Synergia simulations of Booster

Fermilab, May 17, 2017

1. periodic lattice, 48 RFs

24 x identical cell:

cell: -----CPS-----Fmag-----Dmag-----RF-----RF-----CPL-----Dmag-----Fmag-----

correctors: CPL03 = (HL03, VL03, QL03, BPML03, QSL03, QSLERR03, SXL03, SSL03)

2. 19 RFs lattice:

29 RF cavities turned into drifts
19 RF cavities as in the Booster

3. 19 RFs, CPL03 as in the Booster

CPL in cell 3 displaced upstream ≈ 4m

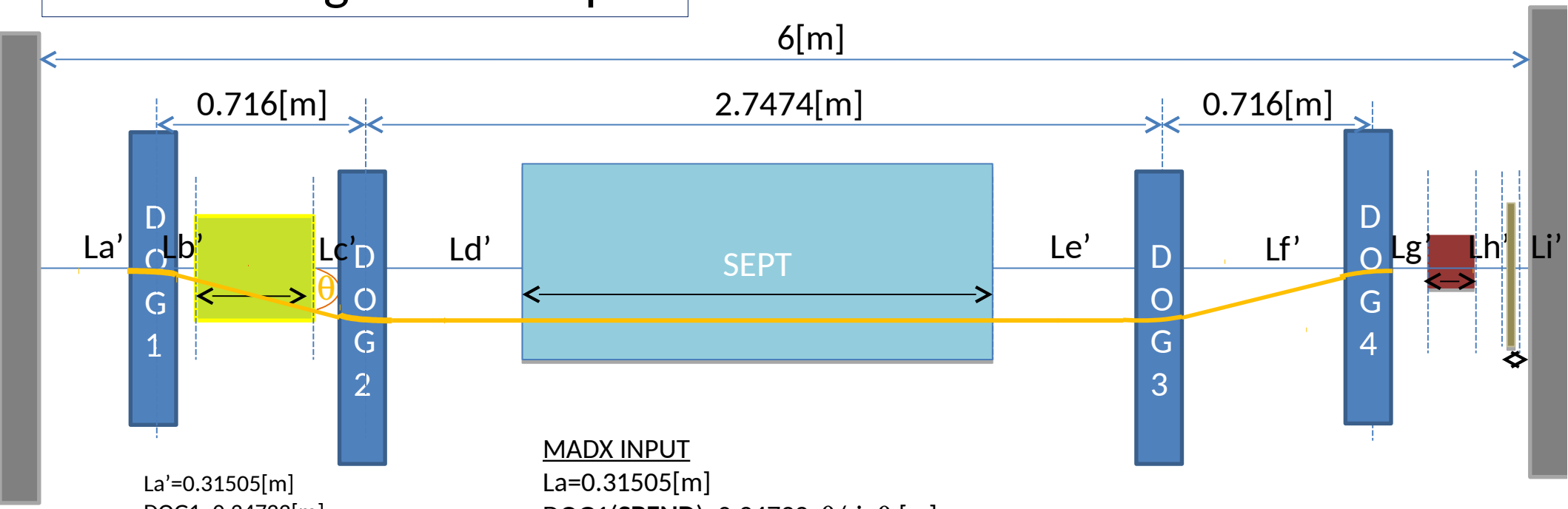
4. 19 RFs, dog magnets as in Booster, CPL03 in symmetric position

