MO4RAC05

Weak-strong Simulation of Head-on Beam-beam compensation in the RHIC

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1. Introduction
2. Simulation results
3. Summary

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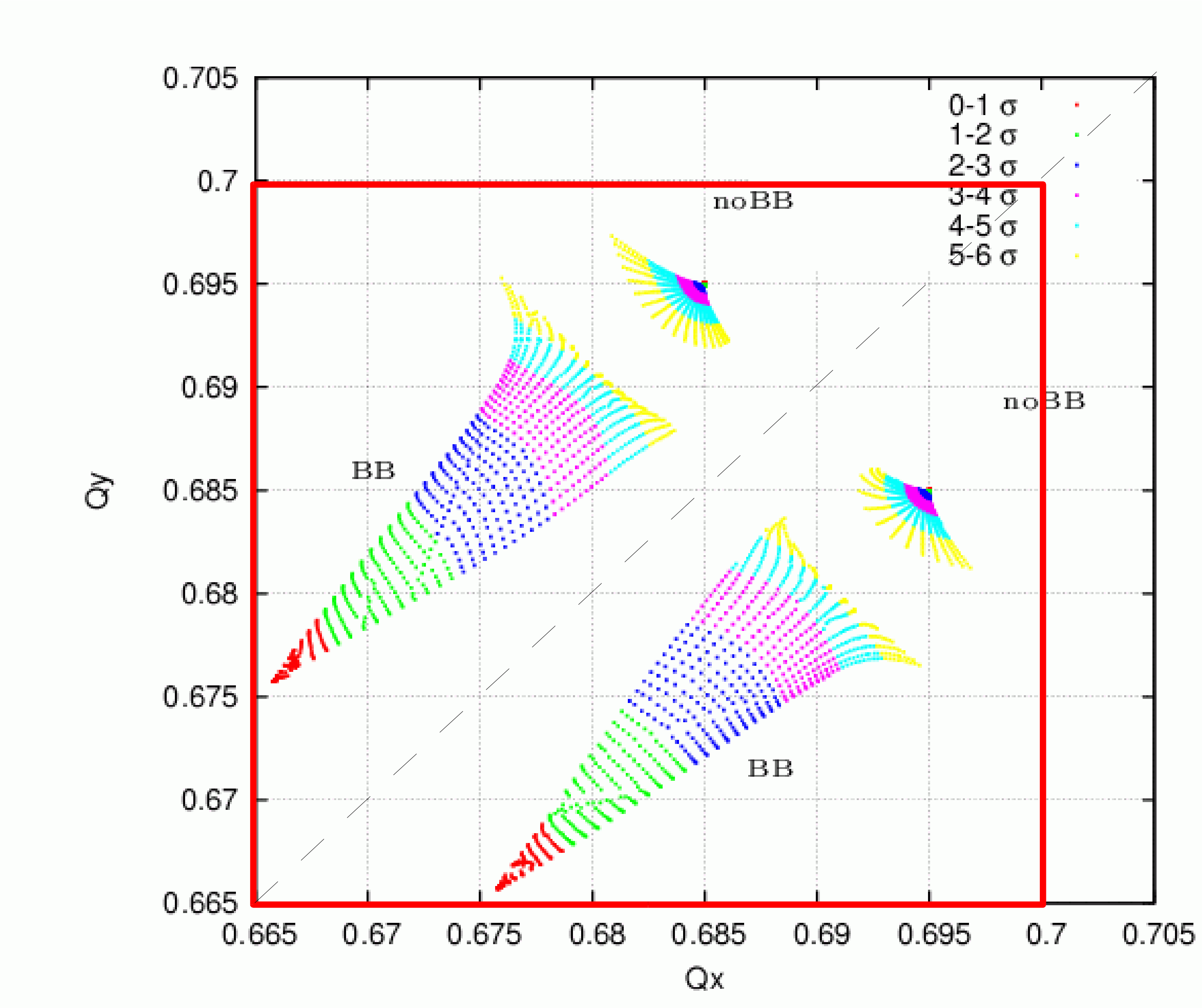
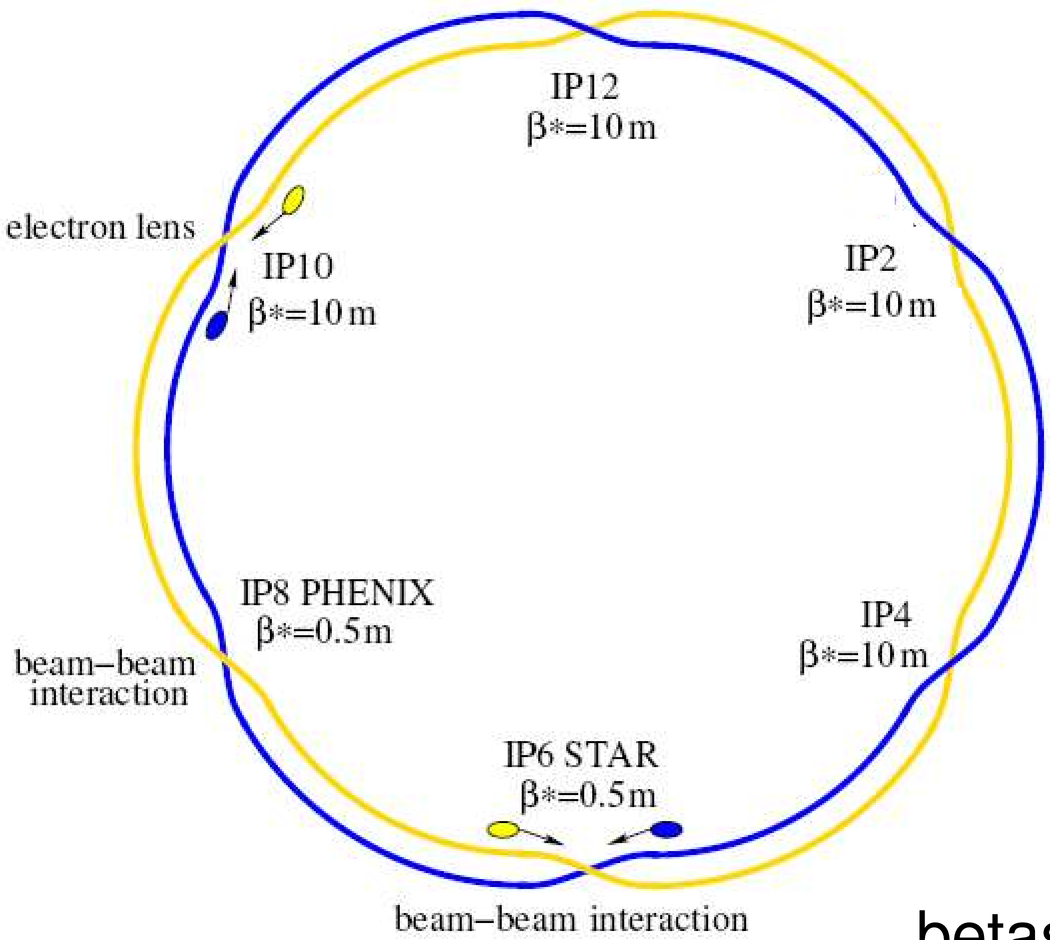
Tune space for RHIC Polarized Proton Run



