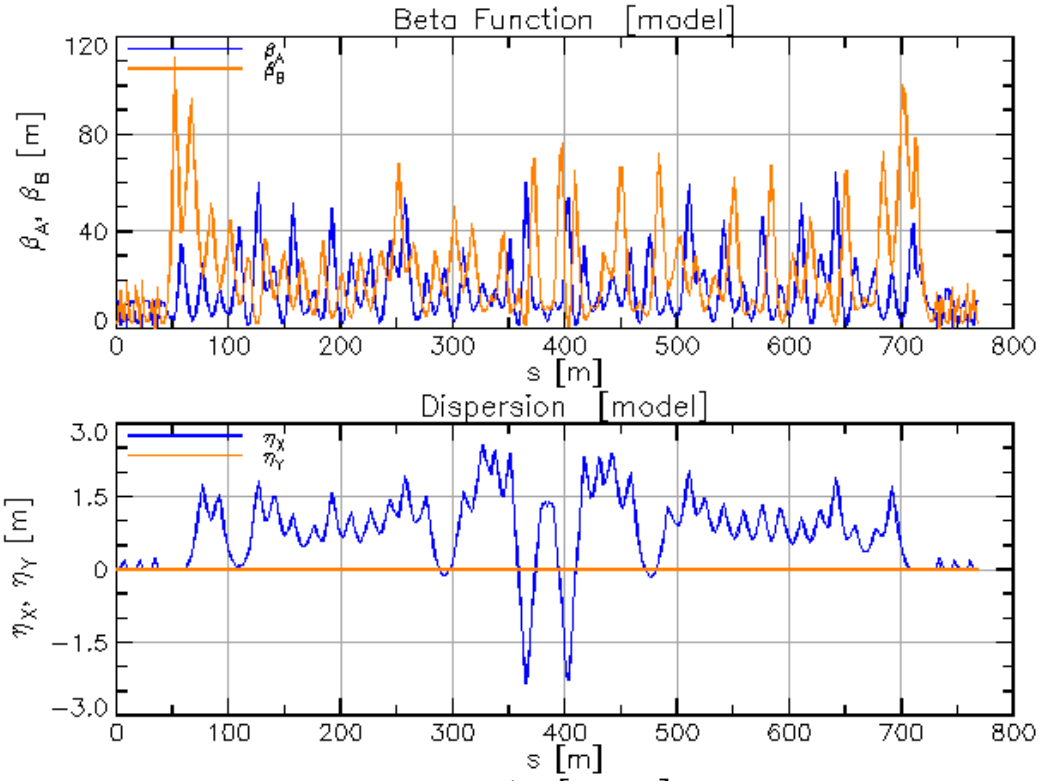
OSC simulation update

Suntao Wang

1. DLR 1GeV bypass CHESS-U lattice

6/26/2018

/home/dlr/lat/des/osc/mpe/bmad_osc_20180620.lat



m51: 3.1737E-04 m52: -1.3797E-02
m56: 3.5886E-03 m56_t: 1.0531E-04

Damping ratio: λ_x/λ_s=33.1

Cooling range:

ε_{x_max} = 4.2510E-09 $\delta p/p_{\_max}$ = 2.9077E-03
n_x = 2.7671 n_z= 7.1516

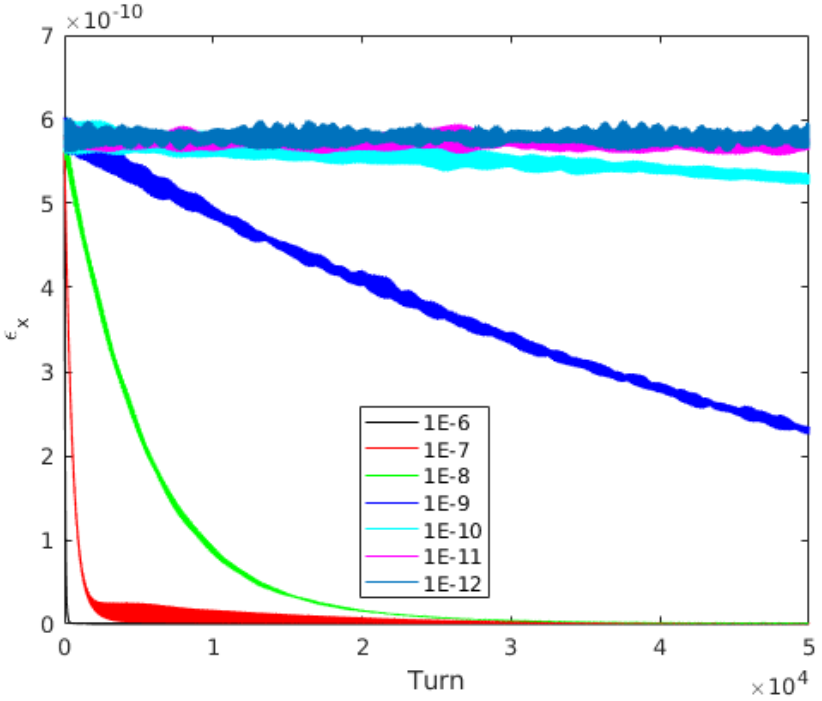
Radiation damping time ~ 0.5s

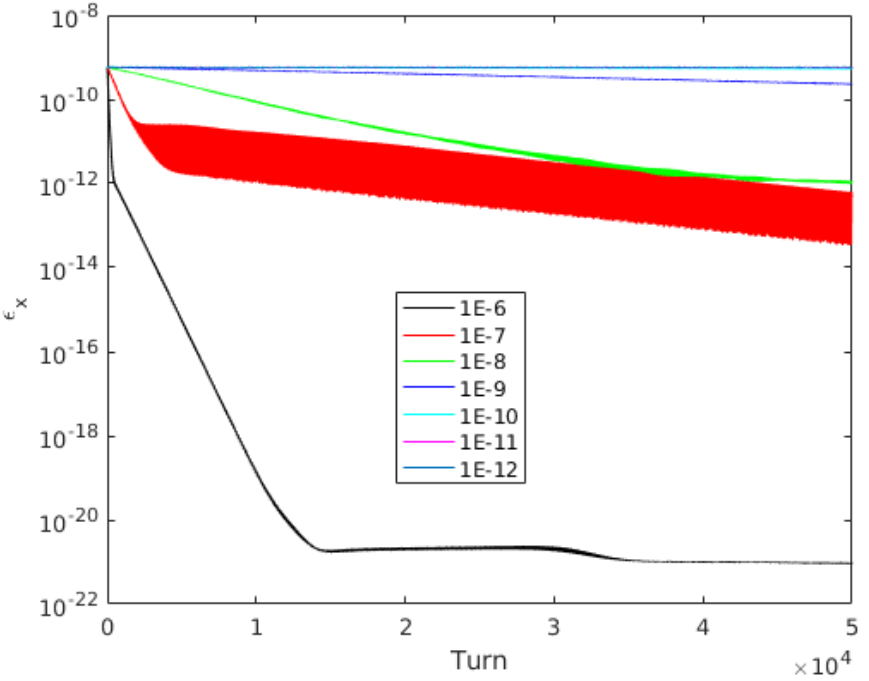
	X		Y		
	Model	Design	Model	Design	
Q	16.6986	16.6986	12.8659	12.8659	! Tune
Chrom	0.8662	0.8662	0.5102	0.5102	! dQ/(dE/E)
J_damp	1.0347	1.0347	1.0005	1.0005	! Damping Partition #
Emittance	5.552E-10	5.552E-10	5.970E-14	5.970E-14	! Meters
Alpha_damp	5.325E-06	5.325E-06	5.149E-06	5.149E-06	! Damping per turn

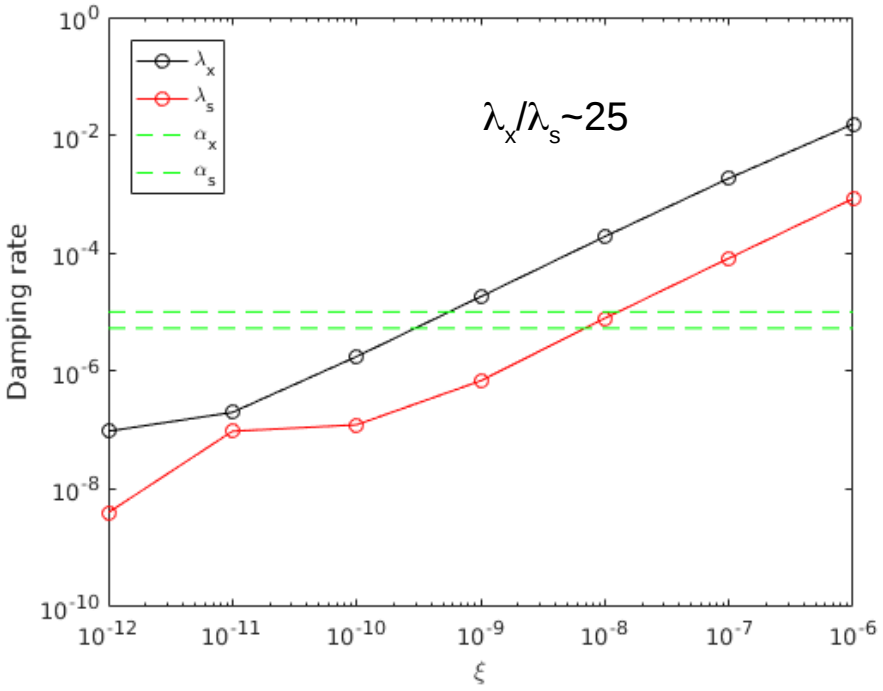
	Model	Design	
Z_tune:	2.660E-02	2.660E-02	! The design value is calculated with RF on
Sig_E/E:	4.066E-04	4.066E-04	
Sig_z:	1.080E-02	1.080E-02	! Only calculated when RF is on
Energy Loss:	1.029E+04	1.029E+04	! Energy_Loss (eV / Turn)
J_damp:	1.965E+00	1.965E+00	! Longitudinal Damping Partition #
Alpha_damp:	1.011E-05	1.011E-05	! Longitudinal Damping per turn
Alpha_p:	5.773E-03	5.773E-03	! Momentum Compaction

