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Publication Date
1988-09-01

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Physics Division

Invited talk presented at the XIX International
Symposium on Multiparticle Dynamics, "New Data and
Theoretical Trends," Arles, France, June 13–17, 1988

Future Directions in High Energy Electron-Positron Experimentation

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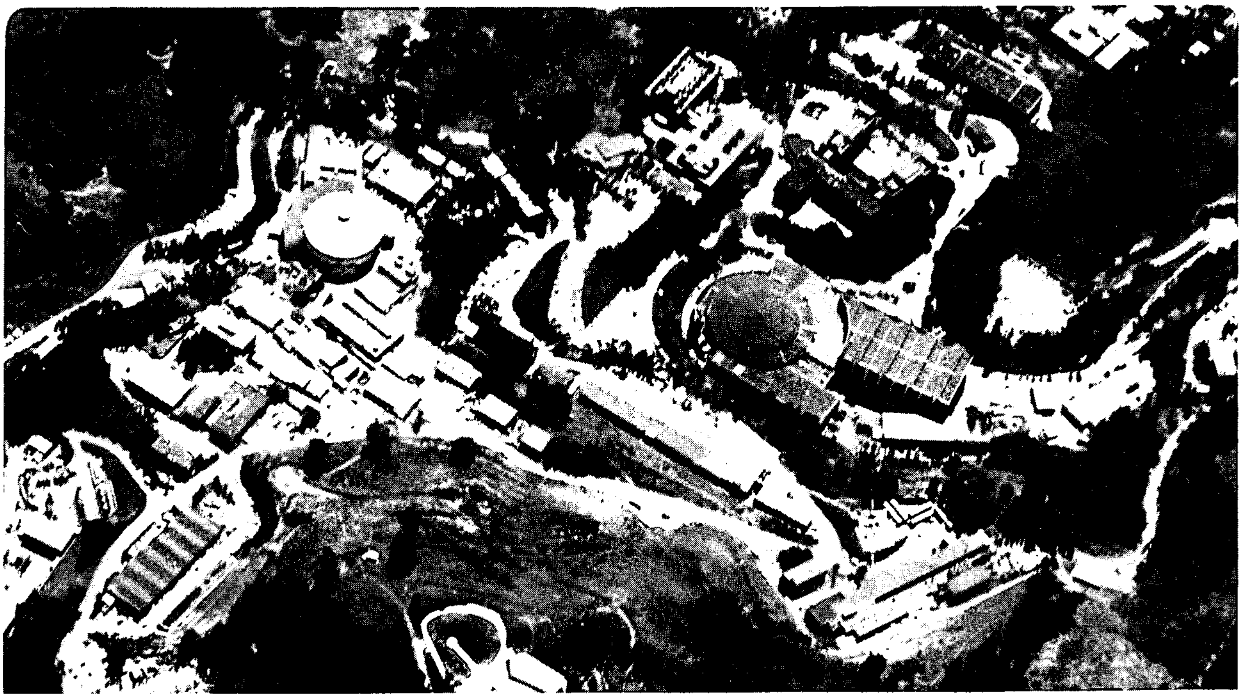
September 1988



Prepared for the U.S. Department of Energy under Contract Number DE-AC03-76SF00098.

FUTURE DIRECTIONS IN HIGH ENERGY ELECTRON - POSITRON EXPERIMENTATION[†]

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In this report, I discuss the possibilities of studying particle physics at the TeV scale with high energy electron-positron linear colliders. A status report on the SLC and the MARK II program is given to provide some insights on the feasibility of experiments at linear colliders. The technical issues in going from SLC to the development of TeV colliders are briefly discussed. I summarize some of the elements of the e^+e^- experimental environment which differentiate it from that in hadron colliders and give examples of processes particularly well suited to attack by e^+e^- annihilation. Finally some concluding remarks are given.

[†] LBL-25921

[*] This work was supported by the Director, Office of Energy Research, Office of High Energy Physics, of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

1. Introduction

My purpose in this talk is to make some comments about future prospects for physics experimentation with electron-positron colliders. The extraordinary cleanliness of such experiments has in the past made possible a rapid pace of discoveries, and follow-up programmatic studies. Thus the charm quark discovery was followed by extensive studies of charmonium, charmed-meson spectroscopy and charm-weak-decay properties. Even now, more than ten years after the tau lepton discovery, our total knowledge of tau decay modes, mass, lifetime etc., comes from e^+e^- annihilation experiments. While the b-$\bar{b}$ upsilon states were discovered in a hadronic fixed-target experiment, virtually all subsequent information on states containing b quarks has come from electron-positron storage ring experiments.

Presently we are on the threshold of a new round of such experiments, focused principally on two resonant energies: (1) at the Z^0 with physics turn-on of the SLC and LEP Colliders expected in the near future and (2) at the Υ (4S) with the development of unrivalled luminosity and detector power at the Cornell facility CESR/CLEO II, as well as continuation of the highly productive DORIS/ARGUS program. At the same time, operations at the Beijing Electron Positron Collider (5 GeV), the upgraded PEP ring (29 GeV), and the recently turned-on TRISTAN facility (60 GeV) will provide strong programmatic opportunities in three different energy regions.

For the future, beyond the colliders which exist or are under construction, there are two regimes of particular interest. The first involves the production of B-$\bar{B}$ hadron pairs with sufficiently high rate to permit exploration of CP violation. This typically requires a machine operating near the Υ (4S) mass with luminosity well in excess of $10^{33}\text{cm}^{-2}\text{sec}^{-1}$ or a Z "factory" with similar luminosity. In this report, I shall not discuss this direction.

The second interesting regime, which I shall discuss here, involves energies substantially higher than that of LEP to extend the natural cleanliness of e^+e^- collisions to the challenging problems of discovering what happens at energies near 1 TeV. This region is also subject to exploration by the proposed LHC and SSC hadron colliders. However one might anticipate that some areas of the high energy domain are sufficiently difficult to study with hadron colliders that the development of an e^+e^- capability may be desirable.

Our physics goals at higher energies generally pose two experimental challenges: (1) the development of colliders of the desired energy and correspondingly high luminosity (since cross sections typically decrease as inverse powers of the characteristic masses under study), and (2) the fabrication of detectors which can handle the desired luminosities and provide sufficiently detailed and precise information on the rather complex processes of interest. It is an approximate representation of the experimental situation that, for hadron colliders, item (1) seems relatively straightforward and item (2) very challenging whereas for e^+e^- just the reverse seems to be true. Extension of e^+e^- techniques to energies well above those of LEP II requires a completely new class of colliders, the so-called linear colliders, which are very different from the storage rings universally used until now.

The Stanford Linear Collider (SLC) is the first linear collider to be built, and I shall therefore devote some of this report to a discussion of its status. I shall then move on to discuss the prospects for the development of higher energy linear colliders and their exploitation to do exciting physics.

It may be useful to recall why linear colliders appear to be the preferred route to higher e^+e^- energies. The cost-scaling law for electron storage rings goes roughly as,

$$C \sim A\,E^4/R + BR \qquad (1)$$

where C = cost, E = energy, R = bending radius, A,B = constants. The first term on the right side is the cost of providing RF power to make up the synchrotron energy loss, and the second term represents the tunneling and other costs proportional to circumference. Cost optimization makes these two terms about equal, with $R \sim E^2$, $C \sim E^2$ as the scaling law. [This optimization does not apply to protons at presently contemplated energies, as in that case A is vastly smaller and R is limited by maximum achievable magnetic field to sufficiently large values as to make the E^4/R term relatively small]. It is the above scaling law which leads to the usual conclusion that LEP is likely to remain the highest energy e^+e^- storage ring ever built.