Np=2e11, Enorm=15pi mm.mrad

Layout of RHIC Head-on beam-beam compensation

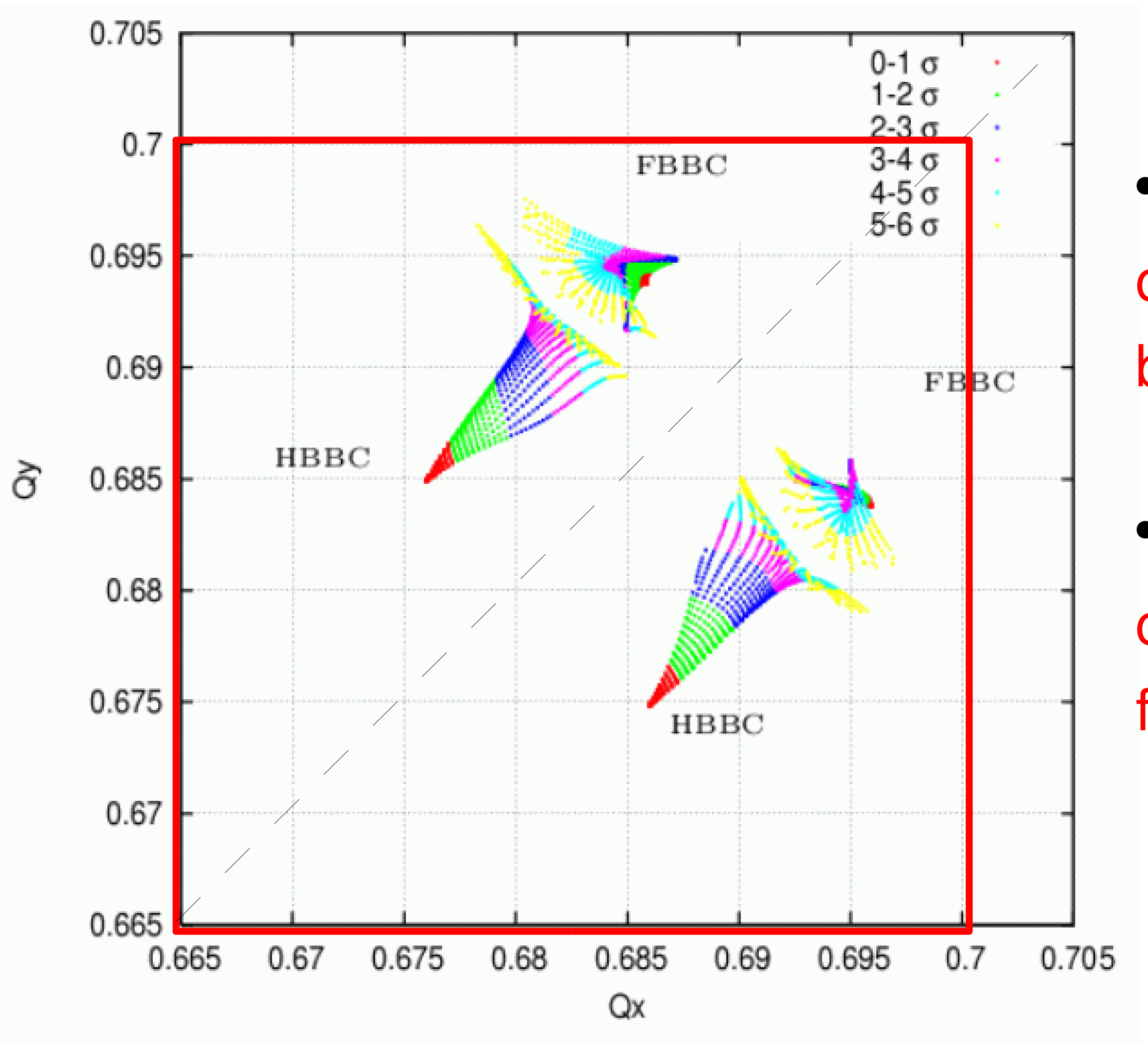


- Proton bunches collide at IP6 and IP8 with beta*=0.5m.
- Electron-lenses (e-lens) are to be installed at IP10 where beta*=10m.

betas and phase advances at IPs

* NAME	BETX	BETY	MUX (in 2 Pi)	MUY
"CLOCK6"	0.5187613667	0.5196453489	0	0
"CLOCK8"	0.5187613667	0.5196453488	5.304811589	4.294930232
"CLOCK10"	10.71138784	9.785402809	9.517622644	9.779139376

Beam-beam tune spread with compensation



- Head-on beam-beam compensation compresses beam-beam tune footprint.
- However full compensation folds tun footprint at low amplitude.

