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ONGOING ACTIVITY AT SLAC*

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1. STANFORD LINEAR COLLIDER—SLC (R. Stiening)

On April 6, 1988 both beams were brought simultaneously through the Interaction Point (IP) into dumps. The number of positrons and electrons per pulse were $0.3 \cdot 10^{10}$ and $0.5 \cdot 10^{10}$, respectively, at the repetition rate 10 pps.

The performance of the SLC Arcs has been improved as the result of correction of the betatron phase advances in each achromat, dispersion correction and reducing the cross-plane coupling by smoothing the roll angles. The system to install coherent gradient deviations on the second harmonic of betatron oscillations is being prepared (P. Bambade, A. Hutton, N. Toge). The rms size of the electron bunch measured at the IP is $\sigma_x = 4\ \mu$m by $\sigma_y = 5\ \mu$m. From measured angle divergence of the beam one can evaluate the beam emittances to be $\epsilon_x = 12 \cdot 10^{-12}$ m-rad and $\epsilon_y = 14 \cdot 10^{-12}$ m-rad, respectively (W. Kozanecki). (Nominal emittance is $\epsilon = 4 \cdot 10^{-12}$ m-rad in each plane.) The damping rings routinely produce 2–$3 \cdot 10^{10}$ electrons and positrons per pulse. The bunch lengthening in the rings is still there and the future plans include the installation of the sleeves for shielding the bellows (L. Rivkin).

The background in the Mark II detector has been analyzed (D. Burke). The main problem arises not from the synchrotron radiation but from the production of the μ mesons by the particles in the tails of the transverse distribution. The installation of additional collimators in the Beam Switchyard and the reverse bend Sections of the Arcs is planned. That should cut the background to a level which will allow operation of the Mark II with currents $1.0 \cdot 10^{10}$ in each beam.

2. STORAGE RINGS (P. Morton)

The installation and commission of the low emittance lattice in the PEP storage ring has been successfully performed (M. Donald and others). That transformed the ring into the brightest source of synchrotron radiation in the world. The evaluated horizontal emittance of the ring is $6.4 \cdot 10^{-9}$ m-rad at the energy 7.1 GeV (H. Winick). PEP has been commissioned with a mini-β lattice in one interaction region and is ready to resume runs for high energy physics. Future plans include development of the timing system for filling the SPEAR and PEP storage rings using the SLC complex and construction of independent injectors for SPEAR and PEP. The last one might well be designed as a test facility for future linear colliders.

3. BEAM DYNAMICS AT SLAC (E. Paterson)

The main beam dynamics activity besides the SLC is now shifted to the future TeV Linear Collider—the *TLC*.

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3.1 TLC

Much progress has been made on the development of the basic concepts and parameters of the linear collider in the TeV energy range. The main conceptual features of the collider are: a) flat beams ($\epsilon_x/\epsilon_y = 100$), b) multibunch system (21 bunches), c) crossing angle at collision point, d) high frequency of accelerating field (17 GHz), e) a possible cluster of 10 relativistic klystrons (1 unit per each 8 m) as the RF power source and f) RF structure with damping of higher modes. Table 1 contains main parameters of the latest R&D design.

Table 1. Main Parameters of the TLC.

N	Parameter	Value	Comment
1	Energy (TeV)	2×0.5	$\gamma = 10^6$
2	Luminosity ($cm^{-2}sec^{-1}$)	$1.6 \cdot 10^{34}$	no dilution
3	Luminosity ($cm^{-2}sec^{-1}$)	$0.5 \cdot 10^{34}$	with dilution
4	Beamstrahlung parameter (%)	20	
5	Linac length (km)	7.41	
6	Acceleration gradient (MeV/m)	186	
7	Average RF power (Mw)	100	36% efficiency
8	Peak RF power (Gw)	5	
9	Length of RF pulse (nsec)	50	
10	Repetition rate (sec^{-1})	186	
11	$\beta_x^\star$ (cm)	1.2	
12	$\beta_y^\star$ (cm)	$3.8 \cdot 10^{-3}$	
13	$\sigma_x^\star$ (μm)	0.16	
14	$\sigma_y^\star$ (μm)	$8.7 \cdot 10^{-4}$	
15	$\gamma\epsilon_x$ (m·rad)	$1.9 \cdot 10^{-6}$	
16	$\gamma\epsilon_y$ (m·rad)	$1.9 \cdot 10^{-8}$	
17	σ_z (mm)	0.76	
18	σ_p (%)	0.14	