Lattice 2 with the dogs in place

5. 19 RFs, CPL03 as in the Booster and dog magnets as in Booster

CPL in cell 3 displaced upstream ≈ 4m
Dogs in place
Lattice 3 with dogs in place

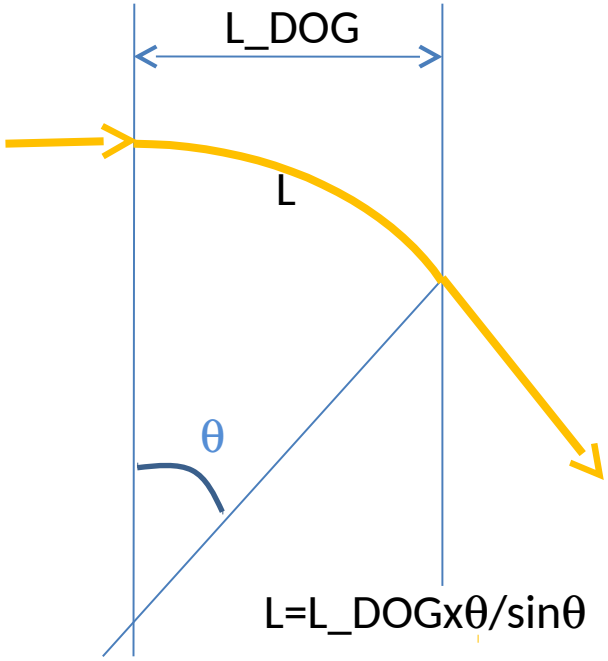
Booster Long3 MADX input



La'=0.31505[m]
DOG1=0.24722[m]
Lb'=0.30039[m]
Corrector=0.15[m]
Lc'=0.30039[m]
DOG2=0.24722 [m]
Ld'=0.43067[m]
SEPT=1.524[m]
Le'=0.54551[m]
DOG3=0.24722 [m]
Lf'=0.76878[m]
DOG4=0.24722 [m]
Lg'=0.2[m]
IBEX=0.33[m]
Lh'=0.064165[m]
BPM=0[m]
Li'=0.064165 [m]

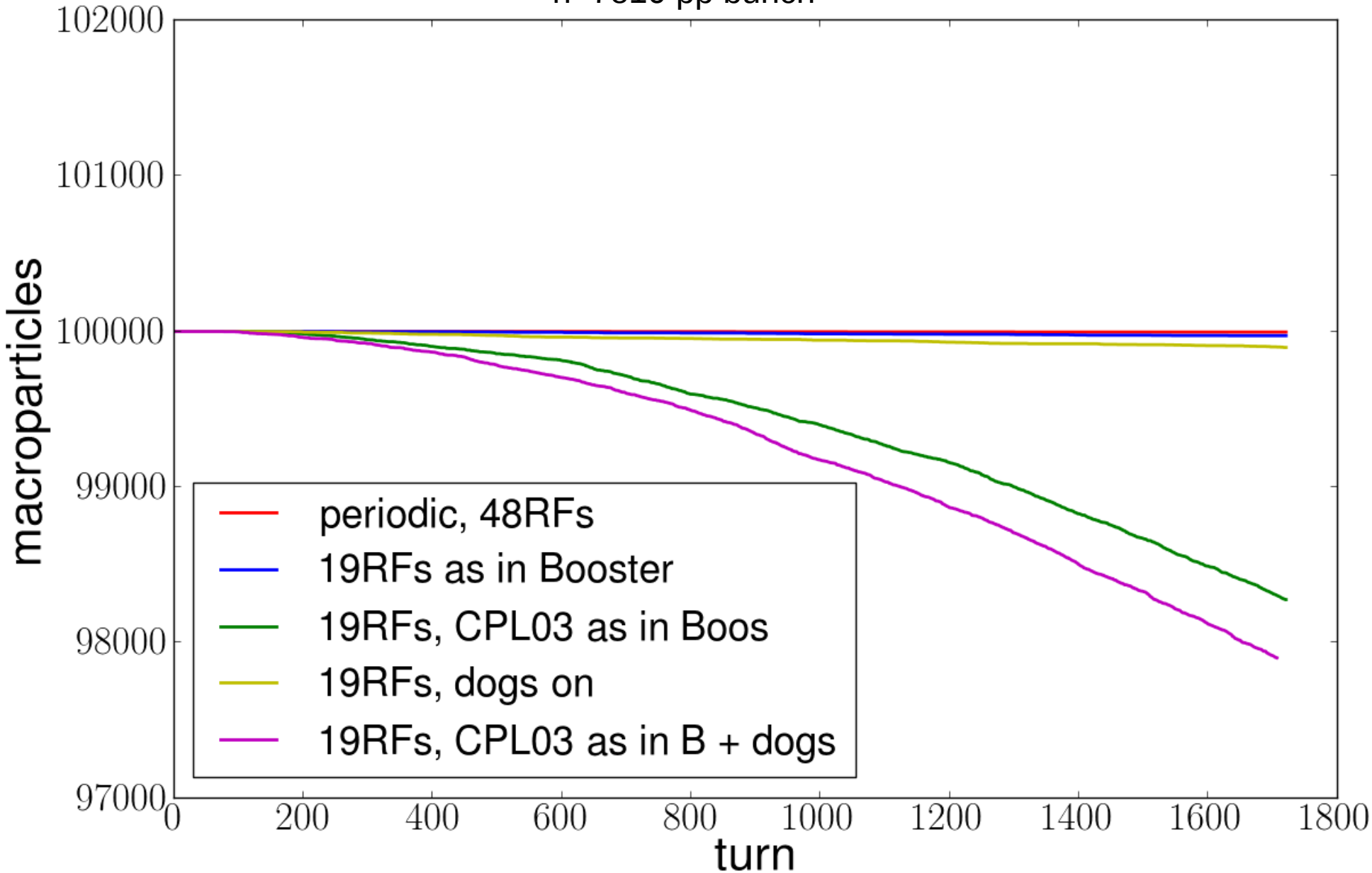
Total=6[m]