HBBC: compensate half p-p beam-beam parameter

FBBC: compensate all p-p beam-beam parameter

Simulation code and beam-beam modeling

SixTrack:

Symplectic / Fast

Two major modifications:

Multi-particle tracking

modify beam-beam parameters turn by turn

Optical tracking (between IPs):

Element-by-element

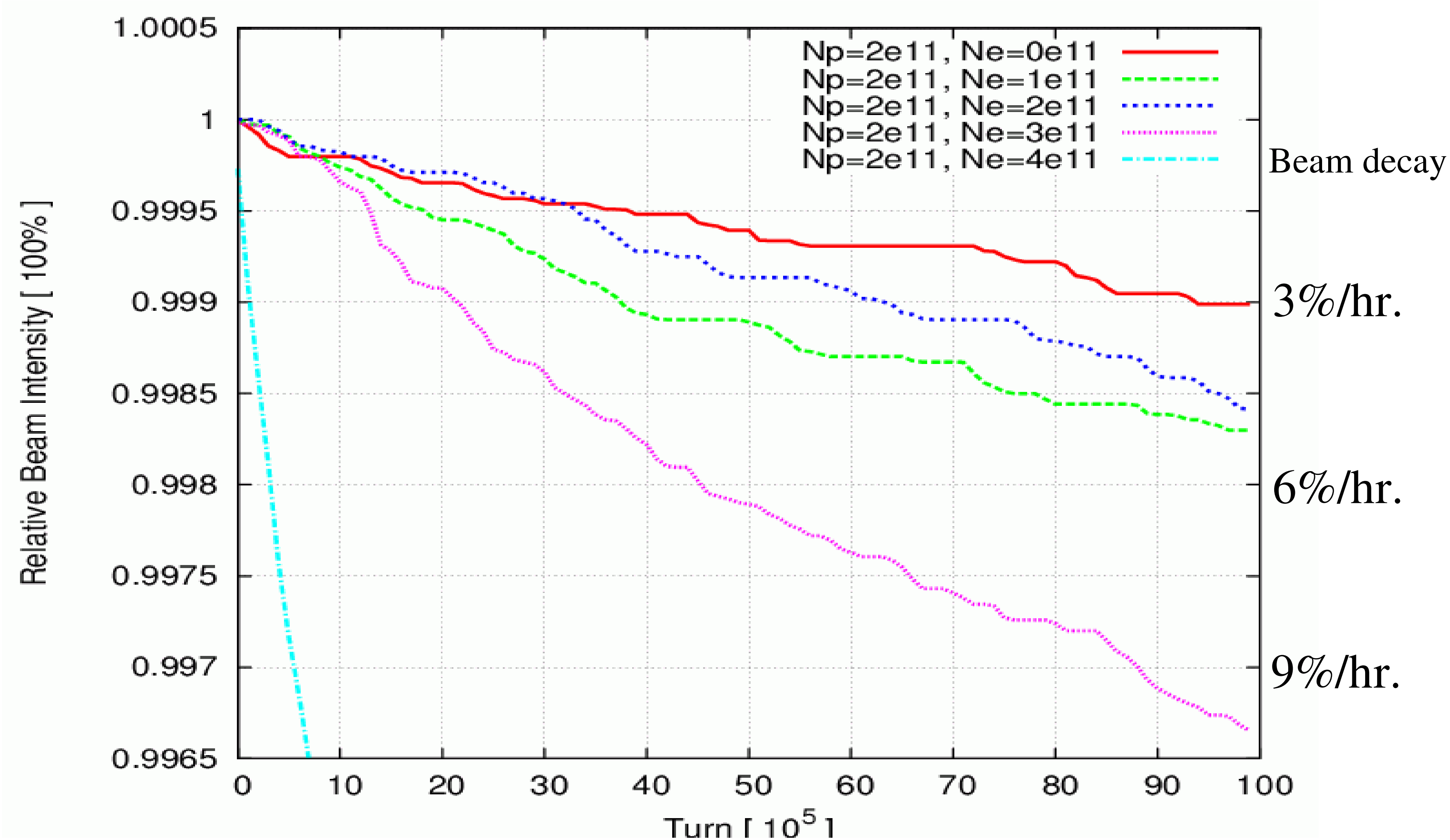
best RHIC lattice model used

Beam-beam model:

Currently 4-D transverse kick

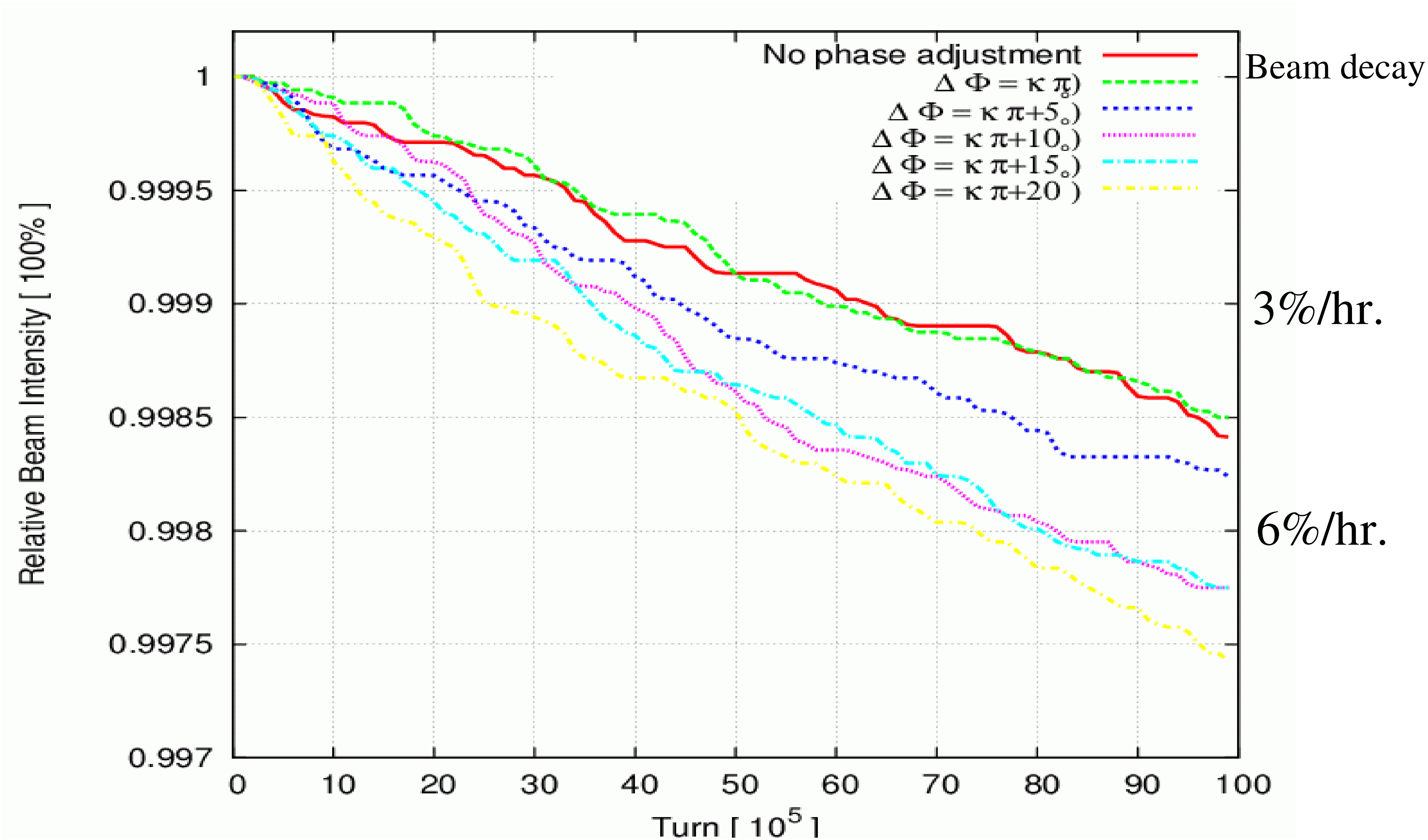
Will upgrade to 6-D treatment

Particle loss versus compensation strength



