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Formal Report (Summary)
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[PARTICLE-96-SYM#1]

New Modes Of Particle Acceleration, Techniques & Sources Symposium

(August 19 - 23, 1996)

Summary Report

BY

Zohreh Parsa

Institute for Theoretical Physics,
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Symposium Summary Report

A Symposium on "New Modes of Particle Acceleration Technique and Sources" was held August 19 - 23, 1996 at the Institute for Theoretical Physics (ITP) in Santa Barbara. This was the first of the 3 symposia hosted by the ITP and supported by its sponsor the National Science Foundation, as part of our "New Ideas for Particle Accelerators" program. The symposia was organized and chaired by Dr. Zohreh Parsa of ITP/ Brookhaven National Laboratory. [A program advisory committee was selected by Z. Parsa which included: T. Tajima, R. Sheffield and J. Kim. Due to various illness and job requirements they were not able to participate. The program was put together by Z. Parsa from the input received from many colleagues in the field].

This Symposium provided a perspective on the future direction of the Advanced Accelerator Research.

The experimental study of elementary particles has become concentrated at a few large laboratories throughout the world because of the size and cost of the accelerator facilities needed for this work. For example, the Large Hadron Collider (LHC) at CERN, currently under construction, is 27 km in circumference and is being financed by the European membership of CERN plus contributions from non-member nations. An evolutionary approach to construction of ever higher energy colliders will only continue this trend towards high cost and large size.

Experimental particle physics cannot continue indefinitely along this path if it is to have a healthy long term future. Methods must be sought to reduce the size and cost of accelerators and thereby return scope and diversity to particle physics. Revolutionary changes in accelerators are needed.

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These could be new methods for colliding hadrons, new collider concepts such as muon colliders, or the use of new technologies, for example lasers or high frequency RF, in electron-positron linear colliders. Also new methods of experimentation such as compensated $e^+ e^-$ collisions (e.g. introduction of plasma at intersection point and four beam, ...), new final focus concepts, or $\gamma - \gamma$ and $\mu^+ \mu^-$ colliders should be investigated. These ideas and technologies should be considered to the degree they will bring revolutionary, not evolutionary changes to accelerators and to the way collisions at ultra high energies can be achieved.

The ITP conference on New Modes of Particle Acceleration featured several presentations reviewing current progress in developing revolutionary accelerators based on laser driven plasma waves. In 1979, Dawson et. al, proposed three basic laser plasma acceleration concepts; however only with the recent development of compact terawatt laser systems could these concepts be fully investigated in the laboratory.

The three proposed schemes were laser wakefield acceleration (LWFA), the plasma beat-wave accelerator (PBWA) and the self-modulated laser-wakefield accelerator (SMLWFA). In the LWFA a single short laser pulse of length L excites a plasma wave of wavelength λ_p. In this scheme $L \simeq \lambda_p$. This method requires short, $\lesssim$1 pico-second, laser pulses of ultra high intensity $\gtrsim 10^{18}$ W/cm^2 and could not be tested until chirped-pulse amplification (CPA) was used to create Table-Top Terawatt (T^3) lasers. Two papers on progress in T^3 technology based on CPA in solid state lasers were presented at the ITP Symposium (G. Mourou, University of Michigan (UMI) and C. Barty, University of California at San Diego (UCSD)).

The PBWA was proposed earlier as an alternative to LWFA because short-pulse, high-power lasers were not available. This approach employs two long pulse laser beams of slightly different frequencies w_1 and w_2 such that $w_1 - w_2 \simeq w_p$ the frequency of the plasma wave which is to be resonantly excited. PBWA experiments have been performed in Japan (ILE), the USA (UCLA), Canada (CRL) and France (LULI). The UCLA experiment observed the highest electron energy gain, $\sim$28 MeV [Clayton (UCLA) et al.], with an effective accelerating gradient of 2.8 GV/m. They plan to continue with PBWA experiments.

