OSC simulation update

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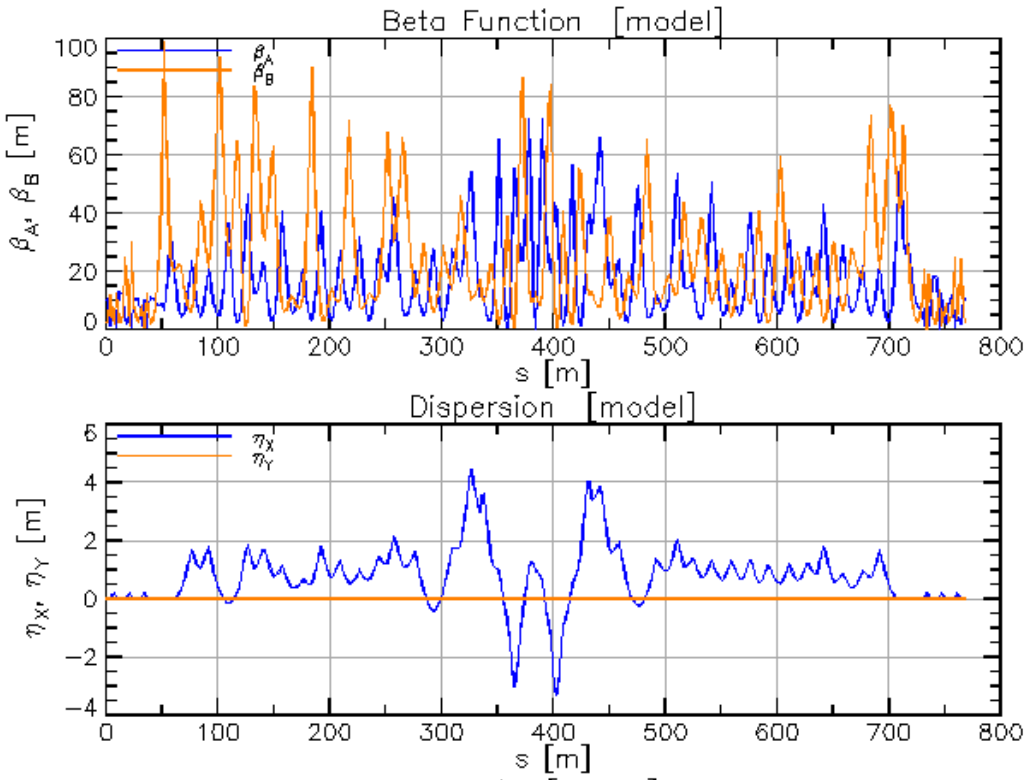
1. MPE 1GeV bypass 35cm OSC bends
2. Compare to 1m OSC bends

8/20/2018

/nfs/acc/temp/ehrlichm/oc/Desktop/OSC/dlr_cont/lat/bmad_standard_wiggler_0.35m_bends
/for_suntao/bmad_2nm_24nm_20180627.lat



m51: 1.4417E-03 m52: -1.4814E-02
m56: 3.3756E-03 m56_t: 1.6126E-04

Damping ratio: λ_x/λ_s=20.0

Cooling range:

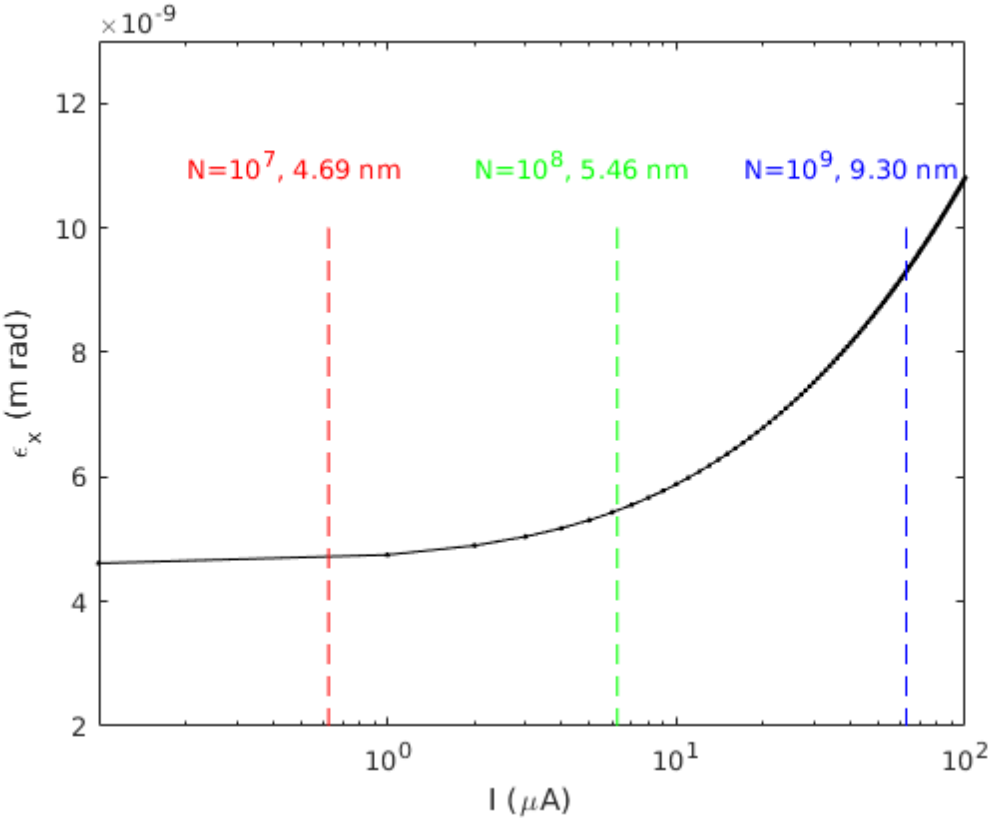
ε_{x_max} = 24.1E-09 $\delta p/p_{\_max}$ = 1.9E-03
n_x = 2.3 n_z= 4.7

Radiation damping time ~ 0.5s

	X		Y		
	Model	Design	Model	Design	
Q	16.6058	16.6058	13.4069	13.4069	! Tune
Chrom	0.9999	0.9999	1.0051	1.0051	! dQ/(dE/E)
J_damp	1.0346	1.0346	1.0005	1.0005	! Damping Partition #
Emittance	4.601E-09	4.601E-09	6.838E-14	6.838E-14	! Meters
Alpha_damp	5.355E-06	5.355E-06	5.179E-06	5.179E-06	! Damping per turn

	Model	Design	
Z_tune:	2.964E-02	2.964E-02	! The design value is calculated with RF on
Sig_E/E:	4.059E-04	4.059E-04	
Sig_z:	1.001E-02	1.001E-02	! Only calculated when RF is on
Energy Loss:	1.035E+04	1.035E+04	! Energy_Loss (eV / Turn)
Alpha_damp:	1.017E-05	1.017E-05	! Longitudinal Damping per turn
Alpha_p:	5.970E-03	5.970E-03	! Momentum Compaction

/nfs/acc/temp/ehrlichm/oc/Desktop/OSC/dlr_cont/lat/bmad_standard_wiggler_0.35m_bends
/for_suntao/bmad_2nm_24nm_20180627.lat



Emittance due to IBS:

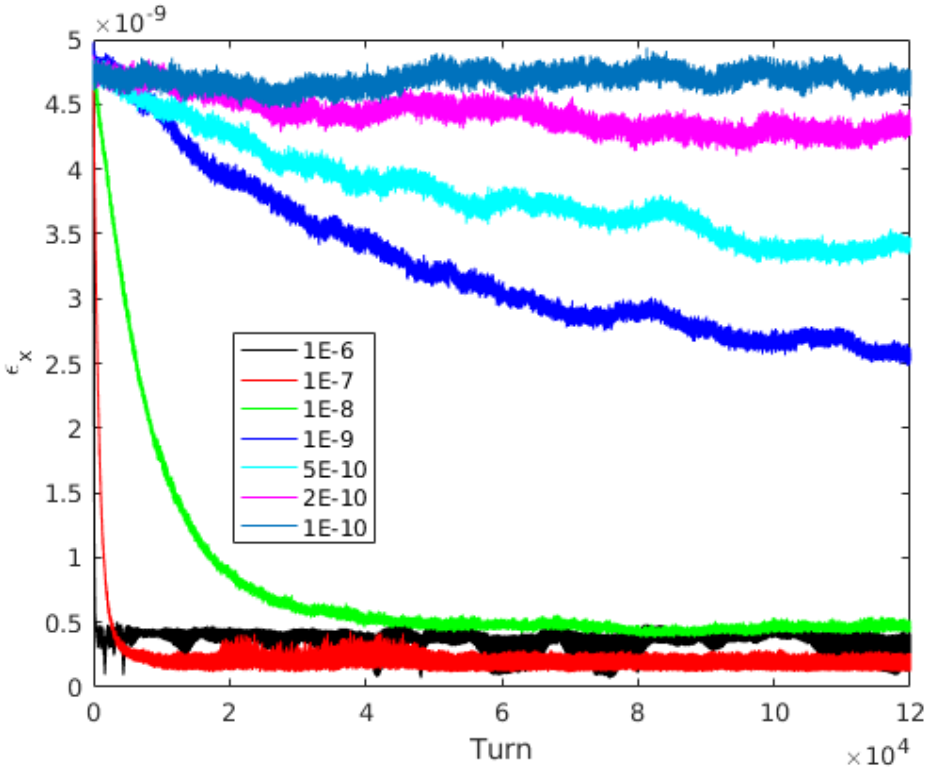
ε_y= 1% ε_x
95% is ε_y from xy coupling

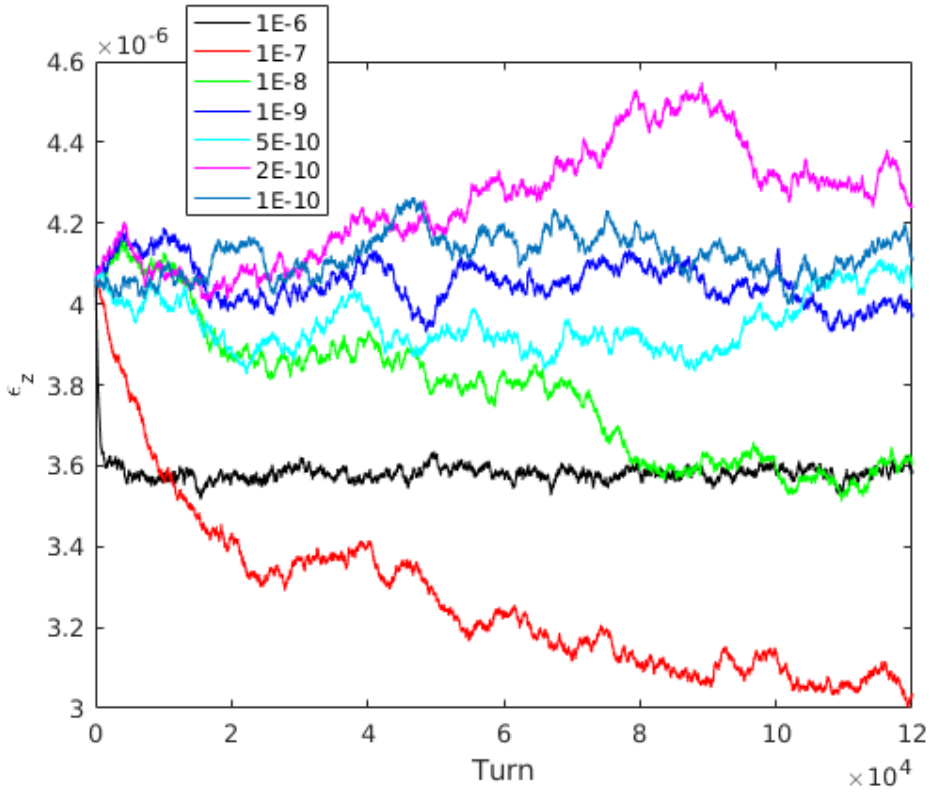
N=1E7, I~0.625 μA, ε_x~4.69 nm
N=1E8, I~6.25 μA, ε_x~5.46 nm
N=1E9, I~62.5 μA, ε_x~9.30 nm

With 10^7 particles in a bunch and 1% xy coupling, the IBS effect on horizontal is not significant.