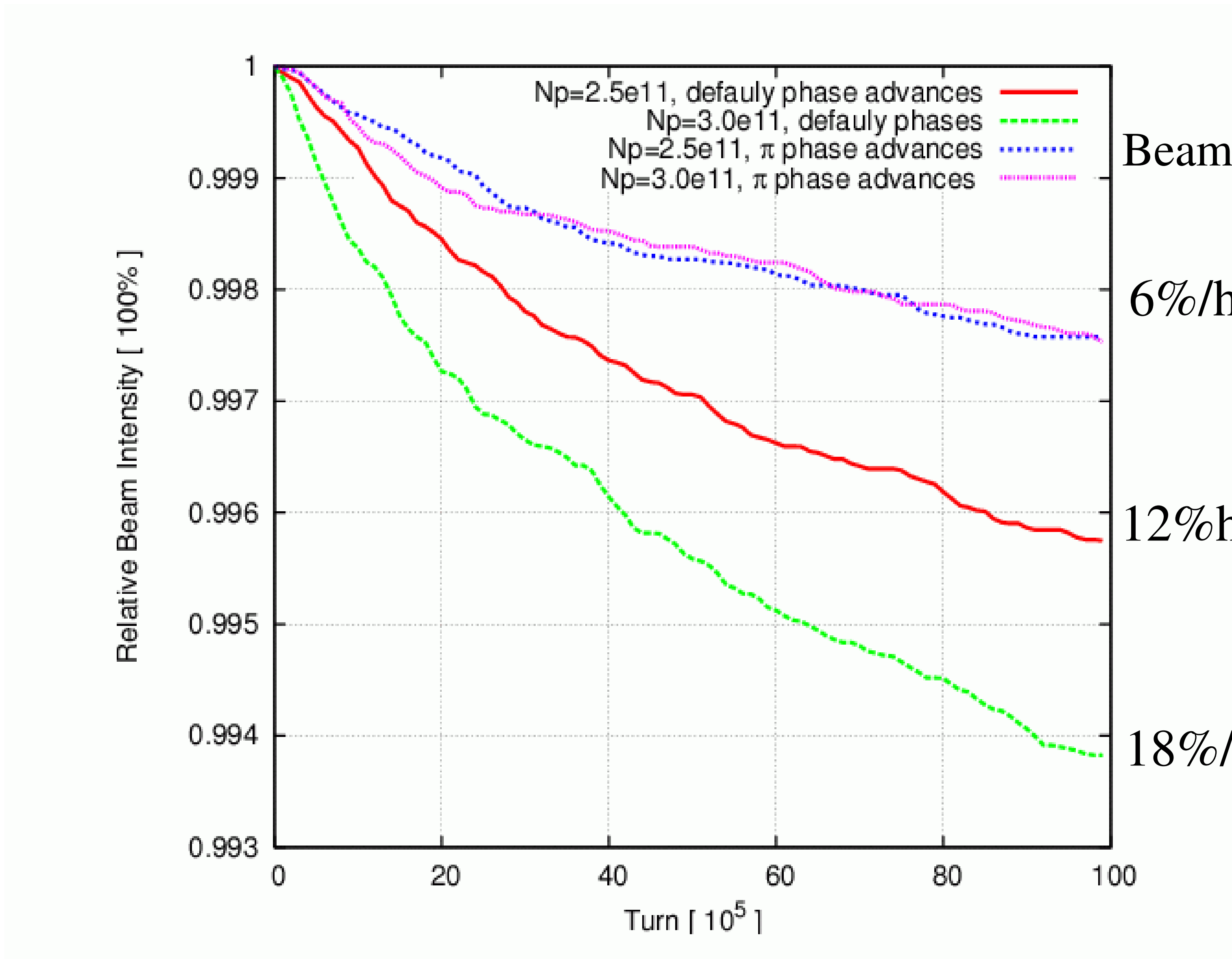
From simulation, stronger than HBBC has negative effect on beam lifetime.