The linear collider, in essence, consists of two linacs which accelerate bunches of electrons and positrons to collide head-on. After collision both bunches are dumped, and for the next collision, new bunches must be injected and accelerated to full energy. The advantage is that the expected scaling of cost with energy is approximately linear, and, therefore, at some energy the linear collider should be cheaper than the storage ring. It may seem paradoxical that in replacing the partial synchrotron energy loss in a storage ring with the total loss incurred through dumping of the beams after each collision in a linear collider, the economics can improve. This is explained by the fact that in a linear collider the bunches can be focused to much smaller transverse size than in a storage ring, precisely because they need not be preserved after each collision. Therefore less intense bunches and lower repetition rates can provide equivalent luminosity, reducing demand for RF power. Obviously the aim is to develop linear collider designs which make the ratio of cost to energy as small as possible in the hope that for the TeV energy range, the actual cost will remain sufficiently modest to allow a viable construction proposal. Such designs go beyond the present state of the art and demand substantial investments in R&D.

2. The Stanford Linear Collider (SLC)

The SLC was proposed by SLAC with two aims: (a) to serve as an accelerator R&D project to develop and test the feasibility of some of the linear collider concepts, including the production, acceleration and control of intense and extremely small (~1μm) beam bunches, and (b) to do e^+e^- annihilation physics at the Z mass. The SLC design luminosity is 6 x 10^{30} $cm^{-2}s^{-1}$, but the large cross section at the Z allows the possibility of very interesting physics at much lower luminosities.

Figure 1 shows a diagram of the SLC. Unlike future high energy collider designs, this rather economical concept involves the use of the single SLAC linac, with energy upgraded to 50 GeV/beam, to accelerate simultaneously both electrons and positrons, magnetically separate them at the end of the linac, and transport them via two magnetic arcs into head-on collision at the interaction point. The SLC cycle involves the transport down the linac of one positron and two electron bunches, one of which is made to impinge at the 2/3 point of the linac on a target to produce positrons for a subsequent cycle. Two small rings of magnets ("damping rings") are used to reduce the emittances of both positron and electron bunches by synchrotron radiation cooling. The gymnastics involved in transporting three bunches simultaneously down the same linac and the effects of the collider arcs are peculiar to the SLC and not directly relevant to high energy colliders. However the problems of producing and accelerating low-emittance intense bunches, focusing them to extremely small sizes at the interaction point, maintaining them in collision, and achieving this demanding level of operation on a continuing and reliable basis are highly relevant to future systems.

The SLC was officially completed in March 1987, and has been in the commissioning process since then.1) The MARK II detector was moved into the beam line in October 1987. A special beam pipe, with a flip mechanism to place transverse horizontal and vertical wires of 4, 7 and 28 μm diameter into the beam at the IP to sample its position and intensity profile, was installed. Two types of signals are obtained with these wires: a secondary emission signal from the wire itself and a bremsstrahlung signal detected far from the interaction point. At intensities above 6 x 10^9/bunch, the latter input is more reliable. A typical vertical beam profile based on the bremsstrahlung signal is shown in Fig. 2.

There has been substantial progress in the SLC commissioning including the simultaneous achievement of small (< 10 μm) $e^{\pm}$ spots, the acceleration of relatively intense bunches and operation at 30 Hz repetition rate (after commissioning at 10 Hz). A major milestone has been the observation of angular deflections of particles in one bunch by the electromagnetic forces from the other bunch as the two bunches cross. Figure 3 shows the deflection angles, as measured by beam-position monitors, when the positron beam is scanned across the electron beam in the x-direction, while the two beam centers remain offset by about 10 μm in the y direction. The importance of these measurement is that they demonstrate directly that the two beams of a few microns can indeed be brought into collision with each other, and that this approach, unlike the use of the flip wires, provides a background-free tool to keep the two beams colliding with each other.

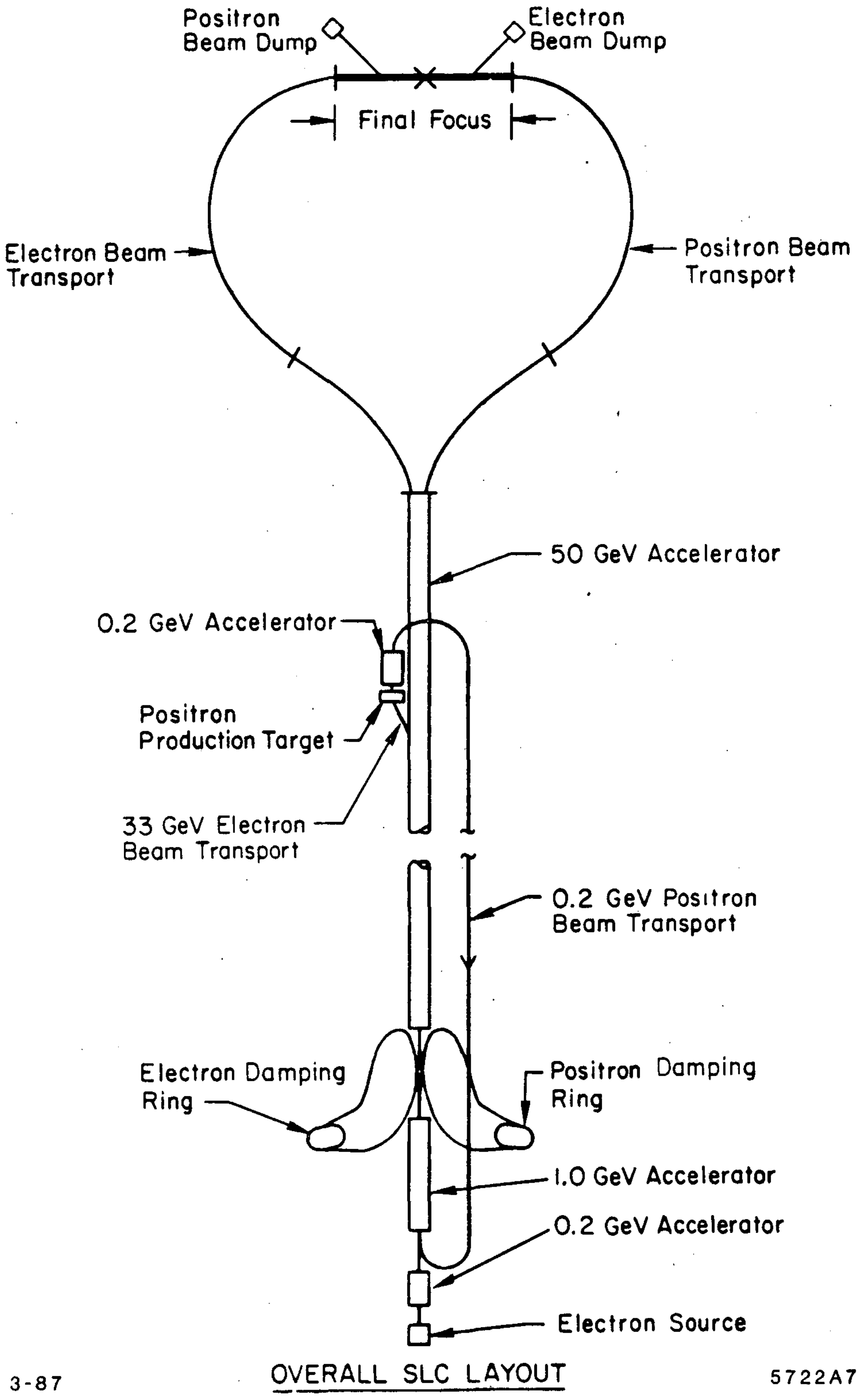

Fig. 1 Diagram of the SLC.

