P5 Presentation

A. Seiden

HEPAP Meeting

July 6, 2006

Charge

We would now like to return to the original goal of P5. We would like you to propose a detailed roadmap for the U.S. high energy physics program for the period of roughly the next ten years, with particular focus on the decisions needed in the next five years, and mindful of the international context. This roadmap should lay out the most compelling scientific opportunities that can be addressed in that timeframe. In addition, we would like a specific prioritization of the major elements of the roadmap. This prioritization should assume a future yearly budget envelope which will be provided by the funding agencies.

Charge

Projects to be included:

Operations of the Tevatron and BaBar consistent with previous recommendations.

U.S. contributions to LHC operations, computing, and upgrades.

The neutrino program.

The Deep Underground Science and Engineering Lab and associated experiments.

The International Linear Collider R&D.

Next-generation dark matter experiments.

Dark energy experiments.

Other major proposals which the agencies request to be included.

My comment (not in charge letter):

In general we will be looking at projects that have reached a significant level of maturity and would represent significant expenditures for the DOE or NSF particle physics programs.

Charge

Where relevant, the subpanel should consider the impact of potential program decisions taken elsewhere within the international HEP community, their relation to the programs of related fields such as nuclear physics and astrophysics, and their broader impact on science and society. The forthcoming National Academy of Sciences' EPP 2010 committee (Elementary Particle Physics in the 21st Century) will provide important strategic context to your roadmap, as well as other Scientific Advisory Groups that are assisting the High Energy Physics Advisory Panel (HEPAP) and the Astronomy and Astrophysics Advisory Committee (AAAC).

Membership List

Abe Seiden (UCSC) Chair

Hiroaki Aihara (University of Tokyo)

Andy Albrecht (UCDavis)

Jim Alexander (Cornell)

Daniela Bortoletto (Purdue)

Claudio Campagnari (UCSB)

Marcela Carena (FNAL)

William Carithers (LBNL)

Dan Green (FNAL)

JoAnne Hewett (SLAC)

Boris Kayser (FNAL)

Karl Jakobs (University of Freiburg)

Ann Nelson (U. of Washington)

Harrison Prosper (Florida State U.)

Tor Raubenheimer (SLAC)

Steve Ritz (NASA)

Michael Schmidt (Yale)

Mel Shochet (U. of Chicago) (Ex-Officio)

Harry Weerts (ANL)

Stanley Wojcicki (Stanford U.)

Gathering Input

We have had four meeting to gather information relevant to our charge and work on the Roadmap and recommendations.

These have been:

March 27-28 near Washington, to hear from the agencies, hear about the LHC program, and about a proposal for a more precise g-2 experiment.

Gathering Input

April 18 –19 at Fermilab, with a focus on neutrinos, potential dark matter experiments, and the Nusag committee report.

April 20 – 21 at SLAC, with a focus on the ILC R&D program, dark energy, and the Dark Energy Task Force report. Also reviewed the issue of the FY08 running of the B-factory.

March 27-28

Monday, March 27

9:00-9:45AM	DOE Comments & Discussion of Charge	R. Staffin, DOE
9:45-10:30	NSF Comments & Discussion of Charge	J. Dehmer, NSF
10:40-11:15	NSF Astronomy, Interagency Projects	D. Lehr
11:15-11:55	NASA, Interagency Projects	M Salamon/P. Hertz
12:00-1:30PM	LUNCH	
1:30-2:15	DOE Budget Discussion	G. Crawford, DOE
2:15-3:00	NSF Budget Discussion	R. Ruchti, NSF
3:15-4:15	g-2 Presentation	L. Roberts/W. Marciano
4:15-5:00	Discussion of g-2	J. Hewett
5:00-5:45	Roadmap Discussion	A. Seiden

Tuesday March 28

8:30-9:00AM	Report of ILC-LHC Group	H. Weerts
9:00-9:30	Report of Neutrino Group	S. Ritz
9:30-10:15	Status Report, Dark Energy Task Force	A. Albrecht
10:15-10:30	Group Discussion of Dark Energy Issues	
10:30-11:00	Report of Dark Matter Group	M. Carena
11:00-12:00PM	LHC Presentation	H. Gordon
12:00-1:30	LUNCH	
1:30-3:00	Budget Group Presentation & Discussion	D. Green

April 18 –19

Tuesday, April 18

9:00-10:00AM	Fermilab Long-Term Plans	Pier Oddone
10:00-10:45	EXO Double Beta Decay Experiment	Giorgio Gratta
10:45-11:00	Break	
11:00-12:00	Daya Bay Reactor Experiment	Kam-Biu Luk
12:00-1:30PM	Lunch	2nd Floor Crossover
1:30-2:30	NOvA	Gary Feldman
2:30-3:15	DUSEL, Homestake Proposal	Kevin Lesko
3:15-4:00	DUSEL, Henderson Proposal	Chang Kee Jung
4:00-4:15	Break	
4:15-5:00	Neutrino Plans in Japan	Hiro Aihara
5:00-6:00	NUSAG Report	Peter Meyers (Closed)
6:00-7:00	Reception and Informal Community Discussion	2nd Floor Crossover

