Minutes
High Energy Physics Advisory Panel
June 23-24, 2011
Hilton Hotel, Rockville, Md.

HEPAP members present:

Daniel Akerib
Edward Blucher
Andrew Cohen
Peter Fisher
Bonnie Fleming
Graciela Gelmini
Donald Hartill
John Hobbs
Steven Kettell
Klaus Honscheid
Daniel Marlow
Patricia McBride
Lia Meringo
Regina Rameika
Melvyn Shochet, Chair
Hitoshi Yamamoto

HEPAP members absent:

Marina Artuso
Karen Byrum
Lance Dixon
Douglas Glenzinski
Wim Leemans
Ann Nelson
Ian Shipsey
Paris Sphicas

Also participating:

David Boehnlein, Research and Technology Division, Office of High Energy Physics, Office of Science, USDOE
Daniella Bortoletto, Department of Physics, Purdue University
William Brinkman, Director, Office of Science, USDOE
Janet Conrad (via telephone), Department of Physics, Massachusetts Institute of Technology
Glen Crawford, HEPAP Designated Federal Officer, Office of High Energy Physics, Office of Science, USDOE
Joseph Dehmer, Director, Division of Physics, National Science Foundation
Marvin Goldberg, Program Director, Division of Physics, National Science Foundation
John Kogut, HEPAP Executive Secretary and Deputy HEPAP Designated Federal Officer, Office of High Energy Physics, Office of Science, USDOE
Andrew Lankford, Department of Physics and Astronomy, School of Physical Sciences, University of California at Irvine
Lek K. Len, Facilities Division, Office of High Energy Physics, Office of Science, USDOE
Kevin Lesko, Nuclear Science Division, Lawrence Berkeley National Laboratory
Marsha Marsden, Oak Ridge Institute for Science and Education
Jay Marx, Director, LIGO Laboratory, California Institute of Technology
Frederick O'Hara, HEPAP Recording Secretary, Oak Ridge Institute for Science and Education
Michael Procario, Acting Associate Director, Office of High Energy Physics, Office of Science, USDOE

Mark Reichanadter, Deputy Chief Operating Officer and Deputy Associate Laboratory Director for Operations, Stanford Linear Accelerator Center
Kate Scholberg, Physics Department, Duke University
James Strait, Project Manager, Long Baseline Neutrino Experiment, Fermi National Accelerator Laboratory
James Symons, Director, Nuclear Science Division, Lawrence Berkeley National Laboratory
Vigdor Teplitz, Physicist, Goddard Space Flight Center, National Aeronautics and Space Administration
Maury Tigner, Director, Laboratory of Nuclear Studies, Cornell University
Hendrik Weerts, Director, High-Energy Physics Division, Argonne National Laboratory
Andreene Witt, Oak Ridge Institute for Science and Education

About 90 others were in attendance in the course of the two-day meeting.

Thursday, June 23, 2011
Morning Session

Chairman **Melvyn Shochet** called the meeting to order at 10:00 a.m. and announced that the meeting was being recorded and that the Designated Federal Officer for June 23 was Glen Crawford and on June 24 would be John Kogut.

He introduced **Michael Procario** to update the Panel on the activities of DOE's Office of High Energy Physics (HEP).

The Tevatron had set a new luminosity record the previous week. The Collider Detector at Fermilab (CDF) and the Collider Detector at D0 Interaction Region (D0) disagree on the W plus two jets signal; it is not known why. The Large Hadron Collider (LHC) has exceeded 1 fb^{-1} of integrated luminosity.

Daya Bay has filled its first detectors and is on schedule. A prototype has started operation. MicroBooNE [Booster Neutrino Experiment] will have a critical-decision (CD-2) review this summer. Tokai-to-Kamioka (T2K) has reported the observation of electron neutrino appearance with a confidence level greater than 99%. This has potentially positive implications on the future program of NOvA [the NuMI Off-Axis ν_e Appearance Experiment] and the Large Baseline Neutrino Experiment (LBNE). A confirmation of the value is hoped for soon. A report will be made later in the meeting on underground science, and decisions on the Homestake Mine are being awaited.

The LBNE is the flagship initiative, and many people within and outside the field think it is the entire Intensity Frontier program. Last year, three intensity-frontier proposals were reviewed, and the Office is now seeking to fund two of them: Belle-II and Muon (g-2). A variety of experiments is needed to cover the broad intensity frontier. The plan is to have a workshop to discuss what is needed for a leadership program on the intensity frontier by identifying the physics topics that are ripe for attack; engaging physicists working on the other two frontiers for their ideas, evaluations, and critiques; and identifying the facilities and technology development needed. Harry Weerts of Argonne National Laboratory (ANL) and Joanne Hewett of the Stanford Linear Accelerator Center (SLAC) will chair the workshop in late fall.

The Alpha Magnetic Spectrometer (AMS) was launched on the space shuttle on May 16, 2011, and is working well. The National Optical Astronomy Observatory (NOAO) has scheduled a November shutdown of the Cerro Tololo Inter-American Observatory's (CTIO's) Blanco telescope to install the Dark Energy Camera (DECam). Xenon 100 has reported a new limit on weakly interacting massive particle (WIMP) cross-sections that is better than that of CDMS. Coherent Germanium Neutrino Technology (CoGENT) has reported a dark-matter signal consistent with the Dark Matter Project (DAMA); a next-generation experiment(s) to search for dark matter is being planned. There is a lot of creativity in the area of dark matter. The hope is to brief HEPAP on the process at the next meeting.

A mission-need statement for a new ground-based dark-energy experiment has been completed. William Brinkman approved Critical Decision 0 (CD-0, Mission Need) for a new, next-generation, state-of-the-art Stage IV ground-based dark energy experiment (DE-IV) on June 20, 2011. DOE/HEP will partner with NSF-Astronomy to build a new or enhance an existing ground-based telescope that is well optimized to make stage-IV dark energy measurements. There are four options:

1. Develop the first Astronomy and Astrophysics Decadal Survey (Astro2010) priority, the LSST, which would include building a new telescope facility and associated instrumentation with the support of NSF.
2. Bring new instrumentation and expanded capabilities to an existing ground-based telescope for studying dark energy as part of the second Astro2010 priority.
3. Participate in both options.
4. Do nothing.

Astro2010's first priority is the ground-based Large Synoptic Survey Telescope (LSST) to look for dark energy, dark matter, near-earth and Kuiper-belt objects, and transient phenomena. It would be an NSF mid-scale innovation, competed program [between Major Research Instrumentation (MRI) and Major Research Equipment and Facilities Construction (MREFC)]. Large space-based projects include the Wide-Field Infrared Survey Telescope (WFIRST) to conduct dark-energy research, exo-planet searches, and galaxy studies. Astro2010 recommended that DOE participate in ground-based dark energy as a priority over space-based because its role was seen as critical to the former.

