission design with possible new constraints based on the new information, and from the present joint scientific and engineering efforts.

The Working Group held monthly meetings from December to April and reported to NASA and DOE on April 15-16, 2010.

There are three techniques to study dark energy:

- Type-1a supernovae, measuring standard candles, the luminosity-distance giving cosmological parameters
- Baryon acoustic oscillations uses a standard ruler, measuring the diameter of a pressure wave
- Weak lensing, measuring the growth of structure

These techniques are related by General Relativity. These methods complement each other.

The Working Group first sought the minimum performance requirements that would make a JDEM mission worthwhile. The Dark Energy Task Force (DETF) minimum requirement of a figure of merit (FoM) 10 times that of Stage II and 3 times that of Stage III is still valid. The DETF estimated Stage II as FoM = 50 and the subsequent Figure of Merit Scientific Working Group (FoMSWG) estimated Stage III as FoM = 116. The Working Group therefore felt that it should aim for a minimum FoM = 500 (the reciprocal of the area of the error) with Planck plus Stage III priors to call it a worthwhile mission. However, the FoM is not the only relevant measure. JDEM should aim for a redshift reach that complements what is possible from the ground. JDEM should also enable at least two (of the three) methods to investigate dark energy.

The Working Group started out with 60 Mission Concepts and narrowed it down to three designs and then to two designs: (1) baryon acoustic oscillations (BAO) plus supernovae and (2) weak lensing plus BAO plus supernovae.

Several significant new design considerations emerged from these studies that allowed a breakthrough in cost-effective designs. The normal telescope obscures 25% of the field of view with its reflecting mirror. A new design enables a view that is unobstructed by the reflecting mirror and makes a 1.1-m mirror as good as a 1.2- or 1.3-m mirror. Another breakthrough was the adoption of new survey strategies. In previous designs [the SuperNova Acceleration Probe (SNAP) for example], supernova lightcurves were built from photometric measurements with a large-area, fine-plate-scale imager with nine filters. A spectrometer was used to take a single spectrum for each supernova for typing. The new survey strategy uses a small-area, wide-field imager for discovery and a high-quality spectrometer to produce photometric lightcurves. The imager is not used for precision photometry and can have a coarse plate scale and only two broadband filters. The spectrometer provides the requisite spatial and wavelength resolution for the lightcurves. Lightcurves from a rolling search follow many supernovae in one field. With the large mirror apertures and fields of view, this technique was very efficient. But all exposures had to be long enough to give precision lightcurve points for the highest-redshift supernova at its faintest (early or late) epoch. With the new strategy, one can tailor each shot to a particular supernova. It is much cleaner.

The significance of these new considerations is that an unobstructed-view telescope enables BAO, weak lensing, and supernova surveys with a 1.1-m telescope and that the new supernova survey strategy can use either of the wide-field imagers required by the BAO or weak-lensing surveys with fewer detectors and larger plate scales, making a supernova survey compatible with BAO or weak lensing. The supernova survey is now an easy add-on to any weak-lensing or BAO mission, requiring only an integrated-field-unit (IFU) spectrographor slit spectrometer, which is relatively inexpensive.

Two 3-year mission concepts were developed. Design A enables BAO and supernovae in a very simple, economical design. Design B also enables weak lensing, which turns out to be much more difficult and expensive. So Design B does not fit into a probe-class mission but has greater science reach.

Design A for BAO and supernova surveys has a 1.1-m aperture; three telescope mirrors, and re-imaging cameras. Design A performance for BAO is 16,000 square degrees in 1.5 years; a redshift range of $1.3 < z < 2.0$; a depth limit of 2×10^{-16} ergs cm^{-2} sec^{-1}, redshifts for 60 million galaxies, and a redshift uncertainty of $0.001(1 + z)$; and for supernovae is 1500 supernovae to a redshift of 0.2 to 1.5 in 1.5 years, supernova discovery with the JDEM imager, and a large sample of ground-based observations of nearby ($z < 0.1$) supernovae. This would give good performance for a 3-year mission (with possible continuation to an 8-year mission, a great mission). The performance exceeds the minimum of 500 that was set for the figure of merit, approaching 750.

The Design B performance for weak lensing is 10,000 square degrees, 30 galaxies per square arc-minute, and 100,000 spectra for photo-z calibration. For BAO and supernovae, the performance would be similar to that of Design A per unit time.

The resulting figure of merit shows a definite advantage of space-based over ground-based measurements. Redshift space distortions measure the velocities of galaxies with respect to the Hubble flow and allow probes of growth of structure by redshift surveys independent of weak lensing.

In summary, the Working Group and the project offices have developed two JDEM mission designs to investigate the nature of dark energy. Two new design innovations, unobstructed-view telescope optics and alternative survey strategies, enable cost-effective designs with a 1.1-m telescope. Design A enables BAO and supernova dark-energy surveys in a 3-year mission; the design does not enable a weak-lensing survey. Weak lensing will cost a lot of money.

The original design was the SNAP Classic; then there were SNAP Lite and IDECS [the original International DECS]. Each of these would have cost $1.5 billion. U.S. Design A is pretty good on supernovae; the redshift reach is better than any but SNAP Classic (at one-half the money); and the BAO is much better than any other. Design B does weak lensing.

Shochet asked how much more expensive Design B was than Design A. Baltay replied, about 1.5 times as much.

Marlow asked whether launch costs dominate the project costs. Baltay replied that launch costs take up $150 million to $200 million of the total cost of the project of $800 million to $850 million. Marlow asked what drives the cost. Baltay answered that NASA uses full-cost accounting, including analysis of data. Testing is very exhaustive. They insist on higher quality and reliability. This is an L2 orbit. The instrument has to work immediately. There is no going out there to fix it.

Dixon asked what the gamma figure of merit parameter was. Baltay responded that it is just a General Relativity deviation measure. Different techniques measure different things. By comparing results, one sees whether General Relativity is correct or needs some correction factors.

Shipsey asked (1) about the recommendations of the Decadal Survey and (2) about and how the Euclid design is different from that of JDEM. Baltay answered that the timing of all this is maximally unfortunate. The Decadal Survey’s analysis was based on last year’s design. Whether it will fine tune its recommendations in light of this year’s findings is yet to be seen. Euclid emphasizes weak lensing with BAO as secondary and no supernovae. It is not a great design.

Kathleen Turner was asked to report on the DOE Dark Energy Program.

DOE, NSF, and NASA have been coordinating efforts on dark energy from the beginning. The Dark Energy Task Force, a subpanel of both HEPAP and the Astronomy and Astrophysics Advisory

Committee (AAAC), recommended medium- and long-range experiments and gave a figure of merit. Two or more techniques are needed for complementary information. In March 2010, the AAAC identified a lead agency for executing each project recommended by Astro2010 and engaged agency heads to facilitate implementation of the Astro2010 recommendations. In September 2010 there will be a report from Astro2010. Agencies will be briefed in August in time to affect the FY12 budget submissions. The agencies will not move forward on major projects until the report is issued; the report will influence the opportunities for DOE participation and provide information on scientific and technical aspects. In October, there will be a report from the Organisation for Economic Cooperation and Development (OECD) Global Science Forum Astro-Particle Physics Working Group on a 2-year study of global coordination and planning of particle-astrophysics experiments. It is a follow-on from the European ASPERA [AStroParticle ERAnet] roadmap.

