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Accelerator Physics WS24/25

Exercise sheet 6 (Submission: 17.12.2024)

Exercise 1: Basic lattice structures (10 points)

This exercise focussed on the comparison of the characteristics of the FODO cell and the Double Bend Achromat (DBA) structure. The attached paper by L.C. Teng presents a way that allows to calculate the approximate value of the equilibrium emittance in an analytical way. The synchrotron radiation integrals are replaced by a form factor F, which is presented for both cases.

(a) The KARA storage ring has a circumference of $C = 110.4\,\mathrm{m}$ and consists of 8 Double-Bend-Achromat cells. The 16 bending magnets each have a length $L_{\mathrm{B,KARA}} = 2.164\,\mathrm{m}$. Calculate the energy loss per turn and the equilibrium emittance at a beam energy of $E = 2.5\,\mathrm{GeV}$. Assume the damping partition number $J_x = 1$. (4)

Hint 1: To evaluate the synchrotron radiation integral $\mathcal{I}_2$, first calculate the bending radius ρ.
Hint 2: Use the "useful and realistic" ansatz for the numerical factor F.

(b) Imagine an alternative KARA lattice built of 8 FODO cells with a dipole filling factor of 80 %, a FODO cell phase advance of $\mu = 90°$ and one dipole magnet in-between two quadrupole magnets. Calculate energy loss per turn and the equilibrium emittance. (3)

Hint: Calculate the FODO cell length and the length of one bending magnet to obtain the bending radius in case of the FODO lattice.

(c) Compare the energy loss per turn and the equilibrium emittance for both lattices.
Discuss your results. Which lattice is beneficial for which application? (3)