Planning is now being conducted on the LSST. The DOE role would be to build the camera subsystem and associated instrumentation. SLAC hosts the camera Project Office. NSF will lead the overall project and build the telescope/infrastructure and data-management subsystems. A DOE-NSF Joint Oversight Group (JOG) has been formed, and biweekly meetings are being held. Schedules and funding are being lined up. The CD-0 was approved June 20, 2011. SLAC held a Director's review of the camera on June 8-10, 2011, in preparation for CD-1 approval and is addressing the recommendations. NSF's Astronomical Sciences is holding a preliminary design review of the entire project the week of August 29. A Lehman review of the project, required for CD-1 approval, is being scheduled for the fall.

The FY11 budget was passed on Apr. 15, 2011. The funding was specified at the level of the Office of Science (SC). The division between programs was determined by DOE with approval of the Office of Management and Budget (OMB). HEP ended up $4 million lower than in the continuing resolution (CR). Also, there will be no new starts for

LBNE, Muons to Electrons (Mu2e), and MicroBooNE. Small amounts of funding were supplied for progress towards CD-1 for LBNE and Mu2e and CD-2/3 for MicroBooNE.

As of now, 95% of HEP's funds are available to be distributed in June.
All funds needed for grants are now available to be distributed. There is little time to complete all of the actions. To make up the $4 million shortfall in funding, the awards for the Collider Detector R&D solicitation will be postponed to FY12; the proposals are out for review now. The largest reductions were in construction and in advanced technical R&D.

There are 243 grants to process this year [compared to 443 last year with the American Recovery and Reinvestment Act (ARRA)]. The long CR has throttled the Office's ability to process grants, and it is limiting supplements to grants to get all regular grants out on time. So far, 195 grant actions have been processed, and all are expected to be completed by the deadline.

The FY12 budget request is the same as was presented at the previous HEPAP meeting. Congress is working on this budget. The House Energy and Water Development (EWD) Committee recommends that HEP receive the President's request of $797.5 million. This was a timely report. All SC construction projects have been reduced 7%. The Committee recommended that SC receive $4.8 billion, which is down $43 million from FY11 and down $616 million from the request. But there is no word from the Senate yet. The full House has not passed the EWD appropriation yet. On the Deep Underground Science and Engineering Laboratory (DUSEL), the Committee supports the funding to dewater Homestake while decisions are made. It cautions against taking over construction and long-term management of the site. It requests a report on an assessment of the alternatives to DUSEL and the Department's recommendations on how to move forward.

DOE/HEP is undertaking a round of comparative grant reviews for existing research grants that are scheduled for renewal in FY12. Existing grants that are not renewing in FY12 ("continuations") will not be affected by this change. Previously, all HEP proposals responding to the general SC call were individually peer reviewed by independent experts. This change in process has been recommended by several DOE advisory committees, most recently the 2010 HEP Committee of Visitors (COV). The goal of this effort is to improve the overall quality and efficacy of the HEP research program by identifying the best proposals.

Conceptually, the review process will be similar to that employed by the NSF, but the implementation is tailored to DOE. The main issue is synchronizing grants to enable comparative review. HEP proposals will continue to be evaluated with the standard SC merit-review criteria. Additional criteria will address the alignment of the proposed research with the strategic directions outlined in recent HEPAP reports [e.g., the Particle Physics Project Prioritization Panel (P5) and Particle Astrophysics Scientific Assessment Group (PASAG)] plus other factors set forth in the funding opportunity announcement (FOA), which will be issued in August.

Principal investigators (PIs) renewing in FY12 should submit the renewal proposal as planned. The proposal will be mail reviewed, and a terminal renewal will be issued that ends in April. There will be no site reviews. A new FOA will be posted in August that will specify how to restructure a proposal into sections for energy frontier, intensity frontier, cosmic frontier, theory, or technology R&D, but it will still be one proposal.

Review panels for each of those areas will evaluate the proposals. After completion of the review, a new grant will be established to provide funding. A new umbrella grant will be established for groups that currently have umbrella grants and review well.

HEP has been doing Comparative Laboratory Reviews (CLRs) for 3 years. An HEP CLR in Theory is planned for late July. This is the second time around for the national laboratory comparative reviews. The CLR in Accelerator Science has not yet been scheduled. Institutional reviews were held at ANL and Fermi National Accelerator Laboratory (FNAL) this year (including facilities, theory, etc.). There is a new HEP Scientific Discovery Through Advanced Computing (SciDAC) solicitation to be announced in August/September. HEP will have a standalone solicitation, but it will be coordinated with other offices.

Laurence Yaffe from the University of Washington has joined the Office as an Intergovernmental Personnel Act (IPA) detailee. A new program manager for accelerator science is being hired. David Mueller will complete his IPA this summer. The Assistant Director announcement closed May 10, 2011, and the interview process is under way.

The completion of the Early Career Awards Completion program was delayed by the late appropriation. There were 14 HEP awards this year out of 69 in SC. Four were in theory, eight in experimental particle physics, and two in accelerator physics. Nine are from universities, and five from national laboratories. The FY12 Early Career FOA will be announced in July, and preapplications will again be required.

Shochet noted that the calls for comparative reviews have also called for comparisons of national laboratories and universities. Procario said that the Office will consider doing that in the future when it has more experience in doing such reviews.

Marlow noted that the number of awards went down. Procario replied that there were about 100 ARRA actions that ended and supplemental actions were not taken because of the late CR. There were about 135 awards, and the success rate was a little less than 10%. Marlow asked about accelerator R&D. Procario responded that that has been delayed and was already in the FY12 budget request.

Joseph Dehmer was asked to report on the activities of the NSF's Division of Physics.

The original figures of the FY12 budget request reflected a doubling of the budget over 10 years. At 6%, the Mathematical and Physical Sciences (MPS) increase is the smallest of the divisions because (inter alia) MPS is not well aligned with the administration's priorities. This will affect the future strength of the nation. The largest increases within MPS (relative to FY10) went to Chemistry, Mathematical Sciences, and Materials Research. The FY12 budget figures have not been acted on by Congress, yet.

On the DUSEL, the NSF is on the sidelines. The activity lies with DOE and the National Academy of Sciences (NAS). There will be a hard-nosed review on July 21. A large panel is working on that review of the preliminary design. The preliminary design report (PDR) is very important. NSF will maintain the infrastructure, with DOE taking it over in FY12. There is no NSF funding for DUSEL except for pursuing physics goals. The money has been kept in the Division and will be used for underground science. The DOE study will be rolled out later at this meeting along with an update on the National Research Council (NRC) DUSEL science report.

In FY11, the Physics Division, along with all other divisions, is down (about $10 million) from FY10; the Physics Division was down the most. Accelerator Physics and

Physics Instrumentation (APPI; midscale instrumentation) has moved to the top priority; it will not be an open competition for a couple of years but will be used to pay for instrumentation in new projects. There will be no more than one Physics Frontier Center. All theory programs are down from FY10. LHC and IceCube remain on their approved funding profiles. The FY11 request announced last year was greater than what the final CR provided.

Shochet noted that the National Science Board (NSB) said that it was all right to support experiments but not facilities and asked if a cavity can be considered part of the experiment. Dehmer replied that it was not for him to decide or even talk about that interpretation. Everyone needs to hear from DOE and NRC leadership. Nothing is impossible. There are two important reports that have to be respected.