The PASAG recommended an optimized program over 10 years under four funding scenarios:

- In Scenario A, a constant effort would be maintained at the FY08 funding level.
- In Scenario B, a constant effort would be maintained at the FY09 President's request level
- In Scenario C, funding would be doubled over a 10-year period starting in FY09.
- In Scenario D, additional funding would be available above the Scenario C level.

Dark matter and dark energy were both high priorities. The PASAG report prioritized potential contributions to the dark-energy program. It stated that dark-energy funding should not significantly compromise U.S. leadership in dark matter, where a discovery may be imminent. Dark energy and dark matter together should not completely zero out other important activities. Under Scenario A, it would not be possible to have major hardware and science contributions to any large project; participation would be supported only in very limited areas. Under Scenario B, there may be just enough funding for significant participation in one large project; but costs are uncertain, and a fast start may not be possible. Under Scenario C, a world-leading program could be enabled with coordinated experiments in space and on the ground; significant HEP participation in one large experiment plus a moderate or substantial role in a second large project would be possible; the project start may need to be pushed out because of the funding profile. In Scenario D, funding would allow major roles in two large experiments.

In dark-energy investigations, complementary methods are needed at each stage to determine the nature of dark energy. The possible methods for studying dark energy are weak gravitational lensing (WL), baryon acoustic oscillations (BAO), Type-Ia supernovae (SN), and galaxy clusters. Other methods continue to be developed.

WL would need a large-scale, multiband imaging survey that would be used to map the mass distributions as a function of redshift to measure the growth of structure and of space. BAO would need a large-scale spectroscopy and imaging survey to measure fluctuations in the early universe imprinted on galaxy distributions to determine the expansion rate of space. SN would need to monitor a wide field for supernovae discovery with follow-up spectroscopy to measure the growth of space. Galaxy clusters and distributions would need large-scale surveys to determine the growth of structure. Other methods continue to be developed, including using visible, infrared, radio, X-rays, etc.

DOE is playing a leading role in several of the supernova surveys to increase statistics over a wide range of redshifts. The Nearby Supernova Factory (SNFactory) discovers and collects detailed data on nearby supernovae to significantly improve systematic errors in their use as standard candles and to provide the baseline for high-redshift studies for future experiments. The first phase of data collection will be completed this summer, and the second phase will begin in the fall. The Quasar Equatorial Survey Team (QUEST) camera is currently being used at the La Silla Observatory telescope in Chile. The Baryon Oscillation Spectroscopic Survey (BOSS) is the primary survey of the Sloan Digital Sky Survey; it started taking data in December 2009. The other Stage-III experiment is the Dark Energy Survey (DES), which is based on galaxy-cluster counting, lensing measurements, 3000 Type-Ia supernovae, and baryon acoustic oscillations. It will be the largest CCD [charge-coupled-device] imaging survey to date and will begin operations in FY12.

Astro2010 was presented with JDEM, BigBOSS, and the Large Synoptic Survey Telescope (LSST). It is expected that Astro2010 will recommend a coordinated ground and space-based dark-energy program with complementary techniques and data sets to do the best job possible within available resources.

BigBOSS is a Stage-IV ground-based dark-energy experiment to measure the growth history of the universe by observing the pattern of galaxies during the past 9 billion years. Its primary method is BAO, looking at fluctuations in the early universe imprinted on galaxy distributions. A proposal for BigBOSS was submitted to Astro2010 in April 2009, and a detailed proposal will be submitted to the National Optical Astronomy Observatory (NOAO) in October 2010.

The LSST is a proposal to study the nature of dark energy; its main method is weak gravitational lensing, but it will also do galaxy clusters, supernovae, etc. The facility will also be used by a large community doing a wide variety of astronomical studies, including the search for near-Earth objects. It is a new 8.4-m telescope facility and associated instrumentation in Chile. SLAC leads the development of a 3.2-gigapixel camera with a 3º field of view. BNL also has a large role in the detector design. A separate dark-energy science collaboration has been set up. NSF reviewed the LSST's design and development in December 2009.

To manage JDEM, a framework MOU was put in place in 2008. NASA and DOE each set up program offices and an interagency management group. It was determined that the IDECS and OMEGA concepts could each do the entire mission, but they are very expensive. Therefore, in September 2009, NASA and DOE agreed to examine a "world-class" cost-capped mission concept with a cost of $650 million plus launch services. The project offices were asked to develop programs that would fit under the funding cap to be independently evaluated. The agencies informed Astro2010 that it is important to understand what can be done with the resources that are expected to be available. The ISWG and project offices presented an option for a Probe Concept A that will conduct the supernovae and baryon acoustic oscillation techniques and fit within the cost box. In the process, they developed a new design concept with an unobstructed telescope and recommended new survey strategies. This conceptual design will go out for an independent cost estimate and will be further developed. A Probe Concept B that also does weak lensing was looked at, but it costs more; further scientific studies are planned of this and other methods.

The European Space Agency (ESA) asked NASA about collaborating on three medium-class missions. Euclid is already designed and would use a BAO and WL methods and is not driven by the supernovae method. Supernovae observations may be possible in an extended mission. The United States' contribution would not exceed 20% of the total mission cost. NASA has appointed two scientists to the Euclid advisory committee. ESA is doing a few-month engineering optimization, and possible descoping of Euclid. Euclid is their top priority.

NASA is pursuing the Dark Energy Mission on two tracks: (1) the JDEM probe (which employs the supernovae and baryon acoustic oscillation methods) with DOE and (2) the Euclid project (which employs the weak lensing and baryon acoustic oscillations methods) with ESA. DOE could make a relatively small contribution to Euclid in two ways: DOE scientists can apply as leaders or as part of a PI-led science investigation and instrumentation contribution that will be competitively selected by NASA. Or DOE scientists could join a European-led team and apply to the ESA, forgoing NASA funding. DOE has several options: funding JDEM with NASA, the LSST and/or BigBOSS with NSF-Astronomy, or some combination thereof.

NASA and ESA appear to be motivated to deliver the most science across a portfolio of activities. It appears that Euclid is one of ESA's highest priorities, with a launch planned in 2018. If selected, it is likely that ESA will go forward on it with or without U.S. participation. Because of NASA's budget constraints and priorities, it is unclear whether funds will be available to develop and launch JDEM until after Euclid is launched. NASA may decide that it does not make sense to duplicate missions. There are pros and cons regarding each experiment or set of experiments reflecting various costs, levels of participation, amounts of participation in the design and development, methods, and instrumental precision.

The Astro2010 recommendations are being awaited. They will likely recommend a coordinated ground and space program to study dark energy. The agencies will then need to decide how to optimize their funding and participation in projects to best impact the study of dark energy. DOE may consider participation in experiments in which the most scientific opportunities are provided, particle physics participation is necessary, and it can play leadership and/or enabling roles.

