The U.S. HEP Program
A Global Viewpoint

by

Jonathan Dorfan
Director, SLAC

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The Next Five Years
Prospects for Data

- Combination of data of the last 10 years from proton and electron machines provide tantalizingly powerful constraints on the SM and its extensions, in particular with regard to the crucial issue of electro-weak symmetry breaking
  - Main Injector significantly extends the reach for Higgs and SUSY searches. CDF and DO provide exciting discovery potential

- Two asymmetric B Factories - KEK / Belle and PEP-II/BABAR - are working very well. We are on the brink of the next major advance in answering the critical question of the origin of CP Violation and its relationship to electro-weak Baryogenesis.

Along with the upgrade of CESR / CLEO, we can anticipate a new level of precision in the study of heavy flavors. In the next 5 years, we could have 10-100 times the statistics of present data
Data Prospects
(Continued)

- Recent oscillation data indicate that neutrinos have mass - this opens up a new horizon of important questions
  - Mini BooNE and NuMI / MINOS are key elements of the next level of understanding

We will need more powerful proton sources to answer all the critical questions

Majorana or Dirac? How to measure masses, as opposed to mass differences?
  - Neutrinoless double beta decays offer exciting possibilities

- We are entering a most exciting era for new data. The US program provides the bulk of the strength of the accelerator-based program of the next 5 years
  - It is crucial that we maximize the physics output. This demands aggressive utilization, expeditious implementation of in-construction facilities

Must make the physics case persuasively to Administration and Congress. We are significantly under-funded, given our exciting prospects
What Lies Beyond 2005?

Global Planning

- What role will the US program play in the post 2005 era?

- What are some of the key elements which will shape the major planning exercise that we are embarking on in the upcoming year?
  - Resources - both human and fiscal - are restricted in every region of the HEP world
    - Without increased international cooperation we risk extinction. Excessive regionalism will greatly reduce the scope of our field
    - Ideally, we should be crafting a world plan - HEP should be doing its planning on a global basis
    - Within the US, we need to collaborate more. We would benefit from
      - more interagency collaboration
      - more interlaboratory collaboration
      - greater involvement of the University/User community in developing the tools of the future
What Lies Beyond 2005?
(Continued)

- Maybe it’s time for a different planning model?
  Traditionally we focus narrowly on “selling” the next frontier machine. This is a short term and somewhat narrow approach
  Perhaps we should develop a long range roadmap - a ≈ 30 year vision which incorporates the major physics themes
    - Ideally such a roadmap would be imbedded in the world plan

- What might be the tools for the accelerator-based elements of such a plan?
  Major lesson of the past 30 years — the necessity for complementary accelerator probes. Without the combined strengths of proton and electron machines, we would not have the clear and detailed picture which is the Standard Model
  The reach of the Tevatron and LHC is impressive — but these machines will not provide enough detail to unravel fully the electro-weak symmetry breaking mechanism
    - We will need the complementary input from an e⁺e⁻ machine
What Lies Beyond 2005?
(Continued)

- Our 30 year roadmap needs to incorporate both of these accelerator probes. Our vision should not be captive to the 1 TeV energy scale; we need to be thinking how we evolve electron and proton collisions to the 5-10 TeV energy scale.

- In addition, we need to develop more powerful (≥ few MW) proton drivers as sources for intense, high energy ν beams. Many branches of science need such drivers — there is opportunity for collaborative development.

- We need to make sufficient room in our plans for non-accelerator experiments. These are fundamental questions to be confronted using earth-based and space-based experiments.
U.S. HEP is in Need of a Plan for its Future

- Within the global elements of a plan for U.S. HEP, we need to set down clear priorities and time lines
  - We are perceived in Washington as lacking a coherent plan and this is used against HEP, severely restricting our funding level

- If we continue to lack consensus we risk relegating U.S. HEP to a second tier program
  - In the future we will become the users of foreign facilities

- The U.S. needs a frontier facility to remain a leader in particle physics. If we wait too long to decide what that facility is, it will come too late
Research and Technology

The Committee recommendation provides $216,020,000 for research and technology, a reduction of $21,700,000 from the original request. Funding for the next linear collider is reduced by $19,200,000 and the Committee urges the Department to develop consensus within the high energy physics community and finalize the development of a long term future plan before continuing investments in this next generation facility. Funding for the other technology R&D is reduced by $2,500,000.

