Experiment 2

Closed Orbit Distortion

The closed orbit can be manipulated with the 100 dipole corrector magnets in CESR. The closed orbit distortion at s due to a kick $\Delta\theta$ at s_1 is given by

$$\Delta x(s) = \frac{\sqrt{\beta(s)\beta(s_1)}\Delta\theta}{2\sin\pi\nu}\cos(\phi(s) - \phi(s_1) - \pi\nu) \tag{1}$$

There are horizontal and vertical correctors in CESR. Most of the horizontal correctors are extra windings on the main dipole magnets. The sextupole magnets have an additional pair of coils about the inner and outer pair of poles that generates a reasonably uniform horizontal field and serve as vertical correctors. Calibration for the steering correctors is in CESR29::[CESR.CONSTANTS]STEERING.CAL. Horizontal and vertical correctors are located at horizontally and vertically focusing quadrupoles respectively. The horizontal steering labelled 28W, for example, uses the extra windings on the pair of dipoles adjacent to Q28W. Because the effect of a particular steering on the closed orbit depends on β averaged over the region where the kick is applied, it is somewhat easier to interpret the effect of the vertical steerings since the sextupoles are only 27cm long, while the dipoles are nearly 7m long. There is no significant change in β over the length of the sextupole. The same cannot be said of the dipoles.

Our objective is to introduce a vertical or horizontal kick of some known amount and measure the change in the closed orbit at a couple of beam position monitors, (labelled DET_00W, DET_01W, ..., DET_49W, DET_49E, ...)

1. Fill a single bunch of positrons to about 3mA
2. Turn off electrostatic separators
3. Check DETEC display and be sure you are in the single button mode, for bunch 1 positrons, and that the attenuators/amplifiers are set for 3mA
4. Type CESRV l:* ⟨cr⟩ on a control system computer.

5. Then at the CESRV prompt type TAKE ORBIT ⟨cr⟩. The orbit will be displayed.

6. To see the measured horizontal and vertical displacement at each of the detectors, at the CESRV prompt type SHO ORBIT

7. Note the number of the orbit butns file. It will be something like butns.12345

8. Assign the corrector magnet of your choice to the control panel. (i.e. RING MAGNETS → CSR HORZ CUR, (or CSR VERT CUR) → 13W)

9. Estimate the change in corrector strength for a 3-5mm maximum displacement of the closed orbit and dial the change.

10. Type TAKE ORBIT ⟨cr⟩ at the CESRV prompt

11. Type READ REFERENCE ⟨number⟩ where ⟨number⟩ is the number of the reference orbit that you took earlier (12345). CESRV will plot the difference in the orbits and show the change due to the corrector.

12. Type SHOW ORBIT ⟨cr⟩ at the CESRV prompt and you will find displacements for reference orbit and final orbit.

13. You will need the design twiss parameters to compare your measurement with theory. If, for example you are interested in computing the closed orbit distortion at BPM 43W, Type SHOW ELE DET_43W ⟨cr⟩

14. Compute the anticipated orbit displacement at a couple of detectors and compare with your measurements. Make measurements first a vertical and then a horizontal steering. Repeat one of the orbit measurements at least twice to get some measure of reproducibility. What systematic effects might compromise this measurement?