Preface

ORIGINS OF THE WORKSHOP

The Division of Particles and Fields (DPF) and the Division of Physics of Beams (DPB) of the American Physical Society held a Summer Study from June 25 to July 12, 1996, in Snowmass, Colorado, to study New Directions for High Energy Physics. The principal goal of the workshop was to begin to develop a plan for the long term future of the United States high energy physics program.

The DPF Perspective

The Snowmass 96 workshop began with concern for the SSC in the summer of 1993. At that time, the DPF Executive Committee started to think about how to develop a future United States high energy physics program without the SSC. Only a few months later the worst fears for the SSC were realized with the cancellation of the project. The Executive Committee organized the Committee on Long-Term Planning (CLTP) as its principal immediate response to this event.

The CLTP did not try to duplicate or compete with the work of the Drell Subpanel on the "Vision for the Future of High-Energy Physics" of the Department of Energy High Energy Physics Advisory Panel that began about the same time. This Subpanel was asked to provide – in a short time and within a fairly narrowly defined charge – a vision of the future of the United States high energy physics program without the SSC. Given these restrictions, there was substantial opportunity for the CLTP to go beyond the effort of the Subpanel.

The CLTP consisted of a broad-based nationwide group of particle and accelerator physicists, organized in 11 working groups, each led by several convenors. Each working group made an in-depth study of the accomplishments of its subfields and the opportunities that future facilities could provide. The CLTP report demonstrated that the field of high energy physics was surprisingly robust despite the SSC setback, reaffirmed the intellectual vitality of the United States and international high energy physics programs, and endorsed the conclusions of the Drell Subpanel. However, the CLTP did not attempt to compare capabilities of different facilities considered for the future. Such comparisons require even broader participation and more direct interaction among participants than was possible with the CLTP. This sort of effort is more appropriate for a Snowmass workshop and the CLTP report proposed such a workshop to promote common understanding and start to build a consensus for the future.

The DPB Perspective

The DPB membership is concerned primarily with the physics of particle beams and with the application of these beams to diverse technologies and sciences ranging from medical treatment to high energy physics. However, high energy physics has a unique, historical position in the accelerator community: study of physics at the energy frontier was the motivation for many of the early developments of accelerators. Even though the accelerator field has diversified, accelerator science and technology still determine the energy frontier where particle physicists work, and a substantial fraction of the DPB membership works on high energy accelerators.

For these reasons the DPB shared the concerns about the implications of the cancellation of the SSC for its members and for the future of basic scientific research in the United States. The DPB Executive Committee concluded that a workshop with broad participation by accelerator and particle physicists offered the best opportunity for the discussion and interchange that would be necessary for establishing a future direction for particle physics. They also concluded that joint DPB and DPF sponsorship would bring the widest possible attendance to such a workshop. This was formally proposed to the DPF Executive Committee near the end of the CLTP study.

WORKSHOP ORGANIZATION

Given the common interests, the two divisions joined forces to sponsor and organize the 1996 Snowmass Workshop. The thinking of the two Executive Committees was in accord with the Drell Subpanel report, including the premise that the LHC program would define the high energy physics frontier in the foreseeable future and that participation by United States physicists in this effort is essential. In addition, these bodies expected that the Fermilab Main Injector, the SLAC B Factory, and Phase III of CESR would provide important frontier capabilities for other aspects of particle physics research. The workshop was chartered to consider the United States program beyond these facilities in the context of the international high energy physics program, particularly the LHC program.

The goals of the workshop included providing an opportunity for individuals interested in different future facilities to interact with each other in order to:

- provide a common understanding of accelerator and particle physics issues,
- develop a common understanding of the contributions of possible future facilities to addressing particle physics issues, and
- start to build a consensus for the future United States program.

