Advanced Accelerator Physics and Accelerator Simulation Homework 8

Georg H. Hoffstaetter, Physics 488/688, Cornell University

May 9, 2007

Exercise 1:
Given a FODO lattice which has the periodic Twiss parameters $\beta_x = \beta_y = 10m$, $\alpha_x = \alpha_y = 0$ at its exit.
(a) If you want to construct a symmetric arrangement of six quadrupoles to design an interaction region with a horizontal beta function of 0.5m and a vertical beta function of 0.05m in its center. How would the transport matrix from the FODO to the interaction point have to lock like?
(b) Why are six quadrupoles with at fixed locations not sufficient to adjust the two beta functions?
(c) Assume there is also a symmetric arrangement of four horizontal corrector coils and that the Twiss parameters at their places are known. Specify the relative strength of these coils so that a closed bump is created that only changes the orbit position at the low beta point, but not orbit angle.
(d) Specify the relative strength of these coils so that a closed bump is created that only changes the orbit slope at the low beta point, but not the orbit position.

Exercise 2:
Assume you are able to change the strength of all optical elements in a storage ring.
(a) How can you measure β_x and β_y in a quadrupole.
(b) How can you measure the beam position in a sextupole?
(c) Assuming there is a BPM just next to a horizontal correction dipole. How can you measure the horizontal beta function at that position?

Exercise 3:
The first quadrupole after an interaction region typically has a very large vertical beta function.
(a) Use thin lens approximation to find β_y in this quadrupole for $\beta_y^* = 1$cm and a distance of 1.5m from quadrupole to interaction point.
(b) If this quadrupole has a focal strength of 0.5m^{-1} and its current changes accidentally by 1%. How many percent of beta-beat ($\Delta\beta/\beta$) would you expect for a tune of $\nu = 0.52$?
(c) What tune shift would you expect?

Exercise 4: Compute the horizontal tune distribution $\rho(\nu_x)$ for a Gaussian beam with an emittance of $\epsilon = 180$nm when the ring has the tune of $\nu = 0.52$ and there is an octupole of

strength 2m^4 with length 1m at a place with β_x of 40m.