TRASH Collaboration

Non-linear dynamics
Beam physics group

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A trash RF Cavity

Tracking particles

Purpose

- To study the stability of the beams

Method

- Start from the lattice of Exercise 3
- Set up a single particle tracking
- Use the thin lens version for tracking with MAD-X

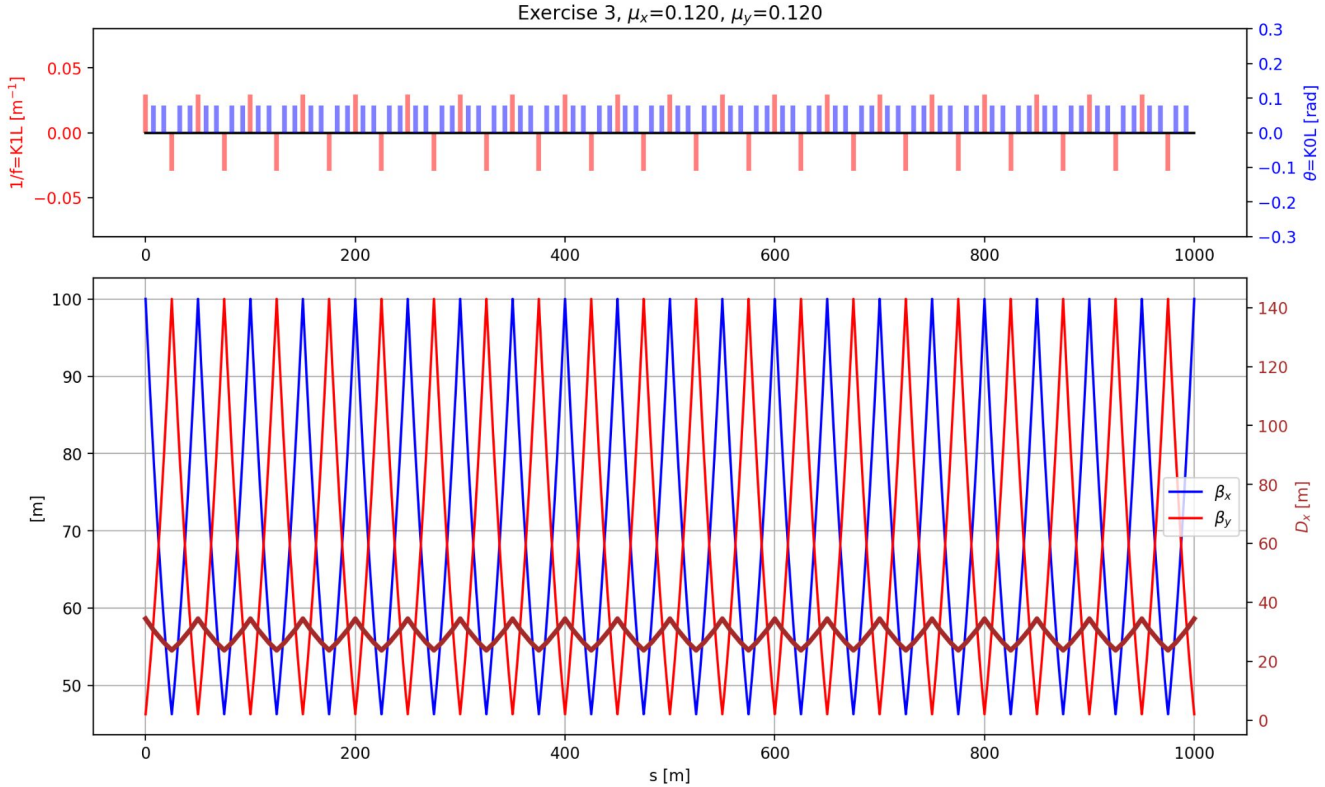
Variables

- Tune
- Sextupole strengths

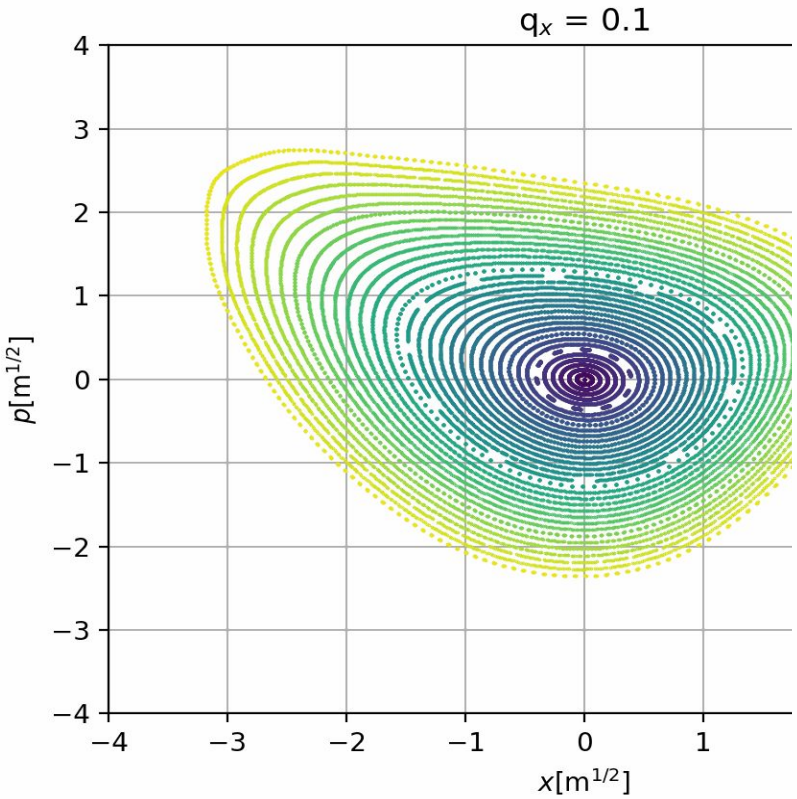
Dynamic aperture

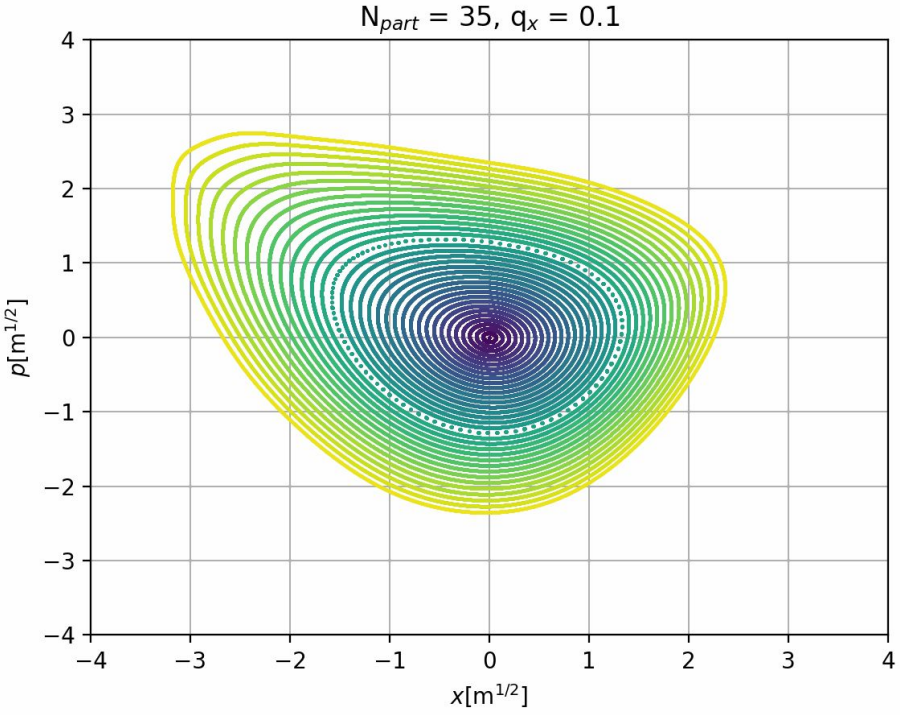
- A particle is said to be outside the dynamic aperture if it becomes unstable after a number of turns.