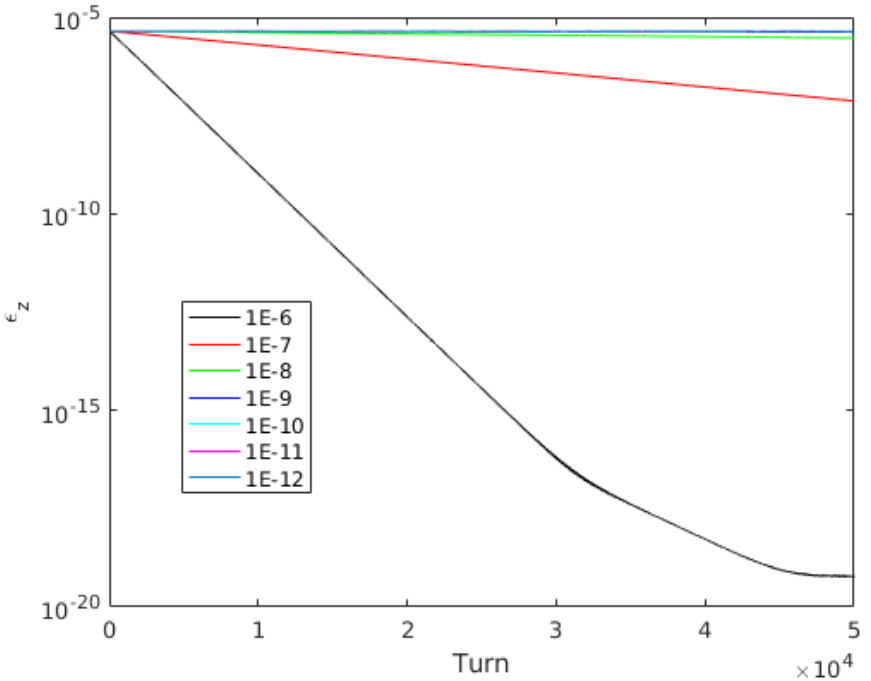
Without incoherent kicks, radiation damping and excitation turned off

Track 1000 particles starting with design equilibrium emittance



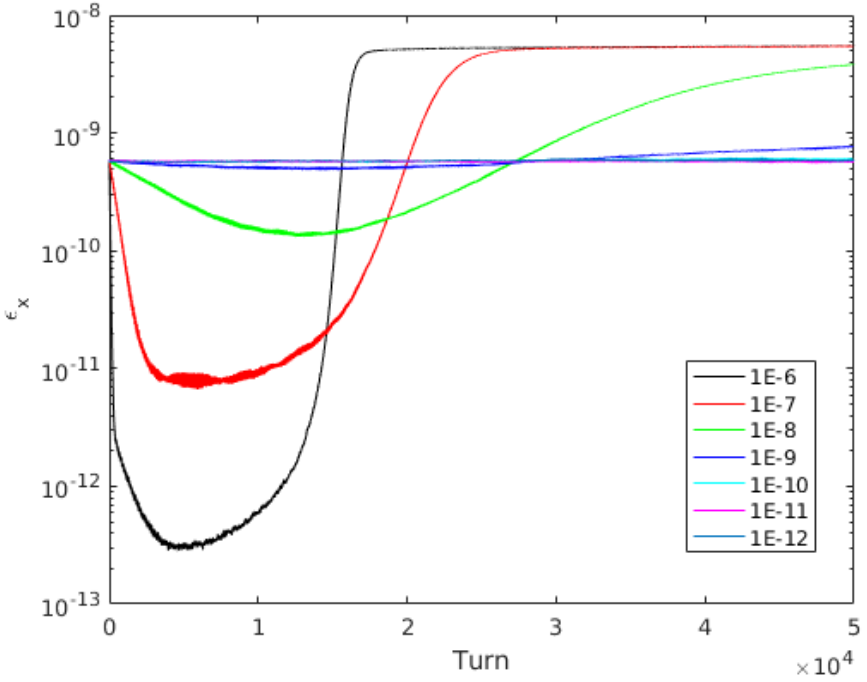


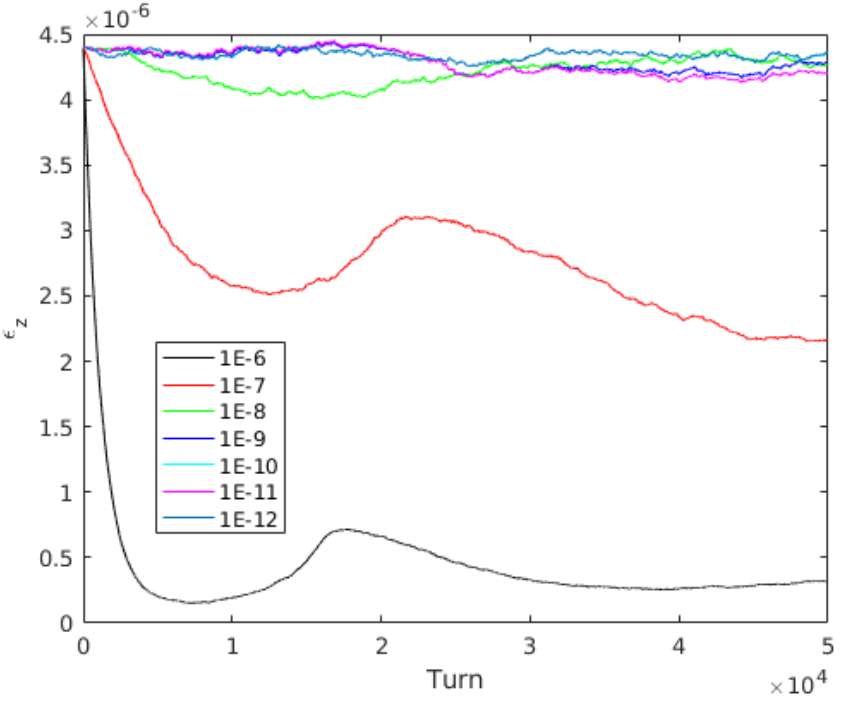




Without incoherent kicks, radiation damping and excitation turned on

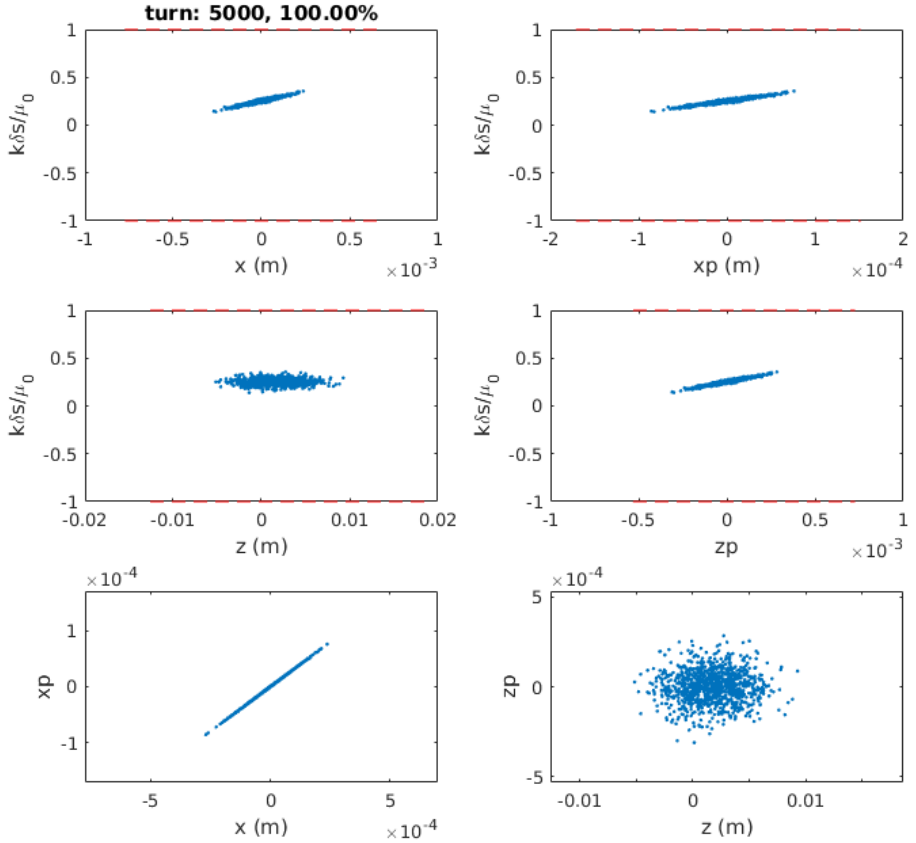
Track 1000 particles starting with design equilibrium emittance

