On-going Beam Dynamics Studies at SSC, LBL and SLAC*

SSC

1. Cell Lattice Optimization

A workshop was held on September 17-18, 1986 at CDG to review the cell lattice parameters (60^o, 192m) of the SSC Conceptual Design. A well-defined optimization algorithm was devised and carried out. It was found that by changing to (90^o, 230m) cells, there is a 4% increase in the linear aperture and a potential saving of 20M$ on the SSC construction.

2. Analytic Calculation of Linear Aperture

An accurate analytical prediction of "smear" now exists (Forest). Excellent agreement with tracking was obtained. This technique, as well as the analysis program package, is expected to be used extensively in later studies. Extension of this calculation to higher orders is straightforward and will be continued.

3. Aperture Experiment

This is a high priority item. A proposal in collaboration with FNAL was submitted to FNAL PAC to perform aperture studies for the SSC on the Tevatron (10 preliminary shifts plus one dedicated week during spring 87). The goal is to check the linear and dynamic aperture evaluation algorithms assumed and developed for the SSC Conceptual Design.

4. Operations Simulations

This effort (sometimes referred to as "modeling") will increase substantially in 1987 and perhaps beyond. The simulation program TEAPOT (Talman, Schachinger) is further being developed for this purpose and two SUN workstations are being installed. The workstations are interactive, dedicated, with good display and windowing capacities. The simulations will include various issues under a wide range of operation conditions

5. Field Quality

Tolerance specification of magnet field errors, random and systematic, is an on-going effort. Compensation of the systematic field errors (including those due to the persistent current) using trim windings receives much attention. To compensate for the random

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* reported by Alex Chao, SSC Central Design Group, URA.

errors, the idea of "binning" (Talman) is being considered instead of the previous idea of "sorting" adopted in the Conceptual Design.

SLAC

1. PEP Possibilities

Various possibilites have been considered for PEP. Among them (Donald, Helm, etc),

- One single low-ß* IR, with ß*=3 - 5 m, for the TPC detector. The ring has symmetry 1.
- Alternating high- and low-ß*. Symmetry 3.
- Gas jet target for nuclear physics. luminosity = $10^{35}cm^{-2}s^{-1}$.
- PEP as a stretcher ring for nuclear physics.
- 4.5 GeV configuration for upsilons.
- hard synchrotron radiation source. The low-emittance configuration (emittance comparable to European design) was demonstrated to work.

2. SPEAR mini-ß*

SPEAR is the only nice ring where mini-ß* has not worked yet! Single beam optics looks fine down to ß*= 3 cm but the expected luminosity gain at low ß* values did not materialize. Bunch length was found to increase by a factor of 2 but pursue of bunch shortening by intentionally installing some capacitive impedance (Bane) gave only inconclusive results. More studies are needed.

3. Dynamic tracking

This is done at SPEAR and damping rings (Hofmann, Morton, Ruth, etc). The idea is to kick the beam and then measure (x,x') turn by turn to observe the phase space behavior. The trajectory exhibits a triangular shape when tune is close to 1/3. More detailed studies are being done.

4. Impedance Calculations

A field-matching program has been developed (Kheifets and Heifets) and is being compared with other existing programs for various types of vacuum chamber discontinuities. Interesting properties of impedance can be observed from the results (pointed out by J.D. Jackson and H. Lee at CDG).

5. Nonlinear Dynamics

Program for superconvergent tracking has been written and tested (Ruth, Warnock). A paper is written. No continuing work is envisioned for now since the technique seems too slow to put to practical uses.

A program based on the Hamilton-Jacobi technique has also been written and tested for 1-D case. Testing for 2-D cases and actual tracking for practical cases will be pursued. Based on this work, an interesting new criterion (slightly different from the residue criterion of Green's) is conjectured for the on-set of chaos. This idea will also be pursued.

6. Big Collider Studies

The possibility of a "site-filler" linac collider (4-7 Km, 0.5 - 1 TeV center-of-mass energy, luminosity to be derived) is being studied. Choice of rf frequency, for example, is one hot topic. Laser-plasma ideas are apparently not too relevant for this purpose.

One critical issue is the study of beamstrahlung in the high energy linac collider. Quantum modifications (Noble, Himel etc), electroweak radiation (Noble, Chen) and a program that includes quantum effects (Noble) have been done. There is apparently some disagreements among experts (Drell, Blanckenbecler, Chen, etc) as far as the coherence effects are concerned. This has to be clarified because it profoundly affects the scaling property of the basic design parameters.

7. SLC

The present highest priority is to commision the SLC, particularly the damping rings, the collider arcs and the positron line. Understanding of the arc optics with errors is an on-going effort (Brown, Murray, Weng, Sands). Modeling the damping rings for operation has played an important role. Present goal is to provide a start-up luminosity of $6 \times 10^{27} cm^{-2} s^{-1}$ (15 Z^os per day) early 1987.

LBL

1. Light Source Lattice Design

The LBL design (A. Jackson etc) has an emittance of 4×10^{-9}m-rad at 1.5 GeV. The triple-bend-achromat design (8 quadrupoles, 3 bends and 2 sextupoles per cell) was found to provide better dynamic behavior than the FODO or the Chaseman-Green designs.

2. Program ZAP

This parameter optimization program (Zisman, Chattopadyhay) has been used in several applications. The manual will be available soon. With lattice as input, it calculates the intrabeam scattering, Touschek lifetime and various instability and Landau damping thresholds. The emphases are user-friendliness and the correctness of formulae used.

3. Nonlinearities in Wigglers and Undulators

That nonlinearities in wigglers and undulators may significantly affect the dynamic aperture is a recent recognition. A workshop was held recently at BNL to study this. The study will continue.

4. Impedance Calculations and Measurements

A program COMET is being prepared (Nishimura). It uses Hertz potentials to do the calculations. The program is being prepared to handle 3-D objects. The algorithm promises to be simpler and more numerially stable. Bench measurements of impedances using both the antenna and the wire methods (Lambertson) are being done.