

OSC simulation update

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1. Evaluate MPE's recent bypass
2. Compare to MPE's first bypass design

3/27/2018

MPE bypass 4: /home/sw565/sw565/osc/lattice/mpe_5mm_500mev/ver2/bmad.lat

1. Not matched to CHESS-U lattice
2. CCU standard Bmad wiggler model

Basic parameters:

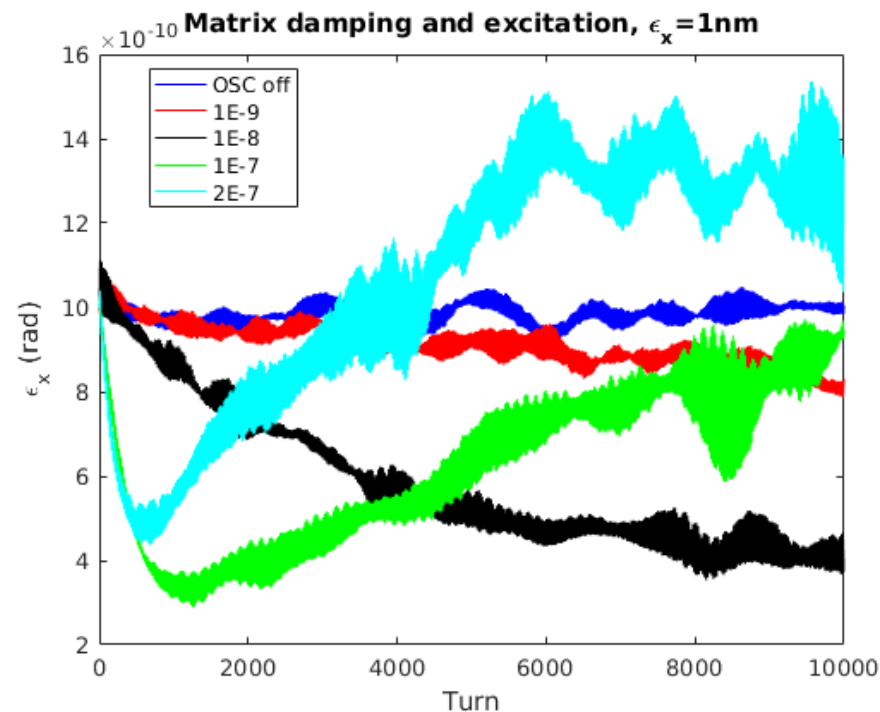
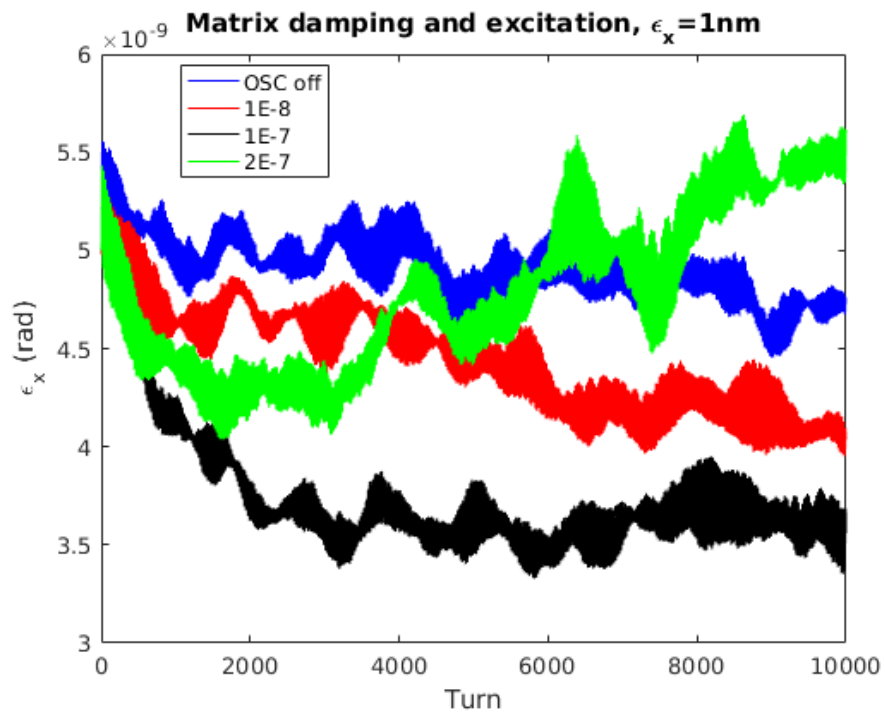
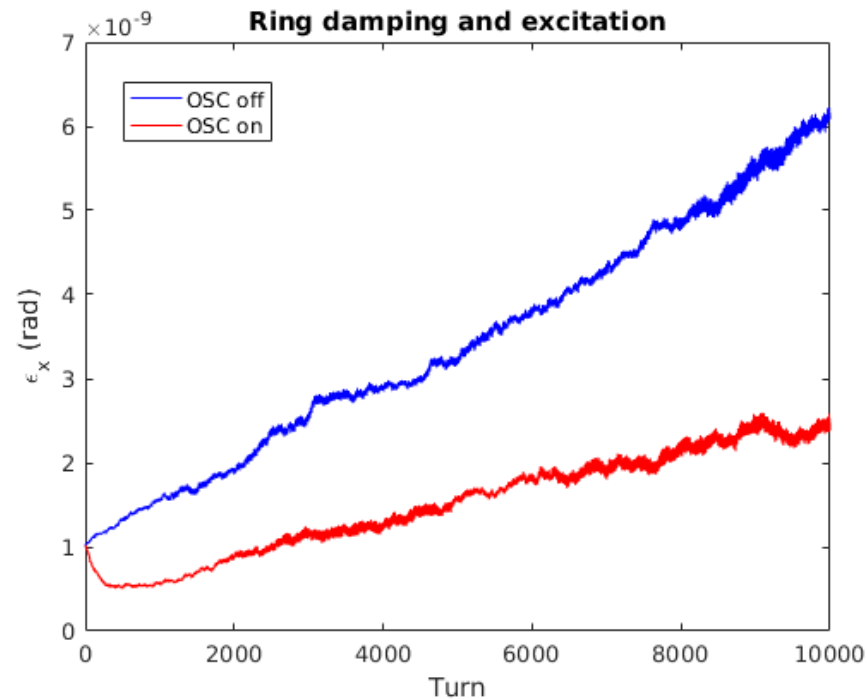
$$\epsilon_x = 95 \text{ nm}, \alpha_{\text{damp}} = 2.576\text{E-}6 \text{ (~1s)}, x_h (x_v) = 1$$

Emittance acceptance:

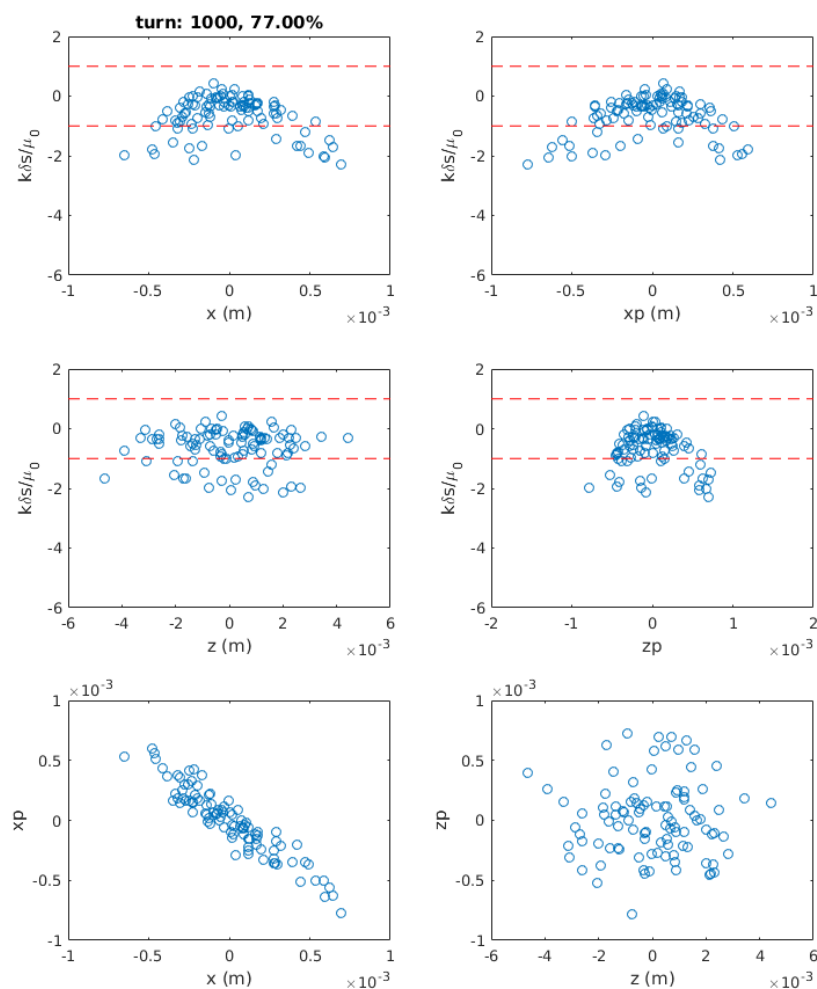
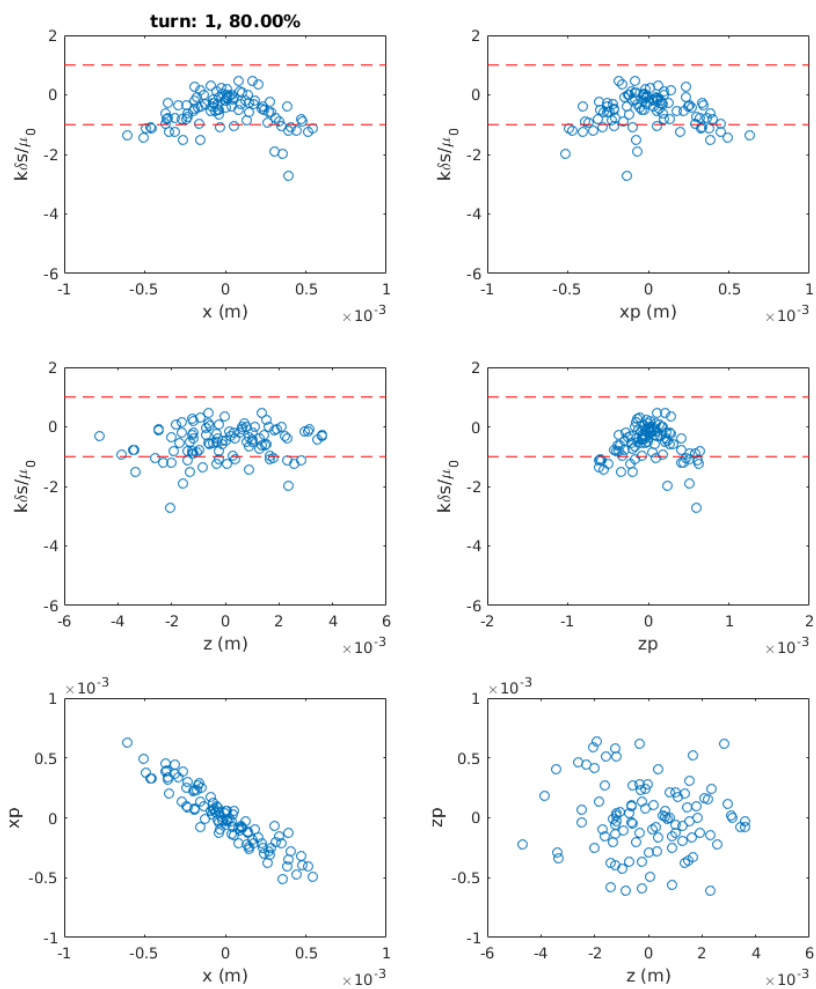
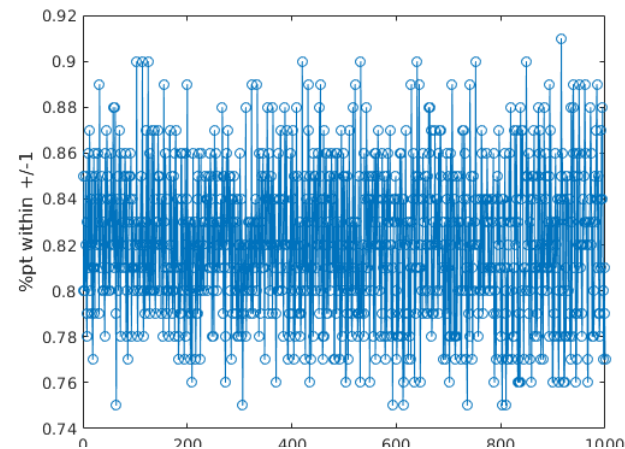
$$\epsilon_{x\text{max}} = 15.1\text{nm}, \sigma_{p\text{max}} = 9.9\text{E-}2$$