<u>MADX INPUT</u>
La=0.31505[m]
DOG1(**SBEND**)=0.24722xθ/sinθ [m]
Lb=0.30039/cosθ [m]
Corrector=0.15/cosθ [m]
Lc=0.30039/cosθ [m]
DOG2(**SBEND**)=0.24722xθ/sinθ [m]
Ld=0.43067[m]
SEPT=1.524[m]
Le=0.54551[m]
DOG3(**SBEND**)=0.24722xθ/sinθ [m]
Lf=0.76878/cosθ [m]
DOG4(**SBEND**)=0.24722xθ/sinθ [m]
Lg=0.2[m]
IBEX=0.33[m]
Lh=0.064165[m]
BPM=0[m]
Li=0.064165[m]



Q_h=0.734 Q_v=0.824 Chrom=(-17,-9)

n=7e10 pp bunch



Q_h=0.734 Q_v=0.824 Chrom=(-17,-9)

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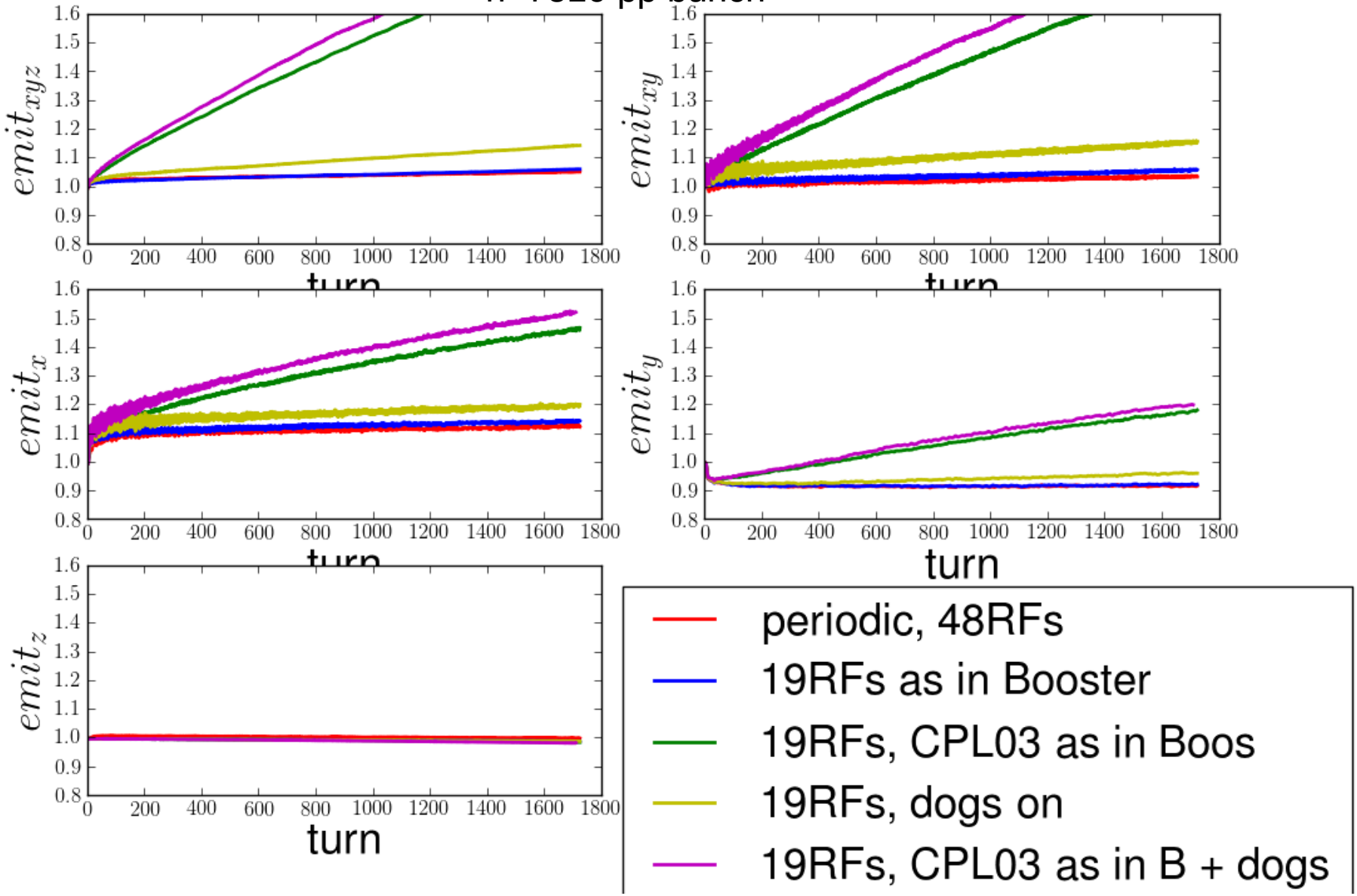
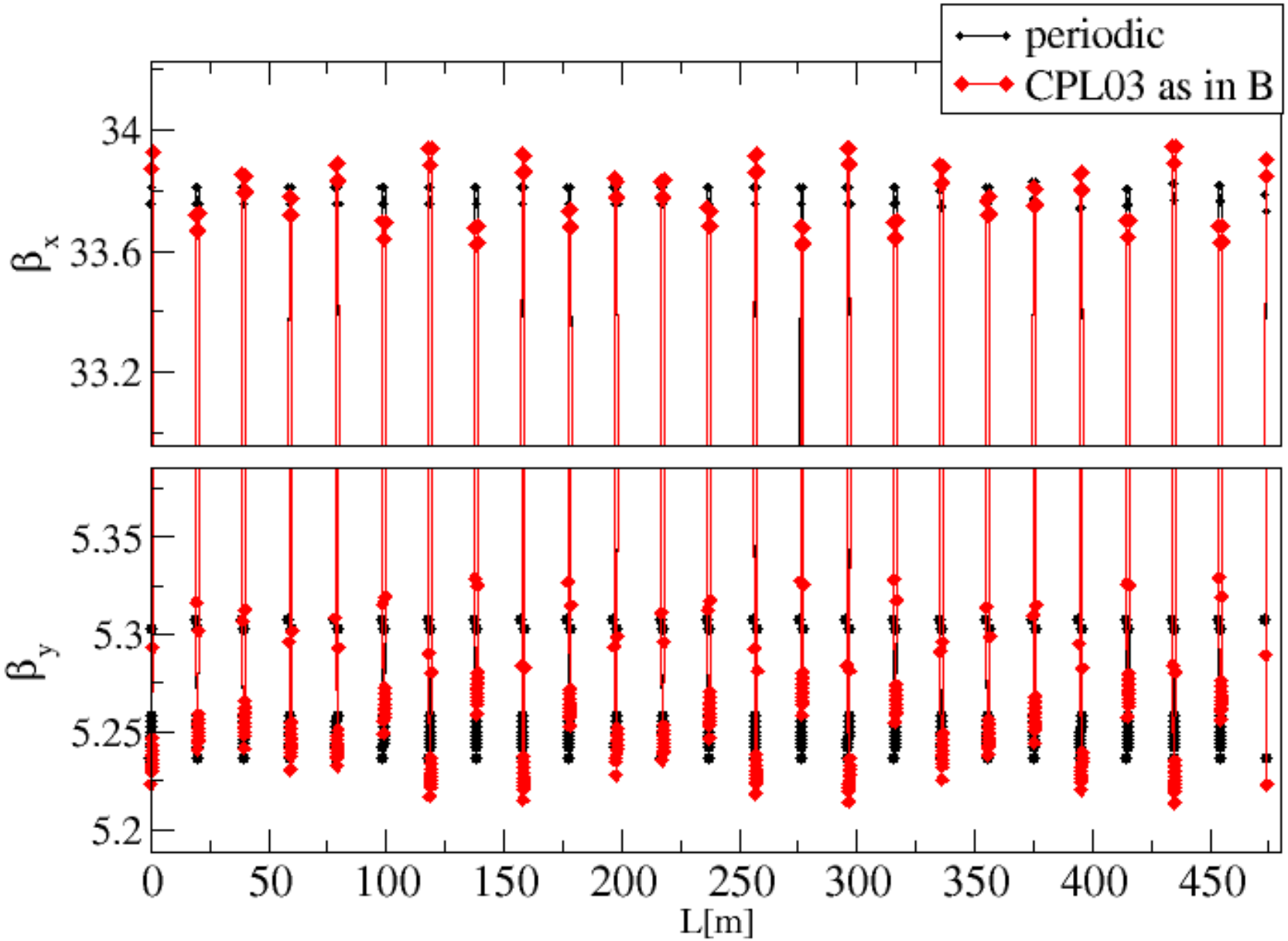
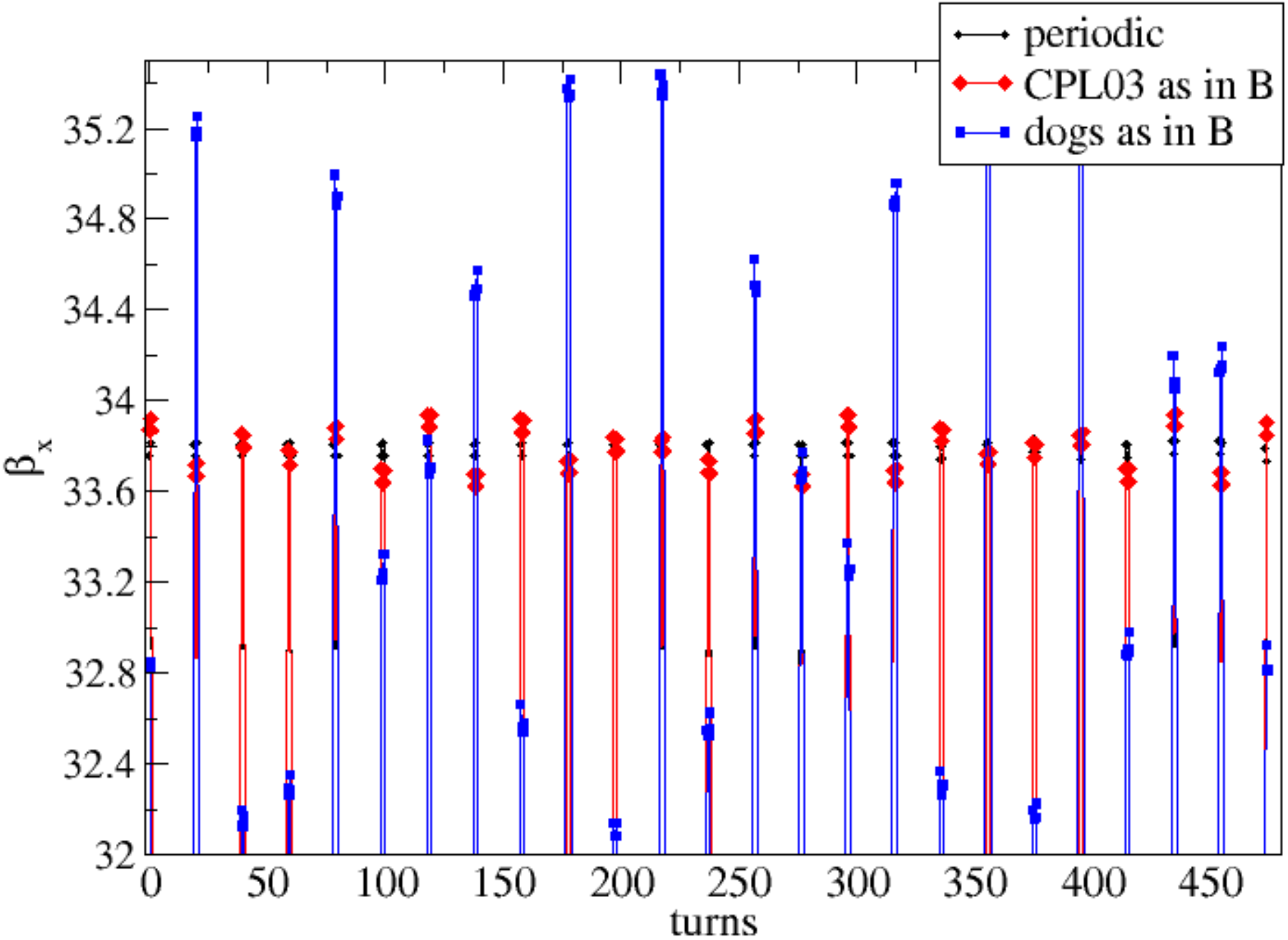
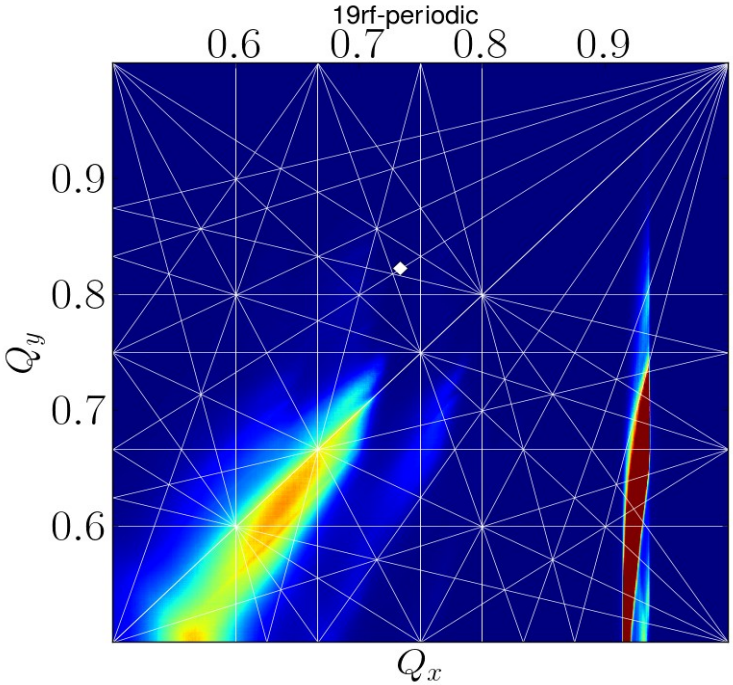