35 cm OSC bends

ε_x=4.6 nm, damping and excitation turned on, no incoherent kicks





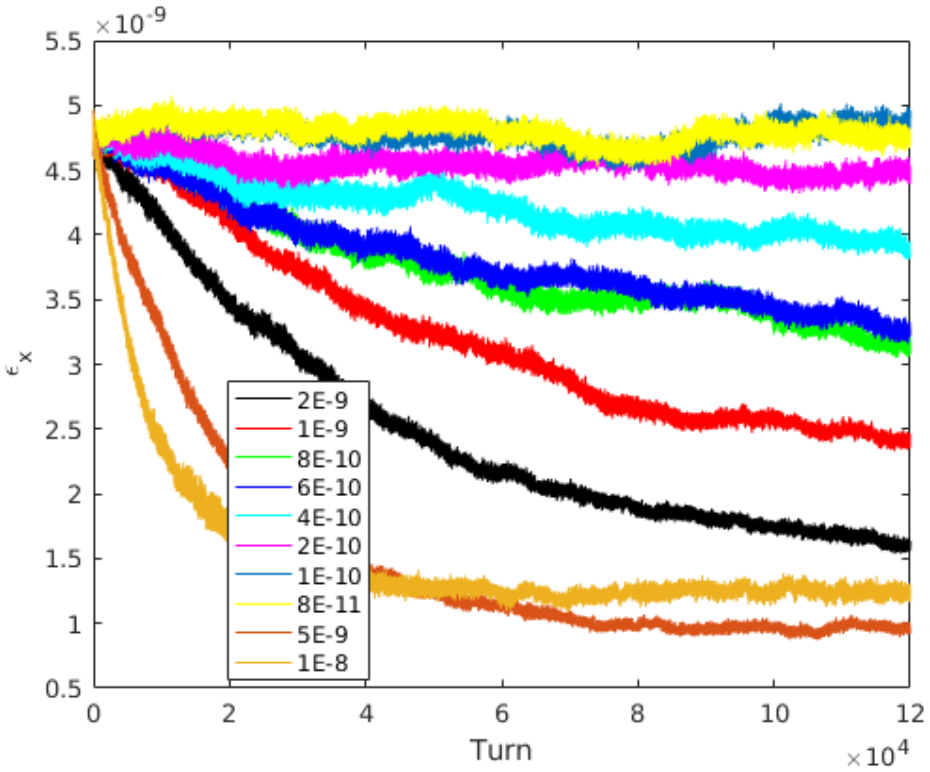
Horizontal cooling when ξ > 2E-10

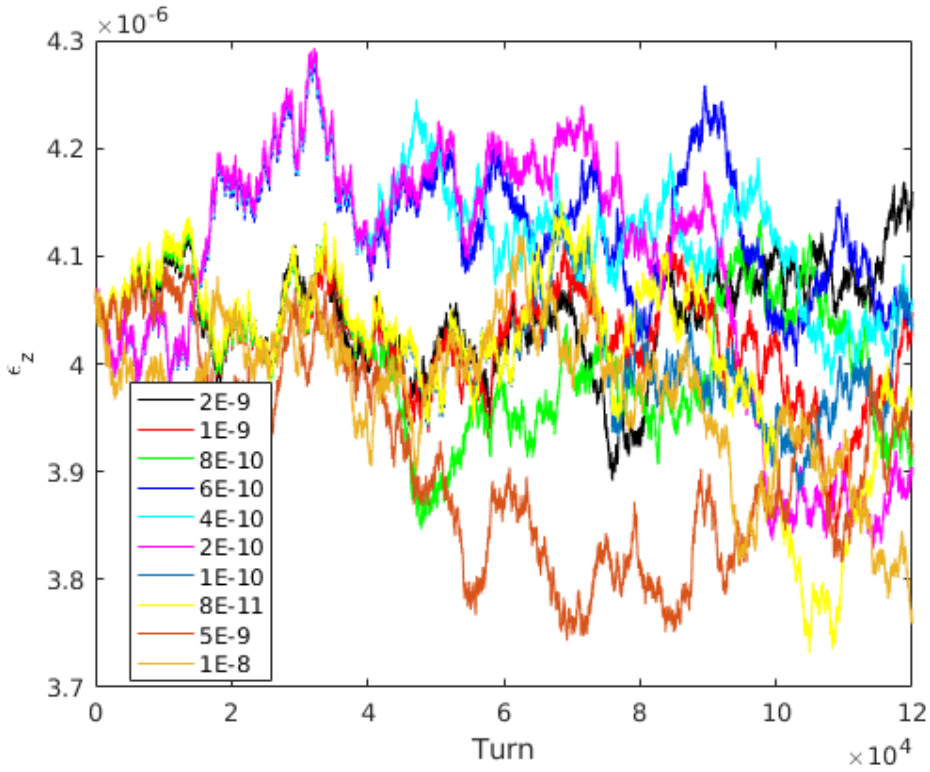
For ξ < 5E-10 But did not observe longitudinal cooling within 12E4 turns (0.31s)