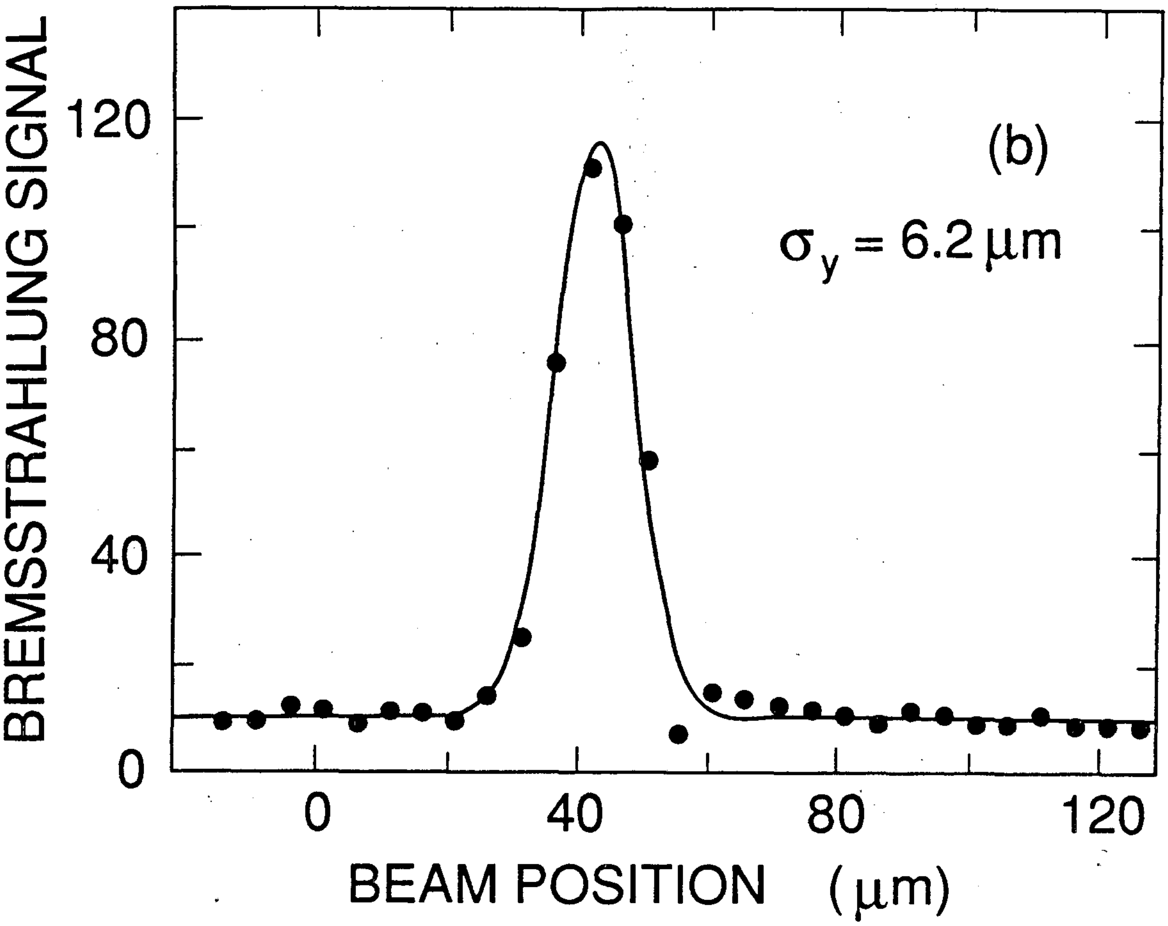

Fig. 2 Vertical profile as observed by monitoring bremsstrahlung emitted by horizontal wire when electron beam impinges on it.

The first column of Table I summarizes the SLC performance which has been achieved to date. Although the individual parameters in that column, if all achieved simultaneously on a steady and routine basis, would in principle lead to the production of about 10 Z/day, it has not in fact been possible to maintain such performance with acceptable detector backgrounds. Thus much of the operating time has been devoted to machine physics studies aimed at understanding all the parameters which determine the collider performance including the background levels (to be discussed later in this report) seen in the detector.

SLC performance goals set by the SLAC management for 1989 and 1990 are also shown in Table I. They represent improvements over present performance by many orders of magnitude, and their achievement represents a major challenge. Many of these improvements demand modifications of the hardware, including the damping rings, the ring to linac transfer lines, the alignment of the linac structure, the instrumentation and control systems, the positron target etc. A shutdown for making some of these modifications is scheduled for the end of 1988 and the beginning of 1989, and it is hoped that the improved SLC will turn on with much greater physics capability in February 1989.

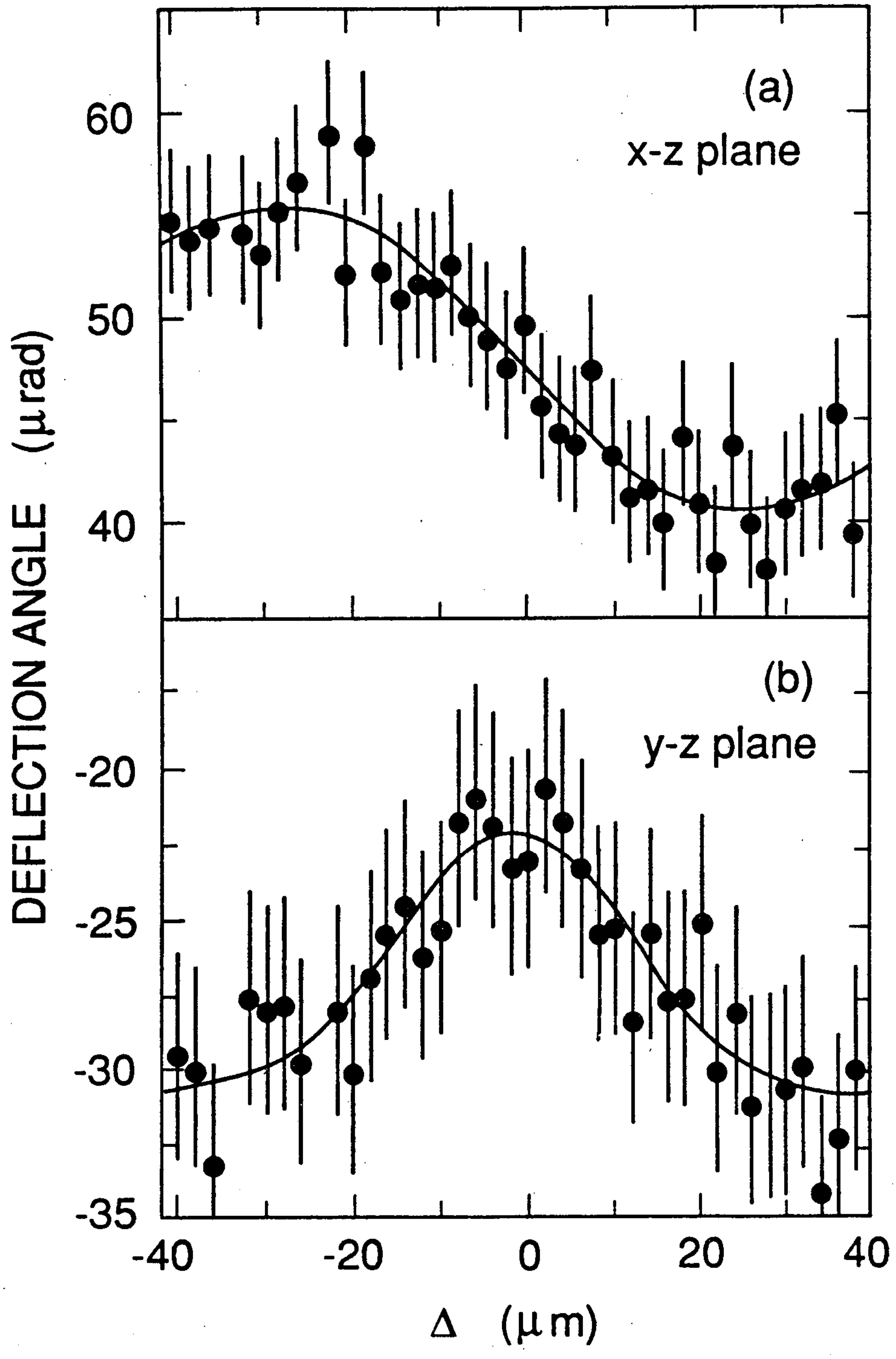

Fig. 3. Deflection angles in (a) horizontal plane and (b) vertical plane as positron beam is scanned across electron beam while beam centers remain offset by about 10 μm in vertical direction.