Helen Quinn was asked to report on the HEP Demographics Subcommittee's activities. The group has been working since about 1999 to understand the flow of young people into and out of the field of high energy physics and where they go. The challenges are to access and analyze data from the LBNL database and to collect relevant data. Data cleaning by the Iowa group led to improvements to the system to reduce errors over the past 5+ years. The 3-year average smoothes the year-to-year fluctuations, and one can be pretty confident in those numbers. But it is more difficult to get good information out of the transitional data. Interchanges with foreign institutions were not of interest to the group. Instead, it was interested in where people go from the tracked institutions. About 80 to 90% who enter the high-energy-physics field leave. It gets fuzzy in particle astrophysics. The group wants to track what happens to the people who leave the field. The survey instrument was altered to try to pin that information down.

115 ended up in another HEP institution, 18 went to another physics institution, 9 went to industry, and 26 to teaching, with about 50% for whom it is not known where they went. The question is whether a better job can be done. The cross-checking approach was an improvement but does not give information on the 50% that are lost. The problem is how we go about getting the data: polling one person at each institution. One person does not know about everybody passing through an institution. One could go to the principal investigators (PIs), but that multiplies the amount of polling work each year.

The response rate would likely be better if DOE rather than LBNL did the polling. It is going to cost something to get these data. The Iowa group is not funded and cannot continue operating pro bono.

Scholberg said that the feedback from DOE is that the information is useful and that a proposal for funding would be welcome. Shochet reviewed the situation: what is being proposed is that the letter to each PI would come from the agencies and the information is important and responses would go into the LBNL database, the data elements would be expanded, and LBNL would report back to the agencies, and the agencies would send out any dunning letters. Quinn said, yes, that is correct.

Crawford pointed out that, if one increases the number of contacts, the number of problems will increase, also. This effort was moved to LBNL because DOE does not have the expertise or manpower to do it. The Office could send out the letter under its letterhead and provide LBNL funding for its effort. Quinn noted that the porting to a new computer system has been completed, but programming costs to expand the database records is not currently available. Shochet asked how much of the lack of detail comes from the person at the institution not knowing the information and suggested asking that person to follow up with others in the letter. Quinn replied that the letter last year did just that. Kovar said that the information is valuable. The Office should meet with LBNL and the Subcommittee and work out a way forward. A funding charge should be set up for this effort. Quinn said that the cross-checking of data is time consuming and is done partly by the LBNL group. It should be done thoroughly. The Subcommittee would recommend the multiple-PI approach, but LBNL will push back because of time and costs. Scholberg said that, if the proposal were made, it would probably include funding the extra effort.

White asked whether these data will be available outside the Panel. Quinn replied that the summary data are available on the LBNL website (lbl.hepfolks.org) now. The full data would be made available.

Teplitz asked if gender and ethnic data could be included. Quinn replied that there are guesses at gender, and that information will be collected going forward.

Trischuk noted that there were a lot of data already. Quinn responded that about half the data were missing, and the data in hand were not very statistically valid. Trischuk asked how added data would be used. Quinn said that the more detailed the data collected were, the lower the response rate would be. Kovar pointed out that the government cannot collect personal information. Quinn added that that is one reason why this work is done at LBNL. Kim suggested getting help from the American Institute of Physics. Quinn said that that was a possibility; people do not feel as much pressure from the Division of Particles and Fields (DPF) as they do from DOE, though.

A break was declared at 3:26 p.m. The meeting was called back into session at 3:47 p.m. **Maury Tigner** was asked to report on the activities of the Linear Collider Steering Group of the Americas (LCSGA).

The important organizations involved in the ILC are the International Committee for Future Accelerators (ICFA) and the Funding Agencies for the Large Collider (FALC); ICFA has a steering committee informed by the regional groups from the Americas, Asia, and Europe. The FALC is informed by its Resource Board. These two guidance groups selected the Global Design Effort (GDE) directorate, headed by Barry Barrish. The FALC appointed CERN as a support group. The GDE directorate was to coordinate international efforts.

The LCSGA is a self- appointed and self-propagating group of Linear Collider supporters. It appointed a Strategy Subcommittee, charged to "Suggest a strategy by which the Americas can best position themselves to participate in a global consortium for constructing, operating and exploiting the ILC. The strategy should include an R&D program now and for the foreseeable future." The Subcommittee report will be delivered to the LCSGA as a whole for debate, revision as needed, and acceptance [done]. The report will then be transmitted to the International Linear Collider Steering Committee (ILCSC) [done]. In addition, it will be conveyed informally to DOE/NSF [done] and formally by this statement to HEPAP.

An R&D program was approved last fall. It calls for supporting the GDE's "ILC Research and Development Plan for the Technical Design Phase"; supporting the ILC Research Director's plan to prepare baseline detector designs; advocating for significant participation in the critical physics and technologies involved, thus paving the way for significant involvement in the ILC; supporting the GDE efforts to collaborate with CLIC [CERN linear collider]; being proactive in supporting and participating in generic accelerator and detector R&D in the Americas as a foundation for current and future accelerator based particle science; and being proactive in devising a strategy for the decision on ILC construction, informed by LHC data.

Joint GDE-CLIC Committees have been formed to consider areas of common interest: physics and detectors, positron generation, damping rings, beam dynamics, beam delivery system and machine detector interface, civil engineering and conventional facilities, and costs and schedules.

Furthermore, the ILCSC and CLIC Steering Committee (CSC) have approved the formation of a CLIC/ILC General Issues Working Group by the two parties with the following mandate: promote a linear collider; identify synergies to enable the design concepts of the ILC and CLIC to be prepared efficiently; discuss detailed plans for the ILC and CLIC efforts to identify common issues regarding siting, technical issues, and project planning; discuss issues that will be part of each project's implementation plan; and identify points of comparison between the two approaches. The conclusions of the working group will be reported to the ILCSC and CLIC Collaboration Board with a goal to produce a joint document.

The LCSGA has some suggestions for the ILCSC, divided into the following considerations:

- Legal status of project
- Management structure
- Representation and voting structure in the governing body
- Duration of agreement
- Attribution of in-kind contributions
- Operating costs
- Budgetary control
- Access policy

While not pretending to be expert in these matters, most of the LCSGA members have been involved in large international collaborations with various rules of organization and governance. Further, they have consulted widely with colleagues in astronomy, fusion, and materials science [the Atacama Large Millimeter Array (ALMA), International Thermonuclear Experimental Reactor (ITER), Facility for Antiproton and Ion Research (FAIR), etc.). From those colleagues were learned some of the conditions that foster an efficient and effective process and some that are inimical to such effectiveness.

Four approaches to establishing a legal status for an international collaboration have been used or suggested in the recent past: (1) treaty organization; (2) limited liability corporation; (3) extension of an existing international organization; (4) reliance on the legal standing of an associated organization. Which approach will prove most effective will depend upon conditions not known now, such as the host country and its legal structures and the predilections of the negotiating parties. Most desirable will be an instrument that: (1) maximizes the incentive of the parties to complete the project on an agreed-upon schedule; (2) provides ready access for the international staff, their families, and for the users; and (3) provides tax-free access to equipment and materials needed for construction and operation of the facility.