Colling rates:

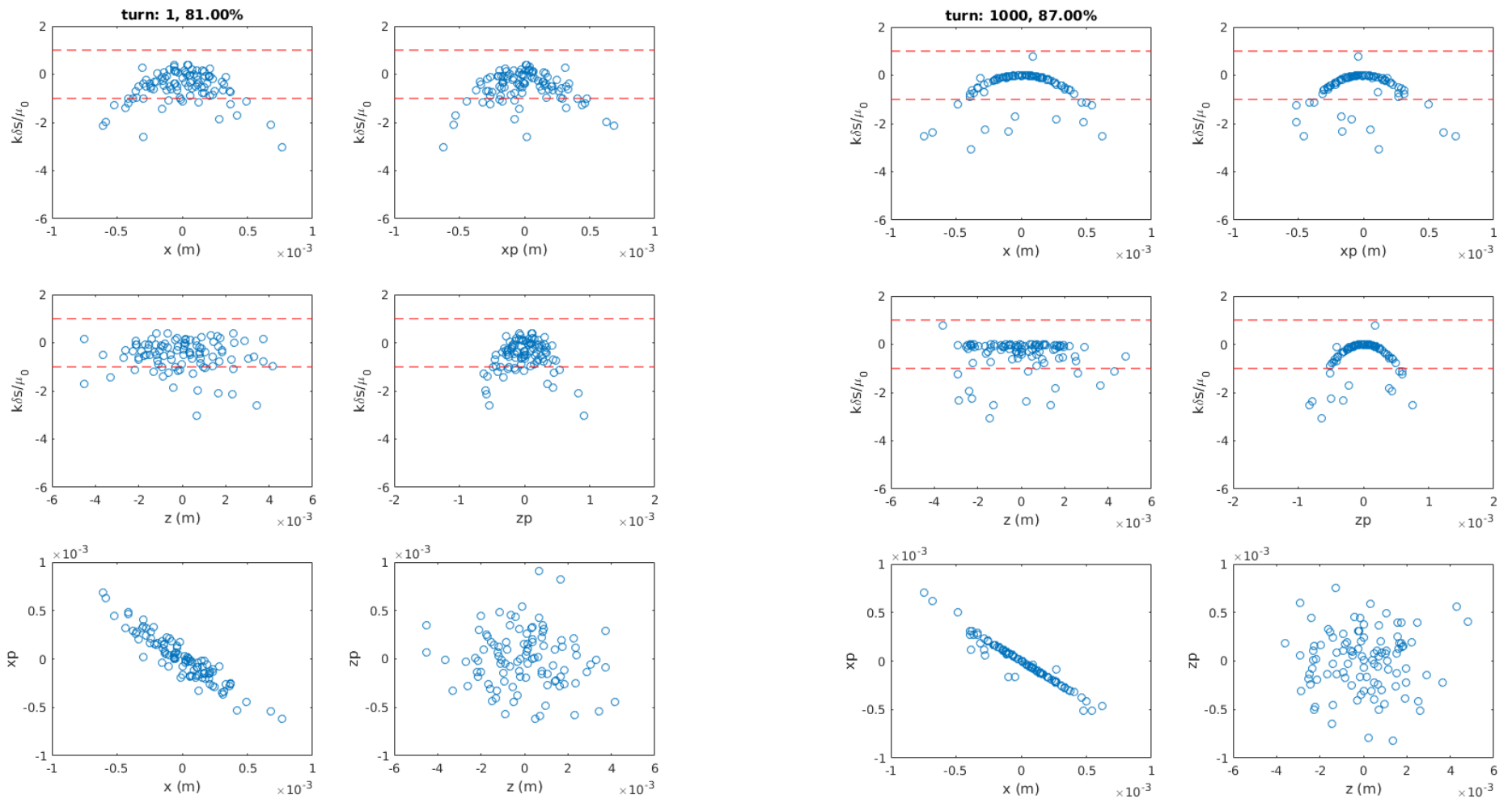
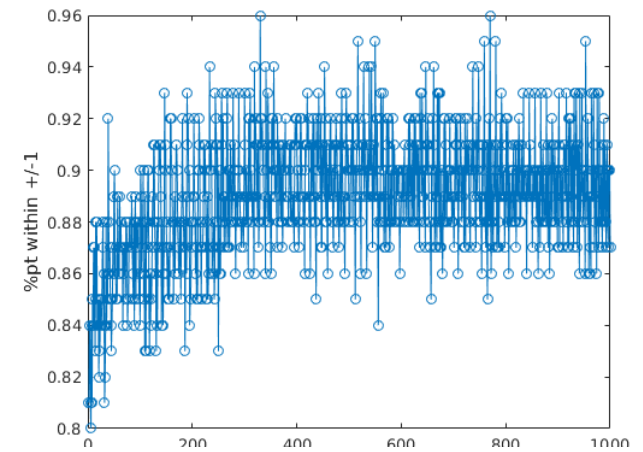
$$\lambda x = 2.28\text{E-}3, \lambda s = 2.99\text{E-}6 \text{ @ } \xi_0 = 1\text{E-}7$$



OSC process off, $\epsilon_x = 1\text{nm}$
 Check particles with $|k\Delta s/\mu_0| < 1$
 Matrix tracking
 100 particles, 1000 turns



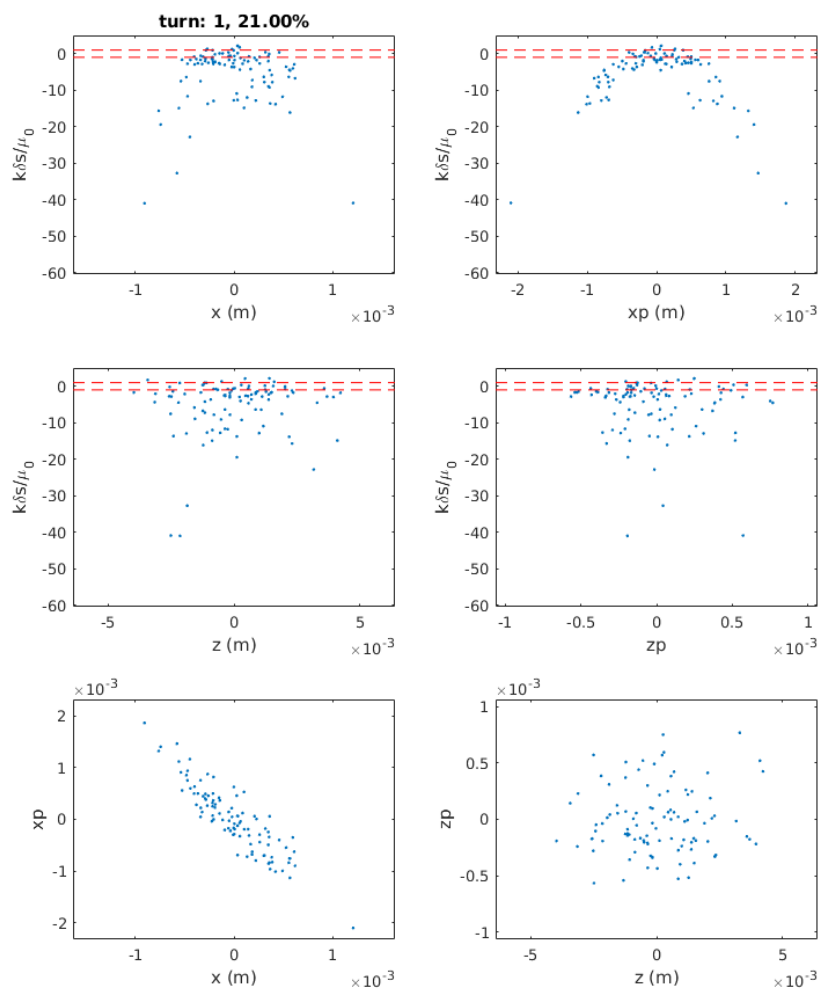
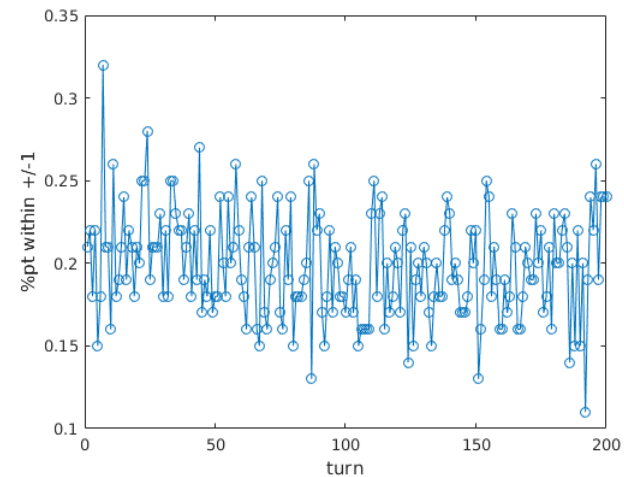
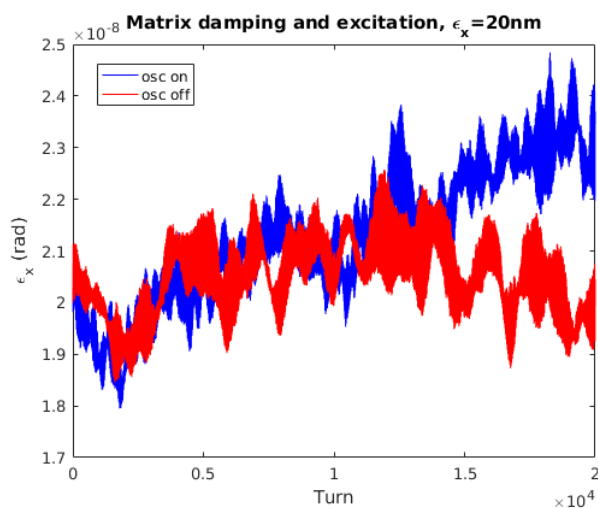
OSC process on
 Check $k\Delta s/\mu_0$, $\epsilon_x=1\text{nm}$
 Matrix tracking, $\xi_0=2\text{E-}7$
 Without incoherent kicks