Table I
SLC Luminosity Goals

	Achieved	1989 Goal	1990 Goal	Design Goal
e^+/pulse (10^{10})	1	2	4.5	6
e^-/pulse (10^{10})	2	3	4.5	6
Pulses/sec	30	120	120	180
Spot Radius (microns)	3 x 5	3	2.5	1.6
Luminosity ($cm^{-2}s^{-1}$)		8×10^{28}	4×10^{29}	6×10^{30}
Z^0/Hour		8	40	600
Efficiency		1/4	1/2	2/3
Physics Hours		5000	5000	5000
Z^0/Year		10^4	10^5	2×10^6

I now want to mention briefly some aspects of the preparation for the MARK II physics program. An essential early component of that program is the accurate determination of Z mass and width. This requires precise determination of the two beam energies, and special spectrometers have been built and installed by the MARK II group in the electron and positron extraction lines. The energy measurement is based on the observation of synchrotron radiation swaths emitted just before and just after passage of each extracted beam through a large analyzing magnet. The expected uncertainty on the energy of each beam is about 25 MeV, and the overall systematic error in the CM energy should be less than 50 MeV. Figure 4 shows energies measured with the spectrometer for 100 consecutive MARK II triggers. The stability appears to be very good; and, incidentally, the figure illustrates one of the great SLC successes, namely the achievement of the large linac energy upgrade to the Z mass region.

Another rather crucial issue is that of detector backgrounds arising from the SLC environment. Such backgrounds are potentially worse in linear colliders than in storage rings because, in a sense, every beam crossing is like a new fill, and yet our typical practice in storage rings is to turn off detector high voltages during the fills and wait for the noise to go away. One of the great virtues of moving the MARK II onto beam line was the opportunity to measure backgrounds under real conditions, using appropriately located ion and proportional tube chambers as well as the actual components of the MARK II detector. Over the early months of 1987, large initial background levels were reduced by many orders of magnitude. The potential background sources include (1) synchrotron radiation, (2) soft shine from the tunnels, (3) electromagnetic debris from the beams hitting various masks or collimators, and (4) high energy muons from Bethe-Heitler pair production in various collimators. The sources (1) and (2) are adequately controlled by appropriate

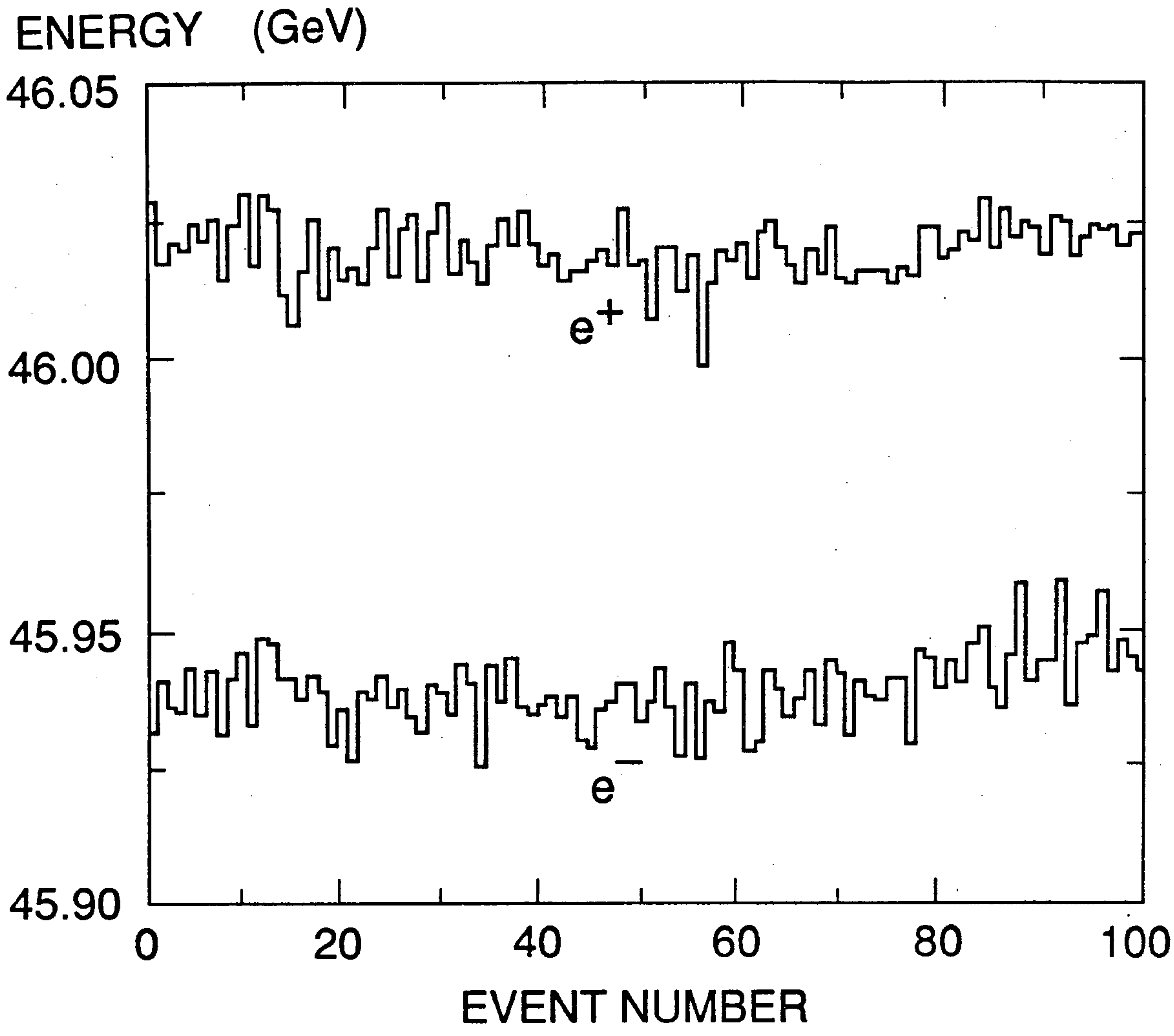

Fig. 4. Measured beam energies for 100 consecutive MARK II triggers.

masking design (1), and concrete/lead walls across the tunnel faces (2). Sources (3) and (4) which are more problematic are controlled by improved collimation and improved understanding of the beam optics to reduce emittance growth. In addition, magnetized iron toroids, to be installed in the final focus regions before the February 1989 SLC run, should provide muon attenuations of 10 to 100 (depending on which collimators are the main sources). Present muon levels, prior to installation of the toroids, are typically of order 10 in the end cap calorimeters per 10^{10} electrons, and somewhat fewer from positrons.

The major background issues involve three items: 1) Feasibility of measuring Z events, 2) Measurement of luminosity in the small-angle monitors and 3) effectiveness of triggers based on tracking and on the calorimetry. The triggering is the worst problem, but with the installation of the toroids and improved understanding of the optics, it is expected that this problem can be reduced to tolerable limits at least for the initial beam intensities.