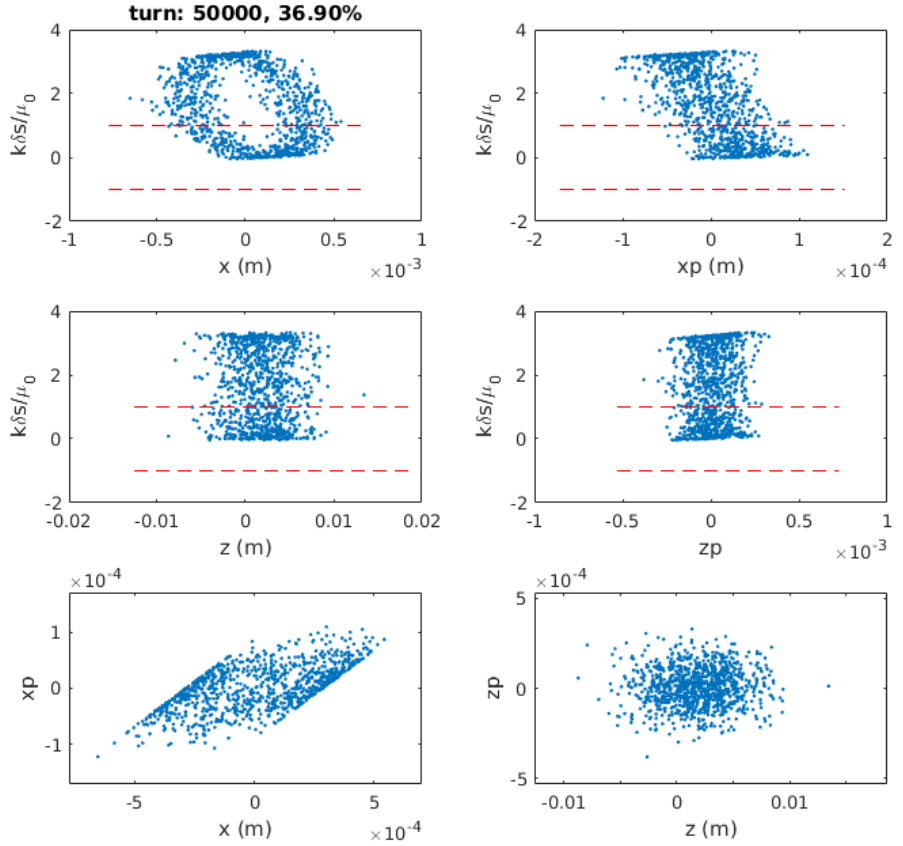




The emittances drop initially then start to increase.

Why the emittances blow up when radiation damping and excitation is turned on?

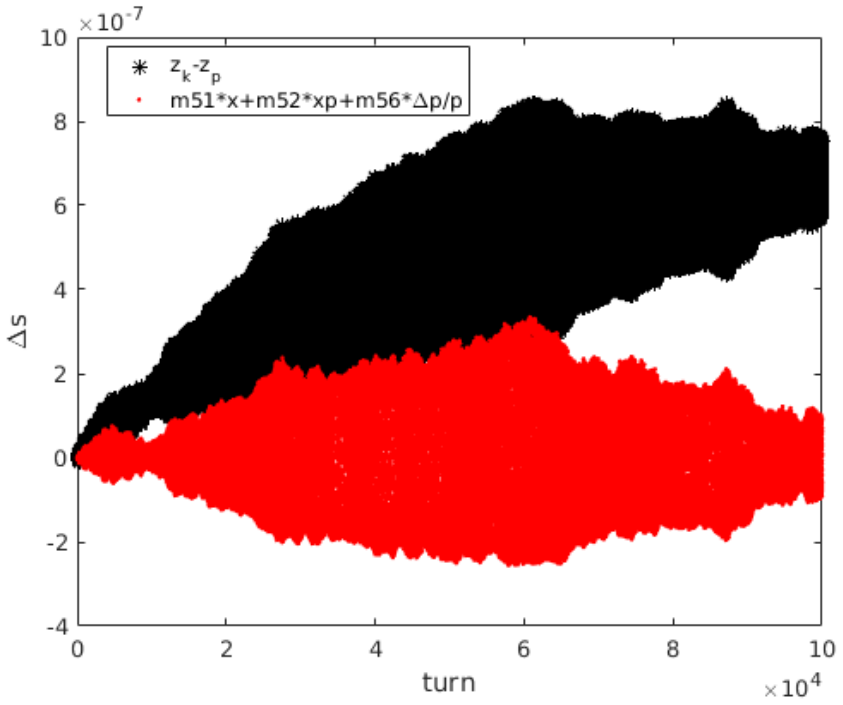




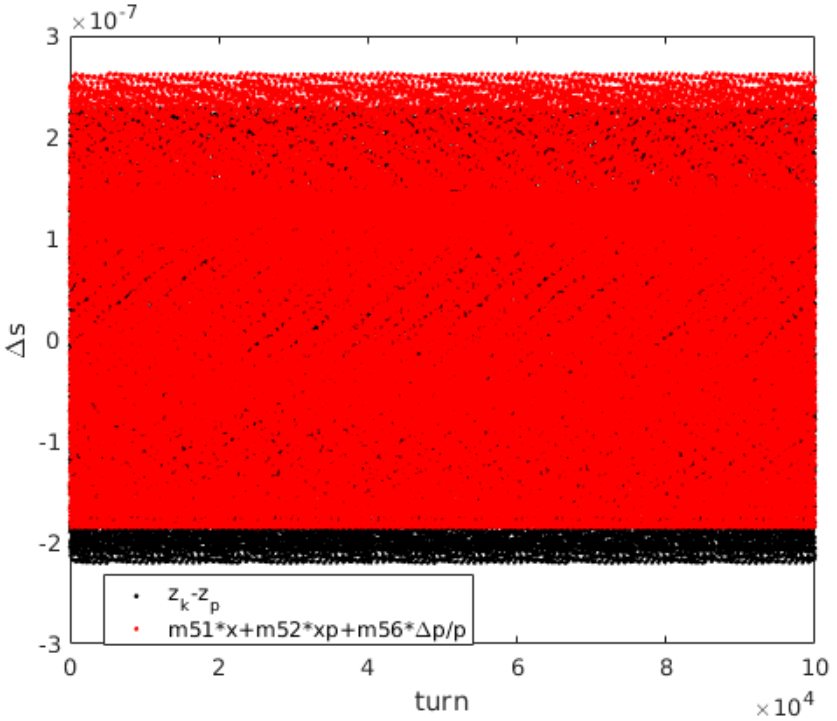
$\Delta s = z_{kicker} - z_{pickup}$ increases for all the particles turn after turn

Eventually, they are outside the cooling ranges so that the emittance increases.

Track single particle with radiation damping and excitation turned on or off, without OSC