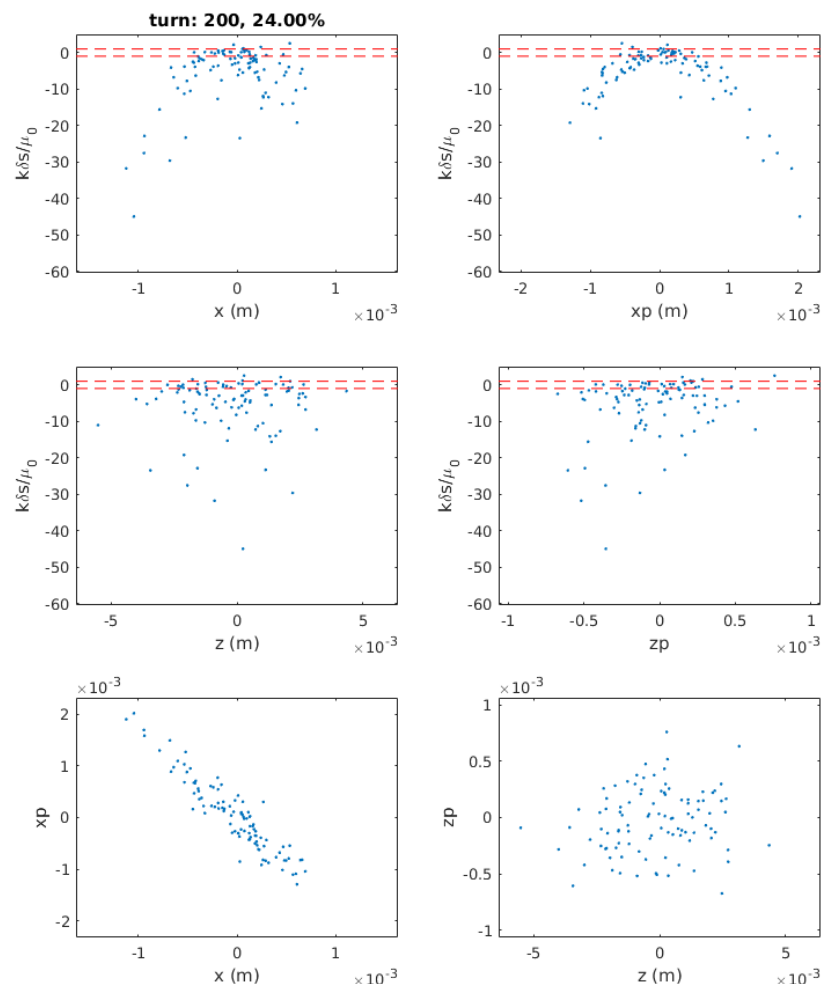
100 particles
20000 turns

$\epsilon_x = 20\text{nm}$

$\xi_0 = 2\text{E-}7$



Turn=100

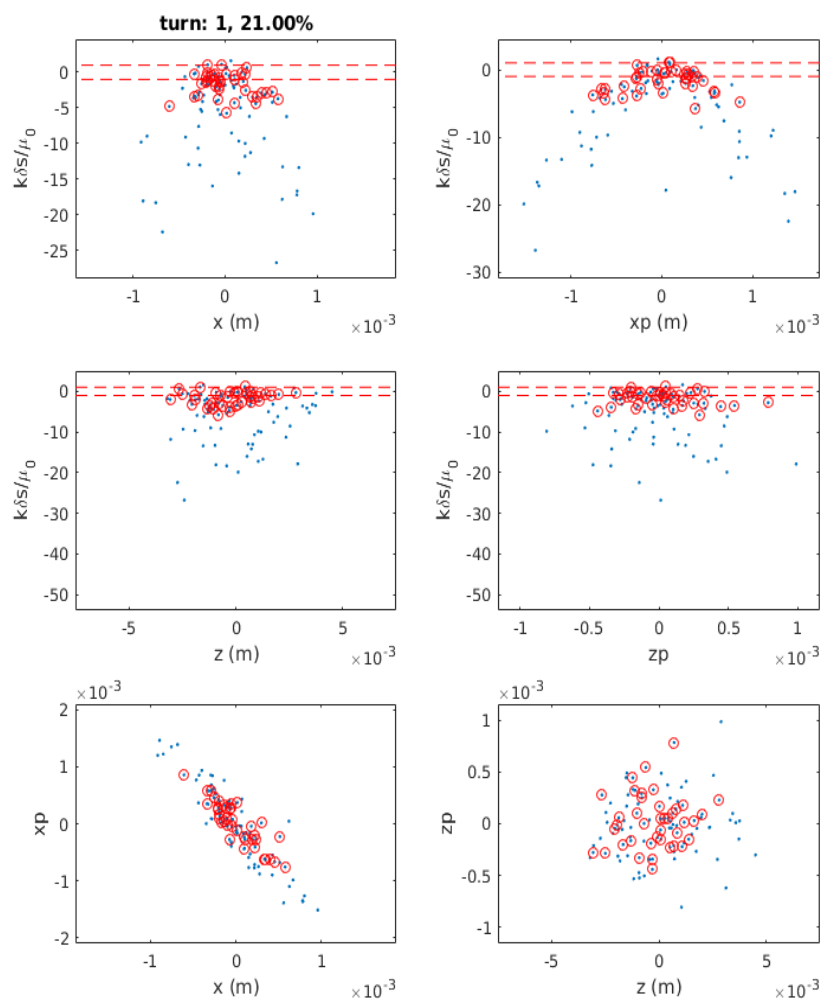
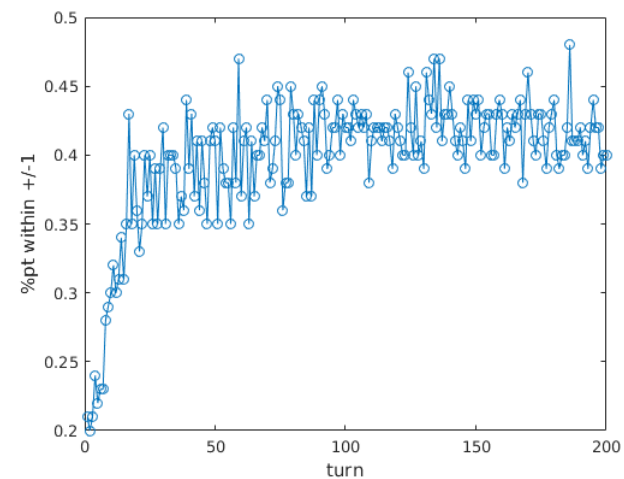
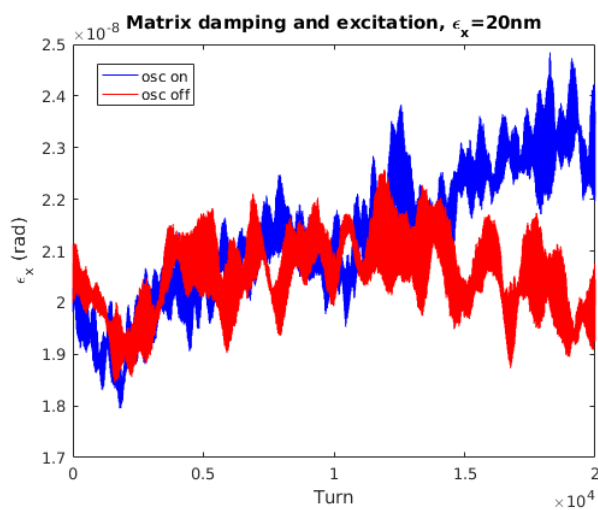


Turn=20000

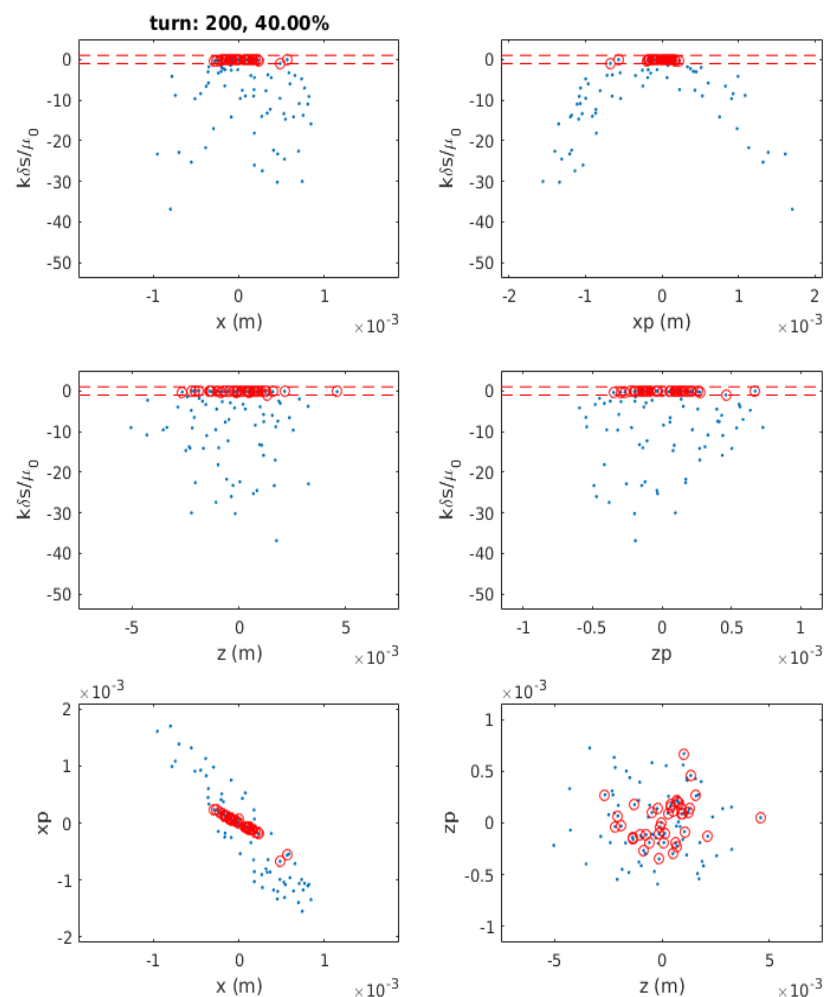
100 particles
20000 turns

$\epsilon_x = 20\text{nm}$

$\xi_0 = 2\text{E-}7$



Turn=100

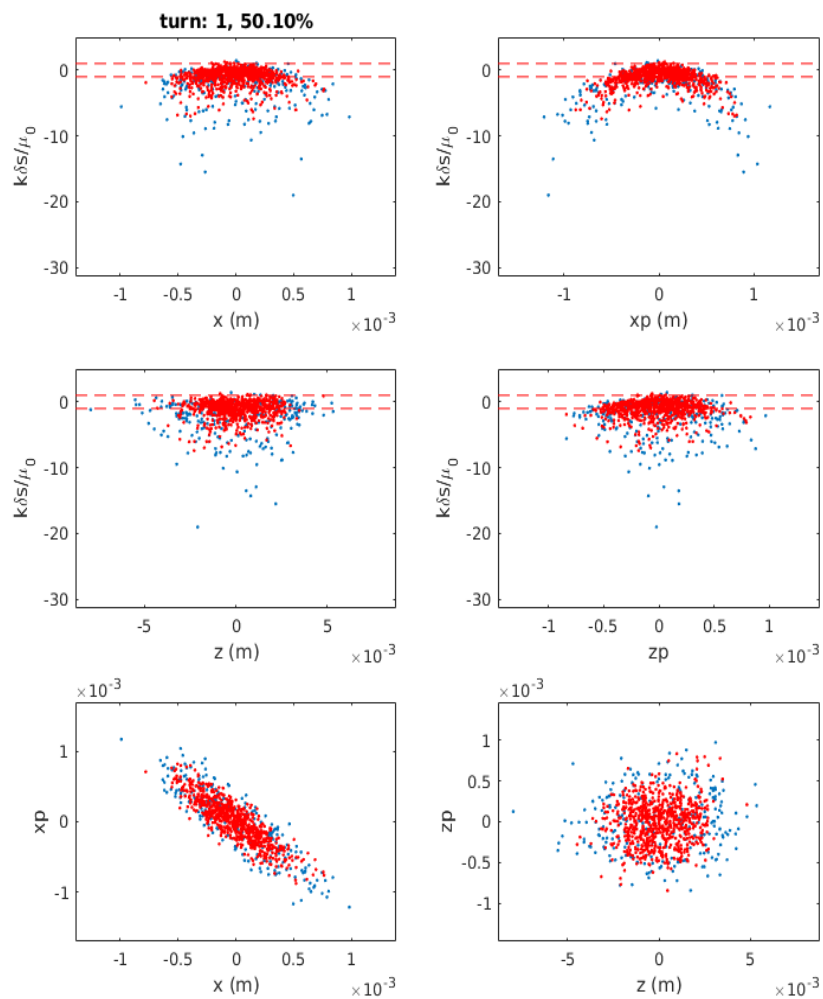
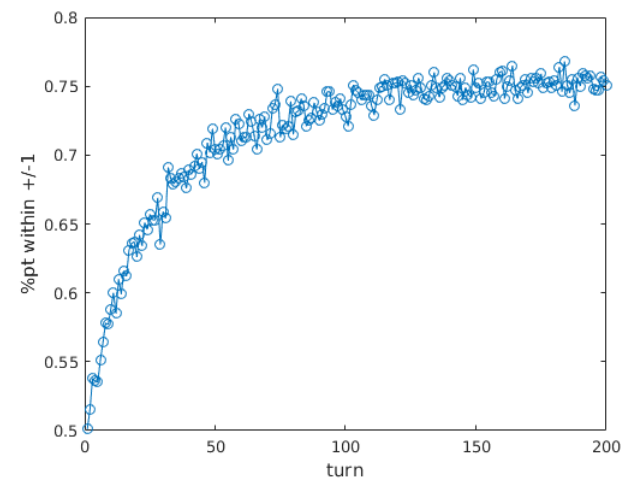
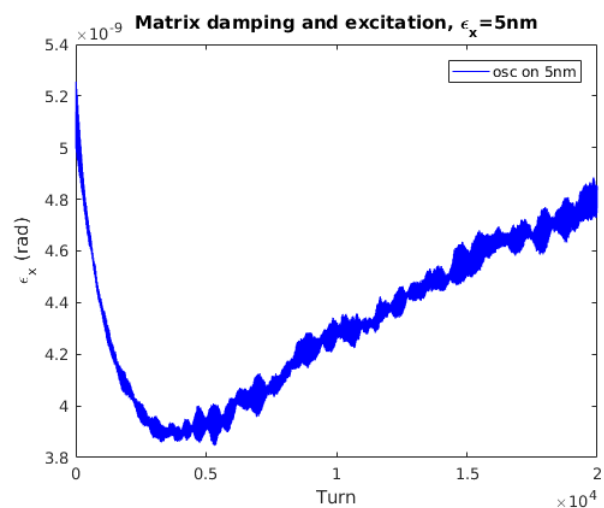