Patricia McBride was asked to report on the DOE response to the congressional request on how HEP research results are disseminated.

The America COMPETES Reauthorization Act of 2010 required DOE SC to assess the current policies and practices of its research programs, and it, in turn, charged HEPAP to supply such information about HEP-funded research. A HEPAP subpanel was formed, met a few times, surveyed practices, interviewed some of the stakeholders, and drafted a report. The preliminary report was circulated May 20, and the final report was issued June 8.

The charge asked the subpanel to submit by July 1 a report describing the current policies and practices for disseminating research results in the fields relevant to HEP. “Dissemination” refers to the circulation of research results outside of the originating collaboration. “Research results” refers to written findings and digital data. And “practices” refers to accepted practices within a given discipline. Specifically, the Subpanel was asked to consider

- What are the criteria for dissemination, and who makes this determination?
- How is access provided/controlled?
- Is access limited?
- Does access come with additional functionality?
- What is the official version of record, and who stewards it?
- Is peer review a condition of dissemination?
- What institution or body upholds the current policies?
- In addition to dissemination, is long-term stewardship accounted for by the existing policy or practice?

It was found that the dissemination practices of the experimental and theoretical HEP communities are quite different. They are discussed separately, and, within each community, a standard set of practices are widely employed. Both experimentalists and theorists use the arXiv to disseminate their results. It provides an open-access electronic distribution system of (pre)publication material that is complemented by the additional functionality provided by SPIRES/INSPIRE [Stanford Public Information REtrieval System]. This whole process benefits from the co-operation of Journals (and vice versa). Together, these facilitate and expedite the scientific dialog in HEP.

Both experimentalists and theorists publish in the same journals, all of which require anonymous peer-review by people outside the originating collaboration. All of these journals are subscription based and offer an open-access option for a fee. They also collaborate with arXiv and INSPIRE.

HEP experiments are mostly international collaborations, and their dissemination practices reflect long-standing practices in HEP. Their analysis methodologies and manuscripts are both subject to internal peer review with the details on dissemination dictated by the collaboration's by-laws. Once approved by the collaboration, a manuscript is posted to the arXiv (and, often, to the host institution's pre-print database) and submitted to a peer-reviewed journal. Long-term stewardship is provided by the journal and arXiv; the version of record is provided by the journals and arXiv. Inside HEP, arXiv, INSPIRE, and the journals all provide additional functionality (e.g., literature, author, title or free-text searches; links to references and citations; etc.). Occasionally, the collaborations will provide more detailed information about the data set or result (e.g., tables giving details of events or functional form obtained from a fit to data).

In digital data, the data sets are very large (0.1 to 10 PB) and require significant additional functionality in order to make use of them. Solving the related technical, governance, and support issues for dissemination outside the collaboration requires significant additional personnel and capital resources. Historically, large-scale access to the digital data has not been provided to people outside the originating collaboration. Many collaborations provide open access to a subset of their data for educational or outreach purposes. Limited additional functionality must be provided to visualize these data. Long-term stewardship (more than 5 years after the end of data taking) faces many of the same challenges as dissemination. There is a IUPAP/ICFA [International Union of Pure and Applied Physics/ International Committee for Future Accelerators] study group, Data Preservation and Long Term Analysis in High Energy Physics (DPHEP), that is charged with understanding the challenges and studying proposed solutions. Standardized analysis tools designed to facilitate dissemination are in wide use.

HEP theory papers are typically authored by groups of six or fewer people. The dissemination practices reflect long-standing practices in HEP. The decision to disseminate is made by consensus among the authors with the ultimate responsibility residing with the group leader. Typically, the manuscript is posted to the arXiv and usually to a peer-reviewed journal. The version of record is provided by journals and/or arXiv. Long-term stewardship is provided by the journals and arXiv.

In digital data, some work generates more than papers, such as computer source code for Monte Carlo physics simulations, computer source code for lattice-gauge-theory calculations, computer source code for cross-section calculations, and global fits to a large corpus of data. These are usually disseminated in an open-access manner via the Internet, accompanied by a paper in a peer-reviewed journal describing functionality and/or specific results obtained with the code. Long-term stewardship and the version of record are provided by authors via web pages. HepForge offers a common repository used by many.

The conclusion of the survey is that dissemination practices reflect long-established practices in HEP. The final report was delivered to SC on June 8. The HEP dissemination model seems to be working well, but there are ideas for evolution of tools (such as INSPIRE) to provide links to additional information (plots, tables, or even datasets). Addressing issues associated with dissemination of HEP digital data will require collaboration among the collaborations, the host institutions, and the funding agencies.

Weerts asked if the Particle Data Group (PDG) work was purposely left out. McBride acknowledged that it was left out of the presentation, but not intentionally. It is in the full report. Weerts asked if HEP was supporting arXiv. Crawford answered that HEP does not support it directly and is considering a request for support from arXiv now.

Fisher noted that, if one's institution does not have a subscription to PRL [Physics Review Letters], one has to pay for it. An alternative is that the laboratory where the work was done is a free repository of that information. McBride confirmed that the host laboratories do provide some sort of service. Shochet added that this is a complex issue because there are not always host laboratories. CERN would like to see universal open access. That requires funding and discussions with the agencies.

Fisher stated that D-0 writes an article; it goes into peer review; the preprint goes into arXiv; Physics Review Letters publishes it; and the preprint goes away. Shochet said that the paper is always on arXiv. McBride pointed out that the collaborations keep the papers for at least 5 years.

Gelmini said that the arXiv should be maintained, and a policy should be set to post (forever) the final version of the paper.

Akerib pointed out that the preprint stays on arXiv and is corrected as changes occur.

Shochet called for approval of the report. It was unanimously approved by a show of hands.

A break was declared for lunch at 11:15 a.m.

June 23, 2011
Afternoon Session

The meeting was called back into session at 1:28 p.m. Shochet noted that Brinkman had asked HEPAP and the Nuclear Science Advisory Committee (NSAC) to look at DOE's options in view of NSF's NSB deciding not to fund DUSEL. **Jay Marx** was asked to present the report of the Joint Subcommittee set up to respond to that charge.

The charge to the Panel was to help define the cost-effective options for planned underground experiments and strategies for implementing a world-class program of underground science consistent with SC's mission in High Energy and Nuclear Physics. This charge was to be accomplished by (1) reviewing the proposed experiments [the long baseline neutrino experiment (LBNE), third-generation dark matter, and 1-ton-scale neutrinoless double-beta decay]; (2) assessing the cost and schedule estimates for deploying these experiments; and (3) providing the "baseline" needed for budget planning and discussion of strategies going forward.

Specifically, the charge called for the Subcommittee to look at eight scenarios; it also looked at a ninth scenario proposed during the course of the study. This review did *not*

- evaluate the compelling nature of the science or set science priorities;
- review the DUSEL project;
- consider strategies for the future of DUSEL;
- pick winners and losers; or
- consider the full range of possible sites, alternate technologies, etc.

The assessment attempted to capture the readiness; technical risks; design, construction, and operational costs; and schedule for each of these scenarios.