3. The Next Linear Collider (NLC) - Some Technical Remarks

As mentioned earlier, one of the purposes of the SLC is to serve as a first prototype for what B. Richter has called the NLC, the Next Linear Collider.2) Actually SLAC has an R&D program aimed toward a TLC (TeV Linear Collider), whereas CERN is pursuing R&D aimed at a device called CLIC (CERN Linear Collider). There is also interest in such machines at KEK and at Novosibirsk. The greatest physics interest may be in a multi-TeV e^+e^- collider which goes beyond the SSC or LHC, but it seems inevitable that as a part-way point on the road to this eventual goal, it will be necessary to build an intermediate device in the CM energy region of 1 to 2 TeV. There have been several workshops aimed at exploring the physics capabilities of such intermediate machines, and I shall say a little about these further on.

I begin this discussion with some remarks about the prospects for such colliders, basing my comments on presentations by Palmer, Richter and Schnell at various workshops and conferences.3) Table II lists some of the relevant parameters for preliminary designs of both TLC and CLIC, and compares them with the corresponding parameters of the SLC.

Table II
Tentative Linear Collider Parameters

	SLC (SLAC)	CLIC (CERN)	TLC (SLAC)
Energy/Beam (TeV)	0.05	1.0	0.5
Accelerating gradient (MV/m)	17	80	190
RF wave length (cm)	10	1	1.7
Repetition rate (Hz)	180	1690	90
Particles/Bunch	6×10^{10}	5×10^{9}	1.8×10^{10}
Beam power (MW)	2 x 0.10	2 x 1.35	2 x 0.13
Horiz. emittance [normalized -rad m]	3×10^{-5}	3×10^{-6}	5×10^{-6}
Vert. emittance [normalized -rad m]	3×10^{-5}	10^{-6}	5×10^{-8}
β_x* (mm)	5	3	15
β_y* (mm)	5	0.3	0.05
Bunch width σ_x* (μm)	1.7	0.06	0.27
Bunch height σ_y* (μm)	1.7	0.012	0.0016
Bunch length σ_z (mm)	1	0.2	0.04
Pinch enhancement	2.2	2.4	2.3
Beamstrahlung loss (δ)	0.004	0.27	0.27
Luminosity ($cm^{-2}sec^{-1}$)	6×10^{30}	1.1×10^{33}	1.2×10^{33}

It should be emphasized that these parameters will certainly change as R&D progresses, and should not be taken too literally. Some of the major differences from the SLC include (a) the absence of magnetic arcs since there will be two linacs, (b) the use of structures with much higher accelerating gradients (100-200 MV/m), (c) the use of higher RF frequencies to obtain improved efficiencies and the higher gradients, and (d) the necessary achievement of much smaller beam spots especially in the vertical direction. Because of the high luminosities demanded by the physics, it will also be desirable (though this is not yet incorporated in the parameters of Table II) to develop RF structures which permit the acceleration of several bunches per linac cycle. The effect of wake fields produced by each bunch on increasing the emittance of the next bunch make this a non-trivial development. To achieve these various improvements will require major R&D in the areas of (*i*) low emittance sources of electrons and positrons, (*ii*) stable, efficient and economical accelerating structures and power sources, (*iii*) a final focus system adequate to provide the very small beam spots, and (*iv*) many areas of beam dynamics. It is interesting to note that in spite of the fact that a number of somewhat exotic approaches to acceleration (laser accelerators, plasma accelerators, etc.) have been discussed for some time, all four groups presently active in this area, have concluded that a conventional RF structure of somewhat higher frequency than the SLC's 3 GHz is the appropriate choice for the next generation. The power sources, however, will require new and possibly exotic approaches.

4. Physics Potential of NLC

I now move on to a discussion of the physics potential of machines with parameters such as those shown in Table II. There have been several studies and workshops devoted to this subject,4,5) and I particularly call attention to the excellent lectures by G. Feldman6) at the 1987 SLAC Summer Institute. Space and time do not permit an extensive discussion here, and I shall confine myself to some general remarks plus a couple of specific examples in areas where the e^+e^- may provide capability which complements the multi-TeV hadron colliders. I shall draw my examples from the SLAC study with which I am more familiar.

I list below some of the general features of the e^+e^- environment, and its impact on the ability to tackle the hard physics problems at high energies.

(a) The cross section scale is defined by the elementary QED point cross section,

$$\sigma_0 = \frac{4\pi\alpha^2}{3s} = \frac{87\text{fb}}{[E(\text{TeV})]^2} \qquad (2)$$

where E is the cm energy and s is its square.

Thus a luminosity of $10^{33}\text{cm}^{-2}\text{sec}^{-1}$ integrated over the usual operating year of 10^7 sec would produce almost 1000 events in a process of cross section σ_0. The total annihilation rate corresponds to about $10^2\ \sigma_0$ taking full account of beamsstrahlung (see point (c) below). This is of course a very far cry from the 100 MHz inelastic interaction rate produced in a high luminosity hadron collider. We have here one of the major benefits of the e^+e^- environment: the problems of high speed, highly sophisticated triggers, and complex data acquisition which give the hadron collider experiments much of their technical complexity will be much reduced.

(b) Another strong benefit of e^+e^- is the absence of beam fragments in the final states. The complexities of interesting events are thereby much reduced, and the problems of properly associating hadronic fragments with decays of particular W's and Z's are greatly eased. Maximal advantage can therefore be taken of well-designed, compensated calorimeters with excellent energy resolution. It follows that, unlike the hadron machines in which W and Z decays are clearly detected only in their leptonic modes, the e^+e^- colliders provide the opportunity to exploit the much more common hadronic decay modes. This circumstance can, in some of the relevant processes in which W's or Z's are involved, make up for the very small signal cross sections.

(c) Another potential advantage of the e^+e^- technique is the relatively well-defined energy of the basic process, as contrasted to the highly variable energies of parton subprocesses in hadron collisions. Actually this feature is somewhat degraded by the beamsstrahlung process in which electrons in each bunch radiate as a consequence of their interaction with the other bunch. The δ parameter in Table II represents the mean fractional energy loss due to this process. For the value of 0.27 given in the Table, the corresponding e^+e^- cm energy spectrum is shown in Fig. 5. While considerably,