(this language was removed in going to the full Committee)

Excerpted from the House Energy & Water Appropriations Bill

Research and Technology

The Committee recommendation for research and technology is $224,820,000, a reduction of $12,900,000 from the budget request of $237,720,000. For fiscal year 2001 the Department requested $19,200,000 for research and development on the Next Linear Collider and $8,700,000 for research and development on the Muon-Muon Collider. Due to severe funding constraints, the recommendation limits funding for these two activities to a total of $15,000,000. With the funding constraints on operating existing facilities and the need to fund major science projects currently under construction, the Committee is not anxious at this time to fund new facilities.
US. HEP is in Need of a Plan for its Future (continued)

- **We are in striking contrast to our colleagues in Europe and Asia** - they have decided that their next facility should be a 500 GeV $e^+e^-$ machine and they are working actively on what they perceive as longer term facilities like a muon storage ring, large hadron colliders, ....

- **We must aggressively embrace the U.S. planning process of the next 12 months:**
  - Everybody is very busy with the present program - nonetheless you must find time to participate in these pressing planning issues
  - The stakes are particularly high for the younger members of our community - consider what you will be doing after the Tevatron Run II program or after BABAR
ICFA Statement on Linear Colliders

Scientific panels charged with studying future directions for particle physics in Europe, Japan, and the United States have concluded that there would be compelling and unique scientific opportunities at a linear electron-positron collider in the TeV energy range. Such a facility is a necessary complement to the LHC hadron collider now under construction at CERN. Experimental results over the last decade from the electron-positron colliders LEP and SLC combined with those from the Tevatron, a hadron collider, have led to this worldwide consensus.
Neutrino Sources Based on Intense Muon Beams

Neutrino Sources based on Muon storage rings have found a lot of interest in the High Energy Physics community (physics study). The strong point is the capability of providing very intense, very well collimated neutrino beams. Based on the work being done by the neutrino factory and muon collider collaboration, such a facility looks very similar in general to what would have to be build for a muon collider. An intense proton beam hits a target, pions decay into muons in long decay channels, the muons have to be cooled and then accelerated and finally get injected into a storage ring where the decay.

On the other hand will this specific application of an intense muon source relax a number of critical parameters. This will smooth the way towards all the different developments that will have to be done, before such a source can seriously be considered. In order to achieve the required transverse emittance, much less cooling is required because the neutrino beam divergence will be dominated by the decay kinematics of the muon and the emittance should only contribute a fraction of that. The total acceleration and the beam power will be less too, because of the lower average intensity required, which will relax the rf system. Both these arguments are good examples to investigate this application in much greater detail to develop an R&D plan for the future of such a facility.

In order to do so, a site specific study has been initiated, which should develop a preliminary design of such a facility based on the more general design being studied by the collaboration. This study will take into account specific circumstances represented by the Fermi Lab site as well as the existing Fermi Lab infrastructure. The study will also investigate a very specific application of such a muon source with a very well defined maximum intensity, energy and a certain baseline choice.

