Overview of RHIC head-on beam-beam compensation

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10:20am

1. Basic facts about RHIC beam-beam

- two rings, head-on beam-beam effect important
- polarized proton run, polarization preservation
- nonlinears in the triplets and separation dipoles D0 and DX
- pp run working points constrained between 2/3 and 7/10
(maximum BB tune shift / tune spread ~0.02,
Np=2e11, e=15pi mm.mrad ==> 0.02 beam-beam paramter)
- Solution to Np limitation
==> mitigation: Q'' and 3Qx correction
==> new working space searching
==> e-lens (Why we are here)

2. Head-on beam-beam compensation in the RHIC

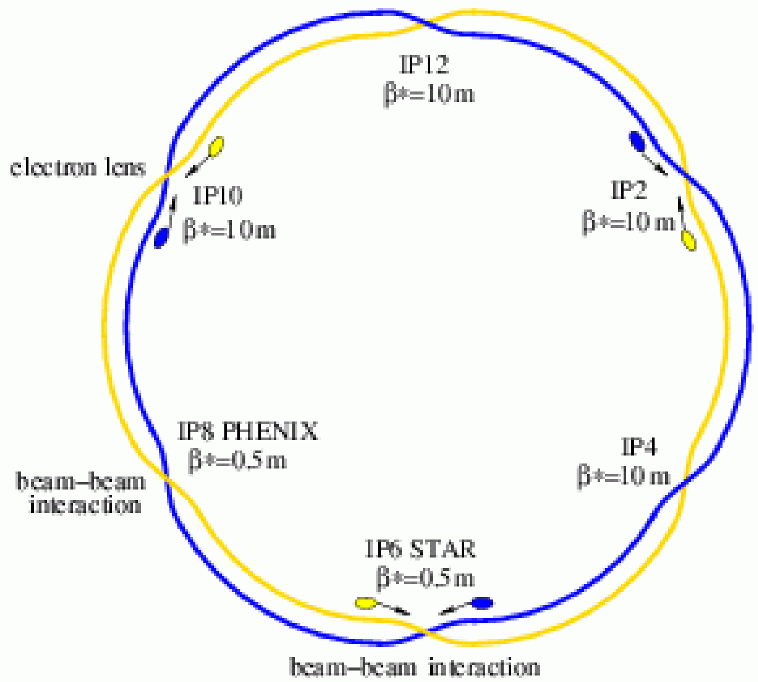


Figure 2: Layout of RHIC head-on BB compensation.

Table 1: RHIC parameters used in the simulations.

lattice	
RHIC ring circumference	3833.8451 m
proton beam energy	250 GeV
relativistic γ	266
$\beta^*_{x,y}$ at IP6 and IP8 (p-p BB)	0.5 m
$\beta^e_{x,y}$ at IP10(e-lens)	10 m
$\beta_{x,y}$ at all other IPs	10 m
proton beam	
particles per bunch N_p	2×10^{11}
normalized transverse rms emittance	2.5 nm
transverse rms beam size at IP6 and IP8	0.068 mm
transverse rms beam size at e-lens	0.40 mm
harmonic number	360
rf cavity voltage	300 kV
rms longitudinal bunch area	0.17 eV.s
rms momentum spread	0.14×10^{-3}
rms bunch length	0.44 m

3. What critical questions we need to answer from simulation

Does e-lens

- reduce beam-beam tune spread (YES)
- increase collision beam lifetime (No for Np=2e11)
- reduce emittance growth rate (not sure)
- increase bunch intensity (Likely)