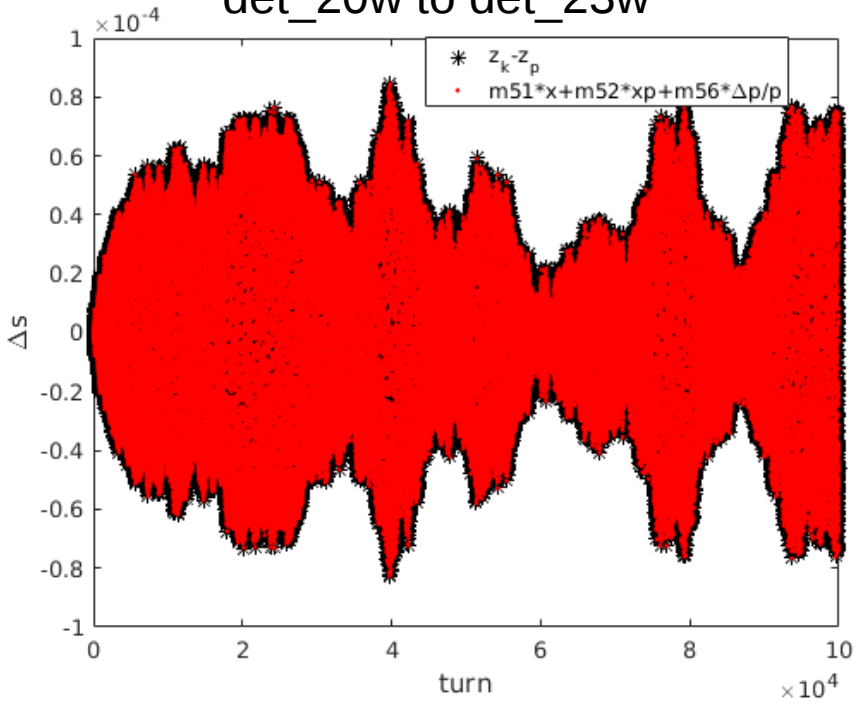


On



Off

det_20w to det_23w



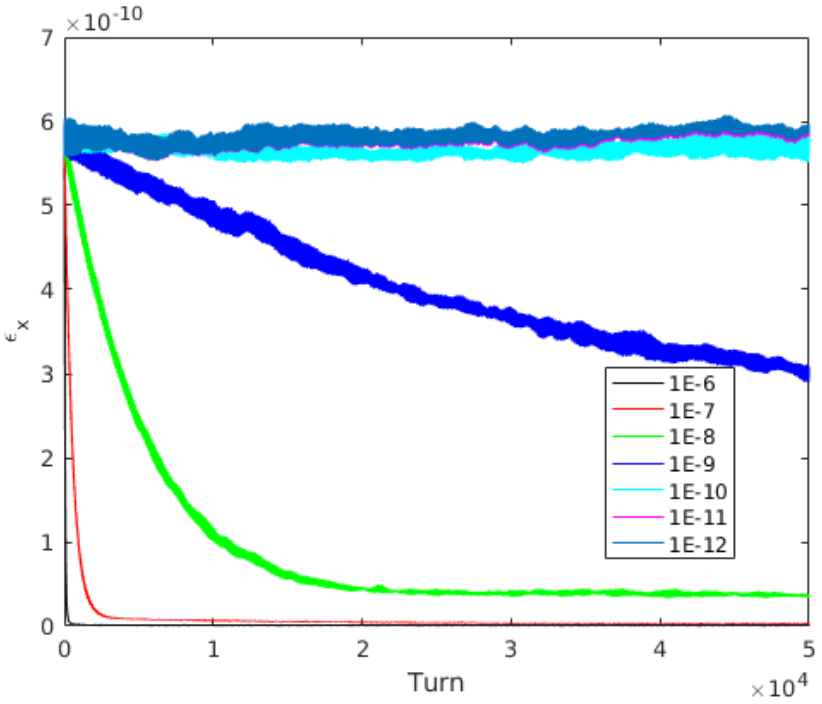
$\Delta s=z_k-z_p$ increases and then stabilizes
Constant delay ~7E-7 ?

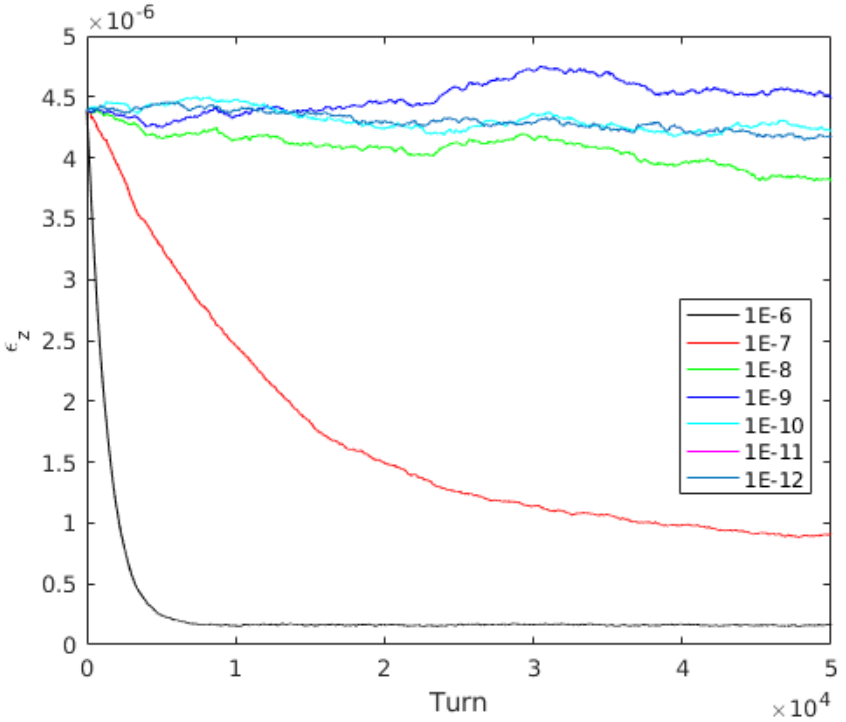
$\Delta s=m_{51}*x+m_{52}*xp+m_{56}*\Delta p/p$ linear part seems to be stable over all the turns

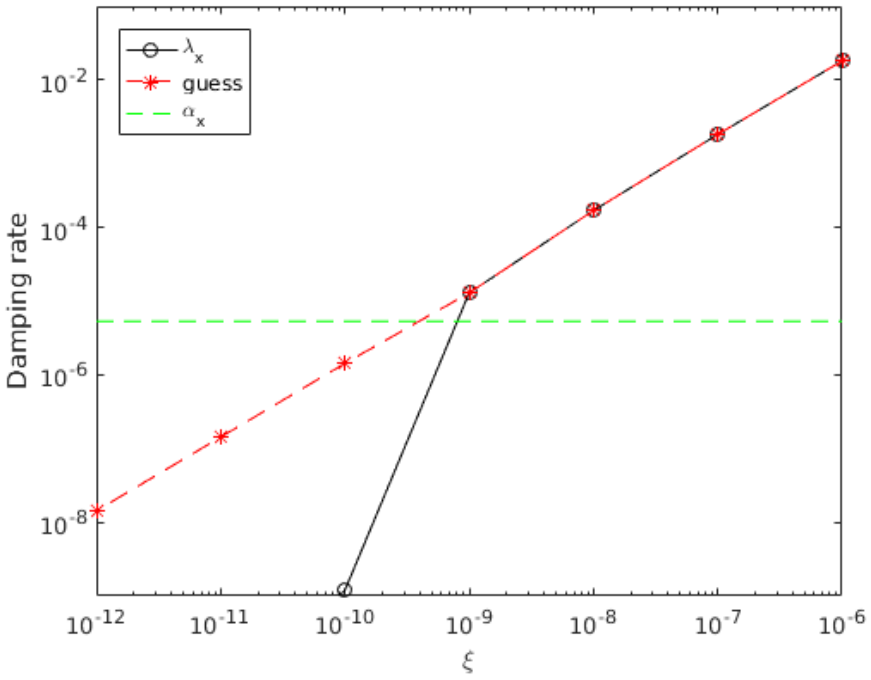
Similar amplitude oscillation around 0 or around 7E-7.

Bypass dependent?

Without incoherent kicks, radiation damping and excitation turned on -- linear delay Δs