The most impressive advances reported at the Conference came in the area of self-modulated laser wakefield acceleration (SMLWFA). In this method, a laser pulse of length $L > \lambda_p$ is subdivided into a series of shorter pulses of length $\sim \lambda_p/2$ by its interaction with the plasma wave (which it created). This interaction creates a large amplitude (resonantly driven) plasma wave. This process requires a laser power greater than the critical level required for relativistic guiding of the laser field. The phase velocity of the guiding plasma wake can become relativistic for high enough plasma electron densities, $n_p \sim 10^{19}\ cm^{-3}$, for example.

Experiments on SMLWFA have been performed in Japan (KEK), the US (LLNL, CUOS, NRL) and the UK (RAL). The latter experiment achieved impressive results: electron energy gains of $\gtrsim$44 MeV and accelerating gradients $\gtrsim$100 GV/m. Conventional accelerators are capable of accelerating gradients of $\sim$ 100 MV/m. This experiment employed a 2.5 TW, 0.5 picosecond laser, producing an intensity of 10^{19} W/cm^2 and a plasma electron density of $10^{19} cm^{-3}$.

The accelerated electrons in this experiment cover a wide range of energies from a few MeV up to the maximum. The theoretical limit for this experiment was $\sim$ 70 MeV. The spectrometer was capable of measuring only up to 44 MeV. The normalized transverse emittance of any particular energy group was about 5π mm-mrad, which is on the order of the emittance of photo injector based linacs. However the measured beam current was 10-100 times lower than that achieved with photoinjectors.

Although the reported accelerating gradients for SMLWFA are spectacular, they are achieved over short distances of the order of 100's of microns to millimeters. The size of the acceleration distance is determined by the diffraction limited Rayleigh length (of the region of minimum focal spot size). Various schemes for getting accelerating lengths greater than a few Rayleigh lengths were discussed at the Conference.

For example, optical guiding can be achieved with preformed lower density plasma channels produced by hydrodynamic expansion of ionized gas generated by another laser focused along the acceleration axis. Other approaches suggested were using laser blow out to create a low density hollow plasma channel or using acoustic wave channel formation. Relativistic focusing can provide optical guiding in the case of SMLWFA for laser power levels $P > P_c = 17(w/w_p)^2$ GW. Other limiting factors on accelerating lengths are electron detuning, (i.e., the length over which the accelerated relativistic electron outruns the plasma wave), and pump depletion,(i.e. is roughly the length over which the laser pulse gives up all its energy to the plasma wake).

All these SMLWFA experiments have accelerated background plasma electrons. Producing and injecting 20-100 femto-second electron bunches is a difficult challenge. Umstadter et al. propose to solve this problem by using two orthogonally propagating laser pulses, one along the acceleration direction as a plasma wave pump pulse, and an injection pulse at right angles. This scheme is called LILAC, laser injection and laser acceleration. The University of Michigan is building an all optical accelerator to produce femto-second electron pulses with GeV energies.

Another approach discussed at the conference, was that of Plasma wakefield accelerators, which are similar to LWFA, except that one or more relativistic electron beams are used to excite the accelerating plasma wave. The electron beam pulse must be shorter than the plasma wavelength in analogy with the situation for the LWFA. This concept was originally proposed by Fainberg in 1956. Enhancing the wakefield by using multiple electron drive bunches spaced at the plasma period was proposed in the original work on PWFA. The first PWFA experiment was performed by Berezin and co-workers in the early 1970's in Ukraine. More recently experiments were performed in the US (e.g. at Argonne Nat. Lab) and in Japan (at KEK).

At this conference Skrinsky and co-workers proposed a system design for a 1TeV PWFA using a pre-ionized hydrogen plasma, which is driven by trains of electron bunches, which are made of 10 micro-bunches of 0.2 mm length. This system would employ a 10 GeV drive beam at 10 kHz rep rate with 2×10^9 electrons/bunch. Challenges involve the energy requirements of maintaining the hydrogen plasma channel. A PWFA test experiment is being proposed at INP, Novosibirsk with a goal to reach more than 0.5

GeV/m over several tens of cm.