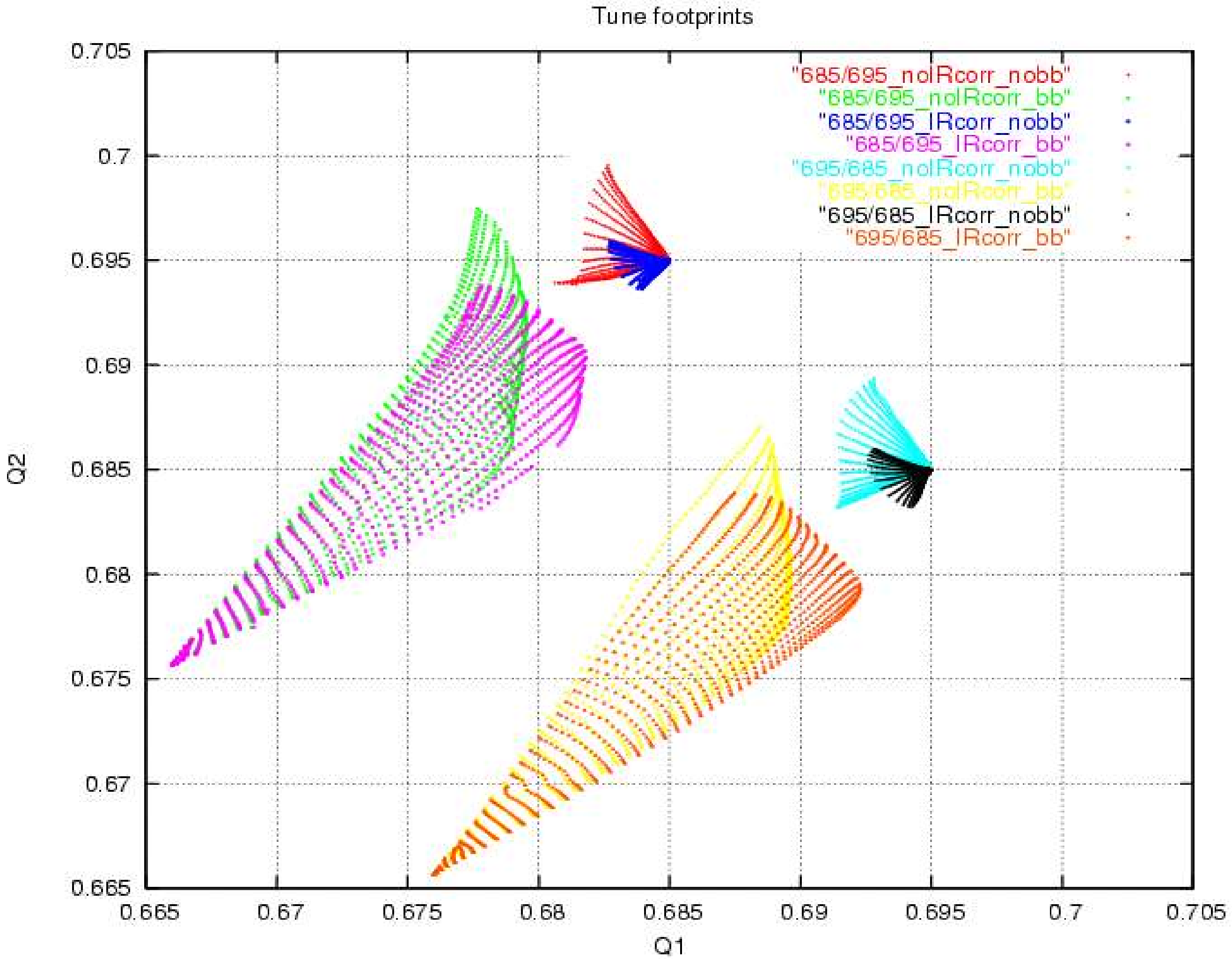
advantages versus disadvantages

5. Physics questions

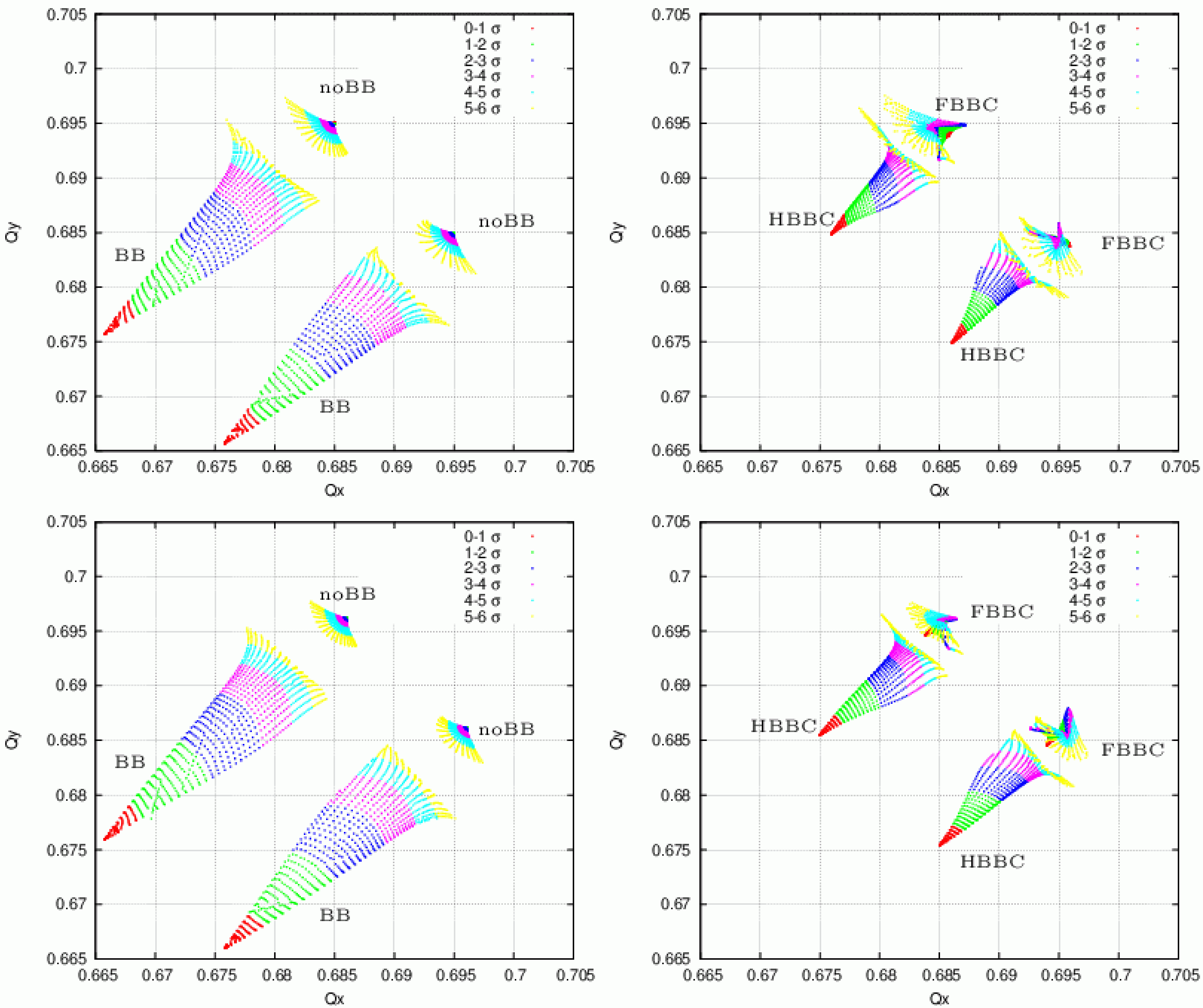
==>Why e-lens works or doesn't work

1) long-range and head-on beam-beam compensations
2) magnetic multipole errors and head-on beam-beam compensations
3) local (zero phase advance, zero distance) and global compensations
4) Phase advance ~k*Pi between IP8 and IP10 give better compensation
5) Roles of IR nonlinears
6) Roles of errors and noises in head-on BBC

