PHY 554. Homework 6.

Handed: Oct 28,2024 Return by: Nov 4, 2024

Electronic copies accepted at yichao.jing@stonybrook.edu or yjing@bnl.gov

1 (35 pts, each 5 pts). Synchrotron Radiation in NSLS II

Let us calculate the synchrotron radiation related problems in NSLS II. NSLS II adopts DBA lattice (separate function magnets).

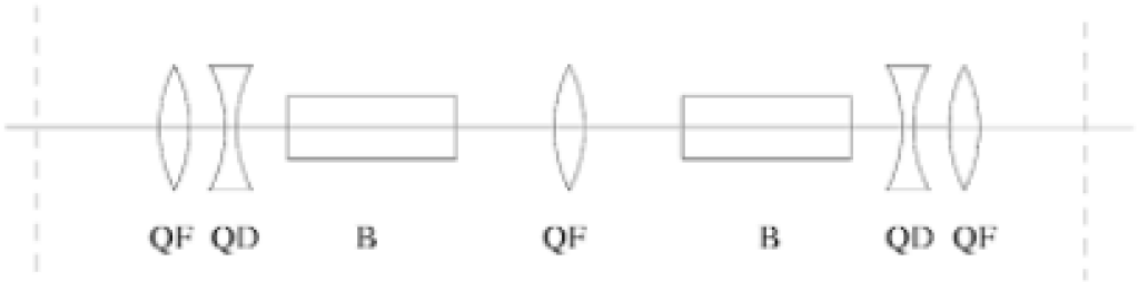

Figure 1: DBA lattice

The parameter of the electron ring is given by the following table.

Table 1: NSLS II parameters

Parameters	Values
Energy [GeV]	3.0
Circumference [m]	780
Number of dipoles	60
Dipole field [T]	0.4
Beam current [A]	0.5
RF frequency [MHz]	499.68
Harmonic number	1320

From the design parameters, please calculate the following parameters (Hint: you can use the results from mid-term):

1. The energy loss due to the synchrotron radiation in all dipoles.

2. If the accelerating phase of the RF cavity is $\pi/6$, what is the minimum RF voltage needed to replenish the loss due to synchrotron radiation?
3. Actually the RF voltage is 3MV. Find the longitudinal tune of NSLS II (Hint: find the ϕ_s)
4. What is the critical radiation frequency of the dipole radiation?
5. Find the partition number in dipoles.
6. Find the longitudinal damping rate E and compare with the period of longitudinal oscillation.
7. Find the equilibrium energy spread of NSLS II.

2 (5 pts). Equilibrium emittance in LEP

The equilibrium electron emittance at 100 GeV in LEP is about 0.06 mm-mrad. If we want to use the same LEP machine as a storage ring for a 5 GeV synchrotron light source by scaling down the magnet strength proportional to the beam energy, what will be the equilibrium electron emittance? (Hint: bending radius stays the same)