Two types of relativistic klystrons are being developed by the collaboration of SLAC, LLNL and LBL: 1) a high gain one-cavity klystron and 2) a low gain subharmonic two-cavity klystron. First experimental runs with a high gain klystron *SL4* were performed at the frequency 11.4 GHz. The RF generation was obtained but the pulse shape is not yet satisfactory (no flat top). In the second design a breakdown, probably due to a vacuum problem, was observed in a low gain klystron. Simulations of a relativistic klystron with the program *MASK* showed 45% efficiency (M. Allen, K. Eppley, T. Lavine, R. Miller, P. Morton, R. Palmer, R. Ruth, A. Vlieks, the Klystron Group at SLAC, W. Barletta, D. Birx, G. Westenskow, S. Yu at LLNL and A. Sessler at LBL).

A test RF structure for 11.4 GHz has been built (G. Loew, H. Hoag). Experiments on this facility will start as soon as the RF power is available. Suppression of higher modes has been checked in a single cavity with carefully designed cuts. The results for the frequency 17 GHz are given in Table 2 (R. Palmer).

Computer study of tolerances for the linac are underway. To preserve small vertical emittance of the beam, the orbit and alignment of quadrupoles in the linac must be kept very tight (R. Ruth): $y_{rms} \leq 30\mu m$. Simulations of the multibunch instability in the linac (K. Thompson, R. Ruth) show that the breakup could be controlled by a combination of a) transverse modes damping and b) tuning the fundamental transverse mode frequency to place bunches close to zero crossings of the wake field.

Table 2. Suppression of Higher Modes.

N	Mode	Q - Value	f (GHz)	Comment
1	Main	$5.8 \cdot 10^3$	17	
2	First Transverse	15	22	no. of waves between bunches ≥ 3
3	First Longitudinal	40	37	$Q \leq 80$

The beam-beam multibunch interaction at the IP could cause an exponential growth of the bunch displacement and as a result dilution of the luminosity (K. Yokoya). Measures which could control this effect are found to be (R. Palmer): a) large bunch separation (number of the RF wave lengths between bunches ≥ 5), b) small distance of septum to the IP, in the present design $l_{sept} = 18$ cm and is smaller than the distance to the first quadrupole magnet $l_{quad} = 36$ cm and c) large crossing angle, $\alpha = 4.2$ mrad. The first example of a Final Focus System was developed (B. Spence) utilizing a quad with a bore 150 μm. It is similar in concept to the SLC FFS and is satisfactory for a beam energy spread of 0.2%. The study of the beam-beam effects continues (K. Yokoya, P. Chen). The self-adjustment of flat beams found in Novosibirsk was confirmed. The disruption for the flat beams is different from that for the round ones.

3.2 Theoretical Studies (R. Ruth)

The longitudinal impedance of the linac-like RF structure in the high frequency limit (S. Heifets, S. Kheifets) was shown to agree both with the diffraction model (K. Bane, M. Sands) for a small number of cavities, which gives $\omega^{-1/2}$ dependence, and with the optical resonator model for a large number of cavities, where the impedance decreases as $\omega^{-3/2}$. The criterion for the transition from one regime to another was found. An important consideration in the design of the linac structure should be to ascertain the proper decrease of the impedance.

A numerical solution of the Hamilton–Jacobi equation was used to construct simplectic whole-revolution maps for tracking and to find invariant curves for nonlinear particle motion (R. Ruth, R. Warnock, W. Gabella). A similar method utilizing perturbation approach has been used to develop a theory of the second-order achromat (S. Kheifets, T. Fieguth, R. Ruth).

3.3 Miscellaneous Studies

The SLC klystron modeling (W. Herrmannsfeldt) was used to define and cure the RF pulse instability.

Collisions of substantially different energy beams for a B-factory has been proposed (G. Feldman) and luminosity of such an arrangement examined (R. Rees).