Turn=20000

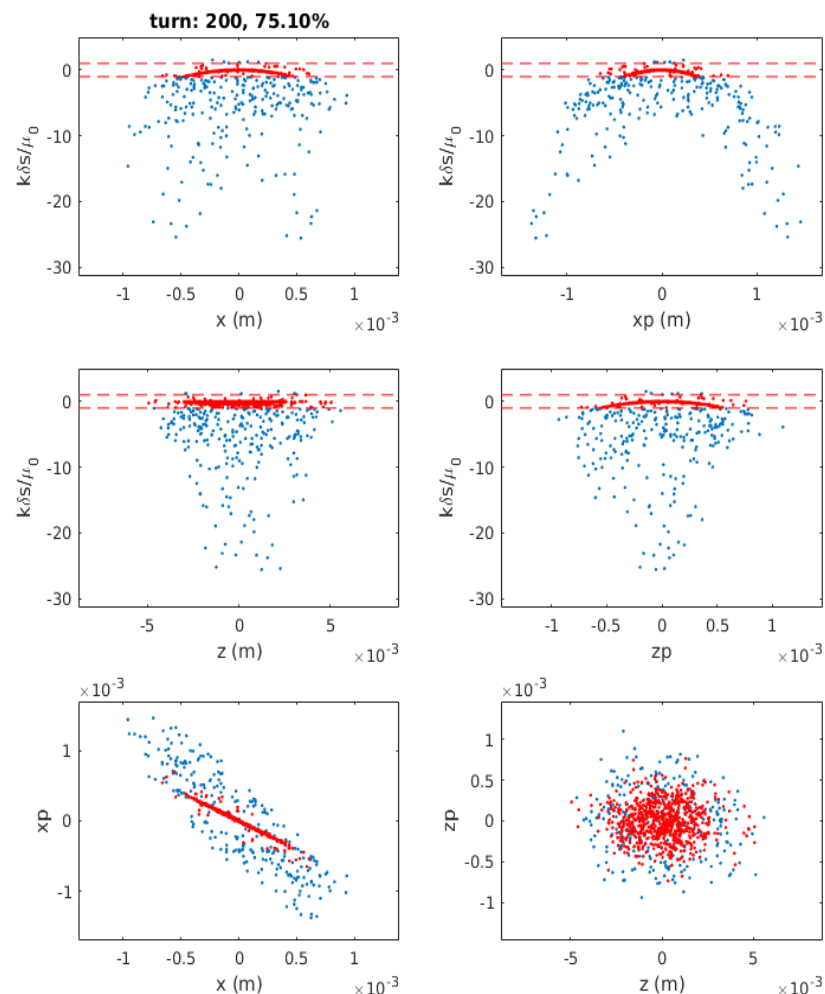
1000 particles
20000 turns

$\epsilon_x = 5\text{nm}$

$\xi_0 = 1\text{E-}7$

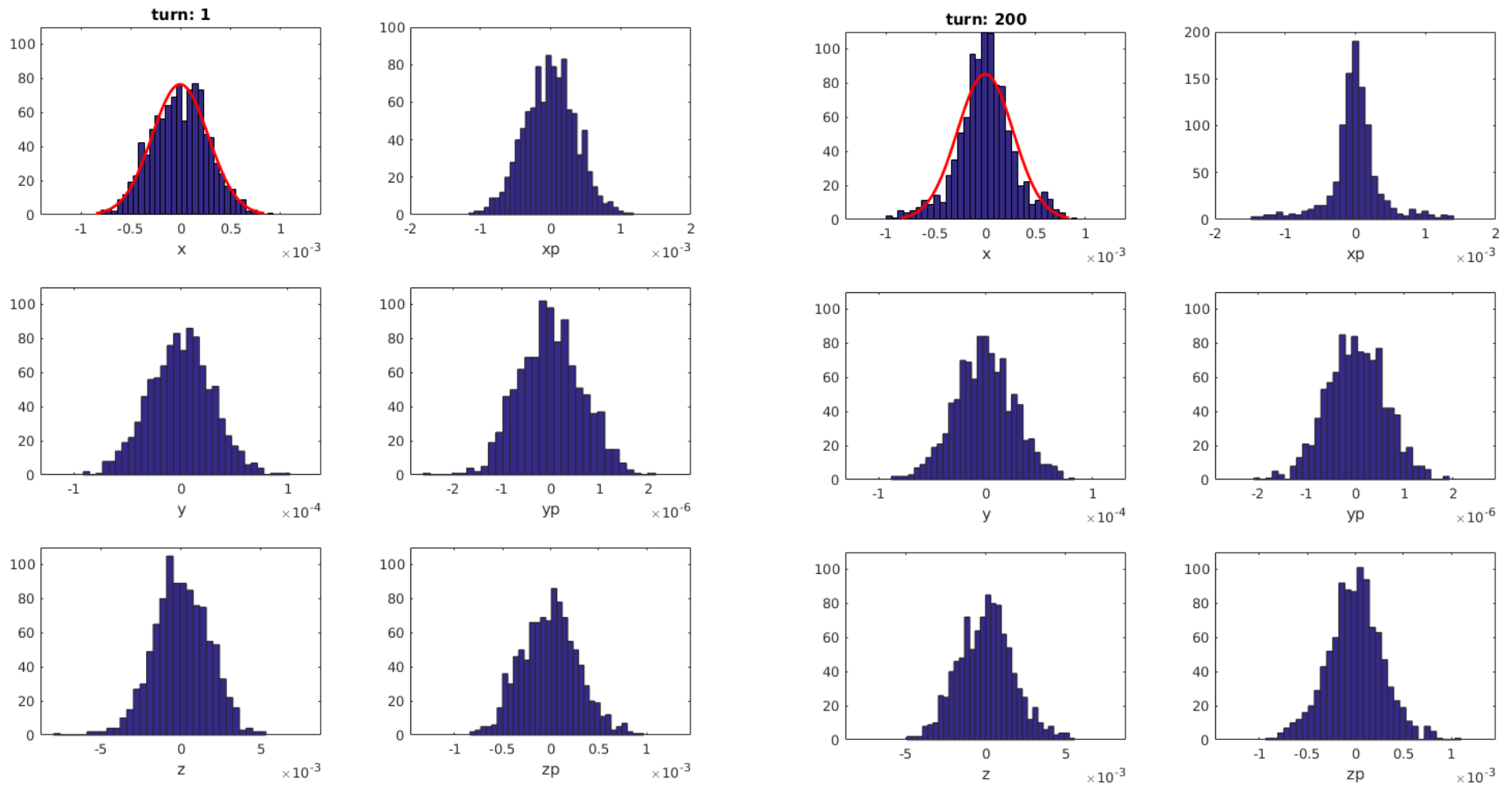


Turn=100



Turn=20000

Track 1000 particles, 20000 turns, $\epsilon_x=5\text{nm}$, $\xi_0=1\text{E-}7$, no incoherent kicks



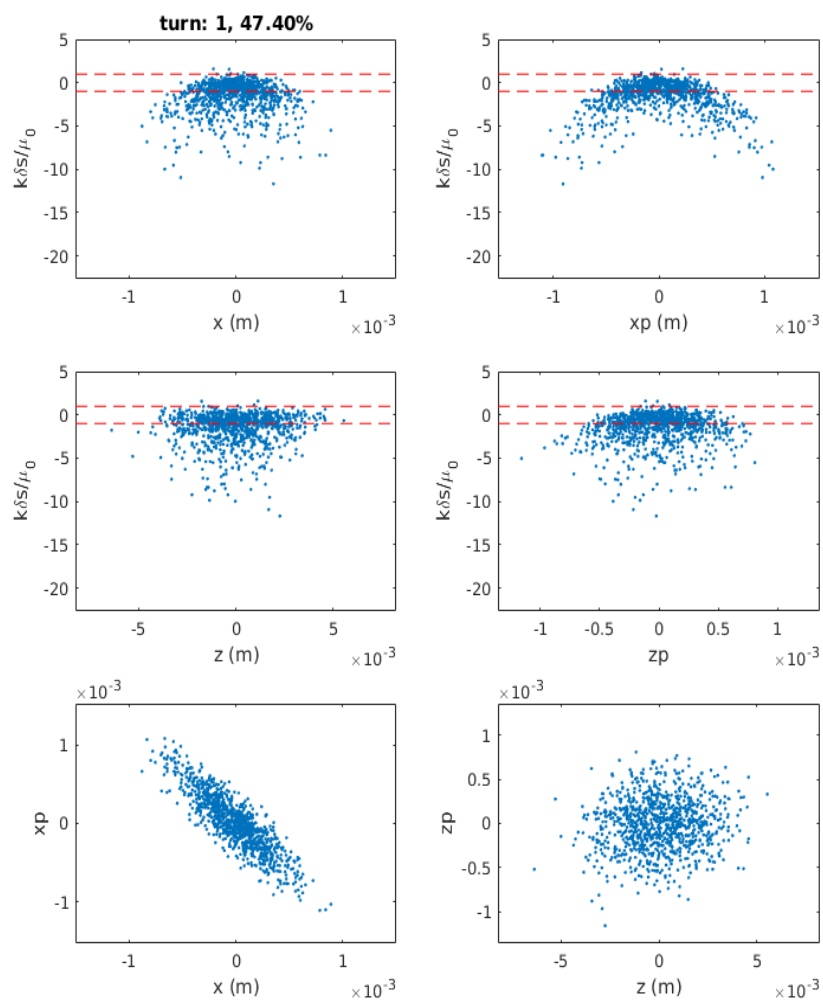
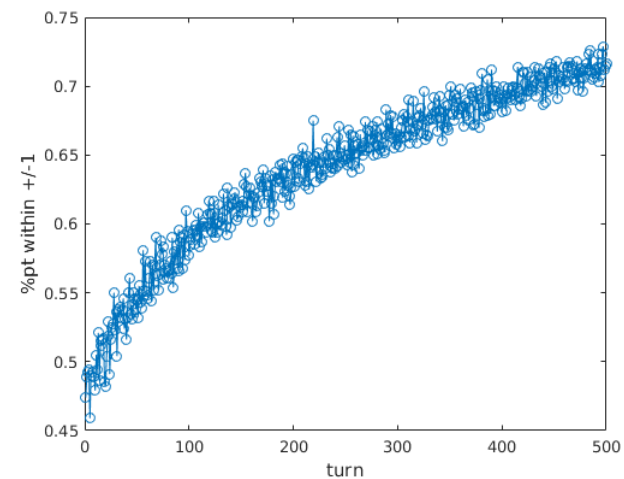
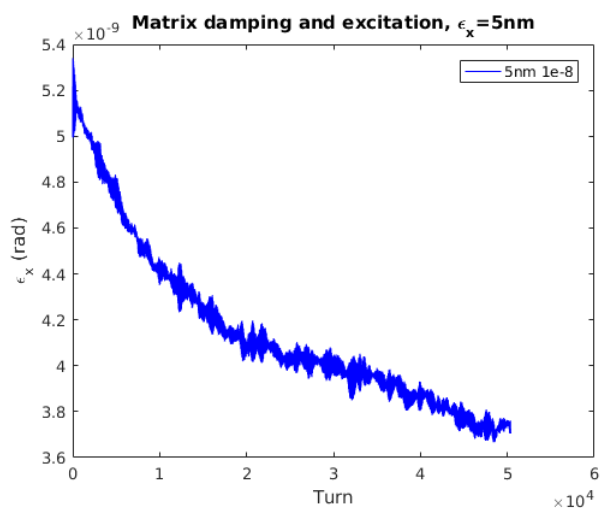
Turn=100