The Executive Committees appointed an Organizing Committee to organize the workshop and an International

Snowmass '96 International Advisory Committee

G.Altarelli	CERN	D. Green	Fermilab	J. Rees	SLAC
C. Baltay	Yale	G. Kane	Michigan	F. Sciulli	Columbia
E. Berger	Argonne	T. Kondo	KEK	A. Sessler	LBL
S. Drell	SLAC	S. Ozaki	BNL	M. Shaevitz	Columbia
M.K. Gaillard	LBNL	R. Peccei	UCLA	G. Trilling	LBNL
F. Gilman	Carnegie Mellon	C. Pellegrini	UCLA	G. Wolf	DESY
P. Grannis	Stony Brook	L. Pondrom	Wisconsin	M. Zeller	Yale

Snowmass '96 Organizing Committee

Co-Chairs: D. Cassel, Cornell, DPF and R. Siemann, SLAC, DPB					
D. Amidei	Michigan	S. Holmes	Fermilab	M. Peskin	SLAC
J. Appel	Fermilab	F. Merritt	Chicago	L. Price	ANL
S. Dawson	BNL	H. Montgomery	Fermilab	C. Sazama	Fermilab
		U. Nauenberg	Colorado		

Snowmass '96 Working Groups and Convenors

QCD					
P. Burrows	MIT	S. Dawson	BNL	S. Ellis	Washington
L. Orr	Rochester	W. Smith	Wisconsin		
New Phenomena					
S. Godfrey	Carleton	J. Hewett	SLAC	K. McDonald	Princeton
		L. Price	ANL		
Light Higgs					
H. Haber	UC Santa Cruz	T. Han	UC Davis	F. Merritt	Chicago
		J. Womersley	Fermilab		
Strong Coupling					
D. Amidei	Michigan	S. Chivukula	Boston U	P. Drell	Cornell
N. Hadley	Maryland	M. Peskin	SLAC		
SUSY					
J. Bagger	Johns Hopkins	U. Nauenberg	Colorado	X. Tata	Hawaii
		A. White	UT Arlington		
Accelerators					
M. Harrison	BNL	S. Holmes	Fermilab	E. Paterson	SLAC
		J. Wurtele	UC Berkeley		
Detector Coordinating Committee					
M. Breidenbach	SLAC	M. Gilchriese	LBNL	R. Lipton	Fermilab

Advisory Committee to provide essential advice – including international perspectives – on the issues to be studied and the Convenors of the working groups.

The workshop was organized around an accelerator working group and five particle physics working groups. The latter groups addressed specific physics topics and examined the possible contributions of several "benchmark accelerators" – given in the table below – to address these issues. These benchmark accelerators were chosen to provide standards, limit options, and avoid confusion among the working groups.

The five particle physics groups were: Light Higgs, Supersymmetry (SUSY), Strong Coupling, New Phenomena, and Quantum Chromodynamics (QCD). The first three studied known approaches to electroweak symmetry breaking, the source of elementary particle masses. The New Phenomena working group considered the potential of different facilities for discovering a variety of possible new particles and interactions. The QCD group studied the contributions that new facilities could provide for clarifying our understanding of this fundamental theory. No groups were organized to study b and ν flavor physics because the next generation of

Accelerators for Physics Studies

Accelerator	E_{cm} (TeV)	L (10^{33} $cm^{-2}s^{-1}$)
LHC	14	10
Tevatron	2	1
NLC	0.5	5
NLC	1.0	20
NLC	1.5	20
$\mu^+\mu^-$	0.5	0.7
$\mu^+\mu^-$	0.5	5
$\mu^+\mu^-$	4	100
pp	60	10
e^+e^-	5	100
ep	1	0.1

facilities to address these topics is already underway, but a subgroup of the Strong Coupling Working Group did study Top physics. The possible contributions of astrophysics to particle physics had been the subject of Snowmass 94, so additional effort was not required at this time.

The Accelerator Working Group concentrated on a subset of the possible future colliders. The participants focused on technical issues, feasibilities and identifying fruitful areas for future accelerator research and development effort. No attempt was made to systematically estimate or evaluate costs because this would have required detailed, engineered and optimized designs, and most of the ideas considered at the workshop were conceptual without this level of engineering study.

Finally, a Detector Coordinating Committee helped to identify a benchmark detector for each accelerator facility and to coordinate changes in these detectors as new physics or accelerator requirements arose.