- Oscillations about the closed orbit will grow in amplitude for particular values of the tunes (resonances) and initial phase space position of the particles.
- The result will be a limited dynamic aperture.

The Lattice


Exercise 3, μ_x=0.120, μ_y=0.120
1/f=K1L [m^{-1}]
θ=K0L [rad]
[m]
D_x [m]
s [m]
β_x
β_y

Xmax = 12 m, 35 particles, 1000 turns & 10 000 turns





Computing dynamic aperture

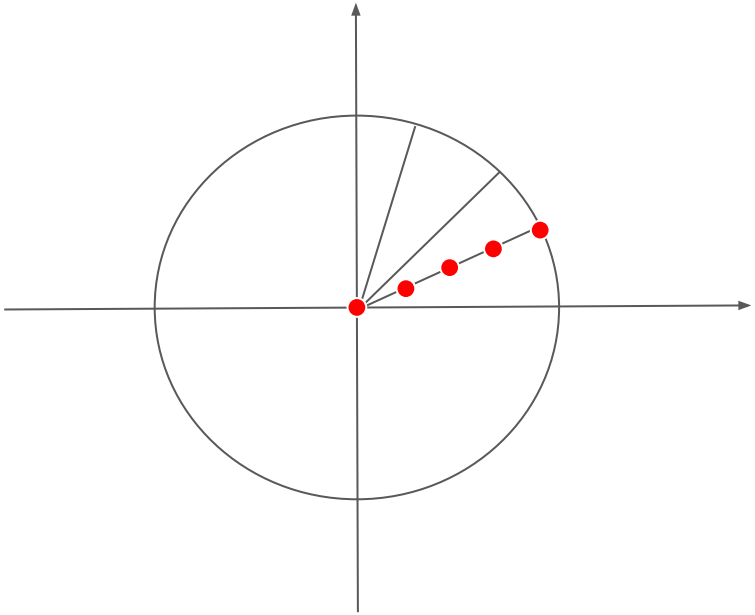
1. The lattice is defined with the required configuration (magnet strengths, magnetic field, etc.)