BACKUP SLIDES



Tunefoot prints with Nb=2.0e11, beta*=0.5m at IP6 and IP8


0-1 σ
1-2 σ
2-3 σ
3-4 σ
4-5 σ
5-6 σ
noBB
noBB
BB
BB
FBBC
FBBC
HBBC
HBBC
Qx
Qy

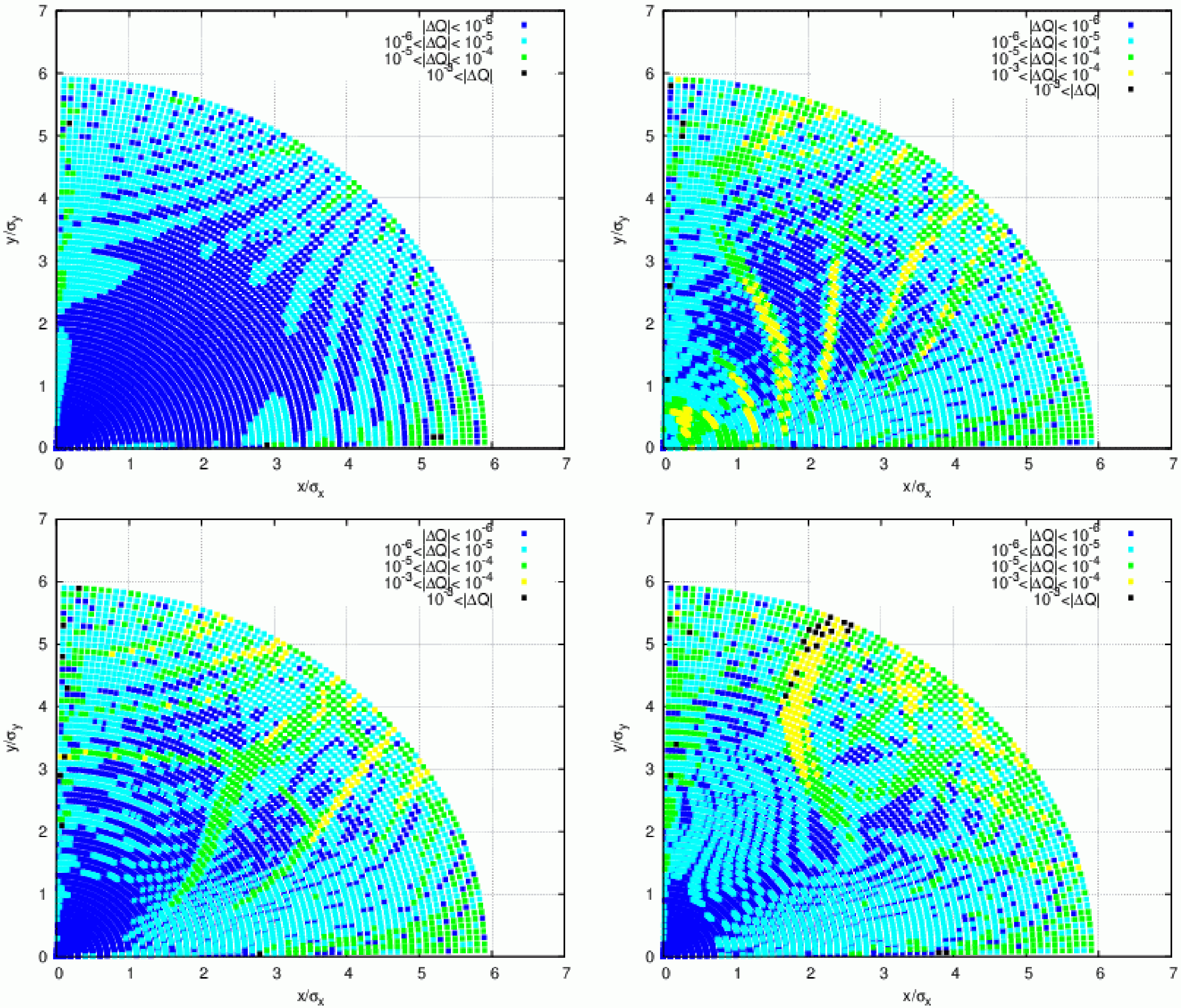


Figure 3: Tune diffusion maps of on-momentum particles for working point (28.685, 29.695): Top-left: without BB; Top-right: with BB; Bottom-left: with BB and half BB compensation; Bottom-right: with BB and full BB compensation.