@ ξ = 2E-10, $\Delta\varepsilon_x$ = 8.9% ε_x (4.71 nm → 4.29 nm)

35 cm OSC bends

ε_x=4.6 nm, damping and excitation turned on, with incoherent kicks (10^7 particles)



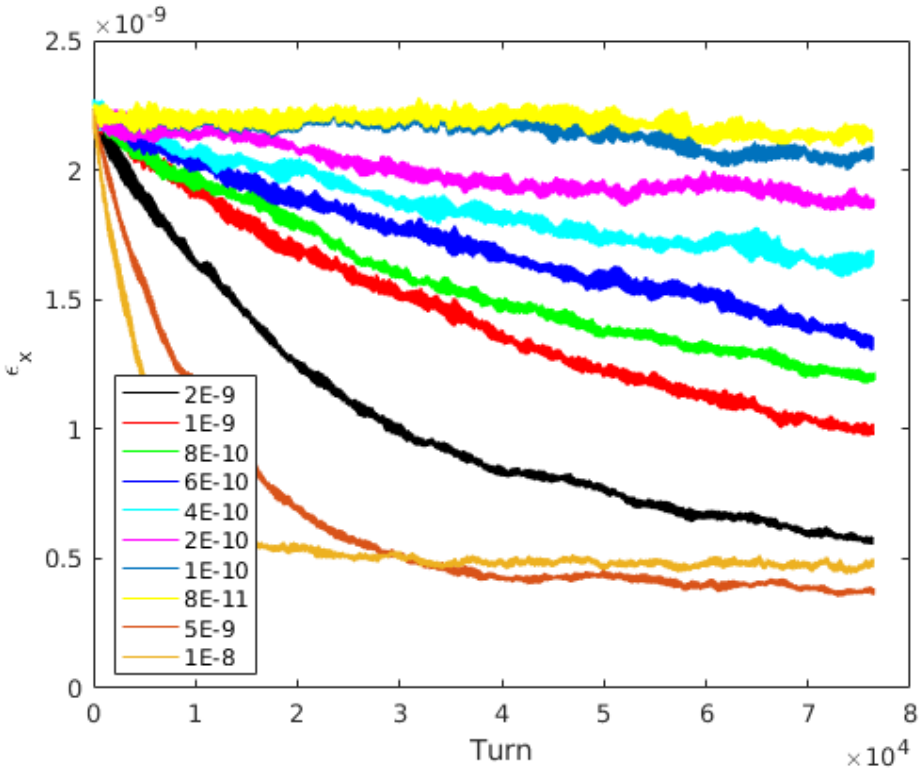


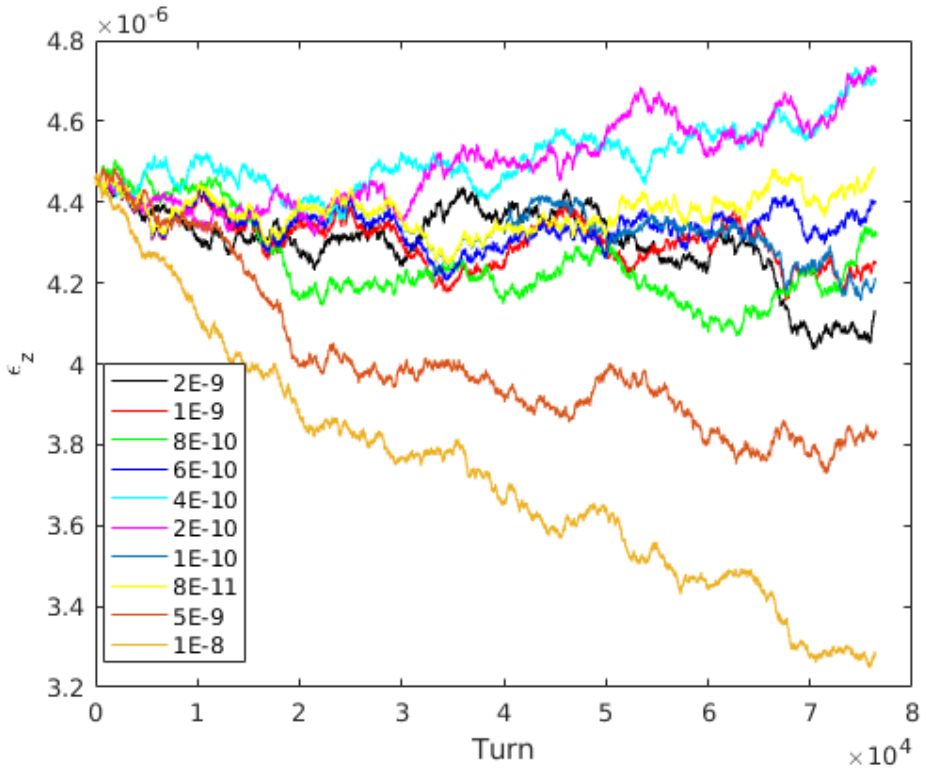
Horizontal cooling when ξ > 2E-10
Did not observe longitudinal cooling within 12E4 turns

