

Homework PHY 554 #4.

Due October 9th, 2024

HW 1 (3 points):

Consider an electron storage ring at an energy of 4.5 GeV, a circulating current of 500 mA and a bending radius of $\rho=8$ meters. Calculate the energy loss per turn, the critical photon energy, and the total synchrotron radiation power.

HW 2 (2 points):

As shown in slide #17, the angular distribution of radiation power is given by

$$\frac{dP(t_r)}{d\Omega} = \frac{1}{4\pi\epsilon_0} \frac{e^2}{4\pi c} \frac{\dot{\beta}^2}{(1-\beta\cos\theta)^3} \left[1 - \frac{\sin^2\theta\cos^2\phi}{\gamma^2(1-\beta\cos\theta)^2} \right]$$

Show that for $\gamma^{-4} \ll \theta \ll 1$ and $\gamma \gg 1$, the angular spread of the radiation power is in the order of γ^{-1} .

HW 3 (5 points): For 3.5 GeV storage ring with circulating current of 300 mA and a bending radius of $\rho=12$ meters, consider an undulator with 78 periods and with $K=0.7$ installed in the straight section. Assume horizontal geometrical emittance of 1.5 nm rad ($1e-9$ m rad), vertical emittance of 30 pm rad ($30e-12$ m.rad) at the radiation point $\beta_x=\beta_y=2$ m.

- Find undulator period that fundamental wavelength will be 0.5 nm (5 Å)
- What will be spectral brightness at the fundamental wavelength?