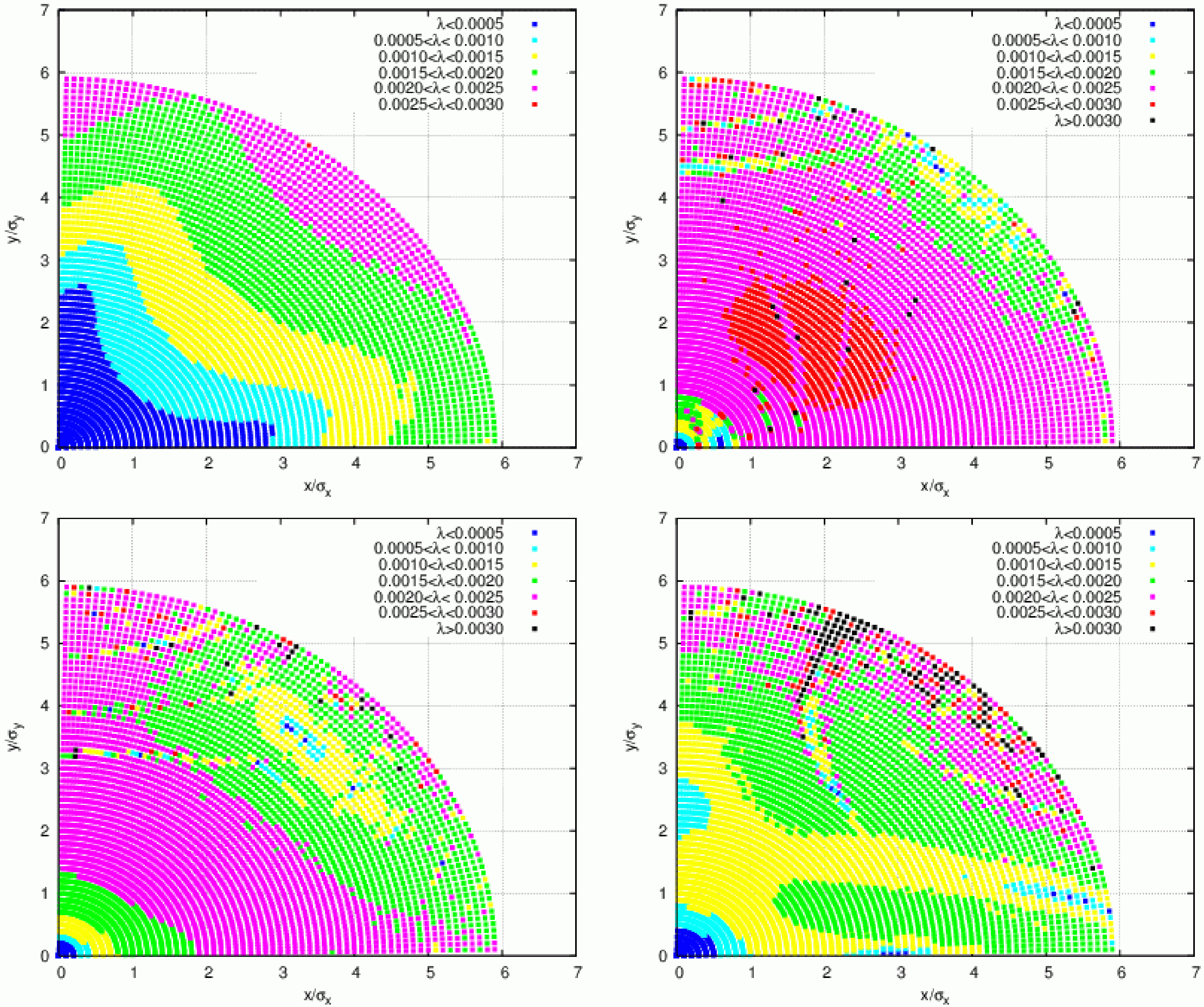


Figure 7: Lyapunov exponent maps of on-momentum particles for working point (28.685, 29.695): Top-left: without BB; Top-right: with BB; Bottom-left: with BB and half BB compensation; Bottom-right: with BB and full BB compensation.