- Mike Witherell’s Letter (Postscript)
- New Final Version of the Neutrino Source Study Report (PDF)
- Organization Chart (Postscript)
- Two Day Meeting at Fermilab on February 15-16, 2000
- General Parameters for the FNAL Study (gif)
- Norbert Holtkamp’s Talk at the Executive Board Meeting, 8 October 1999 (Postscript)
- Dave Finley’s Talk at the Muon Collider Neutrino Factory Collaboration Meeting, 14 December 1999 (PDF)
- Eberhard Keil’s WWW Home Directory
- Factory Parameter Table
Subsystem Specifications (Postscript)

Subsystems

**Proton Driver** - last updated 20 January 2000
**Target** - last updated 19 January 2000
**Decay Channel** - last updated 20 October 1999
**Mini Cooling** - last updated 20 October 1999
**Phase Rotation and Induction Linac** - last updated 20 March 2000
**Adiabatic Capture** - last updated 22 November 1999
**Cooling** - last updated 6 March 2000
**Muon Acceleration** - last updated 7 January 2000
**Storage Ring** - last updated 1 February 2000

Infrastructure Support

**High Power RF Systems** - last updated 31 January 2000
**Target Support** - last updated 10 February 2000
**ES & H Support** - last updated 20 October 1999
**FESS Support** - last updated 14 January 2000
**Magnets, Stor. Ring, RL A Systems Support** - last updated 20 October 1999
**Power Supply Systems** - last updated 26 January 2000
**Power/Cooling Support** - last updated 20 October 1999
**Cryogenic Systems** - last updated 20 October 1999
**Soleniod Support** - last updated 20 October 1999

- Berkeley Lab Neutrino Factory and Muon Collider Page
- Brookhaven Lab Neutrino Factory and Muon Collider Page

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If you have any questions regarding the content of this website contact Norbert Holtkamp <holtkamp@fnal.gov> or David Finley <finley@fnal.gov>.

**Web Suggestions? Contact** Thomas G. Jurgens <jurgens@fnal.gov>

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The Case for a 500 GeV $e^+e^-$ Linear Collider

AMERICAN LINEAR COLLIDER WORKING GROUP

J. Bagger$^{11*}$, C. Baltay$^{28*}$, T. Barker$^7$, T. Barklow$^{26}$, U. Baur$^{18}$, T. Bolton$^{12}$, J. Brau$^{20}$, M. Breidenbach$^{26}$, D. Burke$^{26}$, P. Burrows$^{31}$, L. Dixon$^{26}$, H. E. Fisk$^8$, R. Frey$^{20}$, D. Gerdes$^{17}$, N. Graf$^{26}$, P. D. Grannis$^{19*}$, H. E. Haber$^4$, C. Hearty$^1$, S. Hertzbach$^{15}$, C. Heusch$^4$, J. Hewett$^{26}$, R. Hollebeek$^{22}$, R. Jacobsen$^{13}$, J. Jaros$^{26}$, T. Kamon$^{27}$, D. Karlen$^6$, D. Koltick$^{23}$, A. Kronfeld$^8$, W. Marciano$^2$, T. Markiewicz$^{26}$, H. Murayama$^{13}$, U. Nauenberg$^7$, L. Orr$^{24}$, F. Paige$^2$, A. Para$^8$, M. E. Peskin$^{26*}$, F. Porter$^5$, K. Riles$^{17}$, M. Ronan$^{13}$, L. Rosenberg$^{16}$, B. Schumm$^4$, R. Stroynowski$^{26}$, S. Tkaczyk$^8$, A. S. Turcot$^2$, K. van Bibber$^{14}$, R. van Kooten$^{10}$, J. D. Wells$^3$, H. Yamamoto$^9$

ABSTRACT

Several proposals are being developed around the world for an $e^+e^-$ linear collider with an initial center of mass energy of 500 GeV. In this paper, we will discuss why a project of this type deserves priority as the next major initiative in high energy physics.

Conclusions

- **Near-term program at U.S. facilities is very exciting - exceptional discovery potential**
  - However, we are underfunded to reap the full benefits of this program
  - Long-term plans need to maintain strong support for facility utilization

- **We lack consensus on how to evolve our program beyond the present facilities**
  - The U.S. program is in dire need of a clearly articulated plan. This plan should incorporate all the essential elements, while at the same time providing clear priorities in the time-phasing of the elements
  - It should be part of a world vision

- **The community needs to get energetically involved in crafting this long-term vision**
  - The stakes are high and apathy could spell considerable long-term doom for HEP in the U.S.