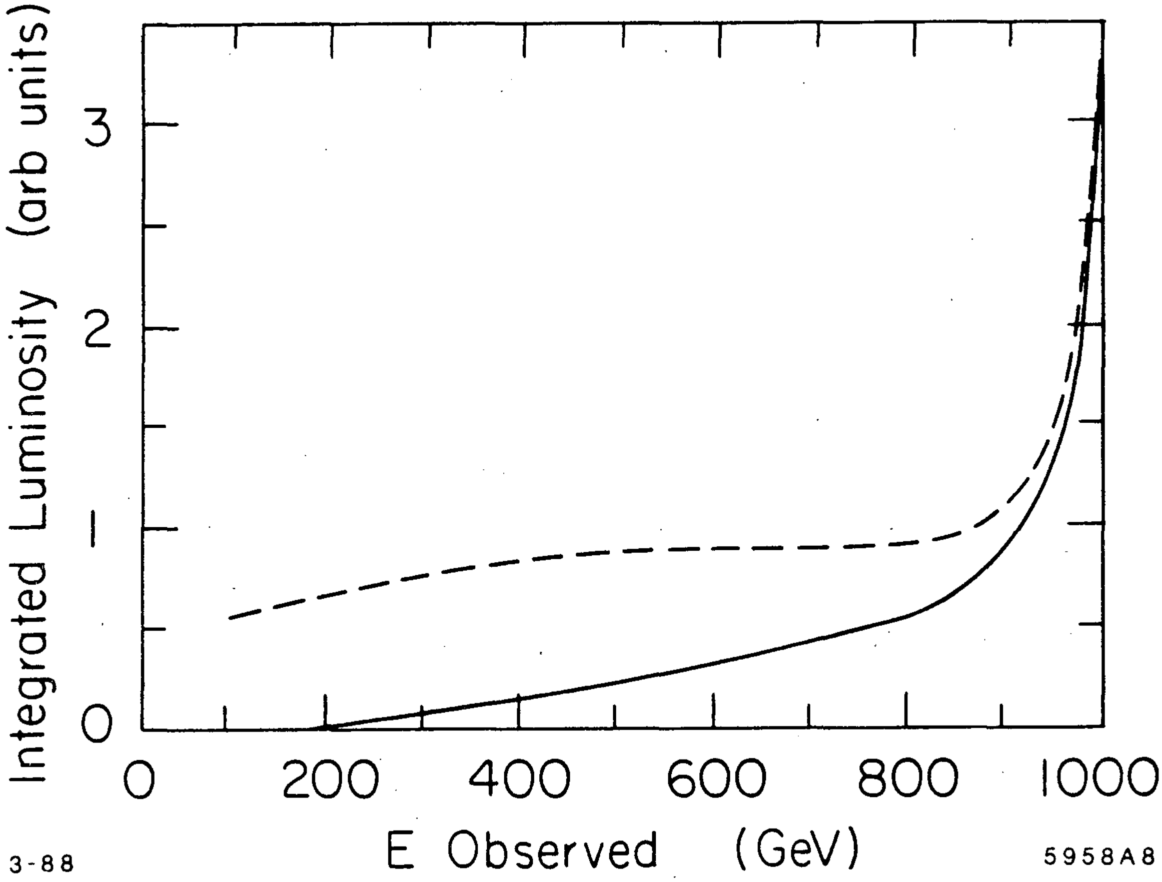

Fig. 5 CM e^+e^- energy spectrum for a 1 TeV collider. The dashed curve represents the spectrum multiplied by E^{-2} to approximate the e^+e^- annihilation cross section (from Ref. 5).

broadened, this spectrum still has about 30% of its population within 1% of the full cm energy. Actually, the energy spread can be turned into a virtue as shown in Fig. 6 which, for a collider operating at 1 TeV nominal energy, exhibits the event population in the case that a Z' of mass 400 GeV exists. It is clear that energy scanning is not needed to detect the Z'.

(d) Some of the processes of interest proceed via the s-channel; and, above threshold, will exhibit the standard 1/s cross section behavior. Thus, for some studies it may be desirable to reduce the collider operating energy to a value just a little above the relevant threshold.

(e) Cross sections for processes of interest are for the most part very small. This is the corollary to item (a) above. Thus in reference 5, many of the interesting reactions are studied in the context of an integrated luminosity of 3 x 10^{40}cm^{-2}. To achieve this in a reasonable period of calendar time, given past experience with the running efficiencies of complex accelerators and detectors, requires very high luminosity.

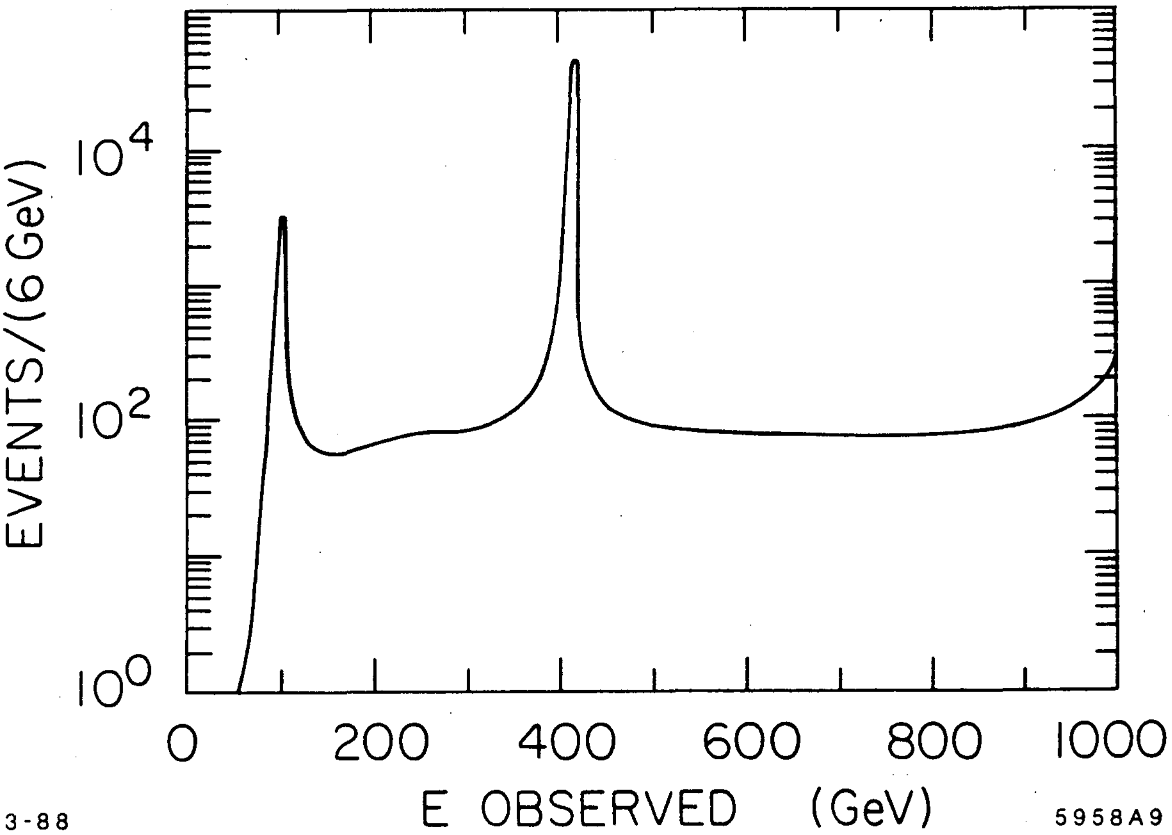

Fig. 6 Distribution of hadronic invariant masses from e^+e^- annihilation to hadrons, including effects of a 400 GeV Z' (from Ref. 5).

(f) My final point involves a different comparison with hadron colliders. Basically an e^+e^- collider operating at a fixed energy probes physics at just the momentum transfer corresponding to that energy. Hadron colliders simultaneously probe all momentum transfers roughly up to their maximum parton-parton subenergy. There is therefore a greater variety of experiments possible on a hadronic machine. For example the SSC is a machine which, at relatively low momentum transfers, makes enormous numbers of B mesons, perhaps enough to study CP violation in B decay. The NLC, on the other hand, is completely irrelevant to such studies.

I now proceed to give a couple of examples of topics which are very hard to tackle via a hadron collider. The first is the search for a Higgs boson whose mass is less than twice the W mass. Relevant production diagrams are shown in Fig. 7, with the lower one being dominant. Diagrams for background processes are shown in Fig. 8. For Higgs masses of 100 to 150 GeV, the cross sections are about 0.1 to 0.2 pb for a 1 TeV collider. Corresponding pp cross sections at the SSC are at the level of 50 to 100 pb.

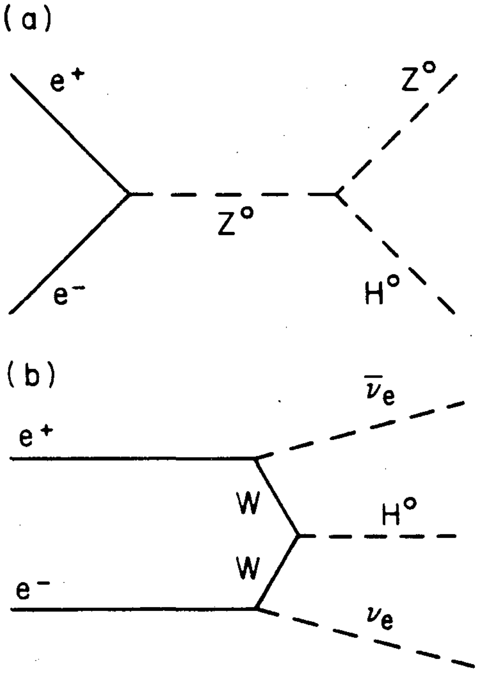

Fig. 7 Feynman diagrams for Higgs production at an e^+e^- collider.