0.4 % difference in lattice beta functions beta

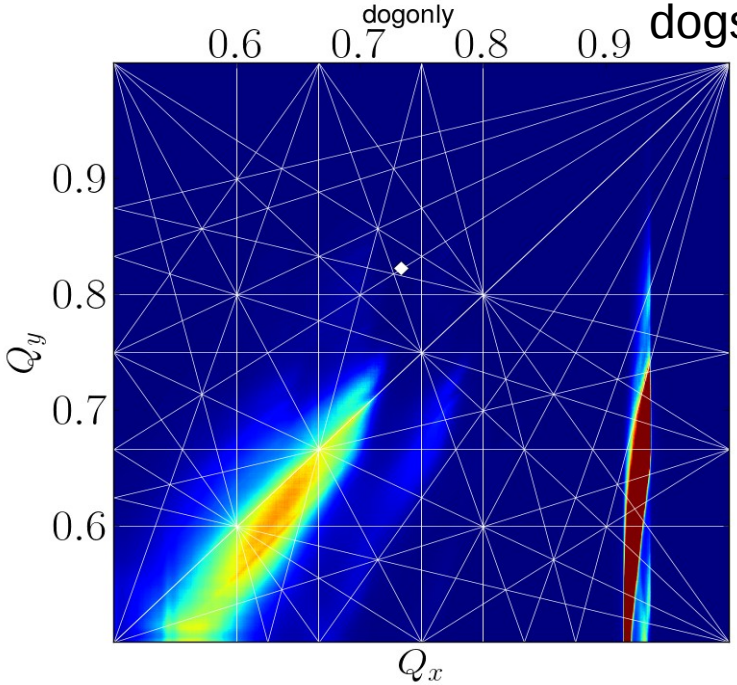



periodic
CPL03 as in B
dogs as in B
35.2
34.8
34.4
34
33.6
33.2
32.8
32.4
32
β_x
0
50
100
150
200
250
300
350
400
450
turns

