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ACCELERATOR DEPARTMENT
Informal Report

INTERSECTING STORAGE ACCELERATOR NOTES

A High Transition Energy Lattice

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A High Transition Energy Lattice

If very short bunch length is desired in a storage ring with modest RF voltage, one may consider making a lattice with high transition energy γ_t since the RF voltage required is proportional to η ,

$$\eta = \left| \frac{1}{\gamma_t^2} - \frac{1}{\gamma^2} \right| . \quad (1)$$

By choosing γ_t close to the operating γ the voltage requirement is reduced. In a relatively normal lattice the value of γ_t is close to the betatron oscillation number ν . For ISABELLE, $\nu = 18.25$, a long way from the 200 GeV value of gamma $\gamma = 216$.

One way to make γ_t be much larger than ν , suggested by Courant for the NAL Booster and recently by Teng for the NAL Main Ring, is to modify the long straight sections so as to produce off-momentum closed orbit oscillations so that the off-momentum function X_p has a low or negative value, since

$$\frac{1}{\gamma_t^2} = \frac{1}{2\pi} \int \frac{X_p(s)}{\rho(s)} ds . \quad (2)$$

Unfortunately the amplitude of the X_p oscillations so produced can be quite large.

An alternative is the Vladimershij scheme employing reverse bending in the regular lattice. Separated function cell structures with reverse bending have been explored by the writer with a view to possible use in PEP.

The most attractive focusing-bending structure found is sketched below:

The negative bending magnets are placed between the horizontally focusing quadrupoles where X_p is a maximum and p is negative, so the largest possible negative contribution to the integral in (2) is obtained. The cell phase advance is made large, $\mu \sim 135^\circ$, for the same reason.

The structure shown gives $\beta_{\max}$ and $\chi_{p,\max}$ values comparable to cells with positive bending only, while the value of γ_t^{-2} is nearly zero or negative. It can be altered by large amounts by moderate tuning of the quadrupole gradients, as would be necessary in order to run at different energies.

The obvious disadvantage of this scheme is that circumference, i.e. energy, is wasted. However one might contemplate a ring built with high γ_t as an option. For normal operation the lattice could be as shown in the sketch except that all the bending magnets are positive. When one desires to run the machine in the tight bunch mode, the fields are reversed in the appropriate magnets, and the operating energy is lowered by a factor of 3/5. This change would require some realignment of magnets or provision of extra aperture.

It should be emphasized that high Transition energy is probably not required in ISABELLE. This note is intended to suggest a fix in case future study points to a requirement for very short bunch lengths.