I follow here the work of Burchat et al.7) A brief listing of the cuts and procedures used by these authors goes as follows:

(i) Boost event along beam axis until the total momentum component along that axis vanishes.

(ii) Require $|\cos\theta_T| < 0.7$, $|\cos\theta_M| < 0.9$ where θ_T is angle between thrust and beam, θ_M is angle between missing momentum and beam.

(iii) Require visible energy between 100 and 400 GeV.

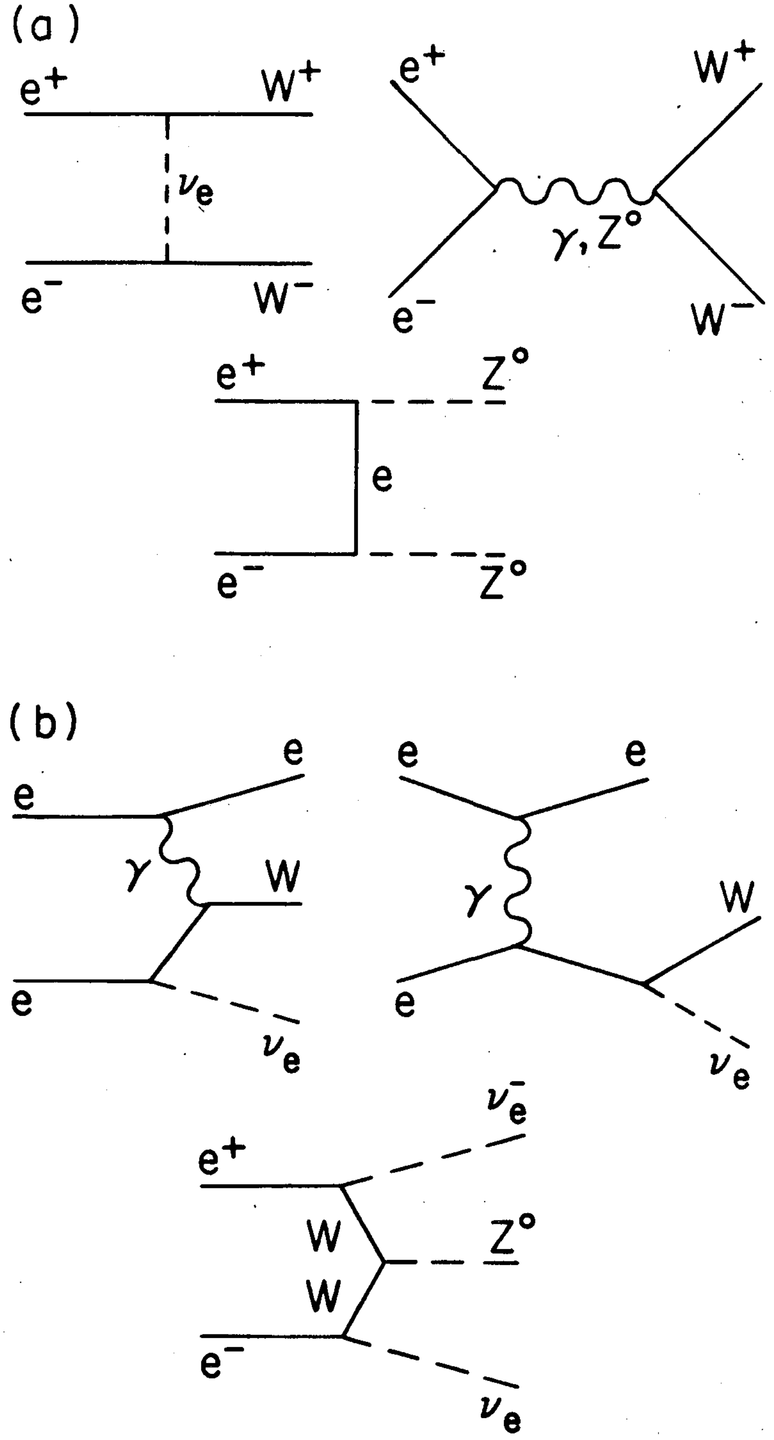

Fig. 8 Feynman diagrams for background processes that appear in Higgs searches with an e^+e^- collider.

(iv) Do a two-cluster analysis and require acoplanarity of the two clusters greater than 10^0 and both clusters to have masses between 1 and 50 GeV.

(v) Require missing transverse momentum greater than 50 GeV, and the number of charged particles outside a 10^0 hole about the beam axis to be between 10 and 36.

There is of course a rough Monte Carlo detector simulation which I have no space to describe it here other than to say that no demands beyond well established technology are made. The principal background to the $\nu\bar{\nu}\, H^0$ production, at low H^0 masses, comes from the $e^+ \nu W^-$ final state, in which the e^+ goes down the beam pipe. Figure 9a shows this background and Fig. 9b superposes the signals from Higgs bosons at 120 and 150 GeV. The integrated luminosity assumed in Fig. 9 is 30 fb^{-1}. One can imagine further cuts, based for example on identifying heavy quark decay products of H^0, to further improve signal to noise. It appears that with adequate luminosity, an intermediate Higgs should be detectable provided that its mass is not too close to that of the W. Incidentally Fig. 9a also illustrates the remarkable sharpness of the W peak, as reconstructed from its hadronic decay, in the clean e^+e^- environment.

My second example involves detection of charged Higgs $H^{\pm}$, produced through the standard s-channel processes via an intermediate photon or Z. This again is a particle which is virtually impossible to separate from background in a hadron collider. For details of the analysis I refer the reader to the paper of Komamiya [8]), and confine myself to showing Fig. 10 based on an integrated luminosity of 10 fb^{-1} and a 1 TeV collider. The signal population for a $H^{\pm}$ of mass 300 GeV is obviously small, but nevertheless appears to stand out above the background.

5. Some Concluding Remarks

High energy e^+e^- linear colliders of adequate luminosity can provide strong opportunities for elucidating some of the existing open questions of particle physics. In principle they provide a cleaner environment than hadron colliders, but this is only true if the rather formidable backgrounds from external sources (electromagnetic debris and fast muons) already encountered in the SLC can be reduced to negligible levels. Cross sections are very small, and luminosities at the level of $10^{33} cm^{-2} s^{-1}$ or more are required to fulfill the physics potential. Unlike the SLC in which operation at the Z allows considerable forgiveness in the failure to meet luminosity specifications, there is very little interest (unless a Z' exists) in a high energy collider which provides luminosity significantly lower than the above level. Furthermore it is integrated luminosity which counts; hence reliability and the capability to maintain a high level of performance, without interruptions, over long time periods is an essential element. I believe that demonstration of these capabilities in a convincing enough fashion to justify a large investment in construction will require a major R&D effort over the next few years. The challenge is formidable, but success will provide substantial physics rewards.