All project organizations have councils at the top, giving representation to the governments and to the scientific communities of the contributing countries. A project whose primary objectives are scientific is best served by a strong council with a balance of representation from the funding agencies and the scientific community. For efficient conduct of business, it is highly desirable that these representatives should have decision-making authority, both governmental and technical. Ideally, the members of the line organization would be selected primarily for their scientific and technical expertise so that they have the capability and stature to conduct the scientific project effectively.

The project councils are intended to represent the interests of the contributing countries or groups of countries. Some existing councils for large international ventures are not effective at making the needed financial or scientific/technical decisions. This can be because of the large numbers of members and even advisors to the members. The governing council will need to meet often enough to keep pace with project-related events. For efficiency, the council should be kept as small as possible consistent with its mission. The LCSGA considers it desirable that one member of each delegation be a particle physicist, that the number of advisors be kept small, and that ministerial-level delegates participate periodically.

Each of the current, large international projects (not something that will go on forever) has a definite duration and each has a provision for extension. Provisions for withdrawal are universally included. It seems reasonable that the founding agreement be for a fixed term based on the anticipated length of the construction and a period of operation long enough for a thorough assessment of the scientific capability of the facility. It also seems important to provide for potential extension of the agreement in increments of some years and for penalties to withdrawal before completion of the facility.

All of the projects assume a large basis of in-kind contributions, and thus there needs to be a framework to evaluate each country's contribution. A typical practice is to establish value in some arbitrary unit, pegged to a certain year. Practical implementation includes arrangements for a common fund and for contingency management. The details of this all important feature of any agreement will be particular to the project. Experience shows the importance of establishing, from the very beginning, procedures for dealing with the many different circumstances that can arise during implementation of a complex, expensive, and lengthy international project (e.g., design changes, uneven inflation for some in-kind contribution elements, contingency caps in some countries and not others, nonperformance of contractors, and so forth).

This is new territory for elementary particle physics; previously, the operating expense has largely been borne by the host. A new paradigm may be needed. The model where the host contributes the operating cost has served well up to the present and may in the future. However, the definition of "host" for a truly international project will depend on the prevailing circumstances at the time. If the host is not simply one country or one region, there will need to be a formula for cost-sharing based upon the various types of benefits that the participating countries or country groups may reap through their participation.

Such a formula might also consider the scientific needs of the enterprise as a whole and would best be established as an ab initio agreement.

In most of the projects, a budget cap is part of the overarching agreement. Cost growth experienced by the individual contributors has to be borne by them up to their own contingency limit. After that, some authority must decide whether or not to use project common funds or contingency to grant relief. As these funds near exhaustion, descoping is usually required by the original agreement. Some current large international scientific projects are under stress because of inadequate common funds or contingency. It is important that the initial agreement provide both a significant common fund to provide for items not obtained by in-kind contributions and an overall contingency fund.

The high energy physics culture has historically strongly supported open access to facilities based only on merit-based peer review of proposals. This may change with the new circumstances, where energy frontier accelerators may no longer be available in all three regions. The current principle appears in an ICFA statement. The LCSGA awaits the ICFA discussion and resolution of this matter.

The next steps to be taken are a presentation to FALC by the ILCSC, a study of how best to carry out the LCSGA's recommendations regarding the R&D plan (cost structure and new technologies) with the follow-up actions, and added attention to the LHC progress and results.

Kovar asked if ICFA were reconsidering its access policy. Tigner replied that ICFA has said that it will rethink its access policy. Trischuk added that there was a cursory discussion of this topic at the February meeting expressing reticence, especially from the Japanese.

Diebold asked how these recommendations compare with those from other groups. Tigner replied that they are very similar.

Glen Crawford was asked to present Howard Nicholson's report on the detector R&D program. The organization is now program-based to support generic sensors, detector systems, and data-acquisition systems important to HEP. It also supports test beams and core funding for a few *key* technical people.

"Generic" is defined as (1) fundamental R&D on properties of particle detectors; (2) detector R&D that may be motivated by a specific experiment but that is likely to be of general use to other existing or future HEP experiments; or (3) upgrades to existing detectors that are far enough in the future so that there is no consensus on a single, well-defined, technological upgrade path (e.g., LHC detector upgrades). Future research will need development of novel detector technologies, improve the characteristics of existing detectors commonly used in HEP and develop less-expensive technologies for large detector systems.

Funding in FY09 through FY11 includes a $25 million program split between universities ($3.5 million) and national laboratories ($20 million). Total funding in FY09 was pumped up to $30.6 million by the ARRA. About 70% of detector R&D funding goes to the national laboratories; there is no core funding currently. Most of the rest of the funding goes to universities.

Current detector R&D focuses on such topics as ASIC [application-specific integrated circuit] development, CCD development, and liquid argon detectors and includes crystal compensated calorimetry, high-pressure xenon time projection chamber (TPC) development, high-rate data acquisition and trigger development, and DC to DC converters.

The advanced detector R&D program is designed to give university researchers relatively short-term detector-development funding. It requires peer-reviewed proposals targeted at fundamental R&D by universities for a short-term program. Currently, $750,000 in new funding for this program is set aside each year. Typically, $500,000 to $600,000 is available to fund new proposals. Some examples are 0.2 5-mm silicon-on-sapphire technology for ASICs, advanced fiber-optic systems, single-crystal chemical vapor deposition diamonds, and large cryogenic germanium detectors. For FY10, 28 proposals were received, of which 27 were considered generic. Each was reviewed by four reviewers. Of these, there were two collaborative proposals. The plan is to fund about five of the highest-ranked proposals. The proposals requested $28.5 million; $6 million is available. Many of the proposal-funding profiles were not well matched to the funding constraints of the program.

In addition to the core and the advanced detector R&D funding, it is desirable to have detector R&D funds set aside for larger initiatives, which can address broad programmatic priorities. These initiatives should have clear timelines and deliverables but are generally understood to be both high-risk and high-payoff. The result may well be that there are technical showstoppers; but if it works, it can be paradigm changing. Community workshops are planned to identify other compelling new opportunities. One example is making large-area photodetectors with atomic-layer deposition, which would be simple and inexpensive, having very good timing resolution, good spatial resolution, high gain, lower costs than conventional photomultipliers, and a thin but mechanically robust construction with relatively few electrical connections. The market for such a device is potentially large, including the water Cerenkov LBNE detector, large-area medical scanners, and national-security applications. Another topic is a water-based liquid scintillator that is currently under development at BNL to produce a liquid scintillator that is intrinsically cheaper than a pseudocumene-based scintillator. A very promising candidate for water-based scintillator is linear alkyl benzene sulfonate, a chemical manufactured in large quantities for biodegradable detergents. The material is inexpensive and relatively environmentally benign. A 10% mixture of this chemical and water is comparable in scintillation yield to a typical oil-based liquid scintillator and appears to be stable with time.

In the past, it has been useful to have directed R&D funds set aside for the development of specific detector concepts. This model worked well enough in the old HEP management model, where one could think of these as virtual facilities. However, this R&D structure does not fit well with current DOE management concepts. Although they are pre-CD-0, they are driven by specific detector concepts and not tied to an existing U.S. accelerator facility. For these reasons, these directed R&D activities are in transition.