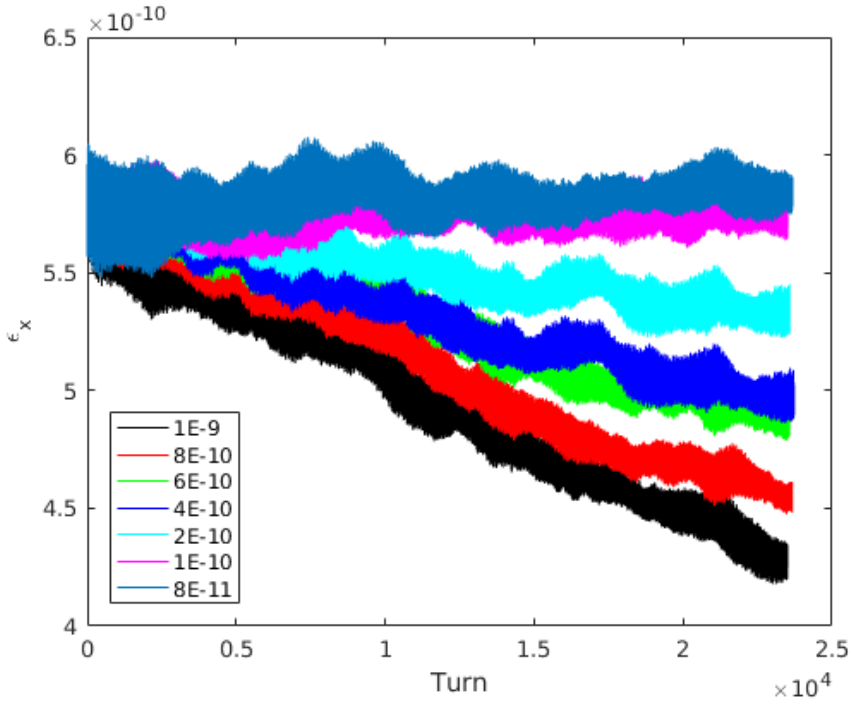


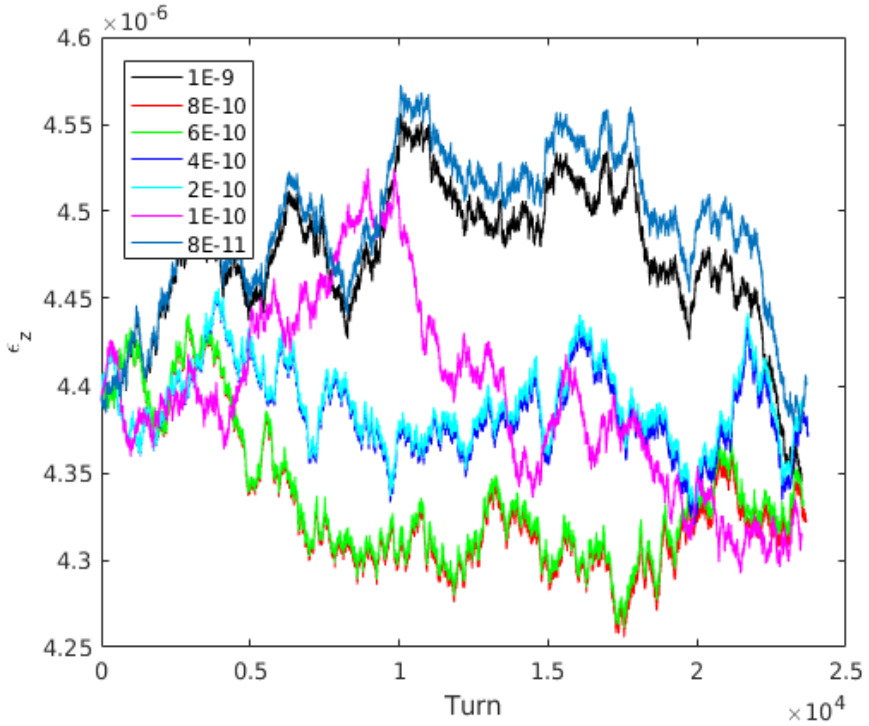


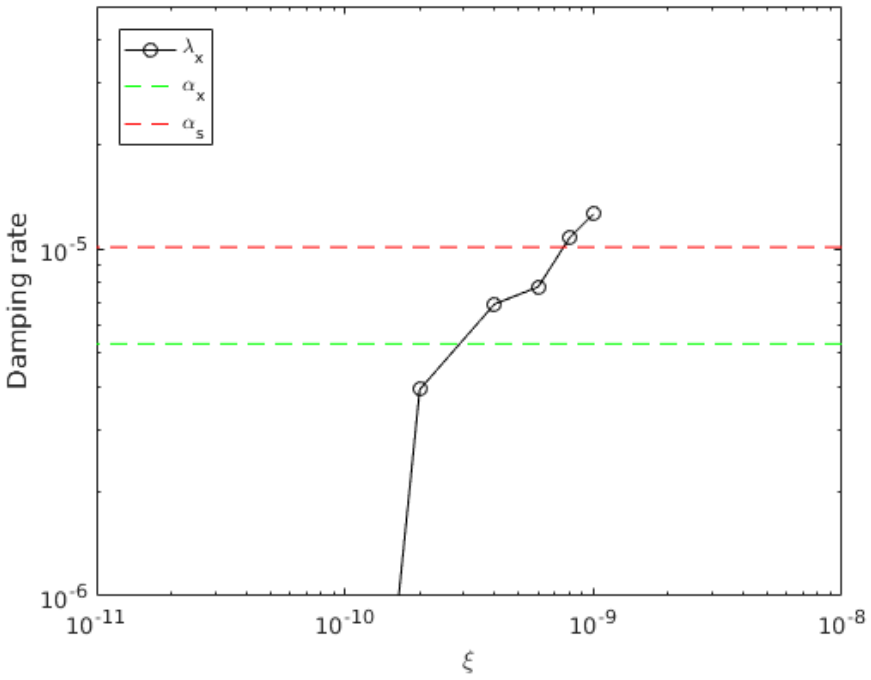


$\Delta s = m_{51} * x + m_{52} * xp + m_{56} * \Delta p/p$ linear part

With incoherent kicks (1E7 particles), radiation damping and excitation turned on -- linear delay Δs



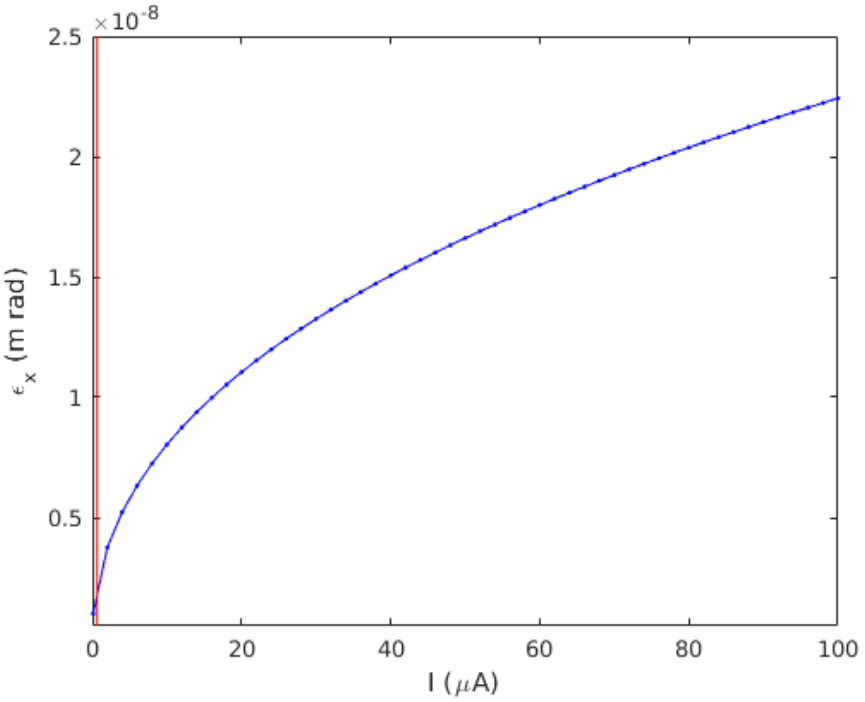




$\Delta s = m_{51}*x + m_{52}*xp + m_{56}*\Delta p/p$ linear part

Lattice: /home/dlr/lat/des/osc/mpe/bmad_osc_20180619-2.lat

Set V_{RF}= 6E5 V, σ_z~11 mm



Emittance due to IBS:

N=1E7, I~1μA, ε_x~2 nm

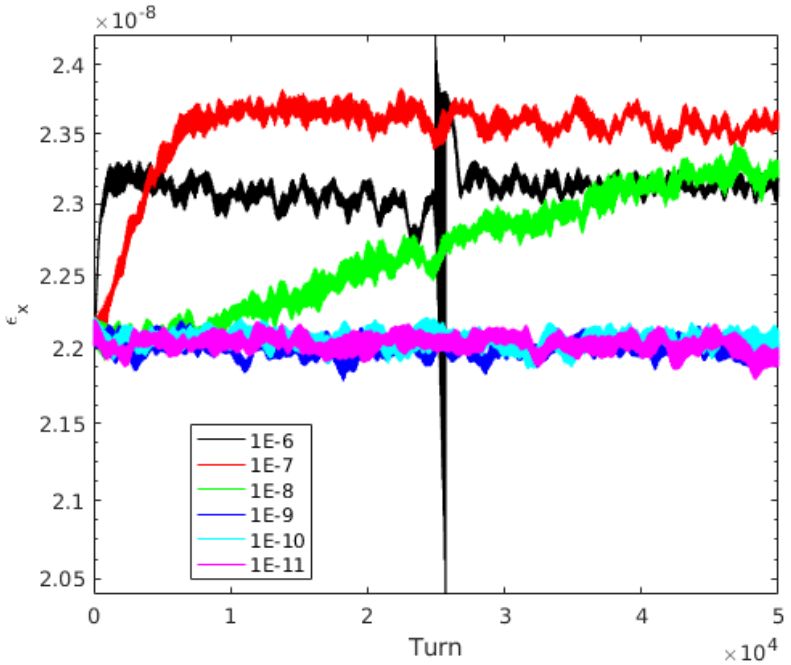
N=1E9, I~0.1mA, ε_x~22 nm

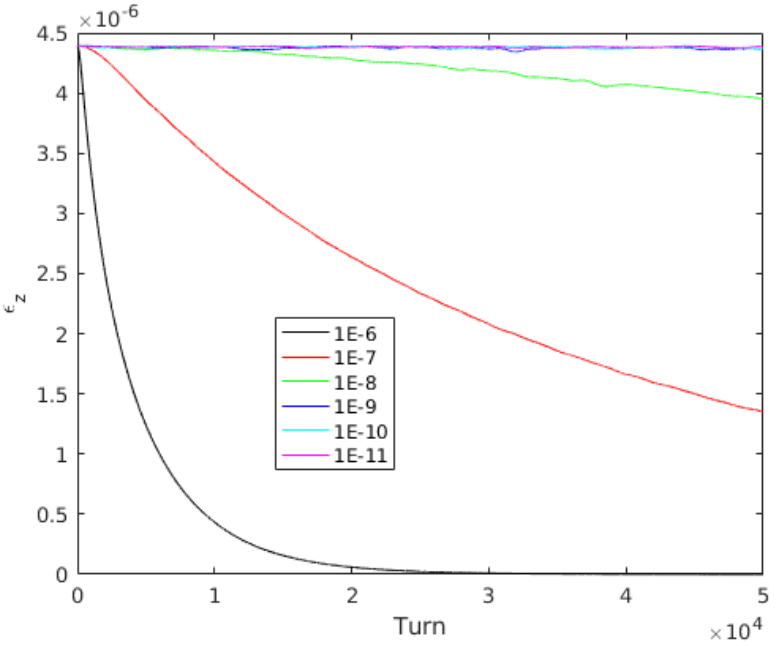
Can we see cooling with an equilibrium emittance of 22 nm?