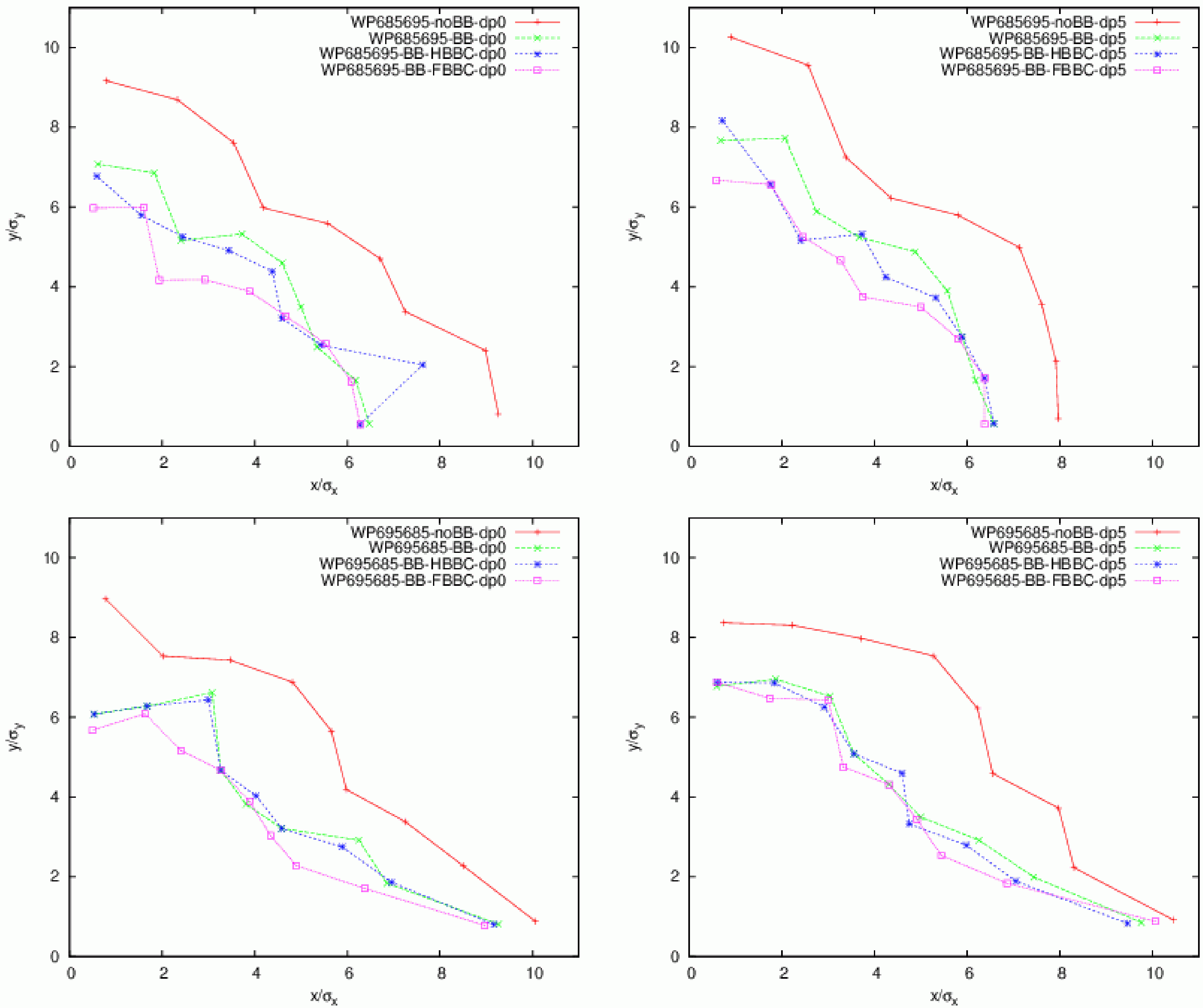
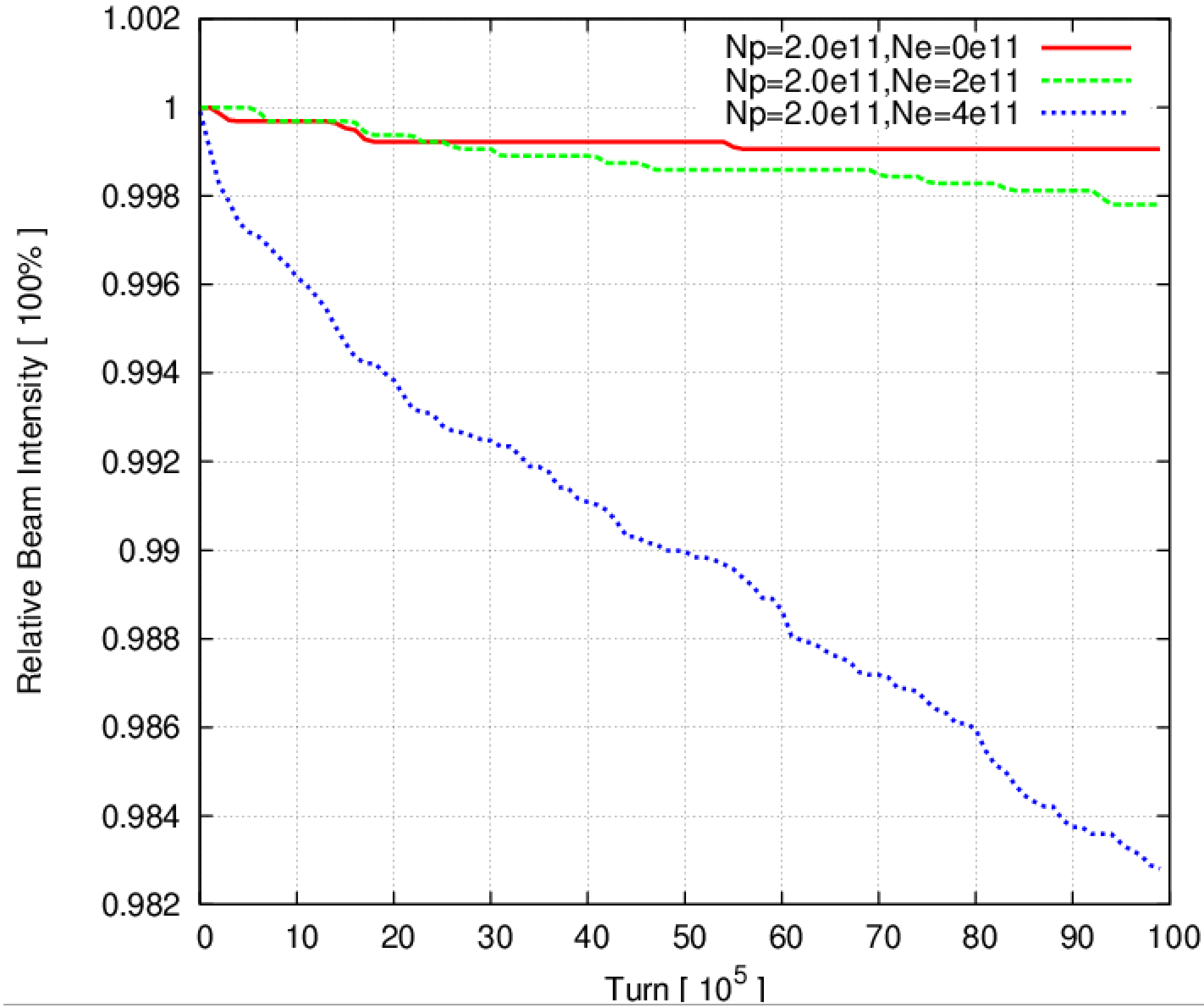
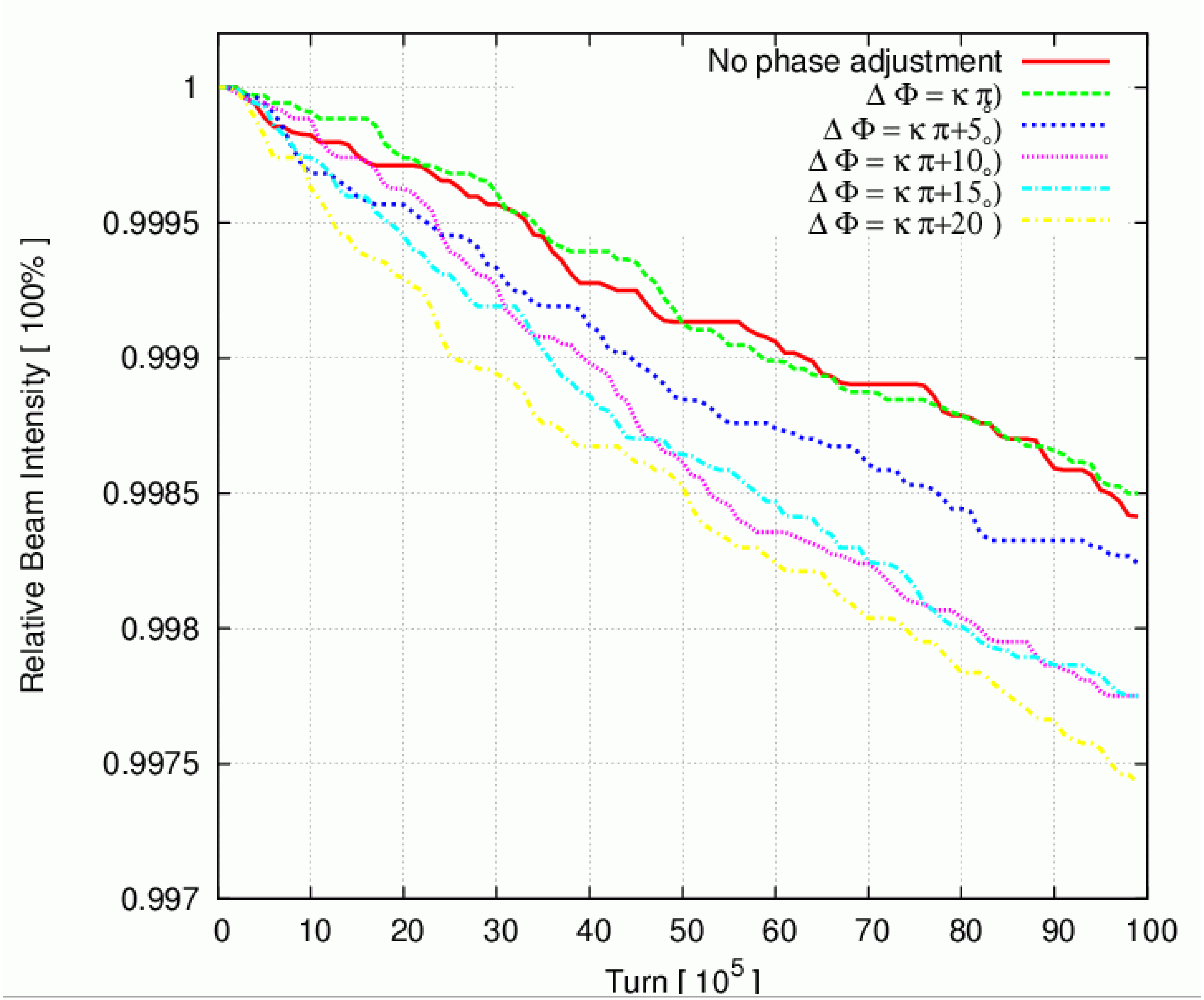


Figure 9: 10^6 turn dynamic apertures. Top-left: on-momentum particles with working point (28.685, 29.695); Top-right: off-momentum particles with working point (28.685, 29.695); Bottom-left: on-momentum particles with working point (28.695, 29.685); Bottom-right: off-momentum particles with working point (28.695, 29.685).

beamdeacy_685695_Np2e11_G.ps



beamdecay_685695_Np2e11_Ne2e11_DPhi_H.ps



beamdecay_685695_Np2d5e11_and_Np3e11_PI_H.ps