There is dedicated DOE funding for ILC detector R&D. It has been largely driven by development of specific detector concepts in parallel with the development of the ILC reference and technical designs. It has been funded under different mechanisms by both DOE and NSF. The Office is committed to completing the current R&D as planned through FY11 to inform the ILC technical design phase process. However, this effort will be transitioned to a generic collider detector R&D program.

Because of the anticipated slow luminosity ramp-up of the LHC, the Office plans to transition some of the directed LHC detector upgrade R&D funding into the generic detector R&D budget starting in FY11. Details of how this transition will take place are still being developed. Beginning in FY12, it is anticipated that peer-reviewed proposals will be solicited for generic detector R&D for CMS [the Compact Muon Spectrometer], ATLAS [A Toroidal LHC ApparatuS], ILC, and possibly muon collider detectors. The exact scope and timing of eventual LHC detector upgrades are still to be determined through international discussions.

HEP has asked Fermilab to coordinate a national proposal for muon-based accelerator R&D. It is anticipated that this R&D will eventually compete for generic detector R&D funding with other collider detector R&D. Once reasonable muon-accelerator beam parameters can be determined, simulations using some of the tools developed for the ILC detector studies would be appropriate.

In summary, the detector R&D program has been recently established at DOE to establish a structure for detector R&D at the universities and national laboratories and to oversee the use of funding to prioritize the use of limited resources to optimize their impact on the HEP program, to reduce duplication of funding in detector R&D, and to identify new areas in which detector R&D funding can affect the HEP program. R&D directed at specific future detector concepts, which was previously supported with dedicated funding, will be largely transitioned to generic detector R&D support. The detector R&D community needs to find mechanisms for identifying new opportunities for detector R&D initiatives and for communicating current work throughout the university and national-laboratory communities. The DOE detector R&D program needs a new program manager because Nicholson’s term will be over on July 31, 2010.

Shochet asked what might constitute the possible LHC upgrades’ generic R&D. Crawford replied that the support structure for the silicon upgrade for LHC would not be generic. Lighter and stronger materials might be. Goldberg pointed out that an ILC detector might have generic components. Crawford responded that that is harder. There are funds for, say, Fermilab; but the ILC does not yet exist. He noted that the core program is being established in the FY11 budget. R&D can be supported through the core program. If one were to have a project in mind but it is pre-CD-0, the Office has not worked through how to fund coordinated R&D for such a case.

Fleming asked how management coordination for LHC upgrades was folded into the review process. Crawford said that the Office was trying to separate them as much as possible, hoping that management aspects were not important. Once the effort got to CD-0, it would fit into a management structure.

Shochet asked whether sufficient LHC upgrade R&D funding will remain for the non-generic work that must be done. Crawford replied that a rough estimate was made based on the recent LHC review; it will probably be revised as the work goes forward. Kovar added that this will work out better as one sees how it is laid out. There will be enough funding available.

Shipsey asked how it was determined how much money is to be moved from one program to another. Crawford replied that this is done on a case-by-case basis. One can discuss the issue with one's grant monitor.

Glen Crawford was asked to report on the delays in getting approved DOE funds to PIs. Some recent developments include that DOE grantees can now travel on non-U.S.-flag carriers for research-related travel to the European Union and Switzerland when there is not a US carrier flying between the pair of cities. DOE is working on a similar ruling for national-laboratory employees. Research highlights have been requested from PIs. Early Career 2010 will be announced this summer. Roughly the same criteria, size, and number of pre-applications as last year are expected.

Not a day goes by that the Office does not get asked where grant funds are. Most grants are several months late. Many universities have been good about "bridging" funds, but not all can manage this. In some cases, this has become an urgent problem. The official response is, "The Office of Science has been experiencing delays in processing Fiscal Year 2010 financial assistance funding actions. The delays in the issuance of funding are caused by a number of factors, including the rollout of new DOE software and the priority placed on a series of special initiatives this year. Financial assistance actions are being processed by our Chicago Office contract specialists and contracting officers in order of receipt of the paperwork requesting the funding from the program managers. Please know that we are working diligently to get the funding in the hands of our awardees as quickly as possible. We appreciate your patience as we work through the backlog."

DOE is not fundamentally a grant maker; only about ten percent of its total funding goes to grants as compared to contracts. Its financial infrastructure reflects this fact and is not optimized for grants. However, grants are a large fraction of the total number of actions. Grant awards are a multistep process with multiple people and software products involved. Therefore, considerable lead time is built in for grants review, action, and processing, but it is is barely enough time in a normal year. But FY09 and FY10 were anything but normal, starting with a continuing resolution that introduced budgetary uncertainties. In addition, there were the ARRA funding actions, a new procurement-software rollout, and the loss of key personnel. These have also been the main issues for DOE Chicago procurement.

Additional actions that occurred in FY09-10 included the Early Career program with about 150 applications and 14 awards and infrastructure supplements and incremental funding with about 120 applications and 109 awards. Implementing the supplements has been complex. HEP actions increased from about 335 to about 450 in FY10; Chicago Operations' actions increased from about 4200 to about 4750. Additional ARRA actions plus software rollout issues caused a backlog in the Chicago office beginning late FY09, and the delays propagated into FY10.

SC was required to move to new procurement software (STRIPES, the STRategic Integrated Procurement Enterprise System) for grant actions effective with FY09 actions. That software touches many aspects of the grants process. The FY09 STRIPES rollout froze processing for an extended period. It has not been a great success with many technical issues that are still being worked out. Fundamentally, it is enterprise procurement software that has to be adapted for research grants. Data validation caused a

1-month lockout. The STRIPES problems have the attention of DOE and SC management at the highest levels. Reviews were held at Germantown and Chicago in April to identify and prioritize issues and suggest improvements. Changes, though, will take time. There will be a detailed report on progress at the next HEPAP meeting.

In addition, HEP lost its key grant procurement manager in 2009, and HEP internal grant tracking was down for the first half of FY10. Temporary staff was hired to cover the ARRA workload and the additional STRIPES burden. The combination of these issues produced a 69-day delay in HEP actions getting to Chicago. This is not satisfactory. The Office hired an experienced federal employee to fill this position in February 2010. The Office is getting back to "normal" and plans to streamline the internal process once FY10 actions are complete. Chicago has also had issues with workload and personnel turnover, and they have brought on additional staff to deal with the backlog.

The overall status as of the week previous to this meeting is that the average FY10 grant delay is about 70 days and much longer in some cases. Delays have dominantly been due to HEP. For the first quarter of FY10, 90% of the actions have been awarded; for the second quarter, 37% have been awarded. An early July completion is being targeted. The Chicago office is holding teleconferences to report status and coordinate work. University offices can work with Chicago office contract specialists to resolve issues. However, frequently "pinging" HEP or Chicago for status reports is not encouraged. HEP *can* identify and elevate urgent actions.