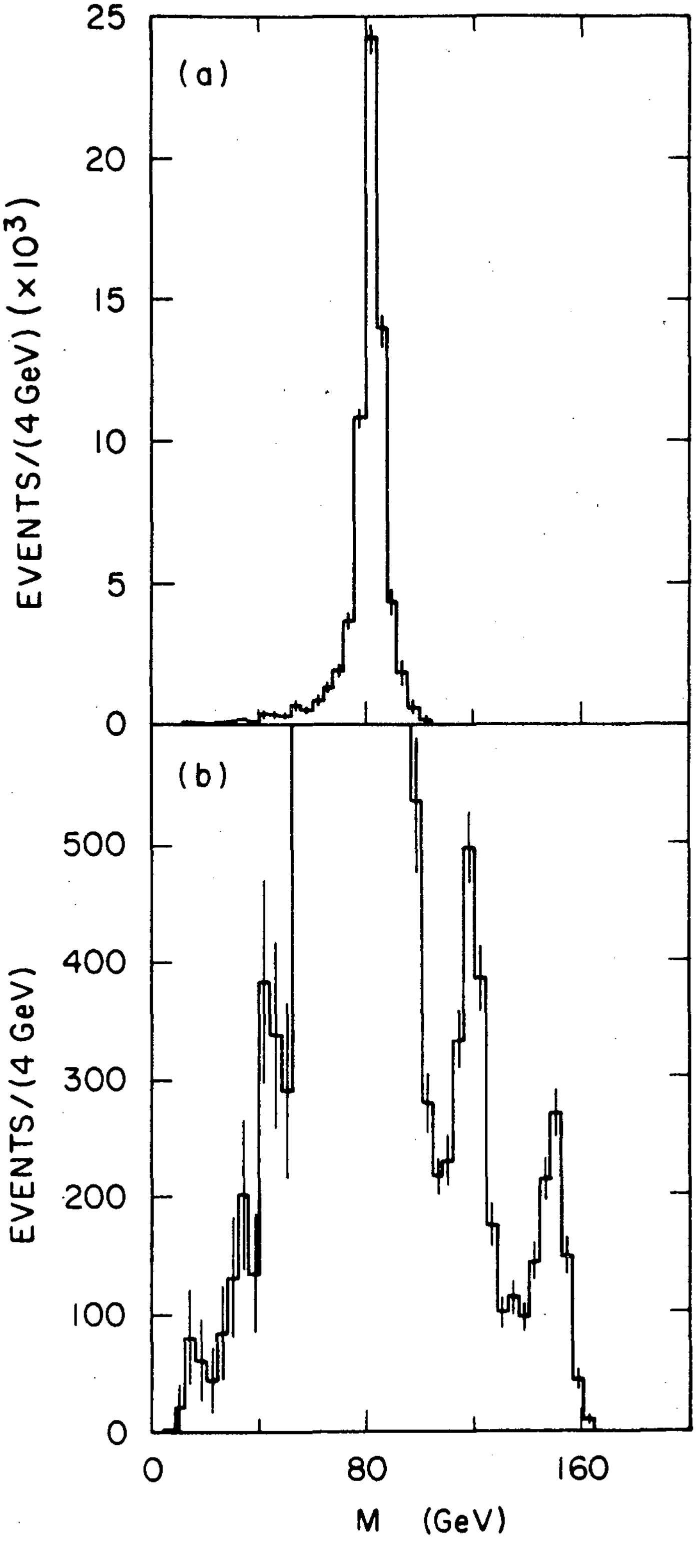

Fig. 9 (a) Reconstructed mass distribution of background events that pass selection criteria used for Higgs search in the reaction $e^+e^- \to \nu\bar{\nu}H^0$. (b) Reconstructed mass distribution for background events with signals from 120 and 150 GeV Higgs particles.

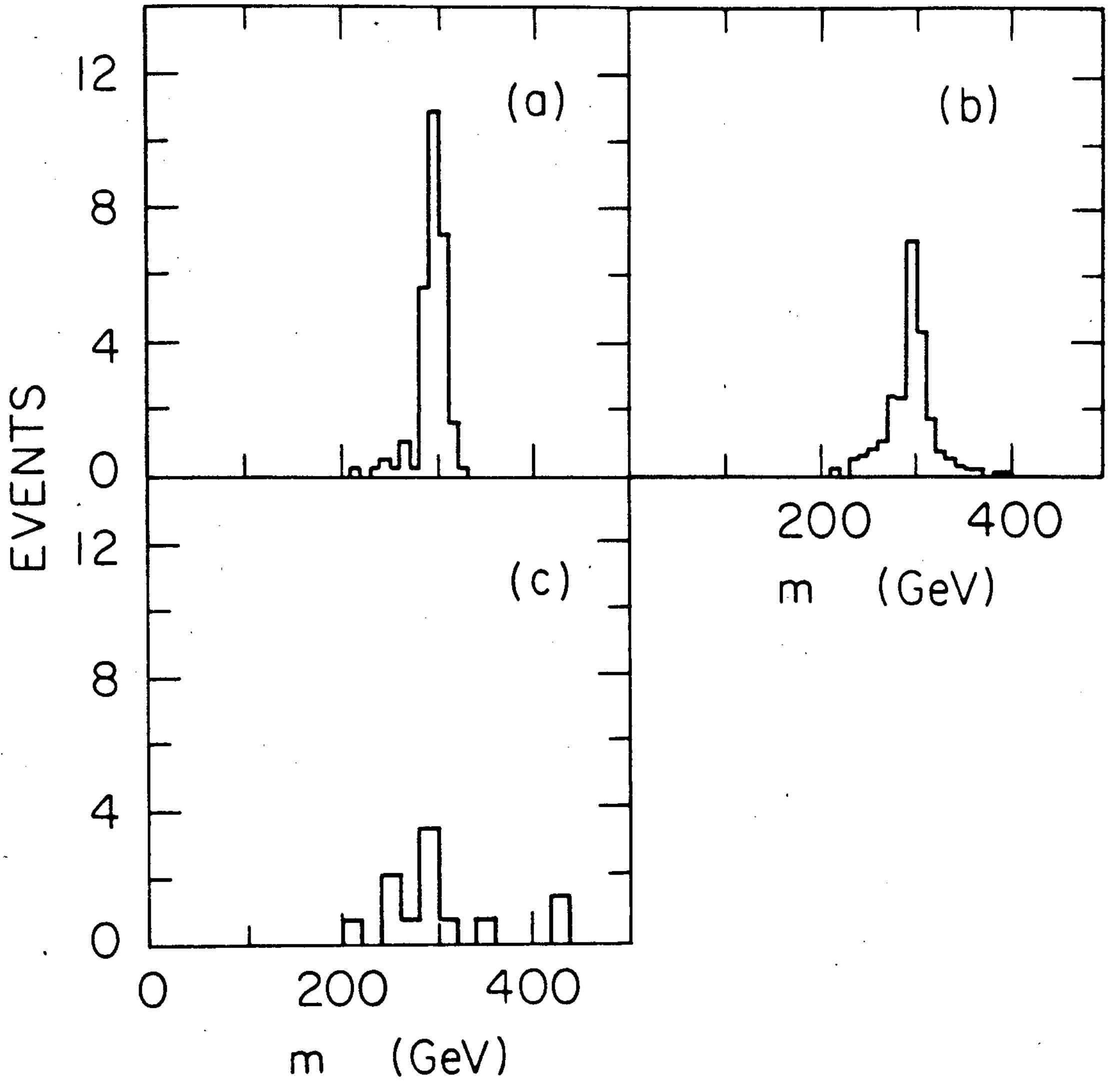

Fig. 10 Reconstructed mass distributions, after appropriate cuts, for (a) $H^+H^- \rightarrow b\bar{t}\,t\bar{b}$ with m_t = 60 GeV, (b) same with m_t = 120 GeV, (c) backgrounds (sum of QCD, W^+W^-, ZZ). The Higgs mass is taken to be 300 GeV, and the cuts are optimized for such a mass.

References

1. For a more detailed report on SLC and MARK II status as of August 1988, see P. Burchat, Proceedings of the Sixteenth SLAC Summer Institute on Particle Physics, Stanford, CA, August 1988.
2. B. Richter, Proceedings of the Seventh International Conference on Physics in Collision, Tsukuba, Japan, August 25-27, 1987.
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