Particle loss versus phase advances between IP8 and IP10



Default phase advance is likely OK for e-lenses in IP10 and N=2.0e11

With increased bunch intensities Np=2.5e11, 3.0e11



Beam decay

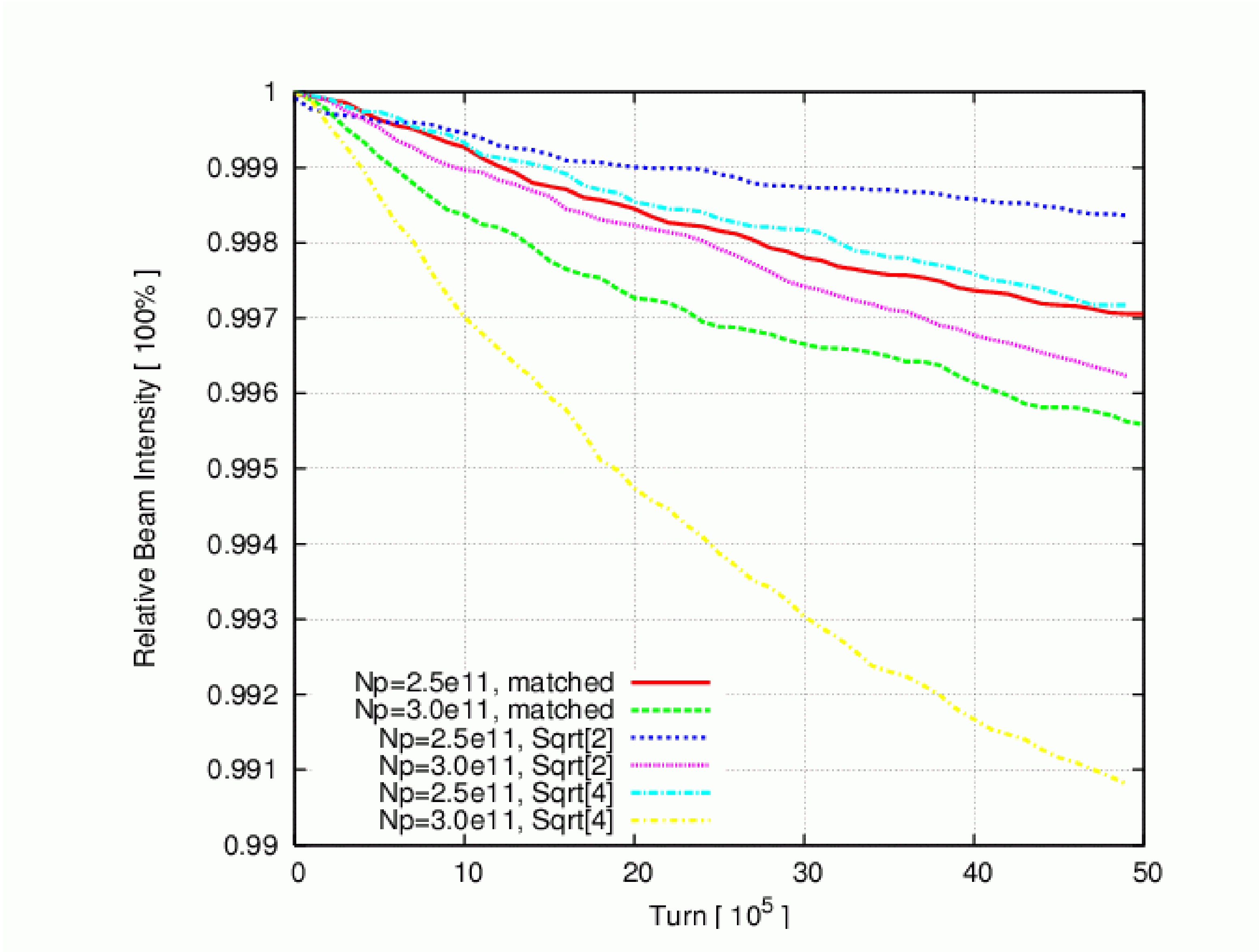
6%/hr.

12%hr.

18%/hr.

Exactly m*PI phase advances improve BB lifetime for Np=2.5e11, 3.0e11

Particle loss with unmatched electron beam sizes



Slightly enlarged electron beam size improves lifetime for Np=2.5e11 / 3.0e11.

Summary

1. Head-on beam-beam compensation can efficiently reduce the beam-beam tune spread and gives possibility to increase beam-beam parameter. Head-on beam-beam with Np > 2.0e11 needs head-on beam-beam compensation. To avoid strong nonlinearities introduced by the compensation, only partial compensation should be considered.

2. Simulation shows that the exactly m*PI of the phase advances between IP8 and IP10 and slightly enlarged electron beam size improve the beam-beam lifetime with bunch intensity 2.5e11 and 3.0e11.

3. Simulation code upgrading is under way. 3-D beam-beam treatment will be integrated. The errors and fluctuations in the beam-beam compensation will be carefully studied.