The workshop began with a two day long opening plenary session with the first day devoted to talks about particle physics and the second day devoted mainly to accelerator facilities. The speakers and topics of this opening session were:

W. Marciano	Keynote Address: A High Energy Physics Perspective
S. L. Wu	Experimental Limits on SUSY and Other New Phenomena
I. Hinchliffe	Strategies for Future Searches for New Phenomena
J. D. Bjorken	Future Directions for QCD
D. Gerdes	Top Physics Results
M. Demarteau	Electroweak Experimental Results for the Tevatron
M. Swartz	Electroweak Experimental Results from Electron-Positron Colliders
D. Burke	Next Linear Collider
N. Toge	Japanese Linear Collider
R. Brinkman	Linear Colliders at DESY
J. Marriner	High Luminosity Upgrades of the Tevatron (TEV33)
E. Keil	Large Hadron Collider
G. Dugan	Very High Energy Hadron Colliders
A. Tollestrup	Muon Colliders

These talks established the foundation of the workshop and did much to set its tone. Written versions of most of these talks have been contributed to this Proceedings.

THE PROCEEDINGS

The results of the workshop are published in this Proceedings which contains contributions from speakers at the Opening Plenary session*, the Convenors of the Working Groups and Subgroups, and individual participants and *ad hoc* groups of participants. The proceedings are available as a conventional paperback book, a CD in the Adobe Acrobat PDF format, and on the WWW at **http://www.slac.stanford.edu/pubs/snowmass96/**.

The CD version of the Proceedings includes four reports on new facilities and their particle physics potentials that were submitted to the Snowmass workshop: *The Tev-2000 Group Report* (Fermilab), *Physics and Technology of the Next Linear Collider* (SLAC), *A Zeroth-Order Design Report for the Next Linear Collider* (SLAC), and $\mu^+\mu^-$ *Collider – A Feasibility Study* (BNL). At the time this preface was written, these reports were also available in printed form from the laboratories indicated in parentheses.

These proceedings were prepared by having the authors submit PostScript files via FTP to a site at SLAC where they were processed into PDF files. The procedure was part of continuing development for automated, electronic production of conference proceedings. Much was new and untested before this workshop, and the results of this electronic publishing experiment are in an article immediately following this preface.

THANKS

We are grateful for the tremendous contributions of Fermilab to the organization and infrastructure of the workshop. It is difficult to imagine how the workshop would have succeeded without the superb organization, insight, and tireless effort provided by Cynthia Sazama. She was ably assisted by the Secretariat consisting of: Denise Bumbar, Marilyn Paul, Patti Poole, and Suzanne Weber from Fermilab; Kathie Hardy and Gail Harper from LBNL; and Mary Litynski from SLAC. Angie Seymour at SLAC provided invaluable support in the organization of the Working Groups before the workshop.

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* This section also includes a paper by I. Hinchliffe and J. Womersley on LHC physics. This paper was not presented in the opening session, but a draft was available to participants. Since the LHC was a context for much of the workshop, it seemed appropriate to include this it here.

Outstanding computing facilities were provided by Al Thomas and the Fermilab Distributed Computing Department. The computing facilities were setup, supported, and taken down by Chuck Andrews, Alden Clifford, Cele Bruce, John Urish, Steve Fry, Darryl Wohlt, Reggie Gibbons, Larry Gryziak, Andy Lego, and Jack Schmidt from Fermilab. Their work insured that participants were able to benefit fully from the local facilities and the network connections to the outside.

Laurie Gennari, who is one of the editors of these proceedings, together with Kathryn Henniss and Jamie Walker developed the procedures and WWW documents for submission and processing of the proceedings. In addition, they provided technical and editorial assistance to the authors who, by and large, were willing participants in this electronic publishing experiment. We are grateful for the extra effort and the patience that all authors contributed toward this venture.

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CLOSING COMMENT

Finally, we would like to take this opportunity to thank all who worked so hard as organizers, support personnel, and participants to make Snowmass 96 a successful workshop. In the longer term this effort will have to be judged by the impact on high energy physics.