2. Particles are tracked over a range of initial conditions. The initial conditions of those particles whose trajectories stay within specified limits for a specified number of turns are considered to lie within the dynamic aperture.

3. The dynamic aperture is defined as the largest initial amplitude of the particles than are not lost

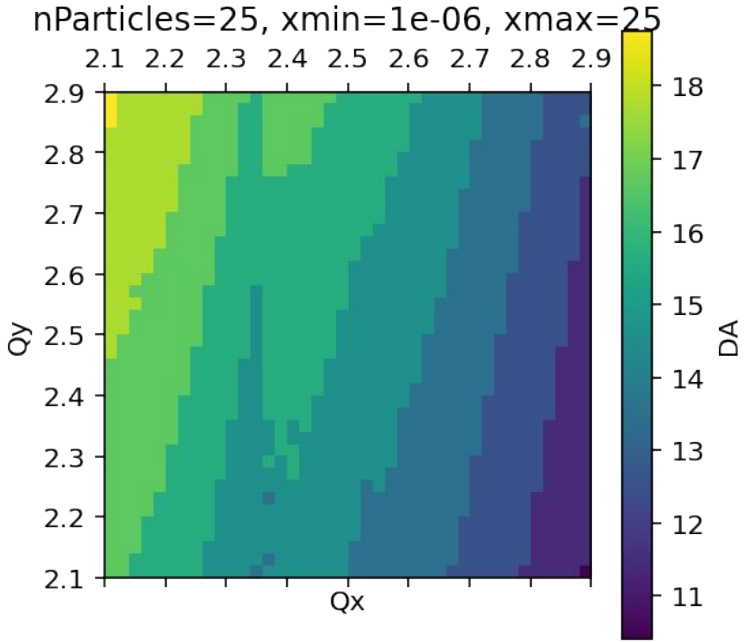
DA vs Initial Position of the Particles

To exclude that our results depend on the initial conditions of the particles, we repeated the simulations for several initial configurations:



We chose as maximum amplitude 25m after scanning a few values

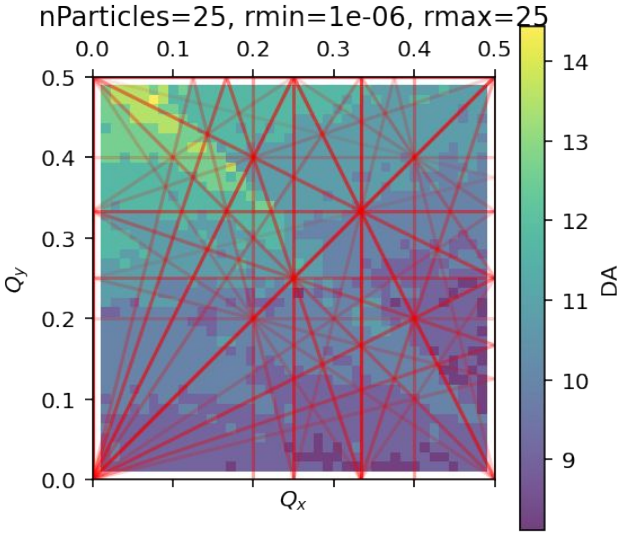
Dynamic aperture for 25 particles initially on x-axis



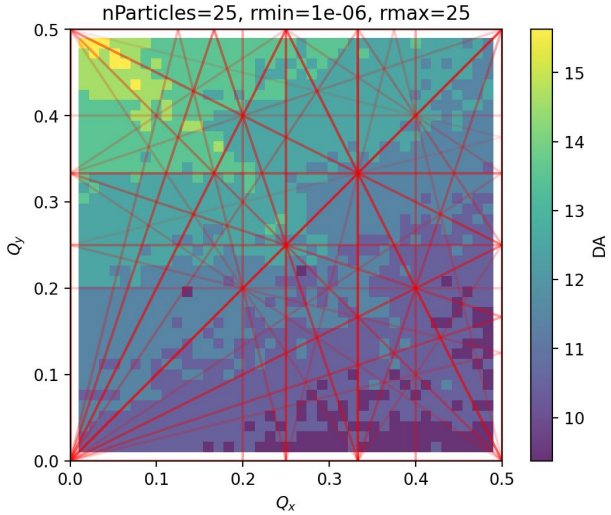
It’s undesirable to initialise the particles on axis, because it will “suppress” the dynamics on the other axis