The Subcommittee considered input from LBNE, FNAL, the NSF-supported DUSEL Project Team, Sanford Laboratory, and Sudbury Neutrino Observatory (SNOLAB) in an intense three days of meetings. In addition, Subcommittee members visited both Homestake mine and SNOLAB. The Subcommittee assessed each of the scenarios in terms of the readiness; technical risks; design, construction, and operational costs; and schedule. It was not a Lehman-type cost/schedule review. Estimates are in current-year dollars and conditions, and inflation can be a very significant cost risk over the time scale of these experiments. Contingency costs were based on design maturity: pre-conceptual 50%; conceptual 40%.

Scenario 1 is an LBNE that uses water Cherenkov detectors at 4850 ft at Homestake. This option was considered viable and the most cost-effective option for LBNE physics. It has a total project cost of $1.2 billion to $1.5 billion, including 50% contingency and infrastructure costs. It was noted that shafts need a full upgrade to support safe/effective construction and operations. The experiment calls for a 700-kW beam, not Project X. The water-Cherenkov-detector technology is mature; detailed design on caverns and detectors can begin immediately. The near detector design could be simplified. The primary areas of risk are general underground construction and the complications to beamline design induced by the FNAL site boundary limitation

Scenario 2 is the LBNE using a liquid-argon detector at 800 ft at Homestake, including an R&D program to prove the scalability of liquid-argon technology. Such liquid-argon technology needs multiyear R&D to prove its viability. The earliest date such a decision could be made would be about 2015. The TPC would range from $1.0 billion to $1.4 billion, including a 50% contingency, infrastructure costs, and costs for liquid-argon R&D. At this time, this scenario is considered less cost effective than Scenario 1 because of the additional escalation in costs during the 4 to 5 years needed to complete R&D and the possibility that liquid argon may be very costly. Its design status is pre-conceptual. The FNAL scope of work is comparable for a water Cherenkov or liquid-argon detector. The primary risks are that liquid-argon technology may not be workable or maybe cost prohibitive; the 800-ft level is not well characterized; and there are liquid-argon cryogenic safety concerns in an underground cavern. Dark matter and/or neutrinoless double-beta decay experiments are not viable at the 800-ft level.

Scenario 3 is a third-generation dark-matter experiment at 4850 ft at Homestake. It is a viable, cost-effective option if the LBNE helps support infrastructure costs; it is not considered cost effective as a stand-alone experiment. The estimated TPC is about $0.3 billion, including a 40 to 50% contingency with LBNE sharing the infrastructure costs. The design status is roughly conceptual. The primary areas of risk are whether the additional background at 4850 ft compared to 7400 ft can be mitigated with additional shielding; there are also risks associated with being underground. The U.S. community consensus is that two complementary dark-matter experiments are needed.

Scenario 4 is a ton-scale neutrinoless double-beta decay experiment at 4850 ft at Homestake. This scenario is similar to the previous one. It is a viable, cost-effective option if the LBNE helps support infrastructure costs. It is not considered cost-effective as a stand-alone experiment. The estimated TPC is about $0.4 billion, including a 40 to 50% contingency with LBNE sharing infrastructure costs. The design status is pre-conceptual. The risks foreseen are that neutrinoless double-beta decay experiments at the ton-scale do not exist today; 3 to 4 years of R&D and operating smaller detectors are needed to confirm a path forward. An extensive R&D program is currently under way to determine whether the additional background at 4850 ft compared to 7400 ft can be mitigated with additional shielding. There are also the generic risks from being underground.

Scenario 5 is a third-generation dark-matter experiment at 7400 ft at Homestake. It is considered viable at 7400 ft. It is not considered a cost-effective option because of substantial infrastructure costs and uncertainties at the 7400-ft level. The estimated TPC is about $0.7 billion, including a 40 to 50% contingency.

Scenario 6 is a ton-scale neutrinoless double-beta decay experiment at 7400 ft at Homestake. The conclusions about this scenario are the same as those for Scenario 5. The estimated TPC is about $0.9 billion, including a 40 to 50% contingency.

Scenario 7 is a third-generation dark-matter experiment at 6800 ft at the SNOLAB. It is considered viable at SNOLAB and appears to be the most cost-effective option for dark matter. The estimated TPC is about $0.2 billion, including a 40 to 50% contingency. However, a careful study of infrastructure costs has not been done, only a rough estimate is included in the TPC. The design status is roughly conceptual. SNOLAB is an operating underground science lab and has much experience with constructing underground science facilities (e.g., clean rooms and cryogens). The primary areas of risk are the Canadian cost/liability uncertainties and coordinating with a commercial mining operation (which could be a benefit).

Scenario 8 is a ton-scale neutrinoless double-beta decay experiment at 6800 ft at SNOLAB and is very much the same as Scenario 7. It is considered viable at SNOLAB and appears to be the most cost-effective option for neutrinoless double-beta decay. The estimated TPC is about $0.3 billion, including a 50% contingency. However, a careful study of the infrastructure costs has not been done, only a rough estimate is included in the TPC. The design status is pre-conceptual. The primary areas of risk are the same as Scenario 7.

The added Scenario 9 is the LBNE 1 + 1, which starts with a water Cherenkov detector at 4850 ft; advances a liquid-argon R&D program to prove scalability; and adds a liquid-argon detector at 800 ft. This design allows the water Cherenkov detector to move forward today while continuing liquid-argon R&D at a modest cost with the aim of adding a liquid-argon detector or another water Cherenkov detector at a later time. Each detector would be smaller than in the single-technology scenarios 1 and 2. Should liquid argon not prove viable, an additional water Cherenkov detector module can be added to do a full neutrino-physics program. The LBNE collaboration favors this scenario. The total cost of 1+1 has not been assessed but is expected to be dominated by infrastructure costs and could be significantly larger than scenarios 1 or 2. More study is needed. The FNAL scope of work is comparable with scenarios 1 and 2. This design would get physics started at a lower initial cost than scenarios 1 or 2; could provide a greater physics reach than with either technology alone because water Cherenkov detectors and liquid-argon detectors have complementary capabilities with different systematics and sensitivities to different final states; and would allow a decision to be made for doing dark matter and neutrinoless double-beta decay at Homestake. The risks are the same as for scenarios 1 and 2, but smaller detectors mean smaller caverns and a reduction in associated risk.