Turn=20000

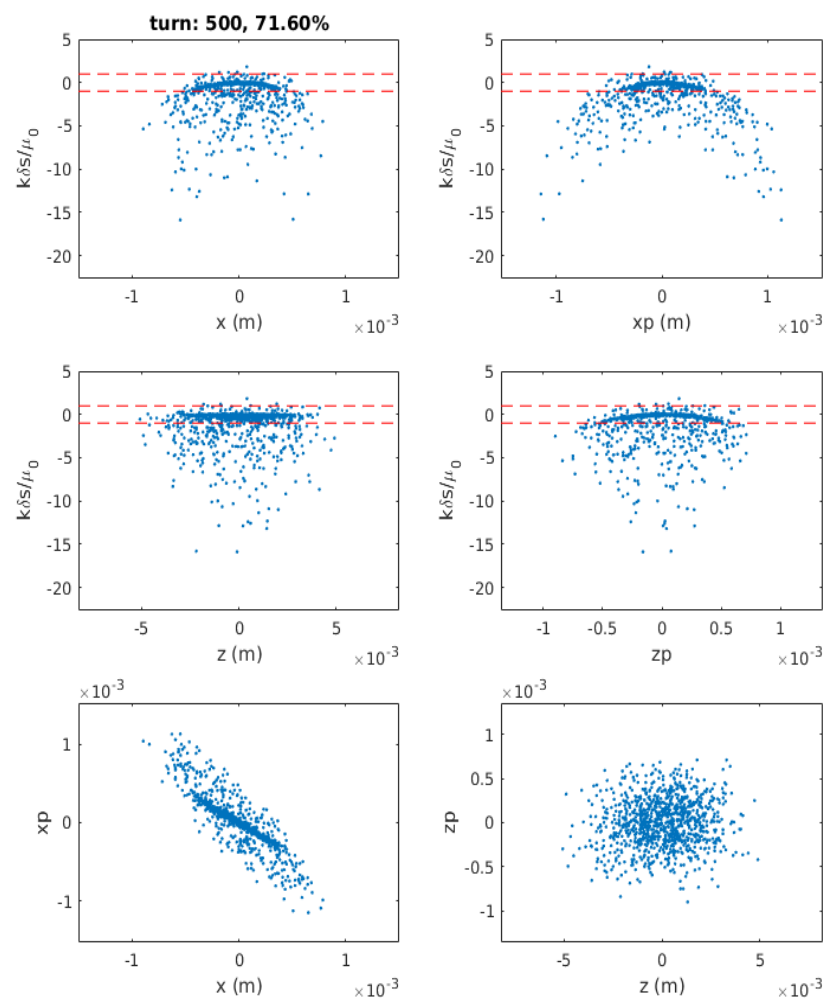
1000 particles
50000 turns

$\epsilon_x = 5\text{nm}$

$\xi_0 = 1\text{E-}8$

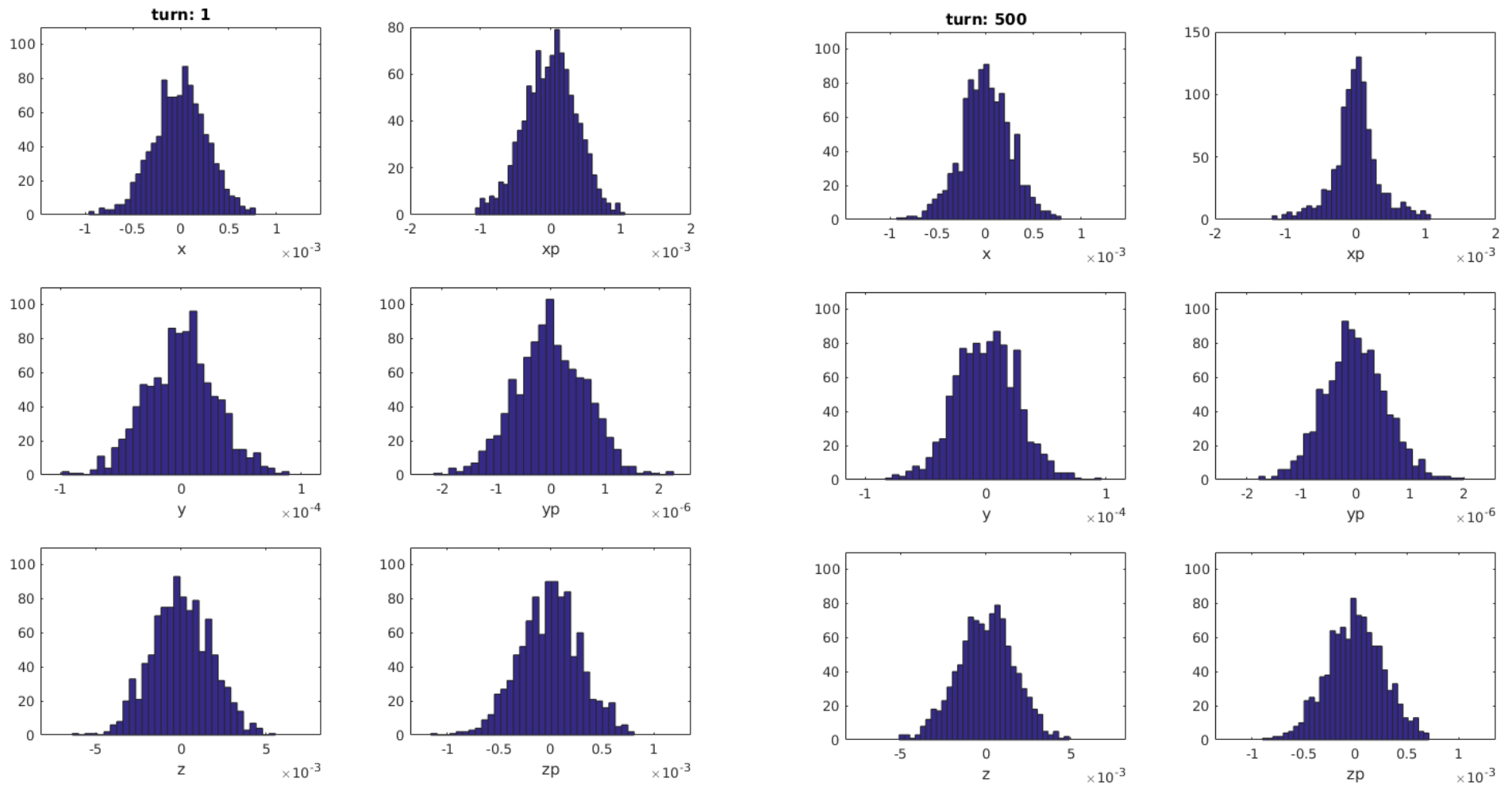


Turn=100



Turn=50000

Track 1000 particles, 50000 turns, $\epsilon_x=5\text{nm}$, $\xi_0=1\text{E-}8$, no incoherent kicks

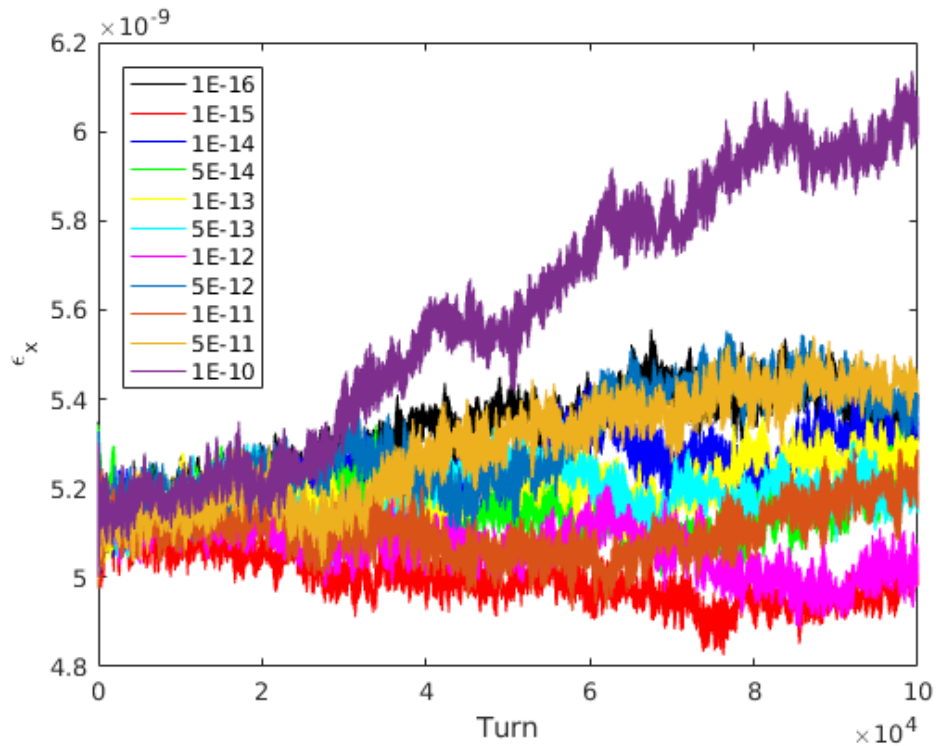


Turn=100

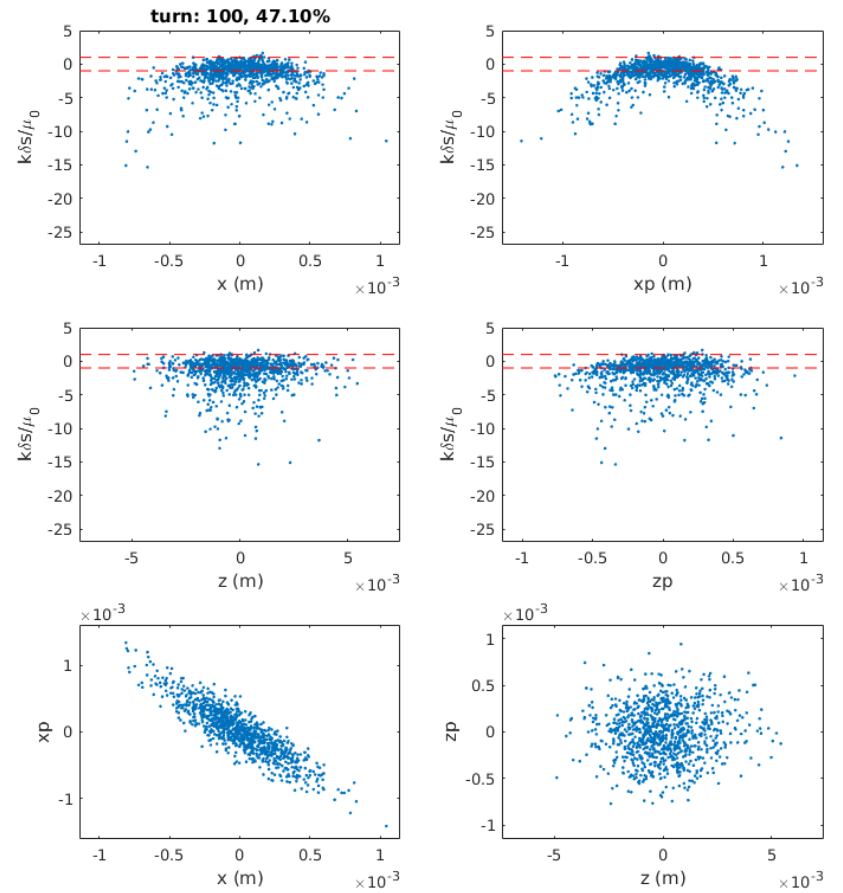
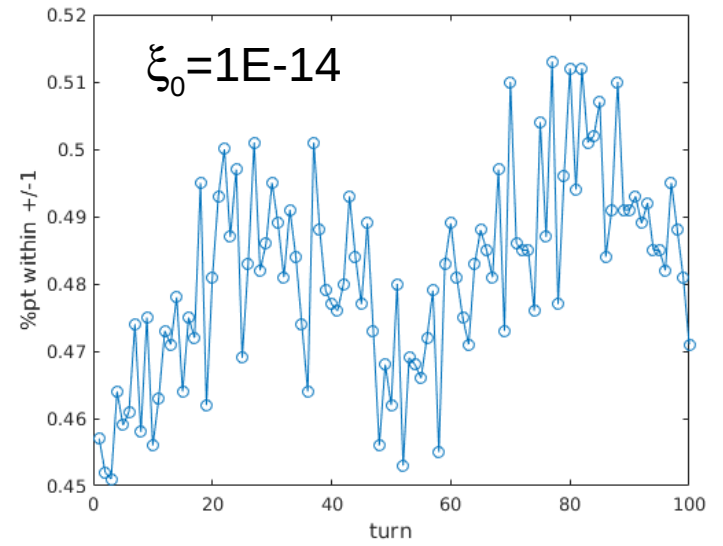
Turn=20000