Dynamic aperture for 25 particles with different initial conditions

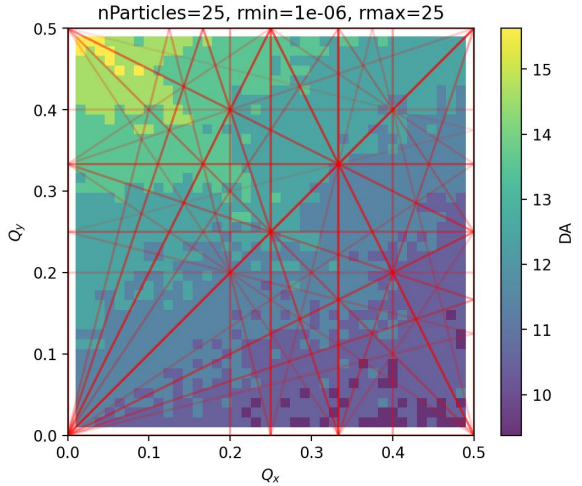
π/6 rads line



π/4 rads line



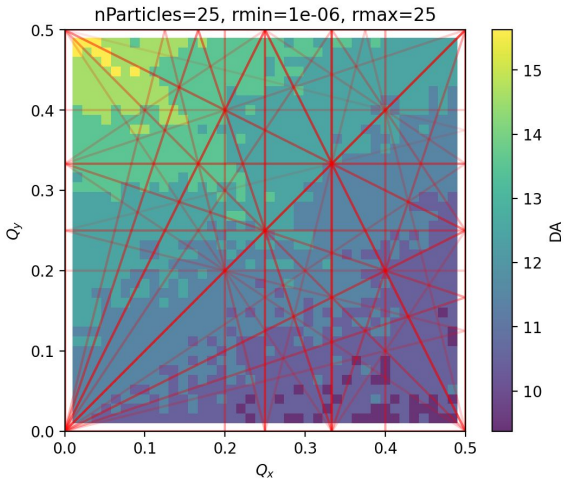
π/3 rads line



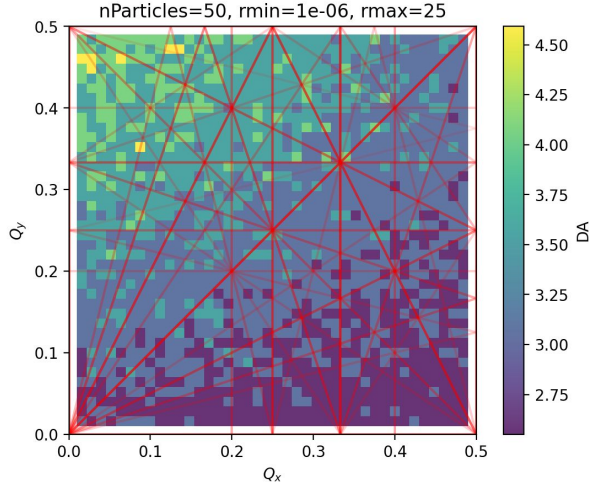
The results are not greatly influenced by the initial angle

Effect of Chromaticity

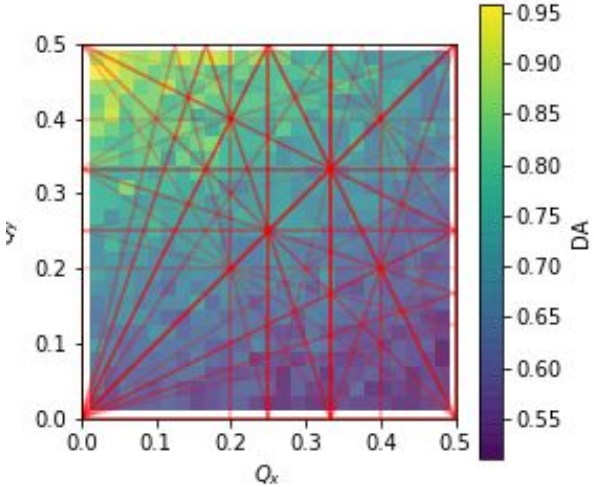
Q'_x = Q'_y = 0



Q'_x = Q'_y = 10



Q'_x = Q'_y = 50



As expected high sextupole currents reduce DA. We should stick to low chromaticities.

Conclusion

1. The chromaticity correction does not impact the DA, but higher sextupole currents can be detrimental
2. The lattice shows a very high dynamic aperture even for high chromaticity values (e.g for a slow extraction scheme)
3. Studies can be extended to include a Landau octupole
4. The TRASH machine is great !