The major conclusions of the Subcommittee are that:

1. At the current level of maturity, the cost estimates for the third-generation dark matter and ton-scale neutrinoless double-beta decay experiments should be taken as accurate to about one significant figure. The cost estimates for the LBNE and associated infrastructure costs are more mature; however, they are not greater than the conceptual design level.
2. The likely approximate costs of the three experiments are: for LBNE, including detectors, beamline, and infrastructure, $1.2 to 1.5 billion; for each third-generation dark matter experiment, $0.1 billion (infrastructure is not included, as this value is site dependent); and for each ton-scale neutrinoless double-beta decay experiment, $0.2 to 0.3 billion (infrastructure is not included, as this value is site dependent). The operating costs for the LBNE detector alone in the Homestake infrastructure are $18 to 23 million per year (FY15 dollars). If one wanted to do dark matter or neutrinoless double-beta decay without LBNE at Homestake, it would cost about $20 million per year and about $2 to 3 million per year in marginal operating costs if the LBNE were already established. The same work at SNOLAB would cost about $2 to 3 million for marginal operating costs; further work is needed to understand if there would be any shared facility/infrastructure operational costs.
3. With LBNE at the 4850-ft level at Homestake, the additional cost of infrastructure to allow construction of a third-generation dark matter or ton-scale neutrinoless double-beta decay experiments would be about $0.15 billion for the first experiment and $15 million for each subsequent experiment if infrastructure for all the experiments is done up front. That means that this approach would exceed the infrastructure costs at SNOLAB for a single dark-matter or neutrinoless double-beta decay experiment by something like $100 million. Adding a second dark-matter or neutrinoless double-beta decay experiment at the Homestake 4850-ft level would have infrastructure cost roughly that of SNOLAB's.
4. It is not cost effective to consider third-generation dark matter or ton-scale neutrinoless double-beta decay experiments as stand-alone experiments at Homestake because of infrastructure costs unless one constructed three or more of these experiments at the same level.
5. Constructing the third-generation dark matter or ton-scale neutrinoless double-beta decay experiments at the 7400-ft level at Homestake appears to be prohibitively expensive because of infrastructure costs and uncertainties. The dark matter experiments can likely be accomplished at the 4850-ft level with additional shielding. Whether shielding can be sufficient for neutrinoless double-beta decay experiments at the 4850-ft level will not be known for several years.
6. Significant investments in infrastructure will be necessary to safely construct, commission, and operate a modern underground laboratory at Homestake. Modernizing the Yates and Ross shafts at Homestake is a necessary prerequisite and should not be considered an opportunity for "value engineering."
7. Constructing a third-generation dark matter or ton-scale neutrinoless double-beta decay experiment at SNOLAB appears to be the most cost-effective option even if a U.S. investment is needed to dig and outfit a pit and provide utilities and other support. This conclusion should be verified by detailed studies.

8. One must recognize that the time needed to carry out the three experiments (LBNE, ton-scale neutrinoless double-beta decay, and third-generation dark-matter) will extend over two decades or more from now, including about one decade before data taking begins. It is likely that, in each case, there will be upgrades and follow-on experiments that will further extend the time scale of these physics programs.
9. Therefore, given the scale of investment needed to carry out these experiments and the long timescales and likelihood of follow-on experiments in each of these areas of research, there are major advantages to developing a common underground site for these experiments despite increased costs. The advantages include (1) opportunities to share expensive infrastructure and coordinate design efforts, construction, management, and operations and (2) significant benefits in training of the next and subsequent generations of scientists by having a common facility serve as an intellectual center in these fields of research. Locating the facility in the United States would help to promote U.S. leadership in these fields for the foreseeable future.
10. That opportunity could be realized only if the three experiments are funded. The LBNE technology choice (water Cherenkov vs. liquid-argon TPC) strongly impacts the strategic options for siting third-generation dark matter and ton-scale neutrinoless double-beta decay experiments. If the LBNE choice is a water Cherenkov detector at the 4850-ft level at Homestake, then the third-generation dark matter and/or ton-scale neutrinoless double-beta decay experiments at the 4850-ft level becomes significantly more cost effective. If the LBNE technology is a liquid-argon detector closer to the surface, then this would not be so. There is a very significant strategic benefit to making the LBNE technology choice as soon as possible.
11. A "1 + 1 option" for LBNE may provide considerable physics advantages because of complementary detectors, but further study is necessary. Implementing a water Cherenkov detector initially, while continuing with liquid-argon R&D for possibly adding this capability later would be consistent with sharing infrastructure among the LBNE, neutrinoless double-beta decay, and dark matter experiments at the Homestake 4850-ft level.

In summary, the Subcommittee believes there are compelling scientific motivations for all three experiments and an important opportunity for the United States to take a leadership position for the foreseeable future. It also believes that there are important advantages and opportunities in developing a common site for these experiments if the needed infrastructure can be shared in a cost-effective manner. A common site only works in the scenario where LBNE has one or more detectors at 4850 ft at Homestake. Either an early technology choice for water Cherenkov or the 1 + 1 option would support this scenario, but it may be several years before it is known if neutrinoless double-beta decay is feasible at 4850 ft. If LBNE pays for the infrastructure that LBNE needs, there would be additional infrastructure costs for a dark matter or neutrinoless double-beta decay experiment. Those costs would exceed those at SNOLAB by something like $100 million. The Subcommittee believes that these added costs are worthwhile given the advantages of a common site and the multi-decade timescale. If there is no LBNE at the Homestake 4850-ft level, neutrinoless double-beta decay and dark matter are not cost effective at Homestake. The lowest-cost option for dark matter or neutrinoless double-beta decay is SNOLAB.

Marlow asked if funds for infrastructure at the 800-ft level affected the lower levels. Strait said that a couple of tens of millions of dollars are saved by putting a liquid-argon detector at the 800-ft level.

Marlow was struck by the statement that it is not known if liquid argon would work. Marx replied that, clearly, there were people who had worked on liquid argon; the question is what it will take to scale up that technology. Conrad noted that it says in the report what needs to be studied. There are several questions, such as whether one can purify that much liquid argon. The community has identified these questions and developed a plan to address them.

Yamamoto said that two scenarios had been identified as cost effective and noted that it is cheaper to do the first. Marx said that the difference in cost is about $100 million over ten years With the more expensive option, one has a community working together and a long-term program, both of which offer advantages (i.e., intellectual cross-fertilization and productivity in one case and operational control in the other) that make the added investment worthwhile.

Akerib asked why it was cheaper to carry out the program at SNOLAB. Marx said that SNOLAB was an operating facility with excellent shafts; in addition, the utilities are already there. The Homestake numbers came from DUSEL; the SNOLAB figures came from their most recent experiment and include incremental power costs etc. Symons pointed out that how many experiments are run is important. One could overload SNOLAB with too many experiments. The facility has 2 MW of power at the moment. Reichanadter spoke to the drivers for reduced costs at SNOLAB. There are some cost subsidies that are picked up from an efficient, operating mine: construction, a mine safety team, power, ventilation, and other marginal costs.

Akerib asked if the discussion was comparing apples to apples. Is $1 at Homestake equal to $1 at SNOLAB? Reichanadter answered that there was a lot of underground infrastructure at SNOLAB. The Subpanel tried to get as close as it could in comparing Homestake and SNOLAB costs. Actual costs incurred at SNOLAB were used with the caveat that additional studies were needed.

Dehmer asked what assumption was made on the longevity of nickel mining at SNOLAB and why there was no mention of proton decay studies. Marx replied that proton decay was not included in the charge. Shochet said that it was in there indirectly. The Subpanel assumed that SNOLAB has a long lifetime; a long-term contract with the mining company is in the works.

Fleming asked what was meant by the statement that a water Cherenkov detector was more cost-effective than a liquid-argon detector. Marx said that a liquid-argon system would turn on later and escalation costs would go up.