Add incoherent kicks

Track 1000 particles
1E5 turns
 $\epsilon_x = 5 \text{ nm}$



Did not see cooling



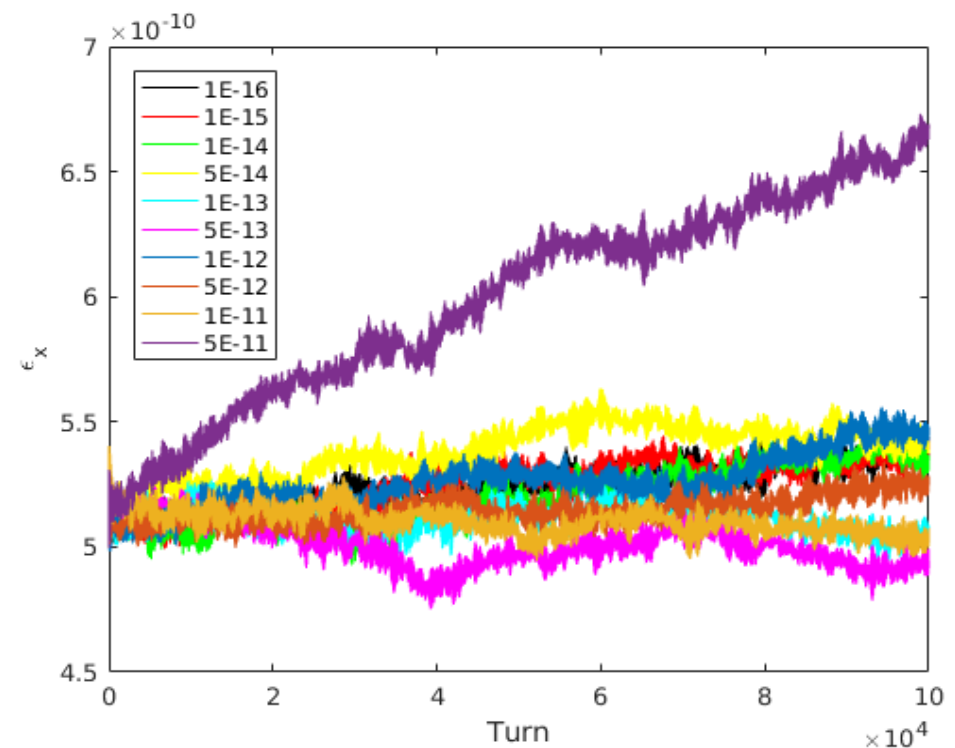
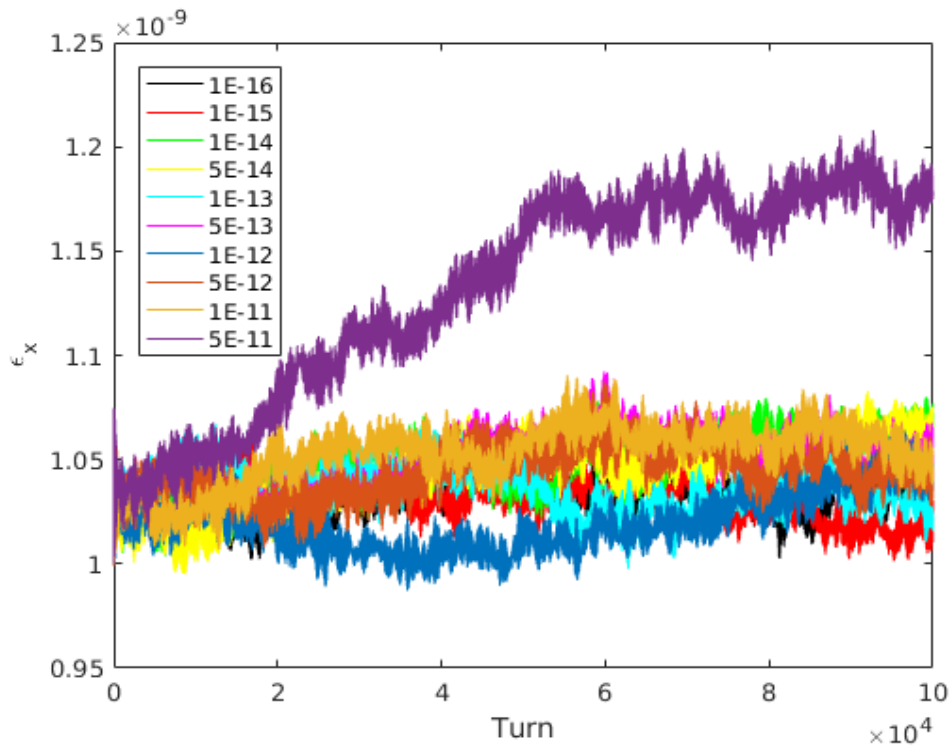
Turn=1E5

Add incoherent kicks

Track 1000 particles for 1E5 turns

$$\epsilon_x = 1 \text{ nm} \quad (n_{\sigma x} = 3.9)$$

$$\epsilon_x = 0.5 \text{ nm} \quad (n_{\sigma x} = 5.5)$$



Lebdev mentioned that both $n_{\sigma x}$ and $n_{\sigma p} > 4$ for cooling.
This seems to be true if considering coherent kicks only.

For this bypass, we did not observe cooling after adding incoherent kicks.

MPE bypass 1, 5.3mm depth, asymmetric bypass

/home/sw565/sw565/lat_des/cta_zero_eta/osc_bypass/new_bmad_input_20171008_ring

Matched to current CHESS layout, **no sextupoles in bypass**

Basic parameters:

$$\varepsilon_x = 82 \text{ nm}, \alpha_{\text{damp}} = 6.017\text{E-}7 \text{ (~4.25 s)}, x_h (x_v) = 1$$

Emittance acceptance:

$$\varepsilon_{x\text{max}} = 0.98 \text{ nm}, \sigma_{p\text{max}} = 5.38\text{E-}2$$

Colling rates:

$$\lambda_x = 3.68\text{E-}3, \lambda_s = 1.68\text{E-}5 \text{ @ } \xi_0 = 1\text{E-}7$$

Observed cooling with adding incoherent kicks with initial emittance $\varepsilon_x = 0.1$ and 0.5 nm

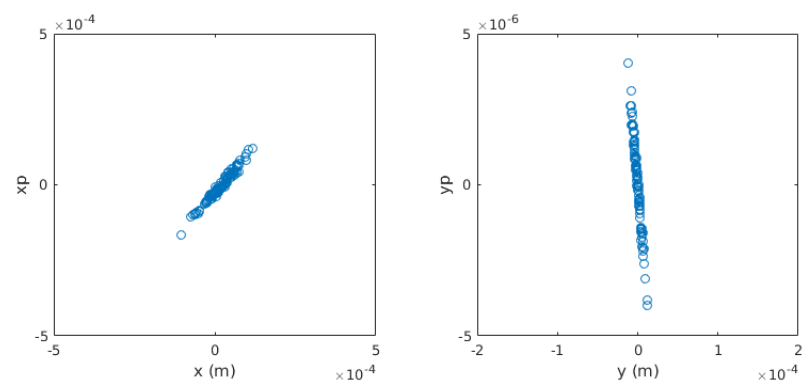
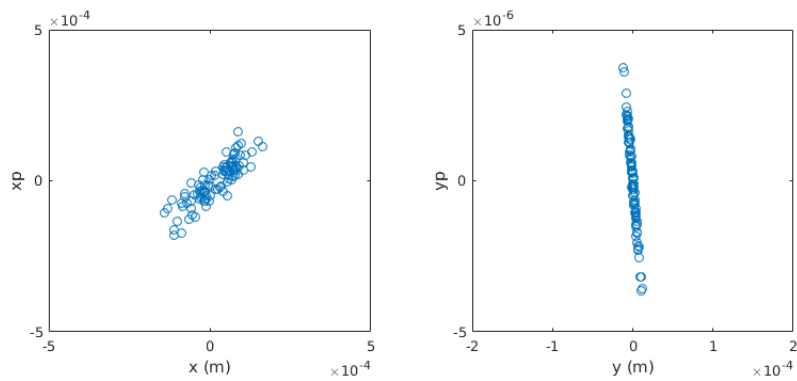
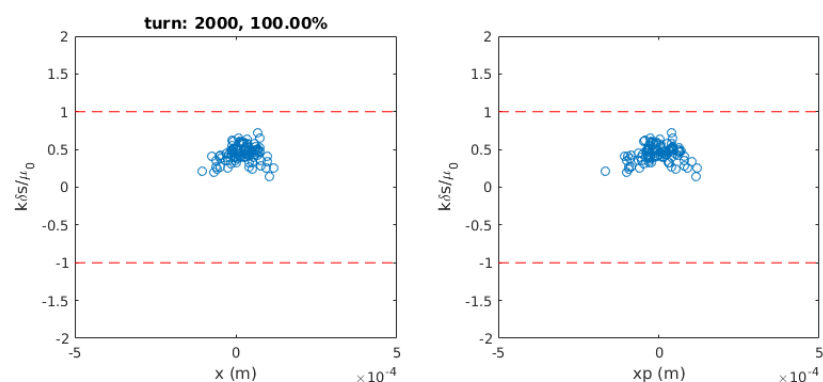
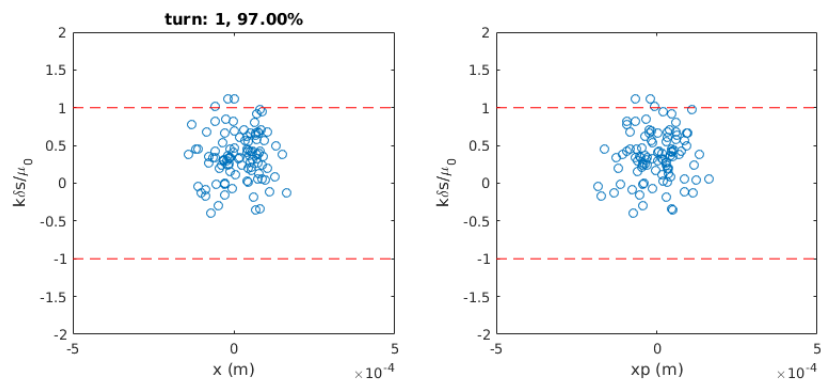
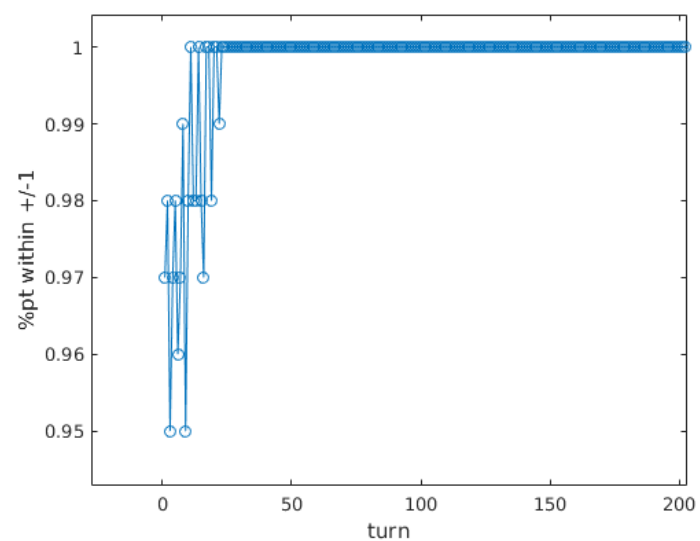
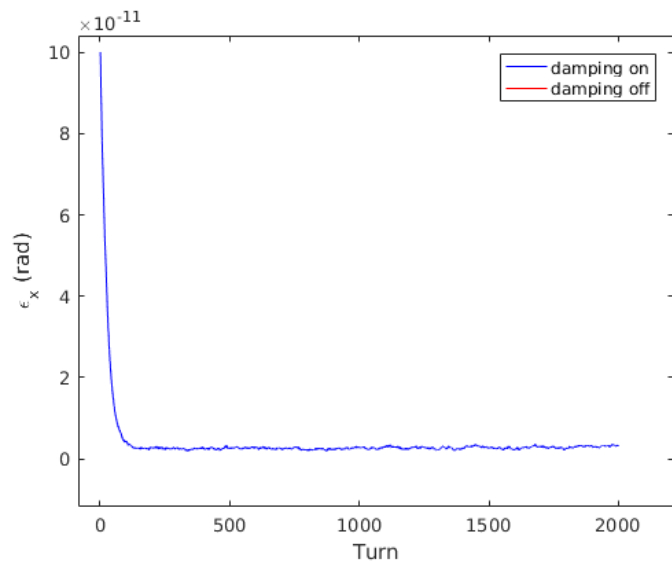
Cooling range $n_{\sigma x} = \sqrt{\varepsilon_{x\text{max}} / \varepsilon_x} = 3.1$ and 1.4 for $\varepsilon_x = 0.1$ and 0.5 nm