In summary, grants are late. This is not just an HEP problem; many issues have SC-wide implications. The Office is actively working through the remaining FY10 actions. The Office will meet these deadlines. It is working to address the root causes. ARRA actions are complete. DOE, SC, and Chicago are working to improve STRIPES, but this is probably a long-term issue. The Office has hired key personnel and will reevaluate staffing needs. More IPAs and detailees are needed to help with the workload. DOE will need to look seriously at streamlining the process for FY11 to improve both the operational efficiency and the large number of actions per grant.

Hadley noted that NSF funding came through on time. Of the DOE grants, only one-third got funded; two-thirds got their funding 2 weeks ago, a 5- to 6-month delay. Crawford replied that that is what has been awarded. Many more have not been awarded yet. The groups that got ARRA funding have not received a dime yet.

Goshaw said that this discussion has been very helpful. He asked what the requirements will be for spending them when ARRA funds arrive. Crawford replied that there will be a start date and an end date of the base grant. There will also be a 90-day pre-spend allowance.

Marlow asked if one could buy something and switch the charge over to ARRA later. Crawford replied, no. Marlow asked how many grants were left. Crawford answered that, of the 97, all but 10 are in Chicago. Marlow asked if moving a supplement into the next year would work. Kovar replied, no; the Office is not going to live on a credit card again. The money needs to be granted once a year, and everyone has to live with that. The continuing resolution wreaked havoc on the system. That is not the way to run the system. Marlow observed that, in the end, it is the amount of money that one can count on. Crawford noted that the overall budget for the programs is unchanged. Kovar noted that changes have to come out of reserves, so program managers will know how much money they have. The expectation that a slug of money will be added later has to be ended.

Burchat asked what the deadline will be for the Early Career awards. Crawford replied that it will be about the same as it was this year.

The meeting was adjourned for the day at 5:40 p.m.

Friday, June 4, 2010
Morning Session

The meeting was called to order at 8:58 a.m. **Paul De Luca** was asked to review developments in the use of high-energy physics in medicine during the past 20 years and what is expected in the future.

There have been many innovations. Digital subtraction angiography allows the doctor to see blood flow in the heart in near-real time. The study of osteoporosis and bone-mineral densitometry has developed so these machines are routinely available. With magnetic-resonance-imaging (MRI) flow-contrast angiography, one can measure blood-flow volume through a vein.

In oncology, the subtle differences between normal and abnormal cell growth are being learned, and the medical community is approaching being able to develop drug therapies to target specific types of cell growths.

In acute myeloid leukemia, a standard treatment is induction chemotherapy for 7 days, bone marrow aspiration and biopsy at two weeks, and repeat chemotherapy, if needed. The results of the bone marrow biopsy are often difficult to interpret, and the predictive power is poor. Imaging can be used as a predictive biomarker to segregate patients into high- and low-risk groups. 3'-deoxy-3'-fluorothymidine positron emission tomography (FLT PET) can be used to sort people into those who will respond to a therapy and those who will not respond (for genetic-make up reasons), leading to the personalization of therapy. Different patients will respond to “dyes” {e.g., fluoro-2-deoxyglucose (FDG), FLT, and copper diacetyl-bis(A/4-methylthiosemicarbazone) [Cu(II)-ATSM)]} differently.

Multiple bremsstrahlung beams articulated into finger lengths are used to scan around the patient in a spiral. Computed tomography then determines the 3-D structural image.

The physical-dose distribution and the biological impact of the radiation are important. Bremsstrahlung beams produce ions, but they are dispersed. High-linear-energy-transfer (LET) rays leave tracks of ions along their paths. This is been known since 1946. The physical-dose distribution is important in depth-dose distribution, with different energy photons having different penetration depths in water. As a result, one can combine beams of different energies to produce spread-out Bragg peaks.

The choice of particle mass is important in how the beam is scattered by water; the heavier ions are scattered less. This scattering affects the dose distribution at the micrometer scale producing effects on the therapeutic effectiveness.

The Loma Linda University Medical Center Proton Treatment Center is huge and must be located in a location that is remote from the downtown diagnostic center. Carbon-ion-beam facilities are also huge and expensive.

All parts of a cancer have to be treated (by multiple techniques, for some cases) or the cancer will come back. But one does not want to irradiate any other part of the body. Substituting protons for photons gives better therapy because one gets greater localization of the dose and one can therefore go to higher doses. One such application is relapsing pituitary adenoma, which can be treated better with protons than with photons, specifically because of the dose that can be delivered. (There is no biological-effect difference between photons and protons.)

Molybdenum-99 is used for diagnostic procedures. It has to be produced in a reactor. The Canadians failed in two attempts to build a suitable reactor. DOE is using the High-Flux Isotope Reactor at Oak Ridge National Laboratory to produce it. An accelerator is being developed to produce molybdenum-99 by accelerating deuterium ions into a gas or solid beryllium target. It requires a great amount of shielding. It consists of two ion-injector–accelerator pairs discharging into a common target chamber whose integrated beryllium multiplier weighs about 1000 lbs. The ion source, pumping power supplies, and cooling systems are fully integrated; high voltage is delivered externally

Henderson asked what De Luca’s perspective on heavy-ion accelerators was. De Luca replied that it requires a culture change in the U.S. regulatory program. In Japan, they have several carbon-ion sources, all of which are at research facilities, not commercial facilities. It is not known whether they will be better therapeutically. Every time the dose has been increased, there have been therapeutic improvements, though.

White asked about the standardization of proton-therapy facilities. De Luca responded that the biophysical effects of protons are known, so clinical studies do not have to be done; it is also known that they do a better job. But the facilities are much more expensive by a factor of 2 or 3. That cost is coming down. Not all tumors benefit from an improved dose distribution. Some tumors have tendrils that can be killed off with a more diffuse beam. One does not need to replace every photon machine with a proton machine.

Gelmini noted that, in Europe, research facilities develop treatment facilities but they do not in the United States. De Luca said that commercial companies have to avoid economic losses; $100 million for a facility cannot be written off. That is not done on a national scale in the United States; in Europe and Asia, those costs are socialized. The National Institutes of Health (NIH) has to move to translational research from hypothesis-driven research.

Pripstein stated that imaging research proposals are routinely rejected by the NIH. De Luca said that this is the same question. Imaging is seen as not hypothesis-driven research. Most detector systems and imaging systems come from the high-energy-physics community.

Samuel Ting was asked to present an update on the Alpha Magnetic Spectrometer (AMS) on the International Space Station (ISS). A large-acceptance, multipurpose, magnetic spectrometer on the ISS is the only way to measure precisely high-energy charged cosmic rays. It is an international collaboration of 16 countries, 60 institutions, and 600 physicists. It is a $2.0 billion project. It has been reviewed extensively; these reviews have been of high quality, producing a TeV, precision, multipurpose spectrometer with a transition radiation detector (TRD), silicon tracker, electromagnetic calorimeter (ECAL), time-of-flight spectroscope, magnet, and Ring Imaging Cherenkov (RICH). 5248 photo tubes were selected from 9000 produced. Their 2-m lengths are centered to 100 μm with a CO_2 leak rate of 6 μg/s, a storage of 5 kg, and a 24-year lifetime. RICH has 11,000 fiber sensors. The calorimeter is a precision, 17 X_0, 3-D measurement of the directions and energies of light rays and electrons. The subsystem was tested in 9000 hours of thermal vacuum tests. Tests were performed with the superconducting magnet charged to its design current of 400 A and to 80 A, corresponding to the field of the AMS-01 permanent magnet. The integrated detector was tested with beams; it measured velocity to an accuracy of 1/1000 for 400-GeV protons.