Wednesday April 19

8:30-9:00AM	DUSEL Science Agenda	Bernard Sadoulet
9:00-9:30	Combining Data on Dark Matter	Ted Baltz
9:30-10:10	CDMS and Other Cryogenic mK Detectors	Blas Cabrera
10:10-10:50	Xenon and Other Cryogenic Liquid Detectors	Elena Aprile
10:50-11:10	Committee Discussion of Neutrinos	(Closed)
11:10-12:00PM	Discussions of Neutrinos with Lab Management	(Closed)
12:00-1:00	Lunch	2nd Floor Crossover
1:00-2:00	Combined Neutrino Discussion	(Closed)
2:00-3:00	Dark Matter Discussion	(Closed)

April 20 – 21

Tuesday, April 18

8:00-8:30AM	Continental Breakfast	
8:30-9:00	Planning Activities in Europe	Karl Jacobs
9:00-9:45	Report from the AAAC	Garth Illingworth
9:45-10:30	ILC Update from the GDE	Barry Barish
10:30-10:45	Break	
10:45-11:25	US ILC Accelerator R&D	Jerry Dugan (by phone)
11:25-11:45	US ILC Detector R&D	Jim Brau
12:00-1:00PM	Lunch	
1:00-2:00	SNAP	Saul Perlmutter
2:00-3:00	Dark Energy Survey	Josh Frieman, Brenna Flaugher
3:00-3:15	Break	
3:15-4:15	LSST	Steve Kahn
4:15-4:45	Dark Energy Program in Japan	Hiro Aihara
4:45-5:15	Dark Energy Program in Europe	Stavros Katsanevas
5:15-6:00	SLAC Plans	Jonathan Dorfan
6:00-7:15	Reception and informal community discussion outside the ROB	
8:00	Dinner [Committee and invitees]	

April 20-21 (continued)

Wednesday April 19

8:00-8:30AM	Continental breakfast	
8:30-8:50	Status and Plans for PEP-II	John Seeman
8:50-9:15	Update on BABAR Physics and Prospects	David MacFarlane
9:15-9:30	Status of the Belle Program	Hiro Aihara
9:30-10:30	Discussion with SLAC management [closed]	
10:30-11:30	Report of the Dark Energy Task Force [closed]	
11:30-12:00PM	Executive session [closed]	
12:00-1:00	Lunch [Committee]	
1:00-3:00	Executive session [closed]	

Gathering Input

P5 received the EPP2010 report around the end of April and discussed the report with Sally Dawson in a phone conference.

We want to express our thanks to the EPP2010 committee for their enormous effort and also our enthusiasm for trying to implement the vision they have given us.

Planning Effort

We had a P5 meeting on June 12 and 13 aimed at starting to produce a Roadmap. One outcome is a letter I have sent to HEPAP. It contains:

- Our Planning Guidelines.
- Recommendation on FY08 running of the SLAC B-factory, but in the context of a Roadmap for FY08 so HEPAP can judge the recommendation more fully.

I will make some general comments on the longer term issues we have been looking at (to be addressed in our final report) and then go over the letter.

Some Items Not Addressed

Our letter concerns mostly larger scale efforts. There is of course more to the program than this. In particular, we strongly value a number of smaller projects, the development of new initiatives and associated R&D, and collaboration on projects abroad. We also do not explicitly mention the critical work in theoretical physics. These are all very important to scientific progress in the field.

Science Planning – Dark Matter

Dark Matter is an area where we expect significant new results in the near future, from:

- Continually more sensitive direct detection experiments.
- Direct production searches at the LHC.
- Search for dark matter annihilation signatures using cosmic photons.
- The axion search experiments will also be covering the cosmologically interesting region.

This is an area where discoveries could happen soon!

Science Planning – Dark Matter

In the area of direct detection a number of powerful techniques are being developed.

These will likely lead to the possibility of using several large detectors, in an international setting, based on different techniques to search for direct interactions of dark matter.

We look forward to receiving the evaluation of the options by the Dark Matter Scientific Assessment Group. Our impression is that it should be possible to start construction of a large-scale detector early next decade.

Science Planning - DUSEL

An attractive option for locating a large Dark Matter detector would be in the DUSEL underground lab, with a plan under development by the NSF.

It is likely that an ambitious experiment to search for Neutrinoless Double Beta Decay could be ready on a time scale similar to that for the Dark Matter detector.

