Eighth International Accelerator School for Linear Colliders, December 4 – 15, 2013, Antalya, Turkey
Homework for Lecture A4, Beam Delivery & beam-beam

(Materials for the task 5 are given in the 2nd part of the lectures, tomorrow)

1) Beam electrons with energy corresponding to magnetic rigidity $B\rho$=1667 T*m has the following vertical rms sizes and angular spread just in front of the final focusing quadrupole: σ_y=30μm and $\sigma_{y'}$=0.6nrad. The final quadrupole length is L_Q=1m and its gradient is G=333 T/m. Estimate the vertical beam size at the IP, assuming that the energy spread in the beam is zero; and also estimate the increase of the beam size due to the 1E-3 energy spread.

2) Before arriving to the final quadrupole, the electron beam mentioned above, passes through horizontal bending magnet with field B=0.15T and length L_B=5m. Synchrotron radiation in this bend result in the average energy loss and additional energy spread in the beam. Estimate:
    a. Longitudinal shift of the beam waist due to the average energy loss
    b. Increase of the vertical beam size in the waist due to energy spread

3) For the above mentioned beam
    a. Estimate increase of the vertical beam size at the IP due to synchrotron radiation in the final quadrupole
    b. Estimate, at what beam energy, with all other conditions the same, the beam size would about double due to synchrotron radiation in the quadrupole

4) For the above described final quadrupole, which of the following arrangements of the sextupole near the vertically-focusing quadrupole and of the dispersion would allow compensation of the final quadrupole vertical chromaticity (K_S/K_F is the ratio of the sextupole strength to the quadrupole strength):
    a. Vertical dispersion η=1m and sextupole with K_S/K_F =0.5m^{-1} ;
    b. Horizontal dispersion η=1m and sextupole with K_S/K_F =1m^{-1} ;
    c. Horizontal dispersion η=1m and sextupole with K_S/K_F =2m^{-1}

5) The beam described above has population N=1e10 electrons and horizontal size at IP σ_x^*=200nm. For the particle of incoming positron bunch, estimate the number of emitted beamstrahlung photons per particle when:
    a. The oncoming e+ bunch has 3nm vertical offset with respect to e- bunch;
    b. The oncoming e+ bunch has 30nm vertical offset with respect to e- bunch;
    c. Estimate the needed length σ_z of the beams for optimal travelling focus

6) The beam described above enters detector solenoid with horizontal angle with respect to its axis equal θ_c= 10mrad. Half-length of the detector is L=5m and its longitudinal magnetic field is B=4 T. In the assumption of hard edge solenoid, estimate the vertical orbit deviation and the vertical angle of the beam at the exit from solenoid. (Ignore any final focusing elements).