MPE bypass 1, 5.3mm depth, asymmetric without CHES-U layout

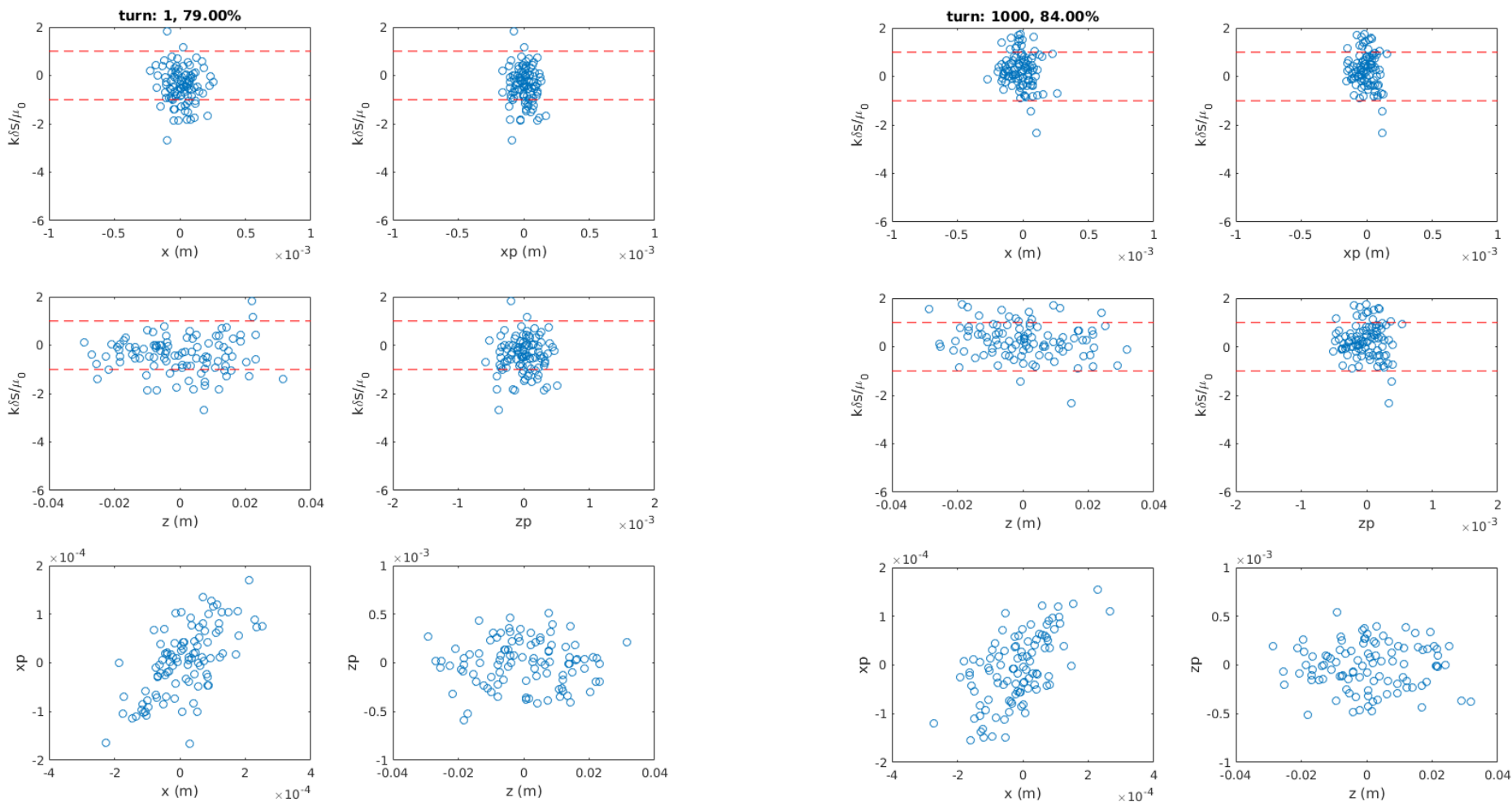
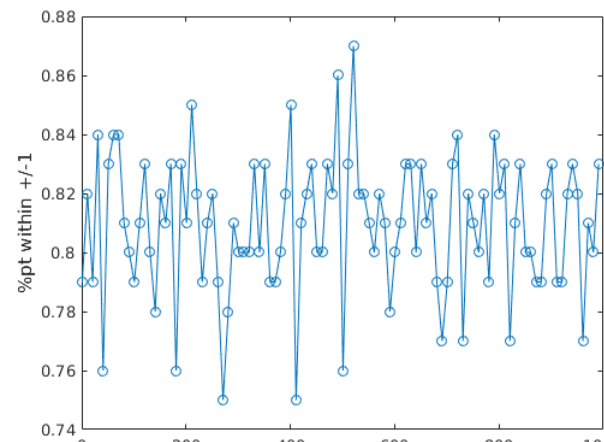
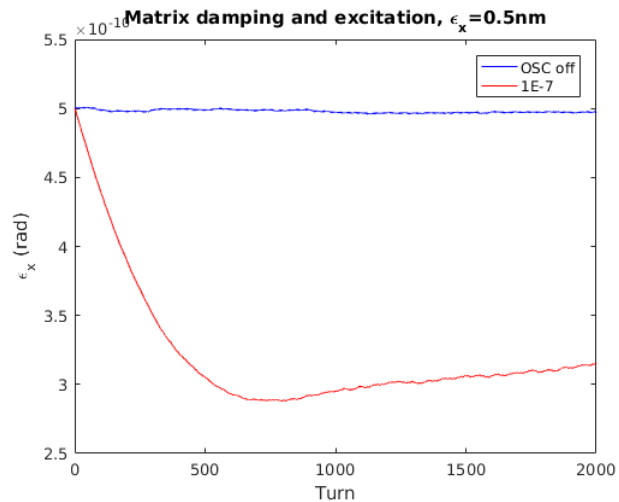
$$\epsilon_{x\max} = 1\text{nm}$$

$$\epsilon_x = 0.1\text{ nm}$$

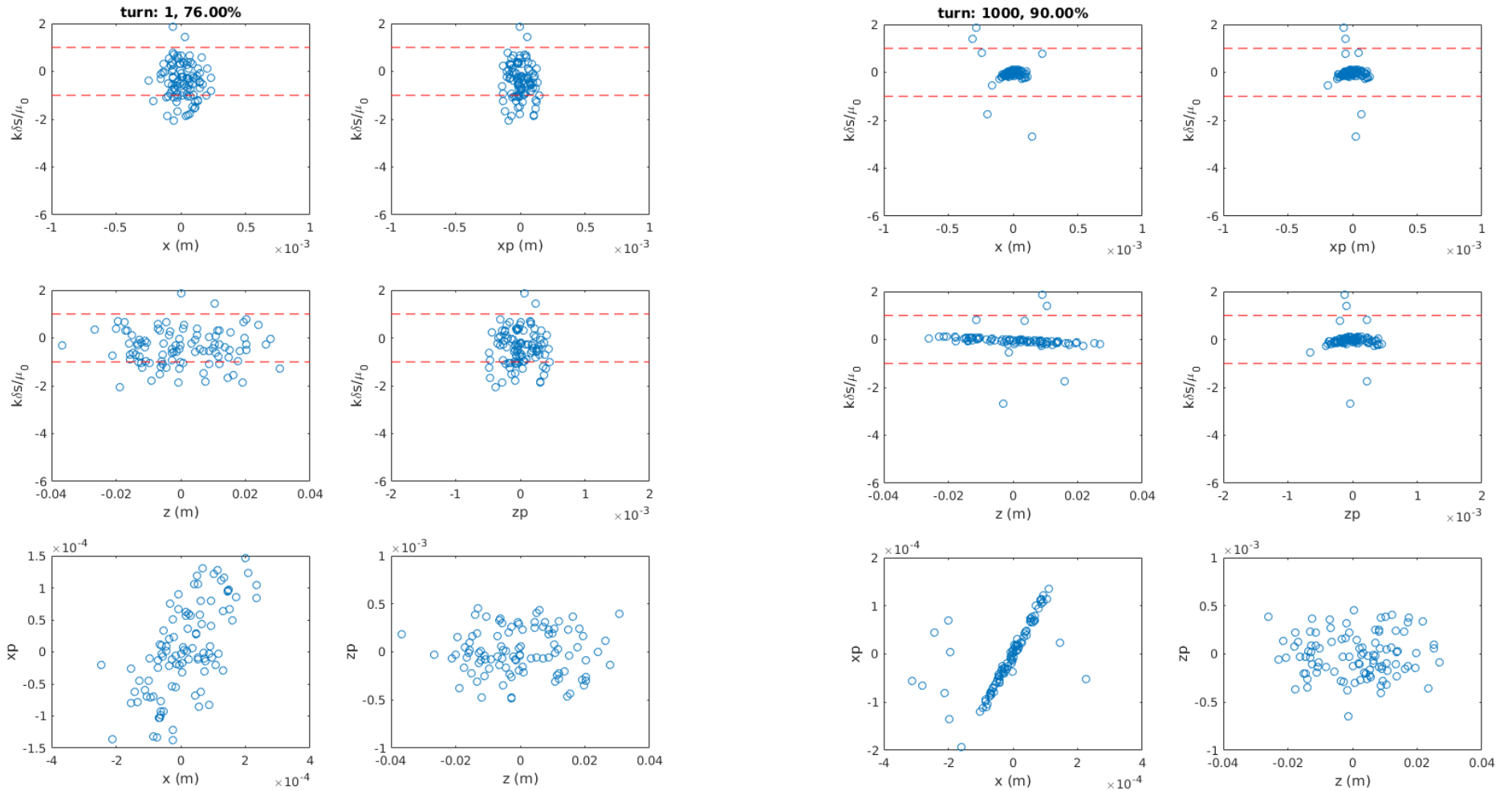
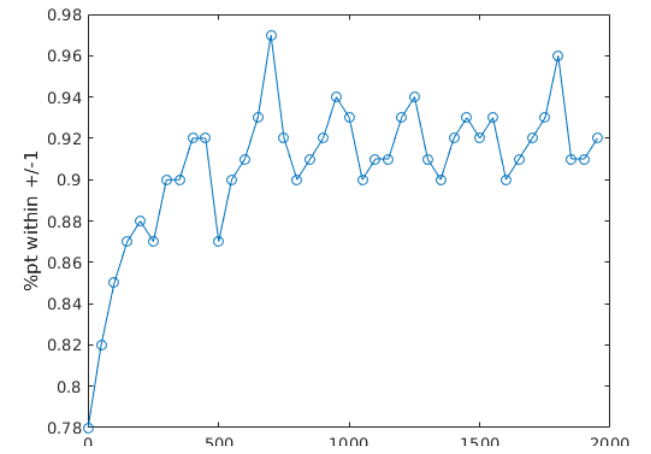
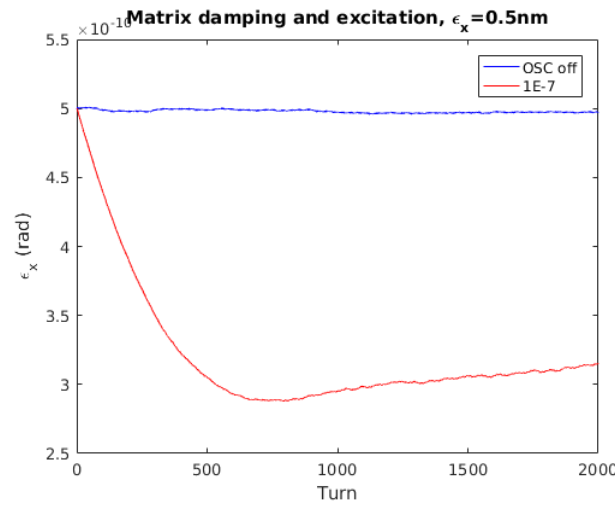
$$\zeta_0 = 1\text{E-6}$$