These could be the initial flag-ship experiments from the particle physics community for DUSEL, providing a very exciting physics program. They should be included in the DUSEL MREFC plan. We would, however, not like to see the development of DUSEL delay the execution of these experiments.

Science Planning- Dark Energy

We have been learning a lot from the Dark Energy Task Force report and are still developing (and working on) further science questions to sharpen some of our understanding. Some of our goals: A better understanding of what the Stage 4 experiments add (we think a lot) if we go away from a linear assumption for w(a) and a better understanding of how well we can test other physics beyond just Dark Energy (for example general relativity). We welcome further input on science potential from members of the Dark Energy Task Force.

Science Planning – Dark Energy

P5 is very enthusiastic about the possible Stage 4 experiments that significantly further our understanding of Dark Energy. The techniques for measuring the effects of Dark Energy have evolved over the past few years and now offer a way to broadly test our cosmological picture of the universe. These experiments also would provide much information of interest to astrophysicists and therefore typically involve interagency collaboration. Developing a plan that works well within the various interagency constraints will be very important to the timely success of this program.

Science Planning – Neutrinos

We have been able to use the Nusag report as input to our planning. They have discussed three kinds of projects: detectors (and associated science reach) to search for Neutrinoless double beta decay, where several techniques are under development; reactor experiments that might unambiguously measure the third mixing angle in the neutrino sector; and accelerator based experiments that might establish CP violation and determine the mass hierarchy.

Science Planning - Neutrinos

The mature accelerator based option within the U.S. is the NOνA experiment. We have spent a considerable amount of time with the proponents to understand the reach of the experiment. It has several important features: can run neutrinos or antineutrinos depending on the state of knowledge at a given time, allows upgrades by increasing the machine luminosity or through detector upgrades, which can make use of new detector options, and provides our best near-term direction for resolving the mass hierarchy among the neutrinos.

Letter to HEPAP

This letter to HEPAP provides the P5 recommendation regarding the running of the SLAC B-factory for FY2008. Following the plan elaborated approximately six months ago by P5 and endorsed by HEPAP, we have evaluated the importance of B-factory running in FY2008 in the context of a longer-term roadmap for the field.

To produce a roadmap we have adopted a number of planning guidelines. We enumerate these guidelines below. They have been developed with the recommendations of the EPP2010 committee in mind, our view of the present science opportunities for the field, and specific conservative budgetary numbers furnished by the funding agencies.

Planning Guidelines

1. The LHC program is our most important near term project given its broad science agenda and potential for discovery. It will be important to support the physics analysis, computing, maintenance and operations, upgrade R&D and necessary travel to make the U.S. LHC program a success. The level of support for this program should not be allowed to erode through inflation.
2. Our highest priority for investments toward the future is the ILC based on our present understanding of its potential for breakthrough science. We need to participate vigorously in the international R&D program for this machine as well as accomplish the preparatory work required if the U.S. is to bid to host this accelerator.

Planning Guidelines

3. Investment in a phased program to study dark matter, dark energy, and neutrino interactions is essential for answering some of the most interesting science questions before us. This will allow complementary discoveries to those expected at the ILC and provide nearer term projects that, along with the LHC, will train the next generation of students in particle physics. A phased program will allow time for progress in our understanding of the physics as well as the development of additional innovative techniques for making the key measurements.
4. In cases where new techniques are under development our recommendations will include rough dates for reviewing technical progress in order to select the most promising directions for new ambitious experiments.

Planning Guidelines

5. In making a plan, we have arrived at a budget split for new investments of about 60% toward the ILC and 40% toward the new projects in dark matter, dark energy, and neutrinos through 2012. This excludes NSF funds made available through NSF investments in MREFC projects, which may include particle physics as part of an interdisciplinary program involving astronomy, biology, engineering or earth sciences. The budget plan expresses our priority for developing the ILC but also allows significant progress in the other areas. We feel the investments in dark matter, dark energy, and neutrino science in our plan are the minimum for a healthy program.

Planning Guidelines

6. The projects recommended for a construction start in dark matter, dark energy, and neutrino science should complete construction by approximately the end of 2012. This will allow maximum flexibility for decisions on future investments to be made toward the beginning of the next decade in the light of new science results, progress in new technologies, better definition of interagency contributions and plans, and progress on the ILC.

Planning Guidelines

7. Recommendations for construction starts on the longer-term elements of the particle physics roadmap should be made around the end of this decade by a new P5 panel, after thorough review of new physics results from the LHC and other experiments. A final decision regarding possible upgrade construction for the LHC, which will likely be a high priority, should also be made at that time. We have, however, included the LHC upgrade construction (starting in FY2011) in our budget plan to be sure that funding for this can be available. In evaluating this we have kept to our funding guideline that 60% of new investment be available for the ILC. The LHC upgrade construction would fit into the remaining 40%, while still allowing significant funds for investment in next-generation dark matter, dark energy and neutrino experiments.

