Experiment 7

Phase space

The phase space for the horizontal motion is the turn by turn mapping of the canonical coordinates of the bunch (x, x') at some point in the ring. We can measure displacement (x) at beam position monitors. But we cannot measure angle (x') directly. If however we can identify a pair of detectors that are 90° out of phase, then displacement at one, suitably scaled by local $\beta-$ functions, corresponds to angle at the other.

1. Fill 2mA of positrons in bunch 1, train 1
2. Turn off electrostatic separators.
3. Reduce positron feedback gain to nearly zero, horizontal, vertical and transverse. (E- TRANSFER → CSR FEED CON → 5, 9, and 11)
4. We drive the centroid motion of the bunch to measurable displacements with the *tune tracker* and magnetic shaker. This is the same device that we used for taking betatron phase data.
5. Collect turn by turn data by typing "PLOTIR" on a control system computer. (CESR29,CESR28...). Turn by turn data will be recorded at detectors 2E:12W, with a few exceptions when you use the "take" command.
6. You can plot the data using the FFT program on a linux box. You will need to choose a pair of detectors, suitable for horizontal, vertical analysis of the phase space. To copy turn by turn data files to the linux cluster from cesr29:
   (a) Log on to linux account
   (b) type "ftp cesr29" and login with username$ and password
   (c) type "cd log3$disk:[cesr.cesrbpm.raw.02]"
   (d) type "get cbpm_⟨*number*⟩.raw" where *number* is the number of the data file that you just wrote. The first two digits will be "02".

(e) Then exit from ftp and you can read the data file with program fft.

7. Measure the phase space as a function of horizontal and vertical tune (QTUNEING 5,6). The phase space will become increasingly distorted as the tunes approach a resonant condition. Take data at nominal tunes, and then again at horizontal tune near 2/3 (i.e. $f_x = \frac{2}{3} f_{rev} \sim$ 260kHz). You may have to take several sets of measurements at slightly different tunes to see significant phase space distortion. Time permitting, try to measure phase space with the vertical tune near 3/4. Now we are looking for vertical distortion so we need to use the vertical tune tracker and shaker to excite the beam. You might also try to set the horizontal tune near 1/2. In the vicinity of the resonance, increase or descrease the shaker amplitude to see how the distortion depends on the ampitude of the oscillations.

8. Compare measurements and simulation. The ANALYZE program can be used to simulate phase space data. The ANALYZE program writes a file named "phase_space.dat". This file can be read by the fft program and plotted as if it were real measurements.