The exciting experimental results on high gradient laser plasma acceleration and the successful modeling and simulation of these systems gives great confidence that these concepts are beginning to be understood well enough to plan the next stage of accelerator development. Such second generation plasma accelerators would address issues of beam quality. It was proposed that a modest near term goal be the production of 100 MeV electrons with an energy spread of $\sim$5%, normalized emittance of $\lesssim 10\pi$ mm-mrad and number of particles per bunch $\gtrsim 10^8$ (T. Katsouleas, University of Southern California (USC)). This would require injecting pre-bunched beams with $\tau_{bunch} < 60$ fsec. Another scheme (D. Umstadter, University of Michigan (UMI)) plans for all optical laser accelerators to produce femto-second electron pulses at the GeV level.

The field of laser plasma acceleration should continue to benefit from research on high power, short pulse lasers. The potential for applications (in other fields) of these high power lasers helps to maintain interest and support for this area of research. Some applications of these lasers include ultrafast x-ray sources for time-resolved diffraction studies of phase transitions in materials, time-resolved absorption spectroscopy, and high resolution, time-gated radiology. For example, the latter application could, in principle, result in improved resolution and lower patient dose for mammography. These lasers are also of interest in studies of ultra-dense plasma physics and highly relativistic laser-matter interactions (C. Barty, UCSD).

Among the other subjects treated were power sources such as RF Sources (R. Phillips, Stanford Linear Accelerator Center (SLAC)), Laser as a power source (G. Mourou, UMI), Pulsed Power Sources (M. Gunderson, USC); Advanced accelerator schemes such as Laser Acceleration (W. Mori, University of California, Los Angeles (UCLA)), Two Beam Accelerator (S. Yu, Lawrence Berkeley Lab (LBL)), Inverse Free Electron Laser & Free Electron Laseres (C. Pellegrini, UCLA), Inverse Cerenkov (W. Kimmura, STI Optronics), open waveguide structure for laser acceleration (R. Pantel, SLAC); beam cooling (A. Skrinsky, Institute of Nuclear Physics, Novosibirsk (BINP)); Laser cooling (A. Sessler, LBL);crystal Accelerator (P. Chen, SLAC).

There were other presentations including parametric x-radiation (A. Shahigan, Kharkov Inst. of Physics and Technology, Ukraine), Femto-second x-ray pulses (M. Zholents, LBL), Advanced Linear Accelerator development (D. Cline UCLA). Beam Sources such as High current short pulse Ion Sources (K. Leung (LBL)), High Intensity Neutron Spallation Sources (R. Macek, Los Alamos National Lab (LANL)), High Intensity Muon Source; Beam Dynamics and emittance, etc.

Laser Plasma issues (Esarey, Naval Research Lab (NRL)), Self Modulation of Intense Laser Pulses in plasma Channels (N. Andreev, Russian Academy of Science (RAS)), Production of Ultra Short Laser Pulses (C. Barty, UCSD), Short Bunch Injection, Synchronization and Acceleration in Laser Wakefields (D. Umstadter, UMI), update on Laser Plasma experiments (C. Joshi, UCLA) also were discussed.

The symposium included two unique discussion sessions on "Laser plasma based Acceleration" and on "New Advances and basic issues" in which participants presented and clarified their views on outstanding problems and topics presented at this conference. This forum provided new and valuable input for future direction and developments in this field. There was a great interest and request by participants to write up a "white paper" on the future direction of the advanced accelerator research. And some have sent in contributions and suggestions on what to be included in the write up of the "white paper", illustrated below..

Following illustrates the interest and high levels of activities and experties of our participants. First is the thoughts regarding the workshop (in response to my request to our participants) from Eric Esarey (Beam Physics Branch Plasma Physics Division Naval Research Laboratory):

1. There has been tremendous progress in the development of compact terawatt lasers based on chirped pulse amplification (pioneered by Gerard Mourou in 1988). These systems deliver short ($< 1ps$) high intensity ($>10^{18}\ W/cm^2$) laser pulses and are ideal drivers for laser-plasma accelerator. This technology is rapidly evolving and improvements are made nearly on a monthly basis (e.g., shorter pulses lengths, higher powers, higher rep-

rates). 2. These new developments in laser technology have led to a whole host of new experimental results on laser-plasma accelerators. All of the recent results (e.g., Rutherford, NRL, Michigan) utilize this new technology. The exception is the Plasma Beat Wave Accelerator experiments at UCLA, which began some 10 years ago and use old, long pulse CO_2 technology.