Marlow said that the 1 + 1 option seems to have been offered to avoid a tough question. A single big detector is a better scientific instrument than two little ones. Conrad said that the Subpanel assumed that the two can be combined because the systematics are different. This is a competitive field, and one needs to think about moving forward soon. The water Cherenkov detector would offer a way to start up soon.

Strait emphasized that liquid argon at the 4850-ft level is being looked at seriously. It may be equally cost effective at 4850 ft as at 800 ft.

Lesko said that an apples-to-apples analytical comparison could be performed.

Brinkman thanked the Subpanel for its hard and excellent work.

Marx noted that a similar briefing will be held at the Nuclear Science Advisory Committee (NSAC) meeting on July 1.

Andrew Lankford was asked to comment on the NRC's process for studying DUSEL.

The proposed DUSEL program was designed to accommodate a suite of experiments in physics (long baseline neutrino and proton decay, dark matter, neutrinoless double-beta decay, nuclear astrophysics, and advanced low-background counting and assay); in biology, geology, engineering (ecohydrology, coupled processes, carbon dioxide sequestration, geophysics, geology, and 16 efforts consistent with the Sanford Laboratory scope); and in education and outreach.

Underground research facilities are required by several critical physics questions and offer opportunities to address other important science questions, as well. The science goals have been reviewed and documented by many studies during the past decade (e.g., the 2007 NSAC Long Range Plan for Nuclear Physics; 2008 HEPAP-P5 Strategic Plan for Particle Physics; 2009 PASAG Priorities for Particle Astrophysics; and a recent NSF report, 2011 AC-GEO DUSEL Science Review). In 2004, a National Science and Technology Council (NSTC) report recommended that NSF lead the conceptual development of an underground facility and that DOE and NSF together identify a core suite of physics experiments. In preparation for final deliberations, NSF and DOE commissioned this independent NRC study.

This study was to assess (1) the major physics questions that could be addressed with the proposed DUSEL and associated physics experiments; (2) the impact of the DUSEL infrastructure on research in fields other than physics; (3) the impact of the proposed program on the stewardship of the research communities involved; (4) the need to develop such a program in the United States, given similar science programs in other regions of the world; and (5) the broader impacts of such an activity, including but not limited to education and outreach to the public.

The NRC formed a multidisciplinary, international committee whose members were independent from the project and who included members of the national academies and the Board of Physics and Astronomy. It held its first meeting in December 2010 to receive presentations from the agencies, project leaders, and researchers in the scientific disciplines affected. It held a second meeting in February 2001 to receive presentations from international programs and to entertain additional information on long-baseline neutrinos and geoscience/geo-engineering. In January 2001, a teleconference touched on DAEdALUS [Decay At rest Experiment for δ_{CP} studies At the Laboratory for Underground Science] and gravitational-wave experiments. In February 2011, the President's FY12 budget request eliminated funding for DUSEL, and DOE commissioned a cost and schedule review of options for major physics experiments. In March 2011, the committee held a third meeting to draw up a draft of its report. In May 2001, it made a presentation to the NSB on the status of the report. The last review of the draft was received late May, and the response to the review is very nearly complete. The target date for releasing the report is July 12.

A break was declared at 2:47 p.m.

The meeting was called back into session at 3:18 p.m., and **Kate Scholberg** was asked to present an update on the activities of the HEPAP Demography Group that seeks to understand the flow of personnel in the field of high-energy physics.
Data on this subject has been collected by Lawrence Berkeley National Laboratory (LBNL) since 1998. The HEPAP Demography Group was formed in 2002 and received a grant from DOE from 2006 to 2007 that provided resources for a code/database setup at LBNL with data checks performed at the University of Iowa. Extensive and detailed cross-checks were verified manually, and the results were fed back to the database. There has been no funding since 2007, and the system is now in steady state; there have been some ad hoc technical improvements in the past few years.

The HEPfolk census is filled out each spring by one PI per institution, and the data are maintained at LBNL. The database is available to the community. The error rate is about 10%. The 2010 census report indicated that there were 1506 graduate students, 931 postdoc or fixed-term staff, 685 untenured faculty or open-term staff, and 1413 tenured faculty or staff. Inflows to and outflows from these categories were tracked along with outflows to and inflows from other categories of employment and foreign institutions.

For those going on in the field from graduate school, the number of positions available in all categories bulged in 1985 to 1990, and the number of postdocs increased dramatically from 1995 to 2010. The percentage of women in the field has increased from 8% in 1998 to almost 14% in 2010. The number of jobs increased in all categories from 1998 to 2010 except for untenured faculty. The number of graduate students is increasing, likely because of the excitement engendered by the LHC. However, 60% of transitioning graduate students leave high-energy physics, and 55% of transitioning postdocs leave the field. Where they go is largely unknown.

Concrete information about departures is poor; it would be highly desirable to do better tracking. The Group proposes hiring a “people person” to do the legwork for tracking people long after their departure from HEP. There is precedent for about a 65% response rate to the census 5 years out. That person would also do some technical development of the database with a long-term view. The Subpanel is currently discussing a possible
SPIRES/INSPIRE role. Other ideas include collecting anecdotes and success stories, making use of American Institute of Physics/American Physical Society resources, and coordinating with other groups seeking demographic information.

In summary, the HEPfolk census is in a steady state and gives a reasonably accurate snapshot of the field. However, the trajectories of departing HEP personnel are largely unknown. The Subpanel will request resources for a deeper study focusing on departures and on long-term maintenance of the demographic data.

Fleming asked if the change in the percentage of women had been broken out at the postdoc, tenured faculty, and other levels. Scholberg replied, no.

Marlow noted that 65% is not a good response rate. Tracking everyone is not a cost-effective way to do this task. One might try a sampling approach and have a bias-free sample. The statistical accuracy would build up over the years. He commented that the number of postdocs staying in the field at that level (45%) seemed high and asked if that number included those going on to second postdoctoral positions. Scholberg replied, no. It counts people going on to untenured faculty positions, tenured faculty positions, foreign institutions, or “other.”

Fisher noted that the total number of people being tracked is about 300 and that a full-time person could cover that workload.

Teplitz asked if information on minority participation were being gathered. Scholberg replied, no. Teplitz responded that it might strengthen the proposal.

Boehnlein asked if the Subpanel had thought of using social media to track people. Scholberg said that the person hired could use any means desired.

Daniella Bortoletto was asked to present an update on the LHC detector upgrades.

The LHC is working spectacularly. In colliding protons in 2010, it achieved 368 colliding bunches with 150-ns spacing, a peak luminosity of 2×10^{32} cm^{-2} s^{-1}, and an integrated luminosity of 46 pb^{-1} per experiment. In colliding lead ions, it delivered about 9.5 Mb^{-1}. In the 2011 run, the Compact Muon Spectrometer (CMS) and A Toroidal LHC ApparatuS (ATLAS) have each collected an integrated luminosity of over 10^{39} and could collect 15 fb^{-1} by shutdown at the end of 2012. For most experiments, the efficiency is at 92 to 94%. During 2011, the electron cloud was improved with scrubbing, luminosity leveling was attained for the LHCb experiment, and the machine was operated with bunch trains.