Planning Guidelines

8. Among a range of funding options for the future provided to us, we have made our recommendations within a conservative funding plan. Significant additional discovery physics, more rapid progress on exciting projects in dark energy, as well as more rapid progress on ILC R&D would be possible with additional resources.

FY2008 Roadmap

We have tried to follow the guidelines enumerated above in making a FY2008 plan. The plan includes running of the Tevatron and the Fermilab neutrino program as presently foreseen. We congratulate the groups at the Tevatron on their recent discovery and precision measurement of B_S mixing and the groups providing the impressive first results from the Numi-MINOS program. We look forward to continued excellent physics from these programs. We also recommend strongly that FY2008 see continued improvement in support for the University program, as foreseen in the FY07 budget presently under consideration.

FY2008 Roadmap

Within our roadmap, we recommend that the B-factory running continue in FY08, allowing completion of the BaBar physics data collection at close to 1000 fb-1 of integrated luminosity. The physics opportunities have been discussed in detail in our report of six months ago. The accelerator is running very well at present. The integrated luminosity through the summer of 2006 is expected to be about 415 fb-1. The combined run in FY07 and FY08 would more than double this, allowing more incisive tests of the Standard Model and the search for new physics in channels where results are presently interesting but not definitive. The BaBar group continues to be very productive. Between January 1, 2006 and May 30, 2006 they have submitted 31 journal publications. They have also submitted 151 abstracts to the 2006 International Conference on High Energy Physics.

FY2008 Roadmap

We also make the following recommendations for other elements of the FY08 program, which are aimed at implementation of the EPP2010 vision for the field. These follow the guidelines we have listed above and provide the context for our B-factory recommendation.

1. We recommend a strongly supported program at the energy-frontier through physics at the LHC and vigorous R&D for an ILC. We note that FY08 will likely be the first year of significant data collection at the LHC and the U.S. participants should be supported to vigorously engage in this first physics. We encourage international coordination of the ILC R&D to maximize progress toward the realization of this accelerator.

FY2008 Roadmap

2. We recommend the start of construction on three smaller projects that have significant potential for important physics. These projects are:
   a) The Dark Energy Survey, which combines measurements on baryon oscillations, cluster surveys, supernovae studies, and weak lensing to significantly improve our understanding of dark energy.
   b) The next phase of the Cryogenic Dark Matter Search experiment, using a 25kg detector deep underground to significantly extend our sensitivity for direct detection of dark matter.
   c) The Daya Bay reactor experiment, contingent on satisfactory review of the costs, the construction plan, the technique, and the ability to control systematic errors to the required level. This experiment will significantly extend the reach for measuring the critical third mixing angle of the neutrino-mixing matrix.

FY2008 Roadmap

3. We recommend the start of construction on the NOνA neutrino oscillation experiment using the Numi beamline at Fermilab. This experiment is complementary to the other neutrino experiments on a worldwide basis and represents the next step for the U.S. in a phased international program aimed at measuring the remaining parameters of the neutrino oscillation matrix, determining the mass ordering among the neutrino mass eigenstates, and finding out whether neutrinos violate the CP symmetry.

FY2008 Roadmap

4. Numerous studies have identified a Large Survey Telescope and a Dark Energy Space Mission as providing large steps forward in the study of dark energy and tests of general relativity, our picture of inflationary cosmology, and measurement of cosmic distributions of dark matter. The particle physics community has been particularly active in developing candidates for each of these projects, which benefit from innovative work on detectors and data acquisition techniques developed in particle physics.

FY2008 Roadmap

These two projects, the Large Synoptic Survey Telescope (LSST) and the SuperNova Aceleration Probe (SNAP) are proposed as collaborative inter-agency projects. In the case of LSST, NSF has been the lead agency with DOE providing substantial resources as the partner agency. In the case of SNAP, DOE has been the lead agency with potential partners of either an international collaboration, which might include a foreign launch, or NASA, or perhaps both. We strongly re-affirm the compelling case for a Stage IV dark energy experiment (as described in the Dark Energy Task Force report). We recommend that both LSST and SNAP be supported to bring these projects to the "Preliminary Design Review Stage" in the case of NSF and LSST, "CD2 Stage" for the DOE parts of LSST, and "CD2 Stage" in the case of DOE and SNAP over the next two to three years (starting in FY07). This will allow sharpening of cost estimates, further interagency planning, further development of the collaborations, and continued work on the science potential as discussed in the Dark Energy Task Force report.

FY2008 Roadmap

We place our highest priority on the new projects outlined above, which have been motivated by the EPP2010 vision. Should additional funds be available in FY08, compared to our planning model, our first priority among the several important uses for it would be to enable an even more ambitious start on ILC R&D.