@ ξ = 2E-10, $\Delta\varepsilon_x$ = 5.3% ε_x (4.73nm → 4.48nm)

Lattice with 1m OSC bends: /home/dlr/lat/des/osc/mpe/bmad_2nm_24nm_20180627.lat

ε_x=2.2 nm, damping and excitation turned on, with incoherent kicks (10^7 particles)

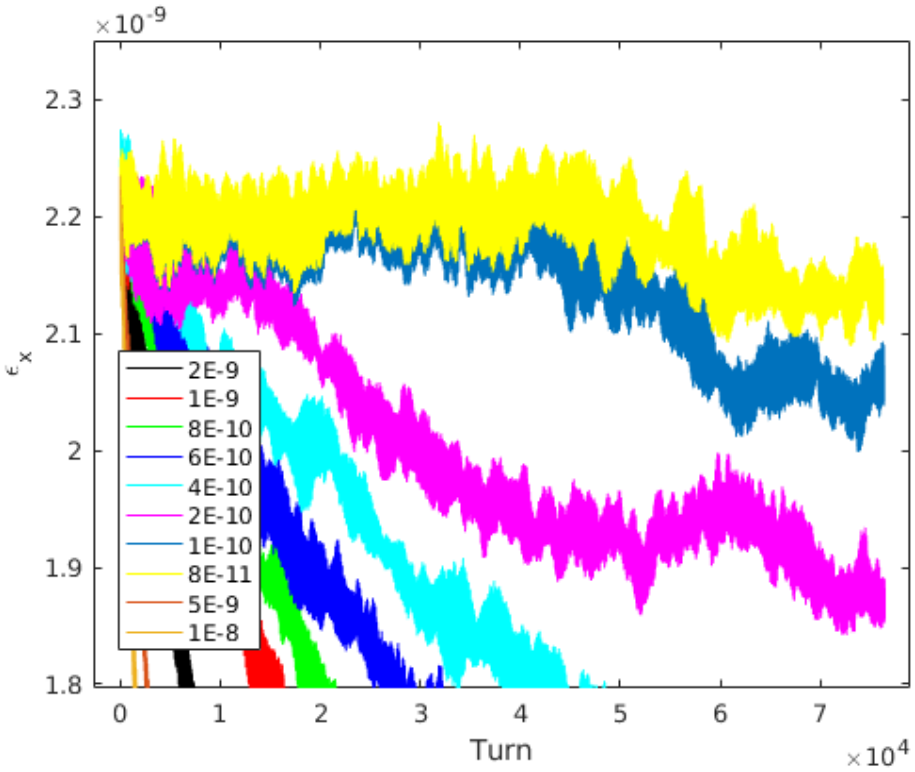




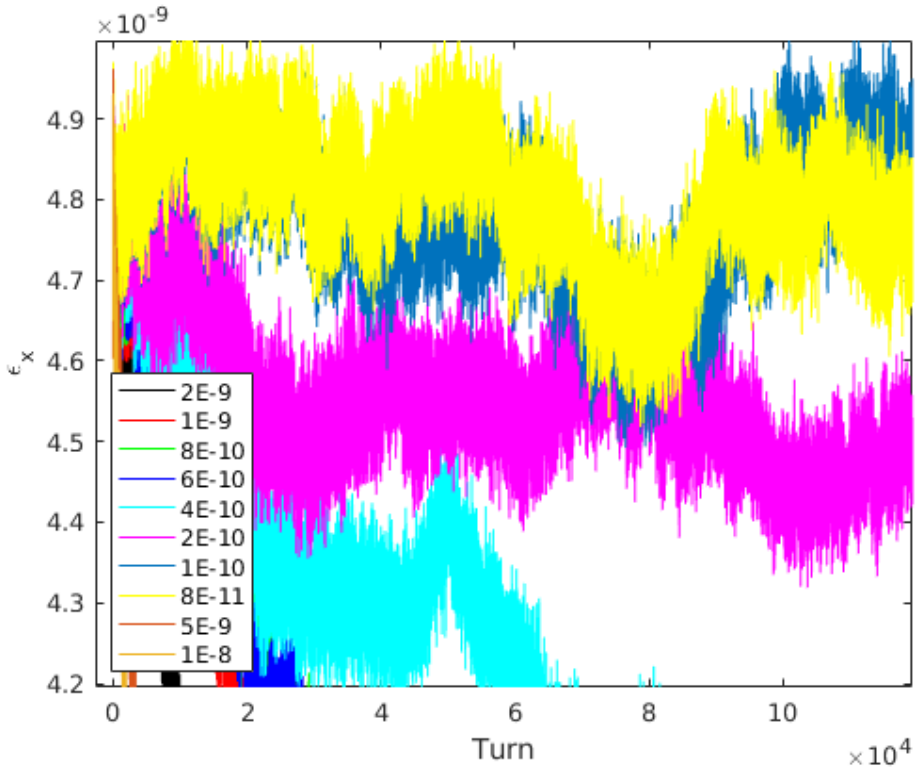
Horizontal cooling when ξ is as small as 1E-10
Did not observe longitudinal cooling within 12E4 turns when ξ <2E-9

@ ξ = 2E-10, $\Delta\varepsilon_x$ = 13% ε_x (2.16nm → 1.88nm)
@ ξ = 1E-10, $\Delta\varepsilon_x$ = 6.4% ε_x (2.19nm → 2.05nm)

1 m OSC bends



35 cm OSC bends



ξ = 2E-10, $\Delta\varepsilon_x$ = 13% ε_x (2.16nm → 1.88nm)

ξ = 1E-10, $\Delta\varepsilon_x$ = 6.4% ε_x (2.19nm → 2.05nm)

ξ = 2E-10, $\Delta\varepsilon_x$ = 5.3% ε_x (4.73nm → 4.48nm)

1 m bend lattice is better

Detectable signal for current horizontal beam size measurement?

Current σ_x is measured by infereometer with a 5 μm uncertainty at 300 μm @ 1mA.

$\Delta\sigma_x/\sigma_x$ =1.67 %