The LHC started up in 2009 and is now in Run 1. In 2013/2014, there will be the first shutdown to prepare the machine for running at design energy and nominal luminosity. Run 2 will ramp up luminosity to 10^{34} cm^{-2} s^{-1} and will accumulate about 50 to 100 fb^{-1}. The second shutdown will occur in 2017 or 2018; Run 3 will more than double the luminosity and will reach about 100 fb^{-1} per year, accumulating a few hundred fb^{-1}. Around 2021, there will be a third shutdown to install new focusing magnets and crab cavities for very high luminosity with leveling. Run 4 will collect data until it exceeds 3000 fb^{-1}.

Detector-upgrade issues include increased interactions per crossing leading to problems with trigger performance, occupancy, event reconstruction, data losses, radiation damage, and decreased discrimination of electrons from jets. All collaborations are planning to upgrade their detectors to maintain and improve the physics performance.

The current LHCb physics goals include an indirect search for new physics via CP asymmetries and rare decays and focusing on flavor physics with b and c decays. The forward spectrometer is designed to exploit the huge $\sigma_{b\bar{b}}$ at the LHC. The current LHCb hopes to collect about 5 fb^{-1} before the second LHC shutdown in 2017. The Vertex Locator (VELO) gives an excellent vertex resolution on the primary vertex. The LHCb physics prospects are excellent for per-event proper time uncertainties and the per-event mis-tag rate. LHCb already compares well with CDF's measurements of B_s oscillations.

The LHCb upgrade strategy calls for a flexible software trigger with a 40-MHz input rate and a 20-kHz output rate by replacing the electronics and data-acquisition architecture. Detectors limited to the current 1-MHz electronics will be rebuilt, and some detectors will be removed because of increased occupancies at higher luminosity.

The intent is to run at a luminosity of about 10^{33} cm^{-2} s^{-1}, to collect about 5 fb^{-1} per year, and to increase integrated luminosity to about 50 fb^{-1} per year in 10 years, leading to a big gain in signal sensitivity. A letter of intent was submitted to the LHC Committee in March 2011. The physics case was well received, and the Committee has recommended LHCb to proceed to the technical design report.

The VELO upgrade faces several challenges. Two options are being looked at: a pixel detector and a strip detector. R&D is currently being conducted. The particle identification detectors RICH-1 [Ring Imaging Cherenkov], RICH-2, and TORCH [time of internally reflected Cherenkov light] are being upgraded.

In ATLAS, there are an inner detector, calorimeters, a muon system, and several forward detectors. In CMS, there are a silicon tracker for momentum and secondary vertex resolution, high-resolution crystal calorimeters, brass scintillator sampling hadronic calorimeters, and a muon spectrometer; neutrinos are inferred from the missing deposited energy. The ATLAS/CMS performance is gorgeous. One of the physics goals of the LHC is the Higgs, which is being investigated in the low-mass, mid-mass, and high-mass regions. A sweet spot has been found at 160 GeV, and preparations are being made to combine the ATLAS and CMS results. If the Higgs boson exists between the masses of 114 and 600 GeV, it will be either discovered or ruled out in the next 2 years. Therefore, CERN decided to run in 2011 and 2012. The upgrade in luminosity will allow researchers to move from exploration to precision studies of Higgs physics, electroweak physics, supersymmetry, and extra dimensions/new forces.

The ATLAS upgrade, which has been supported by the U.S. Operations Program for more than 5 years, includes a new pixel front-end chip, new types of pixel and strip detectors for tracking applications, new calorimeter electronics systems, and new data-collection and transmission components that have lower noise and power consumption. Phase 1 of the upgrade will be installed by the end of the first shutdown. A subcommittee has been appointed to guide the Phase 1 upgrade projects, which will include an insertable B layer, a FastTracKer, a new inner wheel, and topological calorimeter trigger algorithms. The CMS upgrades will include a new pixel detector and improvements in the tracker (employing ultralow-mass mechanics and carbon dioxide cooling), hadron calorimeter (HCAL, replacing the hybrid photo detector with higher-performance silicon photomultiplier), electromagnetic calorimeter (ECAL), muons, and trigger [using Micro Telecommunications Computing Architecture (μTCA) and powerful field-programmable gate arrays (FPGAs)]. Phase 2 upgrades may require new tracking detectors, additional tracking information, and new endcap calorimeters.

Substantial R&D will be required for these massive and difficult projects. U.S. funding of this R&D could play a critical role in enabling the participation of U.S. laboratories and universities in this R&D and in the exploration of the energy frontier for the next decade. However, detector R&D in the United States is historically poorly funded. A clear funding plan for the United States to participate in the construction of the Phase 1 upgrades must be developed as soon as possible; R&D for Phase 2 is at a critical stage and requires funding continuity.

Shochet thanked her for the very complete and clear presentation; there being no questions or comments, the meeting was adjourned for the day at 4:33 p.m.

Friday, June 24, 2011

The meeting was called back into session at 9:00 a.m. John Kogut served as the Designated Federal Official in the absence of Glen Crawford.

Lek (L.K.) Len was asked to report on the stewardship for accelerator science at DOE.

Many communities have an interest in accelerators. HEP's stewardship has gained momentum from the P5 Recommendation to conduct a broad strategic program in accelerator R&D, including work on International Linear Collider (ILC) technologies, superconducting rf, high-gradient normal-conducting accelerators, neutrino factories and muon colliders, plasma and laser acceleration, and other enabling technologies, along with support of basic accelerator science. The current HEP accelerator program could position the United States to recapture the energy frontier in the future.

The program has developed rf cavities, high-power sources, high-temperature superconducting materials, plasma simulations, and design models. It has enabled a lot of discoveries in science and applications in medicine and security in terms of advanced materials, light sources, colliders, powerful acceleration, source technology, and beam dynamics.

The current HEP accelerator R&D program supports long-term, fundamental research in accelerator science including advanced acceleration concepts, the physics of charged particle beams, theory and computer simulations, beam sources, and instrumentations as well as near- and mid-term R&D on accelerator technologies to improve existing accelerators and to develop next-generation accelerators.

Some Current Programs are advanced wakefield accelerators [BELLA at LBNL, which is laser-driven; Facilities for Accelerator Science and Experimental Test Beams (FACET) at SLAC, which is beam-driven; and Argonne Wakefield Accelerator (AWA) at ANL, which is dielectrics loaded]. The program also has a Muon Collider and Neutrino Factory and an Accelerator Test Facility (ATF) and operates the U.S. particle accelerator school with two sessions per year involving 150 accelerator physicists, professionals, and graduate students each.

The current accelerated development programs include (1) general accelerator R&D that has broad applicability and covers improvements for superconducting materials for magnets, warm and cold accelerating structures, instrumentation, and rf acceleration systems; (2) the LHC accelerator research program; (3) the ILC, which is to demonstrate the technical feasibility of a superconducting electron positron collider; and (4) the industrialization of the manufacture of superconducting radiofrequency (SRF) cavities.

The program's funding history does not reveal any trends; ups and downs result from specific initiatives. University research grants comprise about 10% of the budget (about $10 million).