3. The recent results obtained at Rutherford, NRL, Michigan use very similar experimental arrangements in very similar parameter regimes. They all operate in the self-modulated (or forward Raman) regime of the laser wakefield accelerator (LWFA): a multi-terawatt subpicosecond laser pulse is injected into a relatively high density (10^{19} cm^{-3}) plasma. At this high of a density, the laser pulse power is above the critical power for relativistic self-focusing and the pulse length is several plasma wavelengths long. The pulse undergoes a strong self-modulation (or forward Raman) instability, becoming highly modulated at the plasma wavelength, and driving very large amplitude plasma wave wakefields. The plasma wave amplitude is so large that it traps and accelerates a small fraction of the background plasma electrons.

4. The experimental arrangements are virtually the simplest possible configurations, i.e., these experiments are only in their first stage (their infancy) and are most likely far from those that will be used in an actual, practical accelerator. In the Rutherford, NRl, Michigan experiments, a multiterawatt subpicosecond laser pulse is injected into a high density gas jet (10^{19} cm^{-3}). The pulse self-modulates, drives a plasma wave, and self-traps and accelerates plasma electrons. The forward scattered light as well as the accelerated electrons are detected and analyzed.

5. The parameters of the NRL and Michigan experiments are nearly identical: a few terawatts in 400 ps. Rutherford uses 10-20 TW in 800 ps. Rutherford (in collaboration with UCLA and Imperial College) has measured the highest energy electrons: they measured the high energy end of the self-trapped electron spectrum and see an exponential fall-off in the number of electrons in the region 30-100 MeV (44 MeV obtained last fall/100 MeV this spring). Michigan has measured the low energy region of the spectrum (1-10 MeV, obtained this winter). NRL has measured high energy

electrons out to 30 MeV (this summer). All have used bending magnets to diagnose the electron energies and all experiments were limited by the size of the magnet (limits maximum detectable electron energies) and by detector noise. All of these experiments have also measured stokes/anti-stoke lines (lines shifted by multiples of the plasma frequency) in the forward scattered pump laser light, which is indicative of the formation of a plasma wave via self-modulation.

6. NRL was the first (last fall) to use a pump-probe configuration. Prior to injection, part (10%) of the pump laser pulse is split off and frequency doubled to form a probe pulse, which is run through an adjustable delay line and injected some distance behind the pump pulse. The pump pulse drives the wakefield, and the probe pulse detects the wakefield via coherent Thomson scattering. By adjusting the pump-probe delay, the time history of the excited plasma wave can be measured. The NRL results have been submitted to PRL. Michigan performed similar measurements this spring, and Rutherford this summer as well.

7. An actual practical accelerator needs to produce good electron beam quality. In the self-modulated LWFA experiments described above, the electrons are self-trapped from the background plasma which results in a large (100be achieved by operating a LWFA in the "standard" regime (at lower plasma density so that the laser pulse is approximately one plasma wavelength long, e.g., a 1 ps laser pulse in a $10^{16} cm^{-3}$ plasma). In the standard LWFA, electrons will not be self-trapped from the background plasma. Acceleration requires injection of a short ($<$ 1 ps) few MeV electron bunch. NRL is presently completing the construction of a 4.5 MeV rf electron gun, and will be the only lab with both a multi-MeV rf electron gun and a multi-terawatt subpicosecond laser. UCLA has an operating rf gun which they use in there long pulse, CO_2 beat wave accelerator experiments. Good accelerated e-beam quality requires the production of subpicosecond electron bunches and synchronization to the plasma wave wakefield, which are outstanding technical issues. Michigan has a completely different approach to electron injection in the standard LWFA: an all optical injection system which does not require the use of an rf electron gun. They call this

LILAC (laser injected linear accelerator). It utilizes two laser pulses: the first drives the wakefield (as in the standard LWFA) and the second pulse, some distance behind the pump pulse, is used to kick up plasma electrons such that they become trapped and accelerated by the wakefield. This is a novel and promising approach, but one that requires further numerical and experimental study.

