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THE STATUS OF THE SLAC LINEAR COLLIDER PROJECT

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The SLAC Linear Collider Project has two principal goals. The first is to serve as a prototype for a future very high energy linear electron-positron collider. The second is to quickly, at low cost, achieve sufficient luminosity at 100 GeV center-of-mass energy to explore the physics of the Z^0. The first goal is important to the future of electron-positron physics because the rapid increase of synchrotron radiation with energy causes the cost of circular storage ring colliders to increase as the square of the center-of-mass energy whereas the cost of linear colliders increases only in proportion to the center-of-mass energy. The second is important because the existence at SLAC of a linear accelerator which can be converted at low cost to collider operation makes possible a unique opportunity to quickly achieve 100 GeV center-of-mass collisions. At the design luminosity of 6.0×10^{30} many thousands of Z^0 decays should be observed in each day of operation.

An outline of the SLC is shown in Fig. 1. In each pulse of the linear accelerator one bunch of electrons and one bunch of positrons is accelerated to 50 GeV in the linear accelerator. Each bunch is 2 mm long and contains 5.0×10^{10} particles. The bunches pass through a very strongly focused beam transport system to the region of the final focus. The strong focusing of the

transport system is necessary to keep synchrotron radiation from increasing the transverse emittance of the bunches. The bunches are focused to a transverse dimension of a few microns at the interaction point. After the interaction the transverse emittance of the bunches is greatly disrupted by beam-beam forces. The disrupted bunches are deflected into beam dumps.

In addition to the two bunches accelerated to 50 GeV a third bunch of electrons is accelerated to the 2/3 point of the accelerator during the same linac pulse. This bunch is deflected out of the accelerator and strikes a positron production target. The positrons are collected and accelerated to 200 MeV and transported back to the injector end of the accelerator. They are then accelerated to 1.2 GeV and are injected into a small storage ring where their emittance is damped by synchrotron radiation. A second small storage ring at the same location is used to damp the emittance of two electron bunches injected from the electron gun. The storage rings are needed because of the necessity to focus the beams to a transverse dimension of a few microns at the interaction point. Practical optical designs of the final focus are not consistent with the undamped emittance of single bunch electron and positron sources.

The entire process described above is repeated at the 180 Hz repetition rate of the linear accelerator. The principal design parameters of the SLC are given in Table I.

Table I. SLC Design Parameters

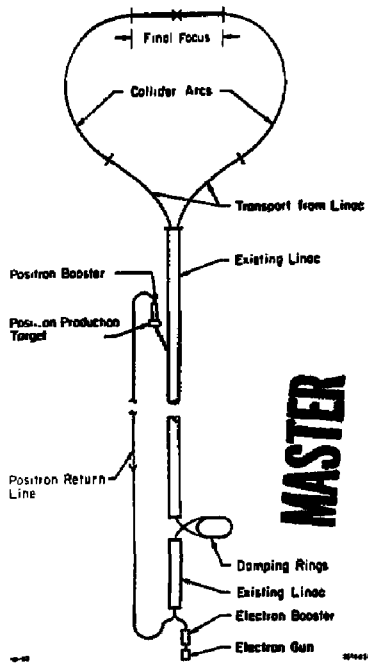|	
Center-of-Mass Energy	100 GeV
Energy Spread	±0.5%
Repetition Rate	180 Hz
Particles/Bunch	5×10^{10}
Emittance at 50 GeV	3×10^{-10} radian-meters
Beam Size at Collision Point	1.2×1.2 Micron
Luminosity	6×10^{30} cm^2 sec

Fig. 1. General layout of the SLAC Linear Collider

The specification and design of the principal system components is in an advanced state. A new, high power, klystron which will permit the acceleration of beams to 50 GeV in the present SLAC linac is being developed. Two versions are under study, a 50 MW long pulse tube, and a 150-MW short pulse tube. The first prototype of the 50-MW cube is being tested now. To date it has produced 52.8-MW at a beam voltage of 320 KV with a 2-microsecond pulse length. The 150 MW tube will be tested in the near future.

In addition, an active research program aimed at determining the performance limitations of the SLC is presently in progress. The research program has three major components; a high current single bunch electron source, a 1.2 GeV emittance damping storage ring, and improvements to the first 1/3 of the linear accelerator including a spectrometer at the 1/3 point to permit the transport and analysis of high current electron bunches.

The high current electron source and the emittance damping storage are presently in operation. A charge/bunch of 5.0×10^{10} at 40 MeV and 1.0×10^{10} at 960 MeV has been achieved. Beam has been stored in the damping ring and an active program of measurement is underway. It is anticipated that in July, 1983, an extraction system for the damping ring will be installed. In

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August, 1983, studies of the transport of the damped beam through 1/3 of the linear accelerator will begin.

The project is proposed for authorization in the President's fiscal year 1984 budget at a total estimated cost of $112 million. The funding profile before Congress is as follows: $40 million in FY 1984, $50 million in FY 1985, and $22 million in FY 1986. If Congress funds the project, the contracts for construction of the arc tunnels, the largest civil construction contract, will be placed in October 1983 and many orders for materials and technical components will be placed shortly thereafter. This three-year fast-track schedule leads to completion of the whole SLC complex including facilities to support experiments by October 1986. The first experiment to use the facility has been chosen by the SLAC Experimental Program Advisory Committee. It will be the MARK II detector built originally for use at SPEAR and now in use at the PEP storage ring.

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