HEP's stewardship plan derives from a 2009 workshop on the accelerator industry, discovery science, energy and the environment, medicine and biology, and security and defense. Several common concerns emerged from the workshop: Stakeholders have difficulty identifying a single federal owner when their requirements cut across agencies. The government can help to bridge the gap between bench-scale demonstrations and full deployment. There is a need for advances in technology that will reduce construction and operating costs. The core competence should be maintained through education. The workshop also prioritized R&D areas, and the plan will reflect these priorities.

To plan and execute this program requires five people, but there are only two available. More are needed.

The strategic plan being developed involves reorganization of the OHEP accelerator R&D portfolios. FOAs will be issued for priority areas with a separate HEP solicitation similar to the SRF grant process or a SciDAC-type solicitation. HEP is coordinating with other offices and agencies.

The Office is trying to fill the vacancies in Accelerator Science by bringing in IPAs and detailees and by filling a federal program manager position.

It is also working on an initiative for accelerator science user facilities to convert existing HEP accelerator science facilities to broaden the user base, provide more visibility, stabilize funding, conform to performance metrics, and employ open access based on peer review. Different models for organizing the accelerator R&D projects are being considered.

Shochet asked if it were still clear in the Department that HEP is the steward for accelerator science in DOE. Len noted that several offices have programs in accelerator science (and no one has objected to that), but HEP is the only one with programmatic and long-term responsibilities. Procario added that added that the accelerator science program in HEP is bigger than that in any other office.

Gelmini noted that there are some long-term-payoff areas (e.g., medical applications of heavy-ion accelerators) that have suffered from a lapse of funding when the basic-research period ended. Industry is interested in immediate returns on investment and not interested in long-term R&D. In Europe and Asia, however, long-term funding is provided to bring such technology to commercialization. She asked if the issue of bridging applied research has been addressed. Len responded that coordination with other agencies will be necessary to avoid the "valley of death" between research and commercialization.

Hartill asked Len how he saw the transition in accelerator science occurring. Len answered that all the facilities are user facilities. One needs to identify which facilities are usable for accelerator-science R&D and seek an allocation of their hours. Procario added that the ATF has been used as a user facility. The goal would be to raise it to the next level, requiring an up-to-date facility and a certain level of reliability, so people can book time and be sure they can do their research when they are scheduled for machine time.

Maury Tigner was asked to describe the accelerator science being performed at Cornell University.

R&D is being conducted on damping rings that are used for electron-cloud physics, electron-cloud mitigation, and low-emittance tuning; on continuous-wave linacs that produce high-brightness, space-charge-dominated beams and high-powered, low-emittance guns and photocathodes; and on superconducting radiofrequency (SRF) that looks at the fundamental limits of what SRF can do, new materials, high-performance cavities, and the breakdown rate. There is also work in theory for simulations and analysis.

One instrument being developed is the X-Ray Beam-Size Monitor, which can measure a beam from the passage of one bunch. It is a vertical array of 32 InGaAs diodes with a pitch of 50 µm and a horizontal width of 400 µm. The time response of the detector is subnanosecond, and it can be used to measure 100- to 8-µ beams.

At the intensity of the ILC, electron clouds cause a growth in the beam size. The cloud is caused by photoelectrons produced by electrons hitting the wall. Different materials for wall surfaces are being explored to see if they can mitigate the effect.

In continuous-wave linacs, Cornell has a 1.5-MeV, 100-milliamp superconducting test accelerator for space-charge and emittance studies. The beam profile can be predicted as it goes through the machine. There is good agreement between theory and experimental measurements.

To produce better materials with low thermal emittance, high longevity, and high quantum efficiency, new materials are grown or procured, evaluated in the test accelerator, and modeled and characterized.

In SRF, Nb_3Sn is being used in SRF cavities to get to 100 MV/m. Another project addresses the question of why some areas are very lossy. It was found that the dislocation density causes the lossy areas. The losses are produced as the dislocations are healed.

RF critical field/superheating field studies are being conducted to understand whether what is being measured is what Ginzburg-Landau (G-L) theory predicted. Solving the Eilenberger equation shows that the parameter does not work well at high magnetic fields.

During the past year, the accelerator science program published 47 papers on damping rings, 11 on continuous-wave linacs, 11 in SRF, and 6 on theory. The program participates in a number of collaborations: in the damping rings CesrTA (Cornell Electron Storage Ring Test Accelerator) with 18 other institutions, in continuous-wave linacs with 5 other institutions, and in the SRF TeV-Energy Superconducting Linear Accelerator (TESLA) Technology Collaboration with 56 other institutions in 12 countries.

The accelerator science program currently has five faculty members with one more on phased retirement. During the CLEO era, it produced about one PhD per year in accelerator science. That rate will approximately double. There is a current enrollment of 12 PhD students. About 50% of the graduates go to the accelerator laboratories in the United States and abroad; 40% go into industry; and 10% go into academe.

Marlow asked where the Bardeen-Cooper limit would lie in the critical-field discussions. Tigner replied that it would be a square root of 2 higher than the curve shown. Marlow noted that 40% of the graduates go into industry and asked if they worked in accelerator science. Tigner answered that that is not known; they seem to go into a broad range of technologies and into computation as well as other private-sector jobs.

Honscheid asked where these people in industry come from if not from academia. Tigner responded that many are trained on the job or may come from accelerator laboratories and some other peculiar places.

Blucher asked what had happened to accelerator-science-research funding in the past few years. Tigner answered that it is difficult to separate research from development. The work is usually inspired by development. $7 million dollars a year are being put into the program. The equipment and the people to operate it are expensive.

McBride asked how they interacted with the teams that write the code. Tigner responded that they work with everybody, from the code writer to the student user. They also collaborate with code developers and users at other facilities.

Yamamoto asked about NSF funding science but not projects. Shochet noted that the policy is not uniformly applied. Yamamoto asked if that policy affects Cornell. Tigner stated that they figure out how to work around the perceived policy barriers; NSF is their largest supporter.

Meringo asked if there were any strategies for increasing the number of accelerator-science students in universities. Tigner noted that academic programs have to be committed to achieve a critical mass of staff and faculty. Few universities have an accelerator on campus that can be used to educate students.

Shochet reviewed the topics that would be included in his letter to the agencies about this meeting; he solicited additional topics to include. He stated that he would circulate the draft version of the letter to the full Panel for members' concurrence. When consensus is arrived at, he will forward the letter to NSF and DOE.

The next meting will be Oct. 27–28, 2011, at the Palomar Hotel in Washington, D.C.

There being no further discussion or public comment, the meeting was adjourned at 10:21 a.m.

Respectfully submitted,
Frederick M. O'Hara, Jr.
Recording Secretary
July 13, 2011

Corrected,
Melvyn Shochet
Chairman
August 30, 2011

The minutes of the High Energy Physics Advisory Panel meeting held at the Hilton Hotel, Rockville, Md., on June 23-24, 2011, are certified to be an accurate representation of what occurred.

Signed by Melvyn Shochet, Chair of the High Energy Physics Advisory Panel on August 30, 2011.