8. A practical laser-plasma accelerator also requires some form of optical guiding (propagation of the laser pulse over many Rayleigh diffraction lengths). The most promising method is the use of preformed plasma density channels, as proposed and simulated by the NRL group in 1991. Milchberg (Maryland) has created plasma channels with an axicon focusing geometry and has guided a low intensity (10^{14} W/cm^2) laser pulse nearly 100 Rayleigh lengths in a channel, a very promising result. More recently Hebrew Univ in collaboration with NRL have guided more intense laser pulses (10^{17} W/cm^2) in a preformed plasma channel produced by a slow capillary discharge (accepted by PRL). Experiments in the high intensity regime ($>10^{18}$) are being pursued at NRL, Maryland and LBL.

9. Overall, the new laser technology has led to a rapid outgrowth of new experimental results on the LWFA. These results were obtained relatively easily (in a few months) and use the simplest possible configurations. Both the laser technology and the LWFA experimental results are improving rapidly – nearly on a monthly basis. The major experimental research on the LWFA in the US is at NRL and Michigan (the plasma beat wave accelerator is at UCLA). Experimental programs are also being developed at Texas, Maryland, LBL, Livermore and UCSD. Funding in the US is modest at best, funded partially by DOE and internal lab funds (Livermore announced a new lab initiative this summer). Japan has announced this past fall (JAERI (?) Japanese atomic energy research institute) the start of a large program ($100 million/year excluding salaries, and plan on hiring 200 full time scientists over the next five years) on the development of short pulse lasers and their applications, including the LWFA. England (Rutherford) and France (LULI) also have significant programs. If the US is to stay competitive in this field, a higher commitment of research funds is necessary.

Another interesting response was from Donald Umstader, Univerrsity of Michigan:

The difference between our (Umstader et al.) measurements and previous measurements of laser wakefields (including those of the RAL collaboration) are as follows: We measured for the first time a naturally emitted beam of electrons. The beam was found to have both a useful transverse emittance (1 mm-mrad) and a useful number of relativistic ($\gamma mc^2 >$1 MeV) electrons, 10^{10} (5 nanocoulombs), over two orders of magnitude higher than previously reported by RAL. The amplitude of the wakefield (2 GeV/cm) is two orders of magnitude higher than previously reported, and four orders of magnitude higher than conventional linacs. A clear power threshold for the onset of acceleration was for the first time observed at the critical power (P_c), indicating that relativistic self-focusing plays an important role in 3-D as predicted by theory. The duration of the wakefield was measured for the first time, equal to 100 plasma periods, or 1.5 picoseconds. The damping of the plasma wave is attributable to beam loading.

If the average power could be increased, this would already make a useful medical accelerator. In terms of applications to FELs and high-energy physics, not only must the duty cycle be increased, but a means must be found to inject electrons with femtosecond precision in order to reduce the energy spread or longitudinal emittance. We have suggested the lilac concept, which is an all-optical cathode-less means by which a synchronized laser pulse takes electrons directly from the plasma wave itself and injections them at the right phase to be accelerated. Another issue especially important for high-energy physics is efficiency. We have suggested a method for obtaining several orders of magnitude greater power efficiency by resonantly driving the plasma wave with a train of multiple pulses with appropriate interpulse spacing and variable widths, called the Resonant Laser Plasma Accelerator (RLPA). What is most interesting is the possibility of accelerating femtosecond electron bunches, four orders of magnitude shorter than conventional linacs. These electrons or the x-rays they could make with an undulator would have applications to the study of ultrafast dynamics on chemical timescales.

The results are listed below.