Without incoherent kicks, radiation damping and excitation turned off

Track 1000 particles

ε_x~22 nm





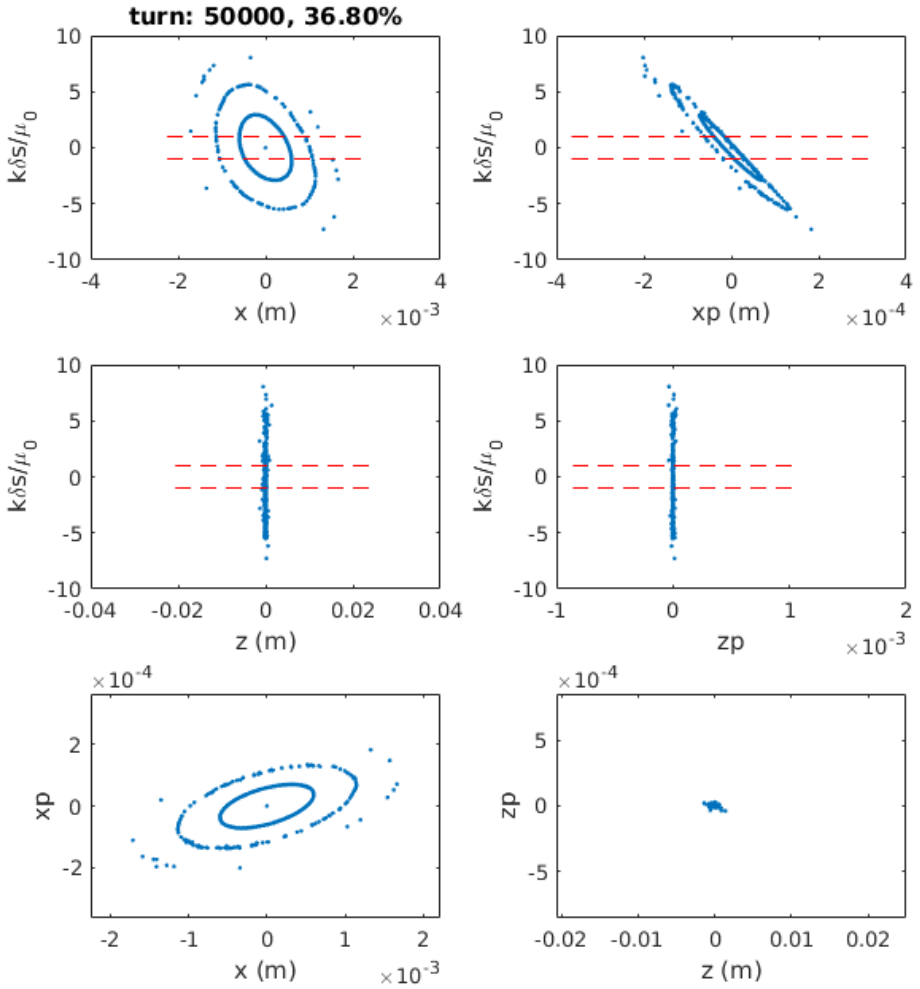
No cooling horizontally

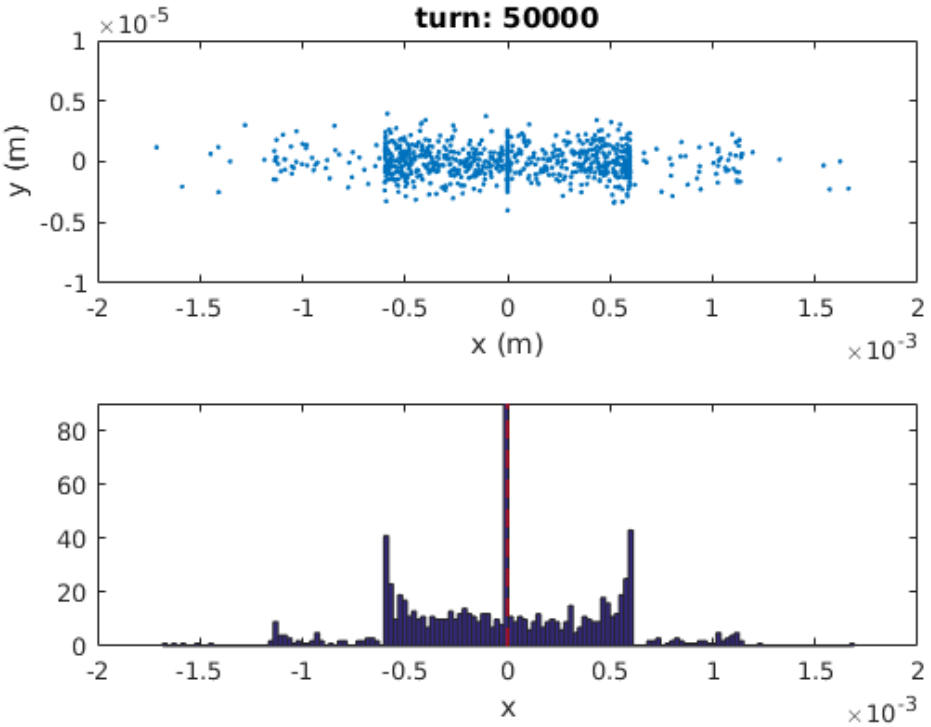
Cooling longitudinally but long damping time.

Since the damping rate is proportional to the gain factor (ξ), it is very possible that cooling with low gain (~1E-10) can be seen with longer tracking time.