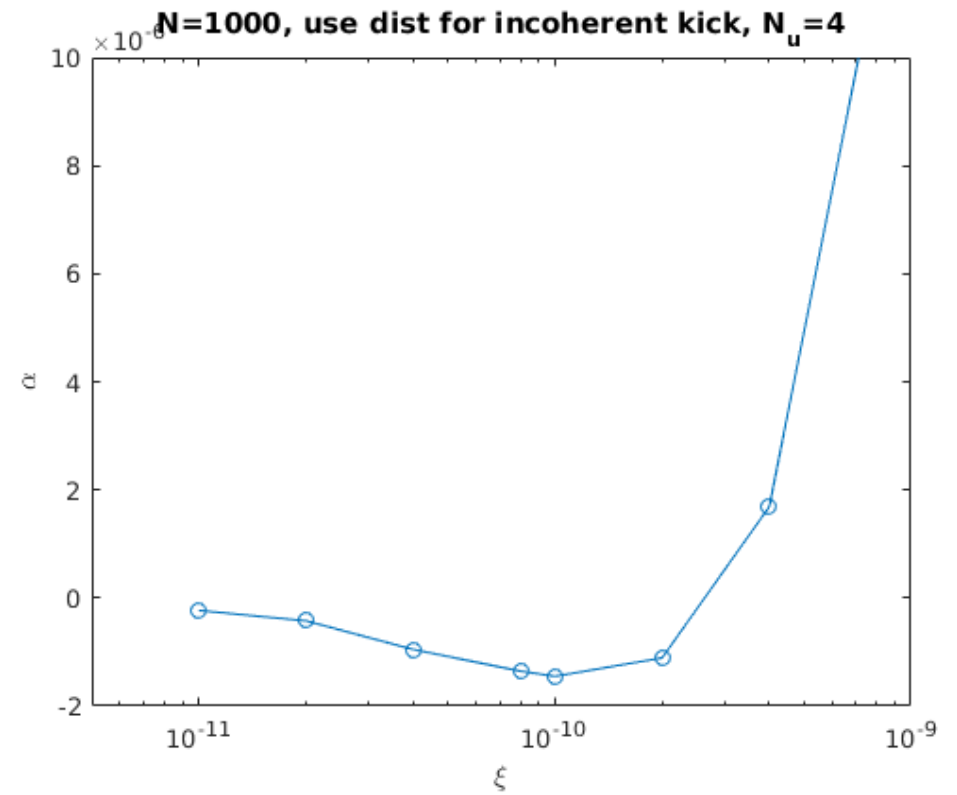
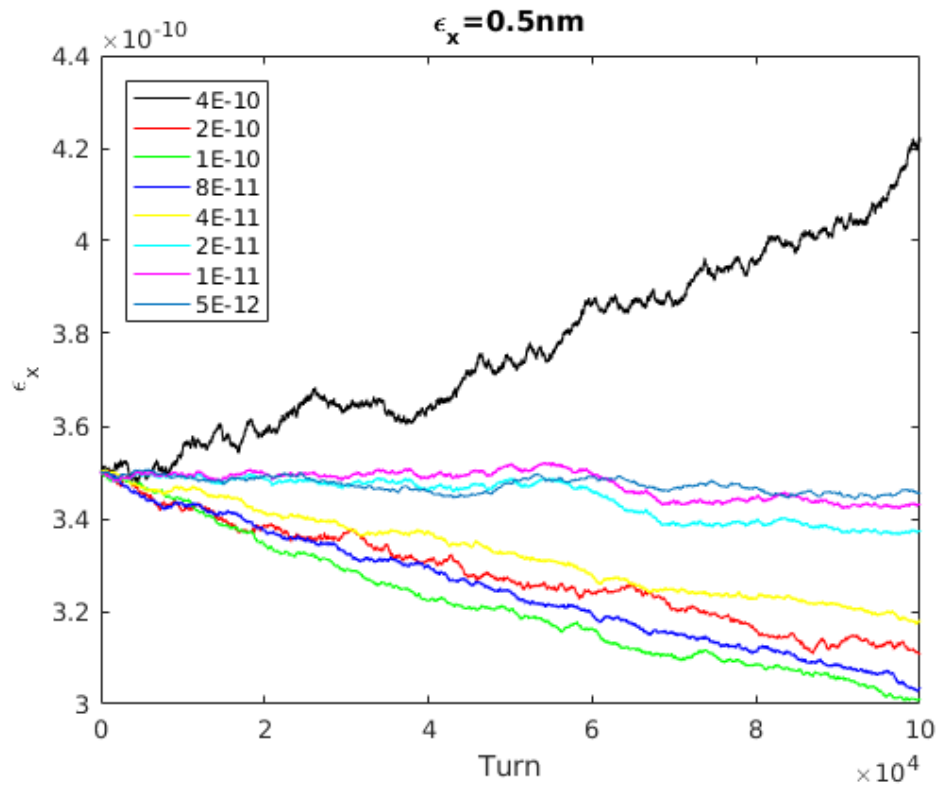
OSC process off
 Check $k\Delta s/\mu_0$, $\epsilon_x=0.5\text{nm}$
 Matrix tracking
 Without incoherent kicks



OSC process on
 Check $k\Delta s/\mu_0$, $\epsilon_x=0.5 \text{ nm}$
 Matrix tracking, $\xi_0=1\text{E-}7$
 Without incoherent kicks

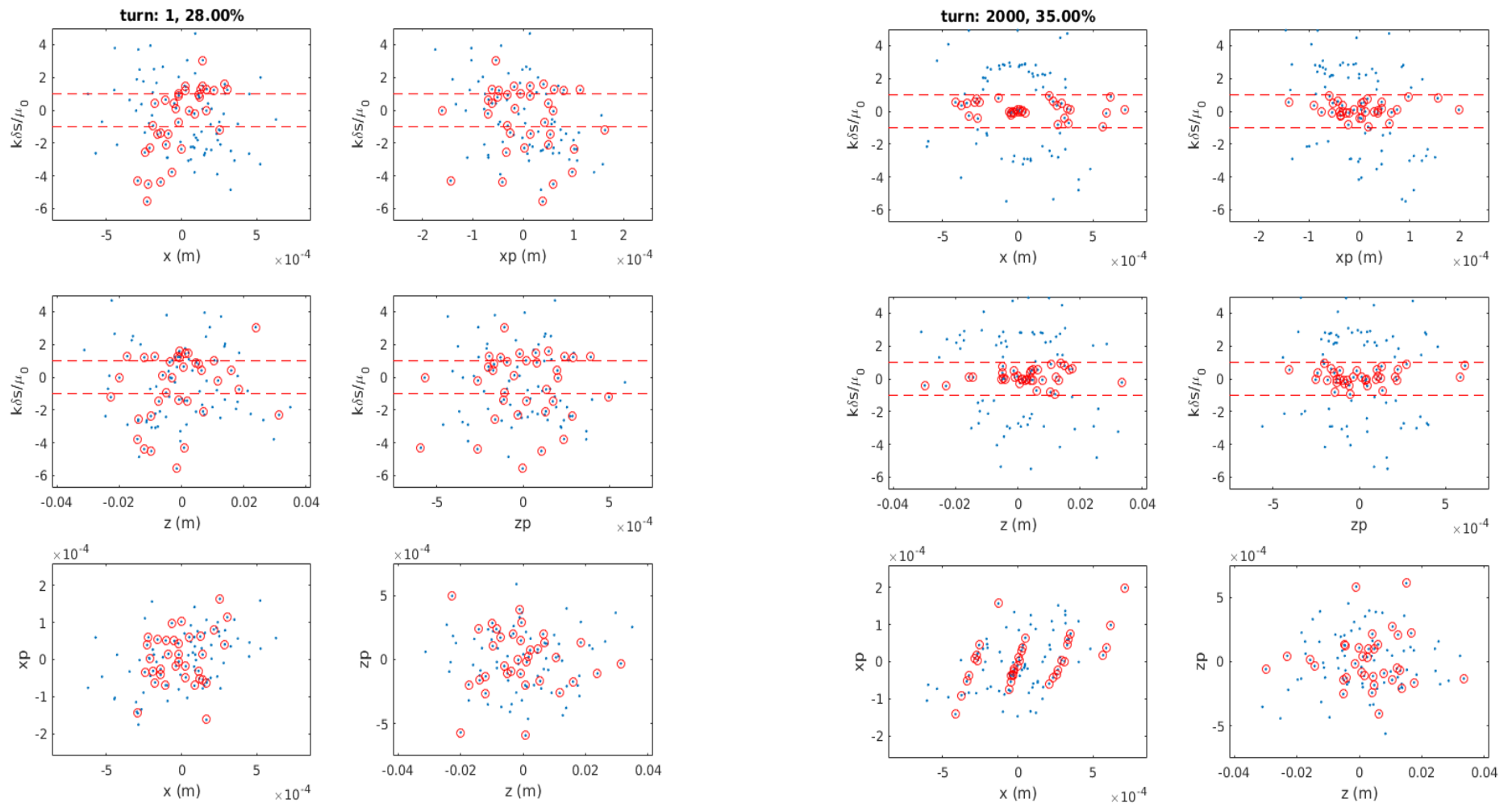
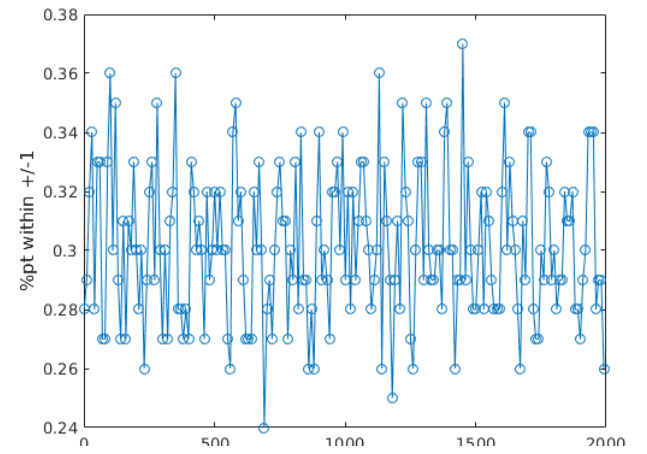
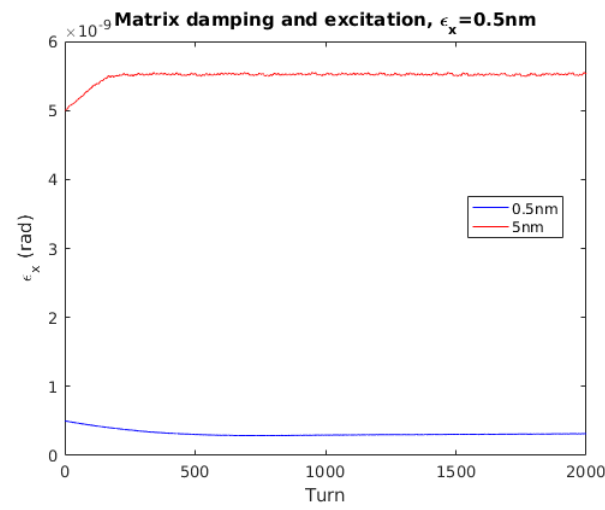


Add incoherent kicks:



$\xi_0 \sim 1.0\text{E-}10$, Damping coeff: $\alpha \sim 1.8\text{E-}6$

OSC process on
 Check $k\Delta s/\mu_0$, $\epsilon_x=5\text{ nm}$
 Matrix tracking, $\xi_0=1\text{E-}7$
 Without incoherent kicks



Conculsion

- Cooling boundaries do matter but not as strict as it should be
- Nonlinearity in bypass significantly affects cooling ranges