$\Delta\sigma_x/\sigma_x = \Delta\varepsilon_x/2(\varepsilon_x + \delta/\beta_x)$ => $(\Delta\varepsilon_x)_{min} = 2(\varepsilon_x + \delta/\beta_x) * 1.67\%$

@ vbsm_electrons (s=394.1812 m)

1. 35cm: ε_x = 4.7 nm, β_x = 32.356 m, η_x = - 0.448, δE/E=4.056E-4, σ_x=430 μm,

$\delta/\beta_x = (\eta_x\delta E/E)^2/\beta_x$ = 1.02 nm

$\Delta\varepsilon_x > 2(\varepsilon_x + \delta/\beta_x) * \Delta\sigma_x/\sigma_x = 2\ (4.7+1.02) *1.67\% = 0.2$ nm

$\Delta\varepsilon_x/\varepsilon_x > 4\%$

2. 1 m: ε_x = 2.2 nm, β_x = 38.269 m, η_x = - 0.238, δE/E=4.066E-4, σ_x=306 μm,

$\delta/\beta_x = (\eta_x\delta E/E)^2/\beta_x$ = 0.24 nm

$\Delta\varepsilon_x > 2(\varepsilon_x + \delta/\beta_x) * \Delta\sigma_x/\sigma_x = 2\ (2.2+0.24) *1.67\% = 0.082$ nm

$\Delta\varepsilon_x/\varepsilon_x > 3.7\%$

Light intensity will be a problem for the interferometer. Need machine studies to check.

Summary

- 1 m bend lattice is better than 35cm bend
- The emittance reduction (>4%) might be detectable using current vBSM.