x-x', z-z' phase space, xy profiles and histogram

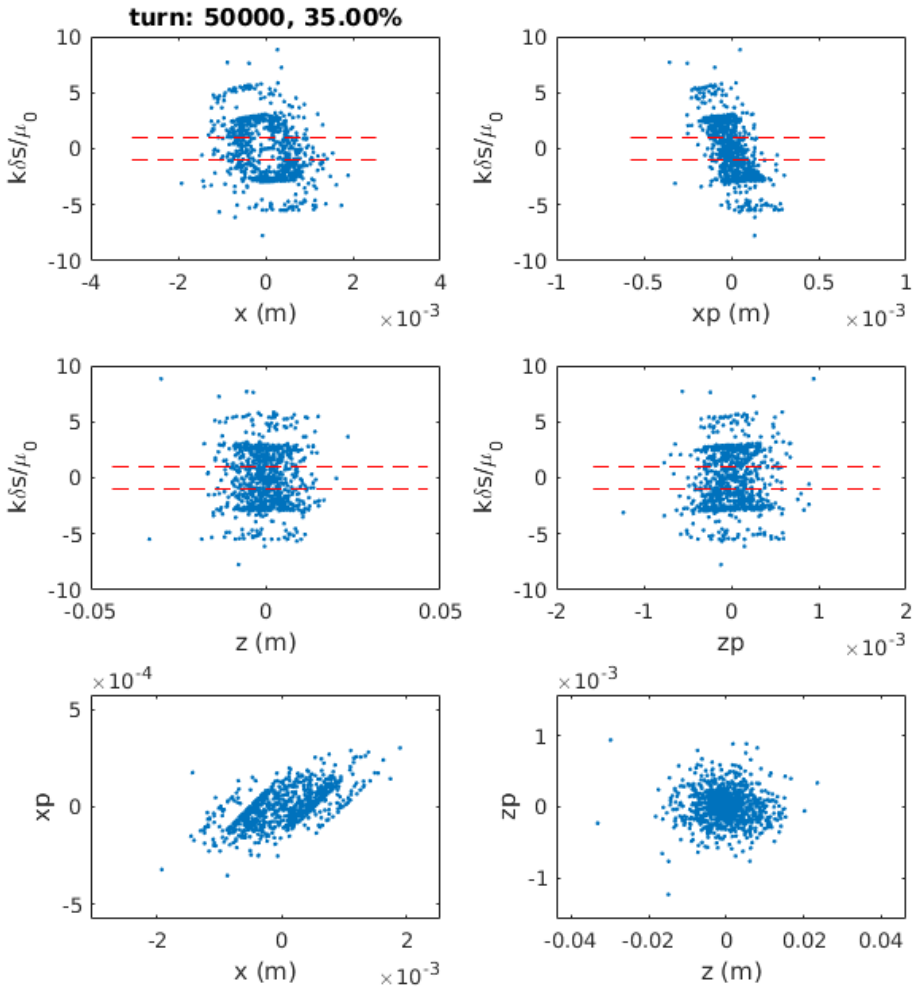
ξ=1E-6

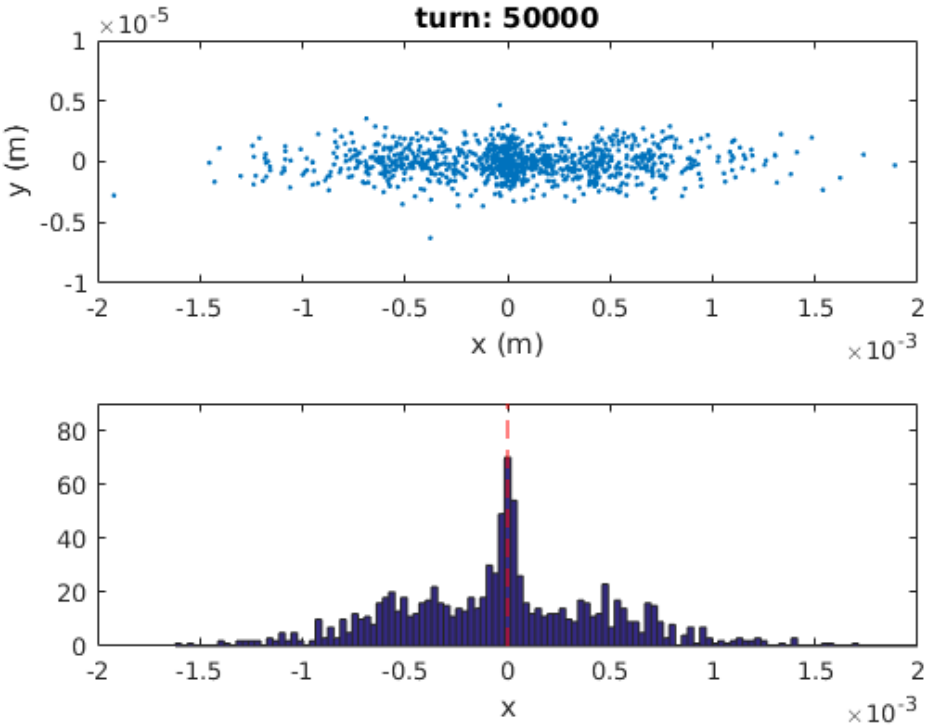




x-x', z-z' phase space, xy profiles and histogram

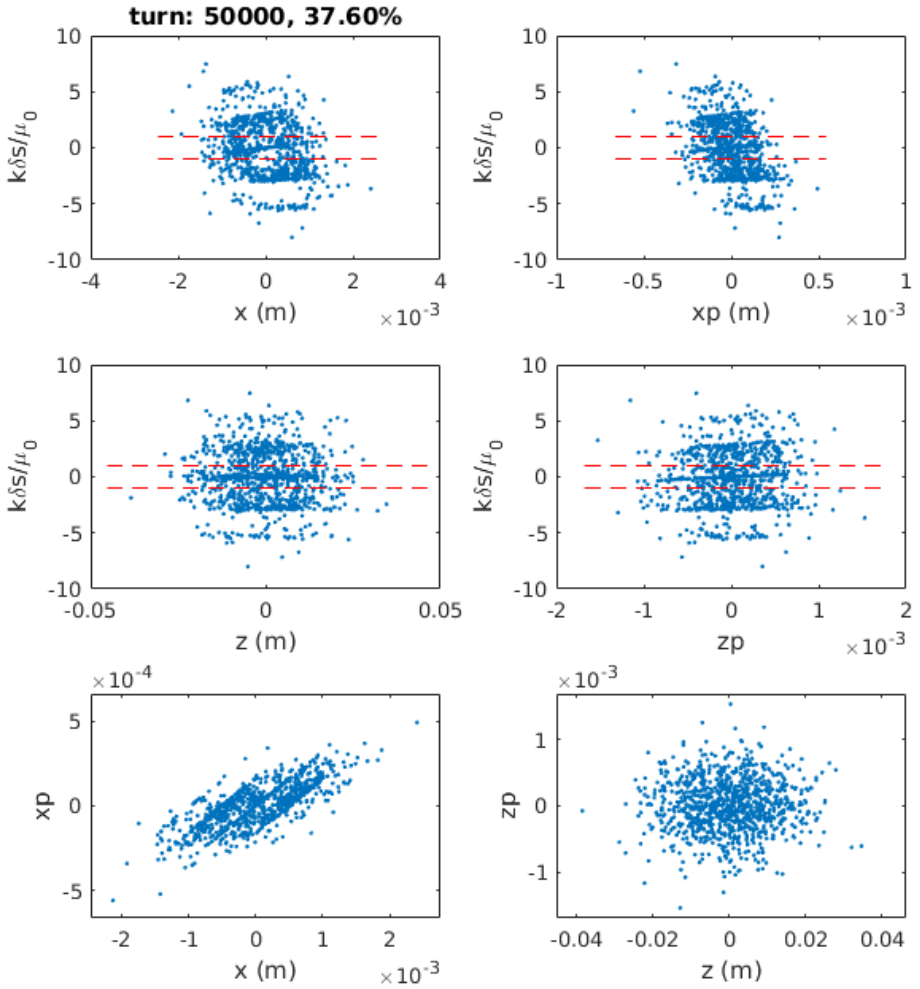
ξ=1E-7

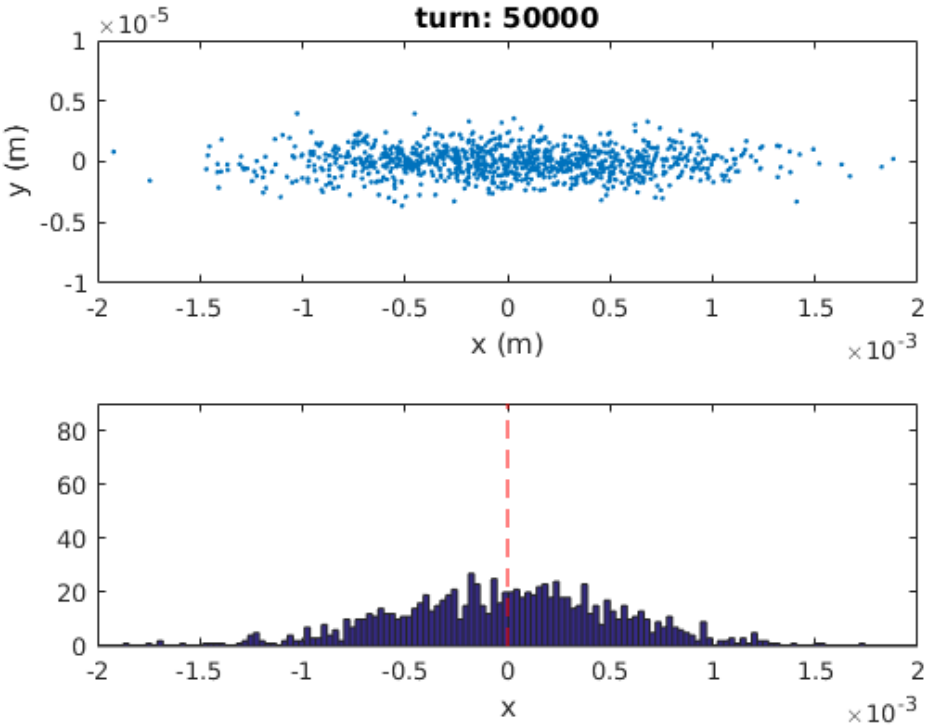




x-x', z-z' phase space, xy profiles and histogram

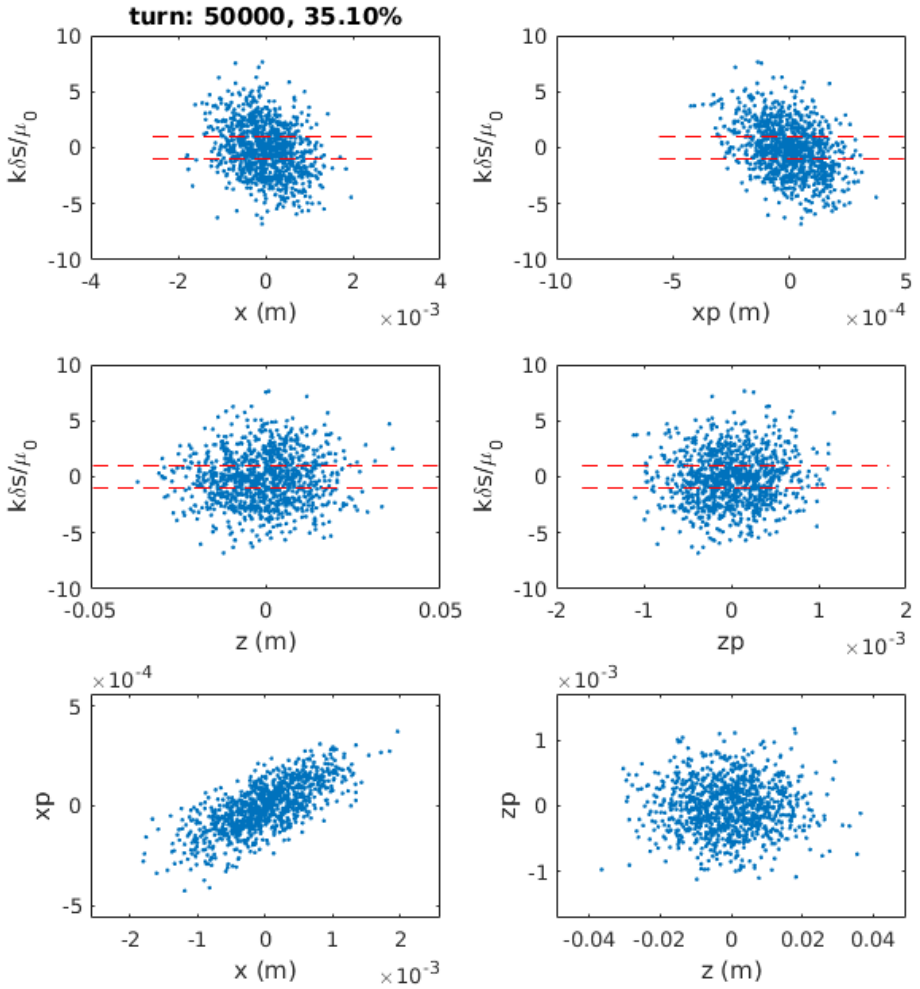
ξ=1E-8

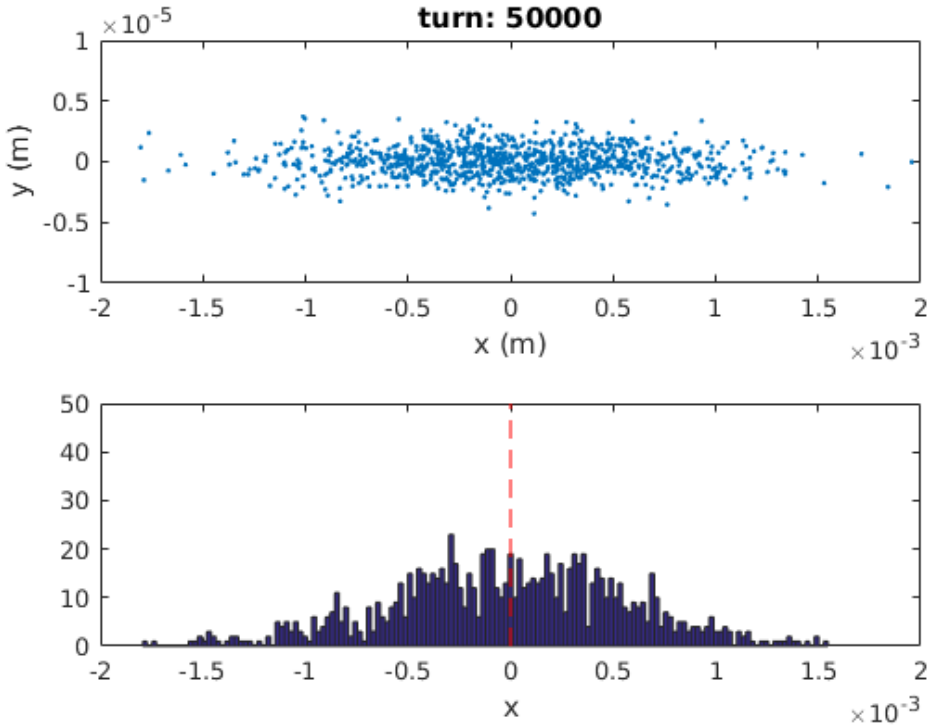




x-x', z-z' phase space, xy profiles and histogram

ξ=1E-9