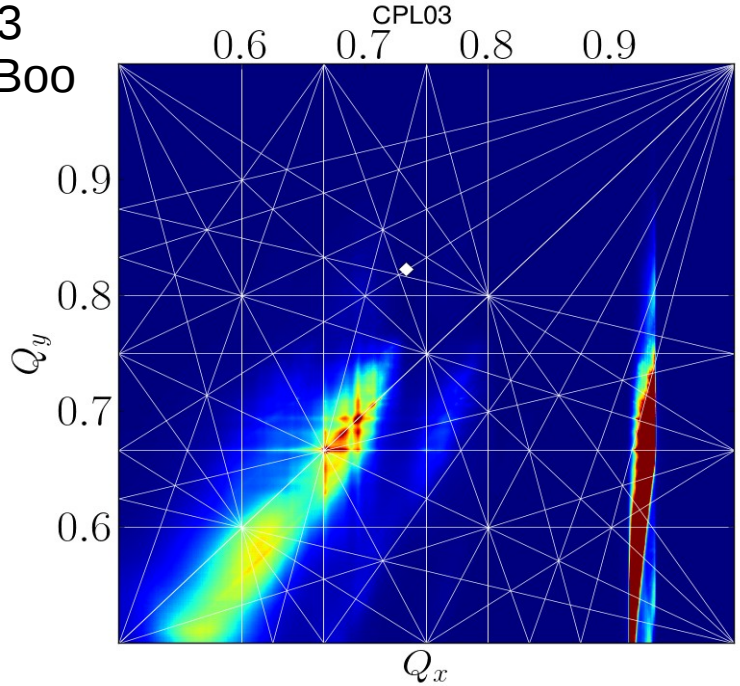
19rf



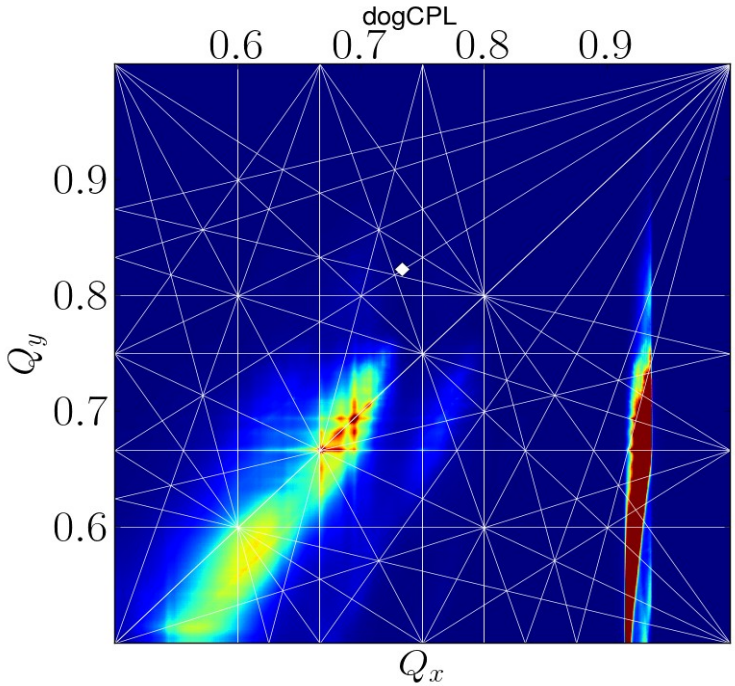
dogs only



CPL03
as in Boo

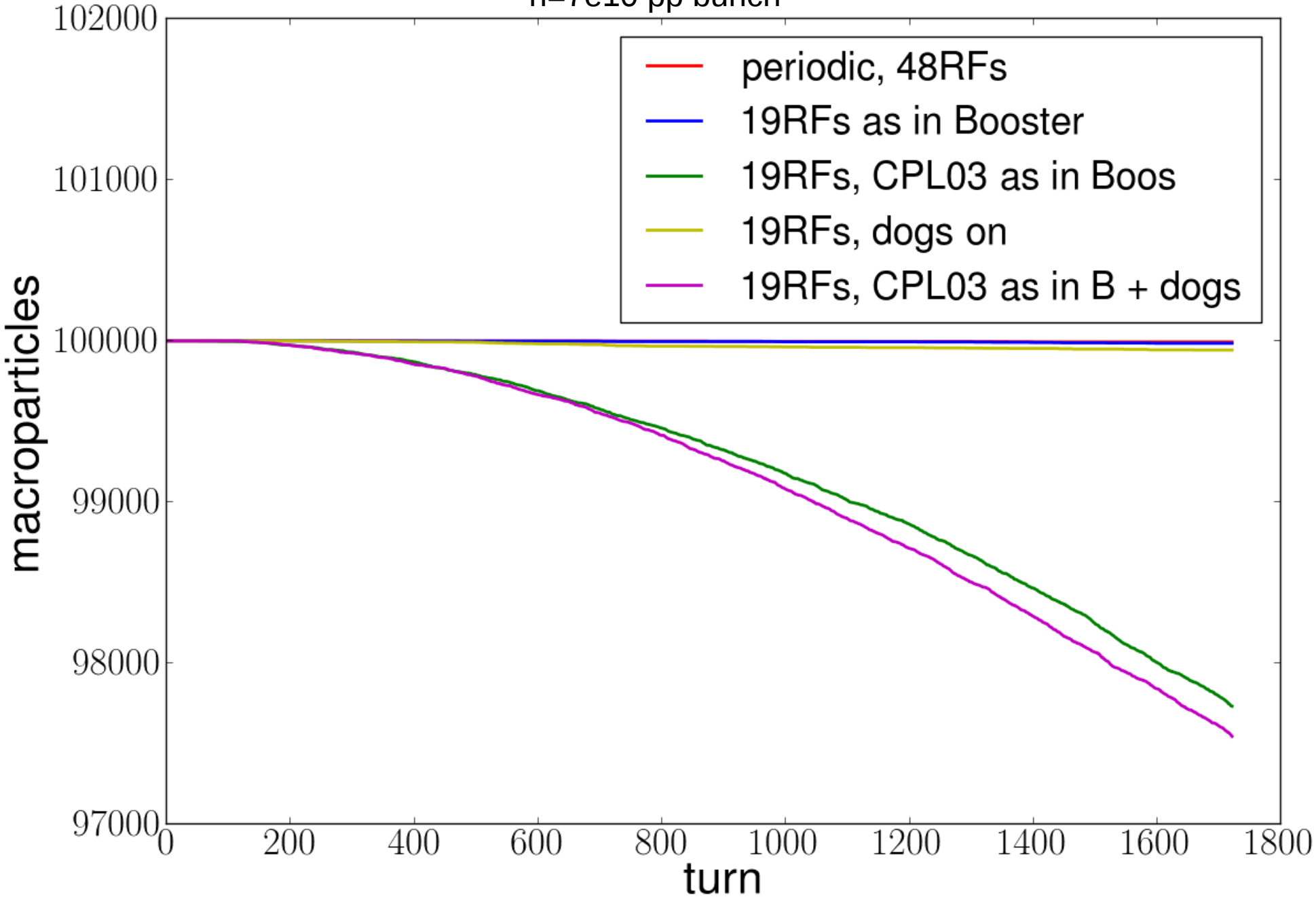