- Wakefield acceleration of MeV electrons

  field gradient ~ 2 GeV/cm

  transverse emittance ~ 1 mm-mrad

  electron bunch-density $> 10^{10}$ (5 nC)

  energy spread $\sim 100\%$

  acceleration onset at $3P_c/2$ and $\tilde{n}/n_e \sim 10\%$

  wakefield onset at $P_c/2 \Longrightarrow$ relativistic self-focusing

  evidence for a relativistically self-focused channel

- Resonant Laser Plasma Accelerator (RLPA)

  optimized laser pulse train

  improved power efficiency ($>$ factor of 10)

- Laser Injected Laser Accelerator (LILAC)

  all-optical synchronized injection and acceleration

  $\tau_e = 10$ fs, low emittance, low energy-spread

In terms of a white paper, Umstadter suggests that the critical issues to be studied are (1) what are the means of injecting electrons with femtosecond precision, (2) what are the means of creating plasma channels many Rayleigh lengths long, and (3) can the electron beam properties preserved through multiple synchronized accelerating stages. Of course, it must also be demonstrated that electron beams can be accelerated in a single stage with suitable properties for high energy physics.

There were many other very interesting comments from the participants, but due to time and space limitations are not included here.

The Symposium started with a defining perspective presentation by R. Siemann (SLAC) and ended with a summary and closing presentation by Z. Parsa (BNL). The symposium was a success, with a very interesting program and an overwhelming active group of expert participants.

The proceedings of this symposium will be published shortly. Those interested may send e-mail to the address given below.

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ITP Conference on

NEW MODES OF PARTICLE ACCELERATIONS TECHNIQUES AND SOURCES

August 19-23, 1996

Coordinator : Z. Parsa

SCHEDULE

Monday, August 19, 1996:

Convener: Z. Parsa

Time	Speaker	Title
8:00 am	Registration	ITP Lobby
8:40	J. Hartle, ITP Director	Welcoming Remarks
	Z. Parsa, BNL	Introduction to Program
Defining Perspective Presentation:		
9:10	R. Siemann, SLAC	Status and Future Direction of Advanced Accelerator Research
10:10	Refreshment Break	ITP Front Patio
Convener: A Sessler		
Power Sources - Status, Advances and Limitations:		
10:30	R. Phillips, SLAC	RF Sources
11:15	G. Mourou, U. Michigan	Laser as a Power Source
12:00 pm	Lunch Break	ITP Front Patio
Convener: A. Skrinsky		
1:30	M. Gunderson, USC	Pulsed Power Sources -- Physics Issues Underlying Power Conditioning for Accelerators
Advanced Accelerator Schemes:		
2:15	W.B. Mori, UCLA	Laser Acceleration
3:00	Refreshment Break	ITP Front Patio

3:20	S. Yu, LBL	Two Beam Accelerator
4:05	C. Pellegrini, UCLA	Advances in Inverse Free Electron lasers and an Update on Free Electron Lasers
4:50	W. Kimura, STI Optronics	New Advances in Inverse Cerenkov Accelerator
5:30	Wine & Cheese	ITP Front Patio
6:00	Buffet Dinner	ITP Front Patio

Tuesday, August 20, 1996

Convener: C. Pellegrini

Time	Speaker	Title
New Modes of Acceleration & Applications:		
9:00 am	T. Katsouleas, USC	Plasma Beat Wave Accelerator (PBWA) and Overview of Plasma Acceleration
9:45	A. Skrinsky, BINP	Plasma Wafefield Accelerator (PWFA) and System Designs
10:30	Refreshment Break	ITP Front Patio
10:50	C. Joshi, UCLA	Progress in Laser Plasma Experiments
11:35	R. Pantel, Stanford Univ.	Open Waveguide Structure for Laser Acceleration
12:15 pm	Lunch	ITP Front Patio

Convener: R. Siemann

Emittance Issues of Acceleration Methods:		
1:45	E. Esarey, Naval Res. Lab.	Laser Plasma Physics Issues
2:30	N. Andreev, RAS	Self-Modulation of Intense Laser Pulses in Homogeneous Plasma and Plasma Channels
3:15	Refreshment Break	ITP Front Patio
3:35	B. Breizman, Univ. Texas	Beam Dynamic Issues in Plasma Wakefield Accelerators
4:20	T. Katsouleas, USC	Beam Dynamic Issues in Laser Plasma Accelerators
5:15	**end of session**	

