USPAS Graduate Accelerator Physics Homework 15

Due date: Tuesday February 16, 2021

1 DBA Light Source

A light source with a circumference of $176\,\text{m}$ contains 8 identical DBA cells, with zero dispersion (and dispersion slope) at one end or the other of all 16 dipoles. Each dipole is $2.7\,\text{m}$ long, and the beam energy is $2.5\,\text{GeV}$.

  a) (3 points) What is the characteristic energy of the photons radiated in the dipoles?

  b) (3 points) How much energy is radiated per turn, per electron?

  c) (3 points) What is the momentum compaction factor of the ring?

  d) (3 points) What are the damping times τ_x, τ_y, and τ_s?

  e) (3 points) What is the approximate equilibrium horizontal emittance?

2 Touschek Lifetime

(10 points) Calculate a rough estimate of the Touschek lifetime for a flat electron beam in a ring, using the following lattice parameters. Assume that the lattice parameters are constant and ignore dispersive contributions to the horizontal beam divergence $\sigma'_{x,RMS}$.

Table 1: Touschek Lifetime Parameters

Parameter	Variable	Unit	Value
Beam energy	E	GeV	9
Path length	L	m	1000
Equilibrium horizontal emittance	ϵ_x	m	4×10^{-9}
Vertical emittance	ϵ_y	m	$\epsilon_x/6$
Bunch length	σ_s	m	5×10^{-3}
Number of electrons	N_0		3×10^{10}
Effective $\beta_{x,y}$	$\beta_{x,y}$	m	3
Momentum acceptance	$\delta_{\text{acceptance}}$		0.001