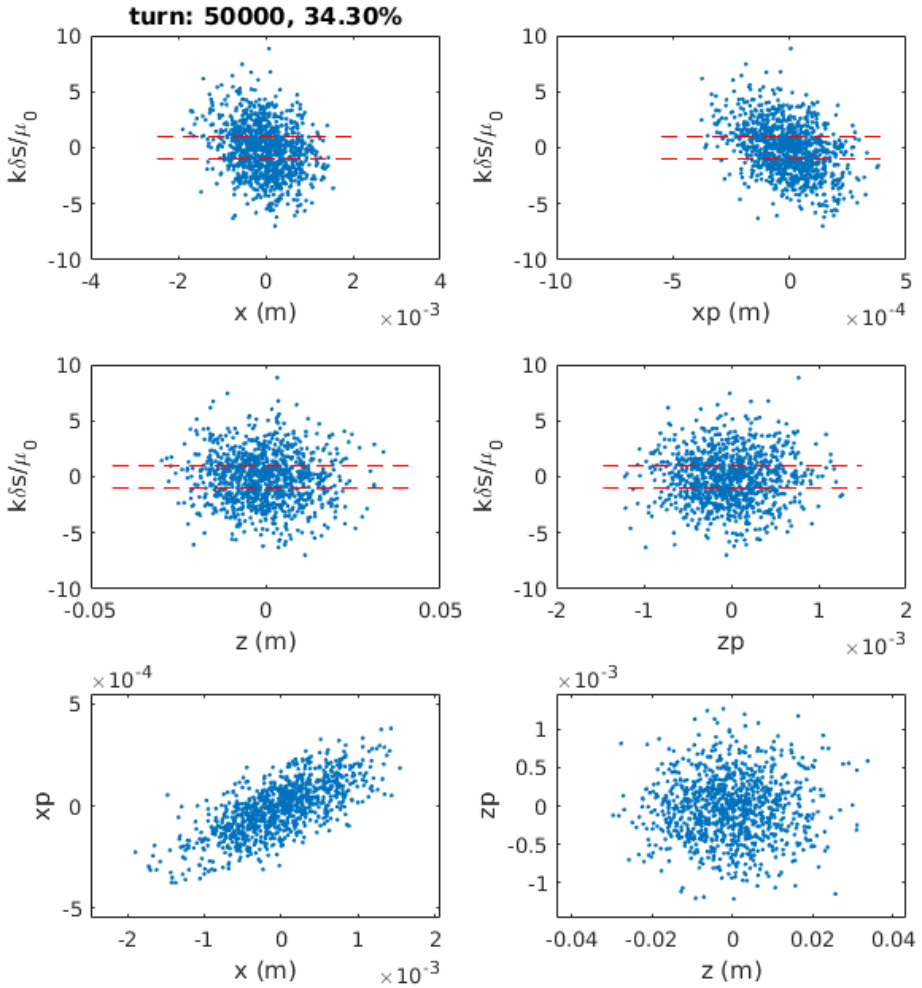


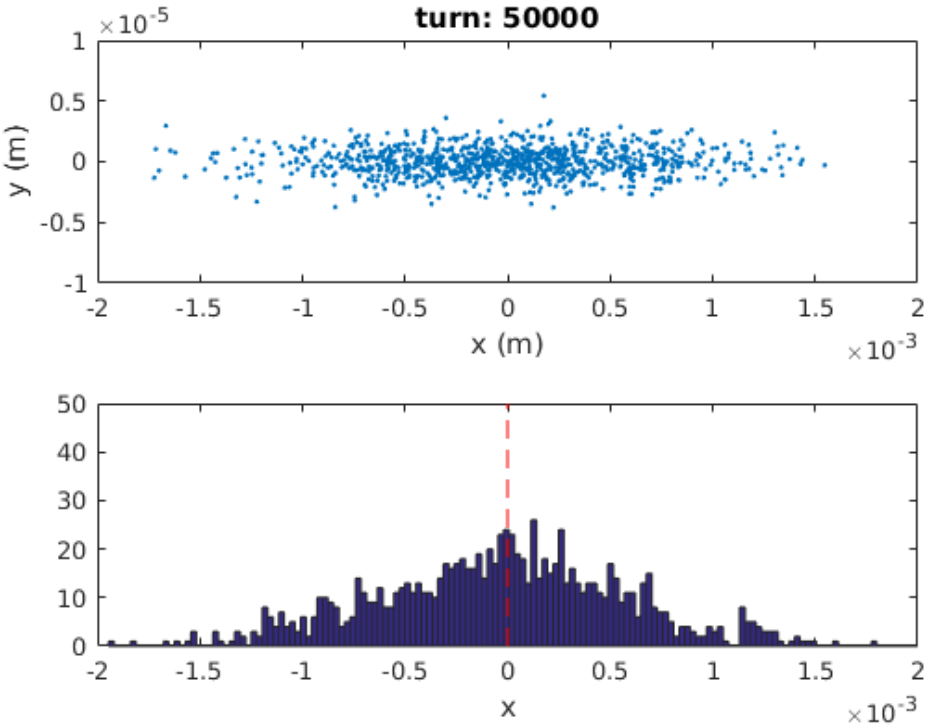


The non-Gaussian profile may evolve after a long time.

x-x', z-z' phase space, xy profiles and histogram

ξ=1E-10





Summary

- DLR 1GeV bypass lattice seems to work
  - Small ε_x (1E7 particles)
    - Horizontal and longitudinal cooling
  - Large ε_x (1E9 particles)
    - Longitudinal cooling and non-Gaussian x-profile
- Further investigation
  - $\Delta s = z_k - z_p$
  - Incoherent kicks for larger equilibrium emittance