Wednesday, August 21, 1996

Convener: W. B. Mori

Time	Speaker	Title
9:00 am	C. Barty, UCSD	Production of Ultra Short Laser Pulses
9:45	D. Umstadter, U. Michigan	Short Bunch Injection, Synchronization, and Acceleration in Laser Wakefields
10:30	Refreshment Break	ITP Front Patio
10:50	A. Skrinsky, BINP	Beam Cooling Techniques
11:35	A. Sessler, LBL	Laser Cooling
12:15 pm	Lunch	ITP Front Patio

Convener: E. Esarey

Time	Speaker	Title
1:45	P. Chen, SLAC	Crystal Accelerator (Plasma wake in conduction electron and channeling
2:20	A. Skrinsky, Z. Parsa, N. Andreev, B. Breizman C. Joshi, W.B. Mori G. Stupakov, T. Katsouleas V. Gorev, D. Umstadter, and others	**Reports*** on New Advances in Lasers, Plasma based Acceleration Techniques **and Panel Discussions** [*= to be announced]
3:20	Refreshment Break	ITP Front Patio
3:40	G. Stupakov	Beam Emittance in PWFA
4:10	T. Marshall, Columbia	Microwave Inverse Cerenkov and FEL Accelerators: "Tabletop" Systems for Applications at 10 -20 MeV.
4:50	V. Telnov, BINP	Requirements of Beam Emittances in Photon--Photon Colliders and Methods of Realization
5:30	**end of session**	

Thursday, August 22, 1996

Convener: D. Rule

Time	Speaker	Title
9:00 am	A. Shchagin, KIPT	Parametric X-ray radiation as Source of Short pulses of X-ray beam
9:30	A. Zholents, LBNL	Generation of Femto-Second X-Ray Pulses at Synchrotron Sources
10:05	Refreshment Break	ITP Front Patio

Convener : K. von Bibber

10:25	D. Cline, UCLA	Advanced Linear Accelerator Development for Linac Ring Colliders

Snowmass 96

11: 00	J. Wurtele, LBL	Summary of Accelerator Issues

Beam Sources - Status, Advances, and Limitations:

11:40	K. Leung , LBL	High Current Short Pulse Ion Sources
12:20 pm	Lunch	ITP Front Patio

Convener: B. Zotter

1:45	R. Macek, LANL	High Intensity Neutron Spallation Sources

Report on New Advances:

2:25	W. Molzon, UCI	High Intensity Muon Source
3:05	C. Bula, Princeton Univ.	Observation of Nonlinear QED Effects in Electron-Laser Collisions
3:35	Refreshment Break	ITP Front Patio
4:00	M. Ottinger, Univ. Texas	SYN2 - A New Model for Tracking Space Charge Perturbed Snychrotron Beams
4:20	Z. Parsa, C. Pellegrini, A. Sessler, R. Siemann, J. Wurtele, V. Telnov, T .Marshall V. Gorev, R. Macek, K. Leung, D. Cline, A. Skrinsky and others.	Reports* on New Advances and Round Table Discussion on Basic Issues
	TBA	
5:45	Beer and Chips	ITP Front Patio
6:15	Fiesta Barbeque	ITP Front Patio

Friday, August 23, 1996

Convener: N. Andreev

Time	Speaker	Title
Reports on New Advances (continues):		
9:00 am	J. Allen, UCSB	Photon Assisted Transport in Semiconductor Quantum Structures with the UCSB FEL's.
9:45	J. Wells, Harvard Univ.	Superintense Laser.- Atom Interactions:
10:15	Refreshment Break	ITP Front Patio
10:35	W. Lee, Princeton Univ.	Perturbative Particle Simulation of Space Charge Efects for a K-V Beam
11:05	M. Pato, Univ. Sao Paulo	TBA
12:15 pm	Lunch	ITP Front Patio
1:45		Reports* (continues)
	Z. Parsa	Summary and Closing Talk

TBA	To Be Announced
*	To Be Confirmed
BNL	Brookhaven National Laboratory
LBL	Lawrence Berkeley National Laboratory
LANL	Los Alamos National Laboratory
BINP	Budker Institute of Nuclear Physics, Novosibirsk
RAS	Russian Acacdemy of Science
KIPT	Kharkov Institute of Physics and Technology, Ukraine
SLAC	Stanford Linear Accelerator Center