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SUMMARY OF PEP SUMMER-STUDY*

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In August 1973, the Lawrence Berkeley Laboratory and Stanford Linear Accelerator Center jointly sponsored a summer study on beam dynamics problems which may affect the next generation of storage rings. It was called the PEP Summer Study, and the participants included many of the world's storage-ring experts. The main emphasis was on the study of collective phenomena that might limit the performance or affect the design of new storage rings. In addition to the study of collective effects, there were also studies on lattice design, superconducting magnet systems, and other problems that must be faced in the building of future storage rings. This summary will be concentrated on the studies done on the following topics: lattice design, single-beam effects, two-beam effects, beam-cavity interactions and possible accelerator experiments that are needed. Many of the results from the PEP Summer Study have been written up as PEP notes and will soon be available as a formal report.

The study on lattice design produced a great deal of discussion about interaction region parameters. Because there was concern about the stability of very short proton bunches, e.g., 25 cm, consideration was given to using longer proton bunches that would collide with several electron bunches each. This would require a crossing-angle geometry at the interaction region that many felt was undesirable and led to a discussion of crossing angles versus head-on collisions. Studies were also done on lattice scaling laws and the synchronization of the protons and electron orbital frequencies for different energies.

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Under the study of collective effects for single beams, the vacuum pressure avalanche mechanism, which limits the current in the CERN ISR, was not considered. This limit requires experimental study such as that presently being conducted at CERN, and is probably dependent upon the average current. Since the average current is not very high in many of the storage rings being considered for future design, this mechanism may be less troublesome.

One of the important problems facing present electron storage rings has been that of bunch lengthening. During the exchange of information on this subject, various ideas were set forth to explain this phenomenon. For example, an attempt was made to determine the longitudinal coupling impedance to fit the present experimental data in SPEAR to the "equilibrium" theory in which the beam induces a change in its potential well while its energy distribution remains unaffected. The idea of many simultaneous unstable coherent longitudinal modes that eventually become incoherent and produce a net diffusion was discussed as a possible bunch lengthening mechanism. Also there were ideas that proposed an amplification of noise in the rf system or noise from the quantum fluctuations as another possible mechanism.

A subject which recieved considerable attention was how various different types of wake fields could affect the stability of the different head-tail modes. It appears that fast-decaying wake fields could explain the stability of the higher order head-tail modes,none of which have been seen in existing storage rings. The effects of multiple bunches upon the head-tail instability and on coherent longitudinal instabilities were considered, and restrictions upon the coupling impedance between the beam and the environment were estimated. Alternatively a fast damping system could be used. Since the bunches are sufficiently far apart in many of the storage-ring schemes being considered, it is possible to design a system that would damp each bunch individually.

In the study of two-beam effects, the two-beam limit due to the incoherent tune shift was considered. This produced a lively interchange of ideas between advocates of a diffusion mechanism to drive particles to a stocastic limit and proponents of isolated resonances to explain the incoherent beam-beam limit. There was also work done to improve the present estimate of the stocastic limit and, in particular, to provide an estimate for the case of beam-beam interactions between transversely separated beams. The work on computer simulation of the beam-beam incoherent effect was also discussed by those developing programs for this study. The effects of crossing angle upon the beam-beam incoherent limit and thus on the achievable luminosity were studied with attempts being made to formulate theories that explain the present experimental results.

The coherent effects between two collising beams were discussed, as well as many schemes to achieve a higher luminosity than one would normally expect.

The people that studied the beam-cavity interactions were concerned with energy that was lost by the beam to the higher cavity modes as well as the voltage the beam induces in the fundamental mode of the cavity. One usually detunes the cavity in order to decrease the induced cavity voltage in the fundamental mode. However, for the case of very high harmonic cavities, one soon encounters the next Fourier component of the bunch spectrum which also drives the cavity. There was also discussion on a high-frequency system to bunch the protons and on the possibility of letting the beam drive the cavity and produce self-bunching.

Suggestions were made on the types of experiments necessary to understand the phenomena that could limit performance in the next generation storage rings. Lists of useful experiments that could be done on the existing storage rings (i.e., ISR, SPEAR, ADONE and ACO, as well as the new rings, DORIS and the LBL MINI project) were compiled.