The stabilization of the helium vessel was tested. It has an expected lifetime of the AMS cryostat on the International Space Station (ISS): 20 ± 4 months with M87 cryocoolers and 28 ± 6 months with GT cryocoolers. Tracker performance was tested at –90 ^{o}C and 10^{-7} mbar, a cold muon track and minimum ionizing particle (mip) signal in silicon. All detectors performed nominally in the thermal vacuum test. Each detector was tested in specially built space-simulation facilities in Italy, Germany, Spain, and Taiwan. The entire AMS detector was then tested at ESA's European Space Research and Technology Centre (ESTEC) in Holland. The AMS-01 detectors have been operating for more than 10 years to study cosmic rays at Southeast University in China. TRD consumables will last more than 20 years. The AMS was designed to be readily assembled and disassembled for modification before liftoff.

The AMS was to be operated as an externally attached payload on the ISS for a nominal 3-year period, after which NASA was to detach the AMS from the ISS, transfer it to a Space Shuttle, and return it to Earth.

In March 2010, NASA announced the continuation of the ISS operations beyond the current planning horizon of 2015 to at least 2020 and that the partnership is currently working to certify on-orbit elements through 2028. A superconducting magnet was ideal for a 3-year stay on the ISS as originally planned for AMS. However, the ISS lifetime has been extended to 2020 (2028), which is after the Shuttle program will be terminated, thus eliminating any possibility of returning and refilling AMS. A superconducting magnet, therefore, is no longer the ideal choice. The upgrade of AMS-02 with the permanent magnet would fully utilize the extended lifetime of the ISS (to 2028). This upgrade has been supported by agencies from Italy, Germany, Switzerland, Spain, the Netherlands, and the United States. The European science community realizes the importance of full exploitation of the potential of ISS, to which they have contributed greatly. To support AMS on the ISS for 10 to 18 years, a new control center is being built by CERN; it will be ready Nov. 15, 2010.

The AMS took its first (10-day) flight in June 1998. It showed there are many more positrons than electrons and there is helium in near-Earth orbit.

Two magnet options have been maintained: the original AMS-01 permanent magnet and a superconducting magnet. During the past 10 years, the AMS-01 permanent magnet has been kept as an alternative for AMS-02 and has been reviewed regularly by the collaboration. The detectors are compatible with both options. The two options have comparable momentum resolutions and ranges. Most importantly, the permanent magnet option will have 10 to 18 years to collect data, providing much more sensitivity to search for new phenomena. In 12 years, the field has remained the same to less than 1%. The detailed 3-D field of the magnet was measured at CERN in May 2010. The momentum resolution ($\Delta p/p$) is the sum of two contributions: A measurement inside the magnet with an effective length $L(Z/p) \cdot (\Delta p/p)$, which is proportional to $1/BL^2$, and a measurement of the incident (θ_1) and exit (θ_2) angles that depend on the length $L_1(Z/p) \cdot (\Delta p/p)$, which is proportional to$1/BLL_1$. For both magnets, L is about 80 cm; but in the permanent magnet, B is 5 times smaller. To maintain the same $\Delta p/p$, L_1 is increased from about 15 cm (for the superconducting magnet) to about 125 cm (for the permanent magnet). In the silicon tracker, Layer 9 comes from moving the ladders at the edge of the acceptance from Layer 1. Layer 8 is moved on top of the TRD to become a new Layer 1N. No new silicon and no new electronics are required. Layers 1 and 9 are far away from the magnet. The seven tracker layers will track 10,000 cosmic rays every minute of every orbit, allowing the tracing of the origin of cosmic rays. With nine tracker planes, the resolution of AMS with the permanent magnet is equal (within 10%) to that of the superconducting magnet. For helium, the maximum detectable rigidity (MDR) for the permanent magnet is 3.75 TeV. With the permanent magnet, the properties of the detectors remain the same as with the superconducting magnet. The magnetic field is used to determine the momentum and the sign of the charge.

The second integration started in 2009. The permanent magnet version of AMS is ready for reintegration two days ahead of schedule. Completion will be on August 7, beam tests will be held August 7–14, and launch will be in November 2010. AMS will measure cosmic ray spectra for nuclei, for energies from 100 MeV to 2 TeV with 1% accuracy over the 11-year solar cycle. These spectra will provide experimental measurements of the assumptions that go into calculating the background in searching for dark matter.

Large acceptance and long duration means less error in finer detail in critical energy regions.

The AMS goals have been (1) to minimize the material in the tracker so it does not become a source of background or of large-angle scattering, (2) to conduct repetitive measurements of momentum to ensure that particles that had large-angle scattering are not confused with the signal, and (3) to separate electrons and positrons with a magnetic field so that particles from the TRD do not enter the ECAL.

AMS has good sensitivity to dark matter. The permanent-magnet upgrade of AMS produces a 600 to 200% improvement in sensitivity in the search for dark matter. AMS is sensitive to supersymmetry (SUSY) parameter space that is difficult to study at the LHC. AMS will allow a direct search for anti-matter in the universe. All of the known material on Earth is made out of u and d quarks. One question is whether there is matter in the universe that is made up of u, d, *and* s quarks. This question can be answered definitively by AMS. The history of high-energy physics has shown that discoveries that have come from new precision instruments were not among the original purposes of and the expert opinions about those instruments. The AMS is expected to probe dark matter and antimatter strangelets, but who knows what will come of it.

Shochet asked if there were any effect on the momentum resolution because of the multiscattering in the TRD. Ting replied, no.

Gelmini asked what the change in acceptance was from the comparison of results with and without superconducting magnets. Ting replied there is no change below 500 GeV. Gelmini asked what the effect of 10 years of data gathering was versus 3 years. Ting answered, it may go to 20 years. Battiston added that the results have been published from the Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics (PAMELA) project. The spectrometer can have an error up to 25.3%. The state will improve slightly in the next few years. It will operate 5 years with data up to about 100 GeV. The AMS-02 will have exposure to 18 years with a positron energy greater than 1 TeV. For 1 GeV, one will need 1 year of data; for 1 TeV, one will need 10 years. Ting noted that it also depends on how one does the experiment. Efficiency goes up with redundancy.

O'Fallon asked whether the primary reason the permanent magnet is replacing the superconducting magnet is the termination of the Space Shuttle program. Ting replied affirmatively. The superconducting magnet would need to be returned to Earth after 3 years for reloading the coolant.

Dixon noted that there are also high statistics from the Fermi satellite and asked if the expectations for AMS were consistent with these data. Ting said that he had not studied that question. Everyone is responsible for his or her own experiment.

A break was declared at 10:37 a.m. The meeting was called back into session at 10:58 a.m. **Michael Procario** was asked for an update on the HEP LHC program and operations.

