Intrabeam Scattering Growth Rates for the 90 degree Lattice

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Abstract

Intrabeam growth rates are computed for the 90 degree SSC lattice at injection and at collision. The results are not too different from those for the CDR (60 degree) lattice, and do not pose any problems.

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1) Introduction

Because of Coulomb scattering, the particles within a bunch redistribute in phase space causing the beam emittances to grow or damp. We present here the results for the growth rates obtained with the program ZAP [1].

2) Description of the calculation

The new lattice has the structure (ARC, UU, MB, MB, ARC, UU, LB, LB) where one ARC is 143 CELLS. The lattice functions for collision optics are different from those at injection for LB and MB, but are the same for CELL and UU. They were obtained in both cases with the program SYNCH and converted to the necessary ZAP input format. The program ZAP was then run separately for each of the 4 modules CELL, UU, MB and LB and the growth rates were obtained for each; these are called R(CELL), R(UU), etc. Then the rate for the whole ring is computed by taking the weighted average of the individual rates, the weights being the lengths and number of the modules,

$$R = \frac{2*143*R(CELL)*L(CELL) + 2*R(UU)*L(UU) + 2*R(MB)*L(MB) + 2*R(LB)*L(LB)}{2*143*L(CELL) + 2*L(UU) + 2*L(MB) + 2*L(LB)}$$

where L(CELL) is the length of CELL, L(UU) is the length of UU, etc. The lifetime Tau (e-folding time) is given by the inverse of the rate.

3) Results

The results at 1 TeV were obtained with injection optics lattice and those at 20 TeV with collision optics lattice.

The lengths of each module are as follows:

Module	Length (m)
ARC = 143 CELLS	143*228.5 = 32,675.5
UU	4,570.0
MB	2,285.0
LB	2,285.0

and the input parameters were taken to be:

	20 TeV	1 TeV
particles/bunch	8e9	8e9
normalized emittance	1e-6 m-rad	1e-6 m-rad
bunch length	7 cm	5.5 cm
RMS momemtum spread	5e-5	2e-4

The lifetimes obtained are the following:

	Tau long.	Tau hor.	Tau vert.
E = 20 Tev	190 hrs	155 hrs	-2091 yrs
E = 1 Tev	30 hrs	31 hrs	-439 days

which should be compared to those in the CDR [2]

	Tau long.	Tau hor.	Tau vert.
E = 20 Tev	126 hrs	277 hrs	-2200 yrs
E = 1 Tev	26 hrs	27 hrs	-500 days

(negative means damping, positive means growth).

3) Discussion

The calculation done for the CDR was somewhat different [3] in that it used a coarser approximation, since the entire lattice was represented by some 350 points only. From our own experience this approximation is not as bad as it might seem, and probably gives results within 20-30% of the fine-grained lattice case. Therefore a rough comparison with the old calculation is meaningful. The horizontal lifetime is shorter probably because of the smaller dispersion of the new lattice and the larger number of particles per bunch. On the other hand, the beta functions are larger in the collision modules, and this tends to offset this effect somewhat.

The new lifetimes are comparable to the old ones at injection and not significantly different at collision. Since they are much longer than other relevant lifetimes anyway, the IBS effect is of no practical consequence.

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References

[1] M. S. Zisman, S. Chattopadhyay, and J. J. Bisognano, "ZAP User's Manual," LBL-21270, UC-28, December 1986.

[2] SSC Central Design Group, "Conceptual Design," SSC-SR-2020, March 1986, p. 184.

[3] S. Chattopadhyay, SSC-N-152, 1986.