The LHC Detector Operations Program is a joint effort of DOE and NSF to manage the common fund contributions for U.S. physicists working on CMS and ATLAS; maintain detector systems and subsystems that are U.S. responsibilities; carry out directed R&D needed to maintain and eventually upgrade the detectors; and provide computing and data storage needed for physics analysis. Its goal is to enable U.S. physicists to fully and successfully participate in LHC physics. The program is overseen by the LHC JOG. The operations program does not support physics research. Research is supported through peer-reviewed funding. The United States contributed to the construction of ATLAS and CMS over a 15-year period. The U.S. ATLAS and U.S. CMS construction projects were formally closed out in June 2008, with a total of $331 million spent. ATLAS is a large group (2700); CMS is a smaller group (1940). ATLAS has 40% long-term residents at CERN; CMS has 33%.

The U.S. LHC construction projects built detector subsystems or subsystem components that have been installed and commissioned in the respective detectors. The United States has major responsibilities and computing activities. Category-A funds are used to cover the general operating costs of the experiments. CERN runs a scrutiny group to scrub the costs. Cash payments in Swiss francs are made yearly, based on the number of PhD authors. Category-B expenditures consist of costs borne to maintain specific detectors and worldwide LHC computing grid pledges for computing. Agencies discuss and agree to these contributions at the Resource Review Board (twice a year).

The common cost shares are calculated each October 1, and payments are completed before the October Resource Review Board meeting. The total obligation in the out years is about $5.5 million per year or about $15,000 per PhD. The computing pledges in 2010 are new T1/T2 CPU, disk, and tape. The cost per PhD author to make the computing pledges is about $30,000 for ATLAS. The contributions are in-kind.

The U.S. LHC software services have included subsystem reconstruction, core software, services, general reconstruction and analysis algorithms, and interfaces to grid-enabling software. The NSF Data-Intensive Science University Network (DISUN) initiative brought additional T2 computing to CMS.

The United States is the big user of computing services. The total number of jobs processed has exceeded the goals set for capabilities scaling tests.

Physics analysis is enabled for U.S. physicists on ATLAS and CMS. Effectiveness is tracked by metrics. The LHC Physics Center at Fermilab and the ATLAS analysis support centers are primarily research-program activities staffed by physicists for physicists. ATLAS support currently has three components: analysis support centers, analysis support groups, and analysis forums. The U.S. physicists are getting the support they need to participate well.

Many U.S. universities have received funding for Tier-3 centers; software and computing activities provide Tier-3 support through Nebraska and Colorado with help from Fermilab; currently, CMS has 45 Tier-3 centers registered in PhEDEx [Physics Experiment Data Export]. 15 U.S. Tier-3 centers have successfully received data during the past quarter from all Tier-1 sites around the world. Each experiment has a host laboratory that is responsible for managing the program (BNL for ATLAS and Fermilab for CMS). The Tier-1 centers are at the host laboratories; the Tier-2 centers are at universities or SLAC. Computing/analysis funding splits in FY10 after common costs are expended with $11 million going to ATLAS and $17 million to CMS. The 2010 planned CMS/ATLAS spending profile is $4 million/$6 million for category A, \$11 million/\$12 million for management and operations (M&O), \$13 million/\$15 million for computing facilities, \$4 million/\$5 million for software development, \$0.8 million/\$0.4 million for analysis support, \$4 million/\$4 million for upgrade R&D, \$0.2 million/\$0.05 million for outreach, and \$1 million/\$1 million for program management. In 2010, each program received \$28 million from DOE and \$9 million from NSF plus additional support grants for the open science grid (OSG), DISUN, and USLHCNET. The level of funding for the LHC operations program is likely to be constant. In the out-years, one can assume a 2.5% escalation for the DOE component; NSF Cooperative agreements are up for renewal in 2011. (The guidance is that it will remain at the same level.) NSF support for LHC operations and detector upgrades has ramped up from \$5.0 million in FY03 to \$18.0 million in FY11. Operations support includes Tier-2 computing facilities, major research instrumentation (MRI), partnerships for international research and education, OSG, DISUN, graduate student awards, and education outreach.

The JOG meets at least twice a year. There is a yearly peer review of the operations program charged by the JOG; the most recent one was in May at Argonne. There are biweekly working group phone calls between the agencies and the operations program managers.

A reconsideration of the LHC performance and schedule came out in February 2010. The CERN Council will consider the new plan in June. The 7-TeV LHC runs began in March with a targeted delivery of 1 fb^{-1} by late 2011. A long shutdown in 2012 is required to fix the splices to enable safe operation at design energy. An LHC run in 2013 and 2014 is expected at 13 or 14 TeV with an integrated luminosity between 10 and 20 fb^{-1}. A shutdown around 2015 is needed to add collimators and to tie in the Linac4. The beam operating parameters continue to evolve. The CMS and ATLAS detectors were generally built to handle 300 fb^{-1} and $1–3 \times 10^{34}$ cm^{-2} sec^{-1}.

The accelerated upgrade plan had to be revised. CD-0 was approved for the accelerator project for the upgrade of the LHC in October 2008. APUL [Accelerator Project for the Upgrade of the LHC]] presented a plan to construct new dipoles and cold powering for the upgrade of the ATLAS and CMS interaction-region (IR) magnets. A review for CD-1 was held in January 2010. However, the APUL deliverables do not fit the new (2010) plan. It was decided to put APUL into hibernation while an alternative useful scope could be developed. The FY10 appropriation saw one cut from the request (\$7 million less for LHC). The APUL request was up \$6.5 million. The official statement was, “The Committee questions the increased investment in [LHC] support when the timing of the restart of the LHC is in doubt.”

At this time, the United States does not anticipate requesting upgrade funding in FY12. The justifications are not currently compelling in light of the schedule and luminosity profile. Participation in the upgrades will be reevaluated after data are collected and the CERN accelerator schedule is meeting milestones. DOE is planning a redirection of its LHC operations fund, which was previously targeted for long-term Phase-II LHC detector R&D, to a generic detector R&D program. (The R&D funds necessary M&O support will remain in the budget.) This will be a proposal-driven process that will also include the ILC community. Details are being planned to enable an orderly transition.

The NSF upgrade strategy is to keep the R&D funding support in the operations program to stimulate a focused R&D effort by a closer coupling between actual operating experience and perceived upgrade goals. The construction strategy is totally changed because of the change and remaining uncertainty in the LHC run plan and the upgrade schedule. It is now focused only on the upgrades with possible funding support no sooner than FY13.

O’Fallon asked what impact this will have on the collider runs at Fermilab. Procario replied, none.

Shochet said that the draft summary letter will be circulated to Panel members for their input. The floor was opened to public comment. There being none, the meeting was adjourned at 11:45 a.m.

Respectfully submitted,
Frederick M. O’Hara, Jr.
Recording Secretary

June 17, 2010

Corrected by
Melvyn Shochet
HEPAP Chairman
November 5, 2010

The minutes of the High Energy Physics Advisory Panel meeting held at the Palomar Hotel, Washington, D.C., on June 3–4, 2009, are certified to be an accurate representation of what occurred.

Signed by Melvyn Shochet, Chair of the High Energy Physics Advisory Panel on November 5, 2010.

Melvyn J Shochet