CPL03
and
Dogs as
in B



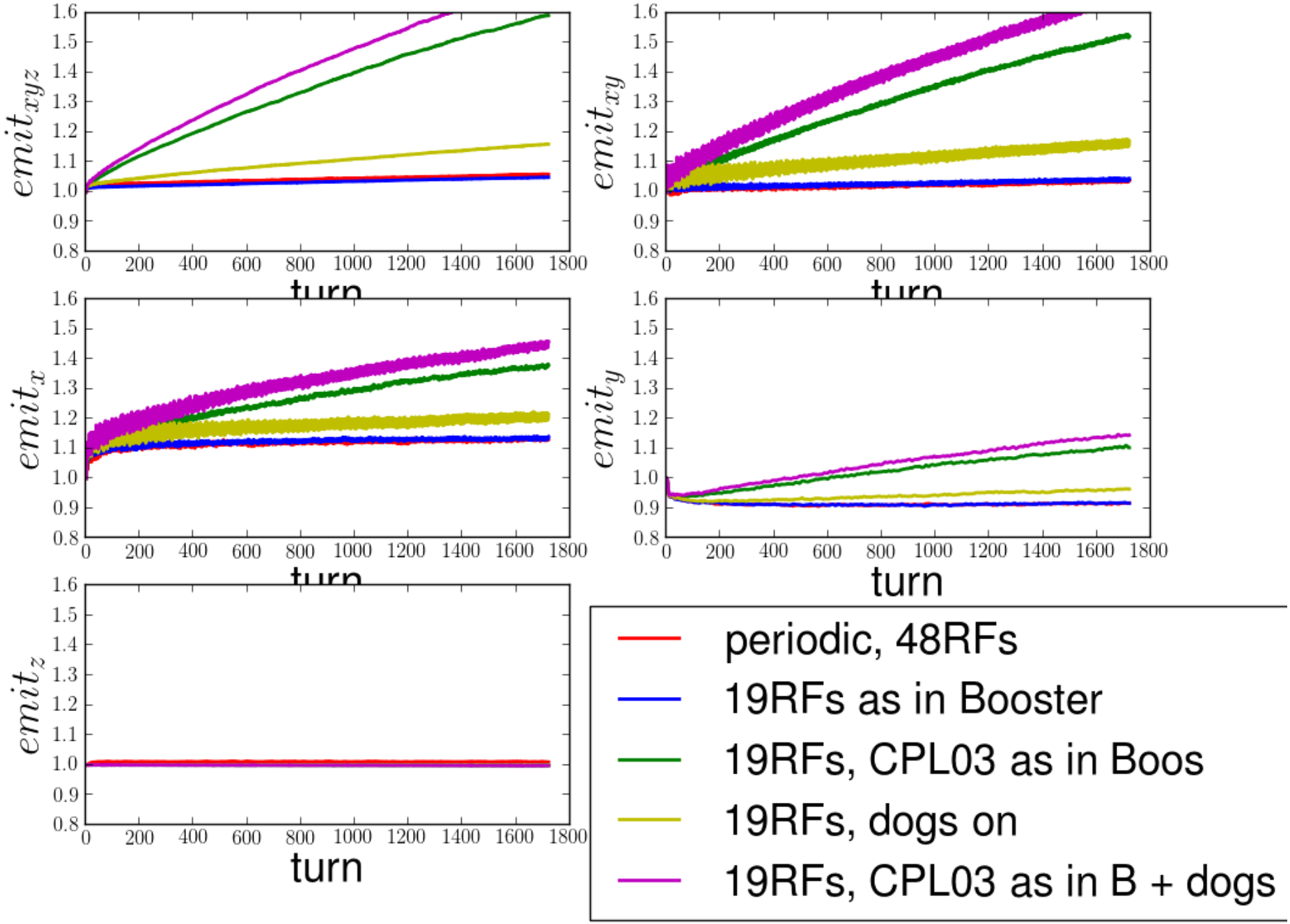
No wakes Q_h=0.744 Q_v=0.788 Chrom=(-17,-9)

n=7e10 pp bunch

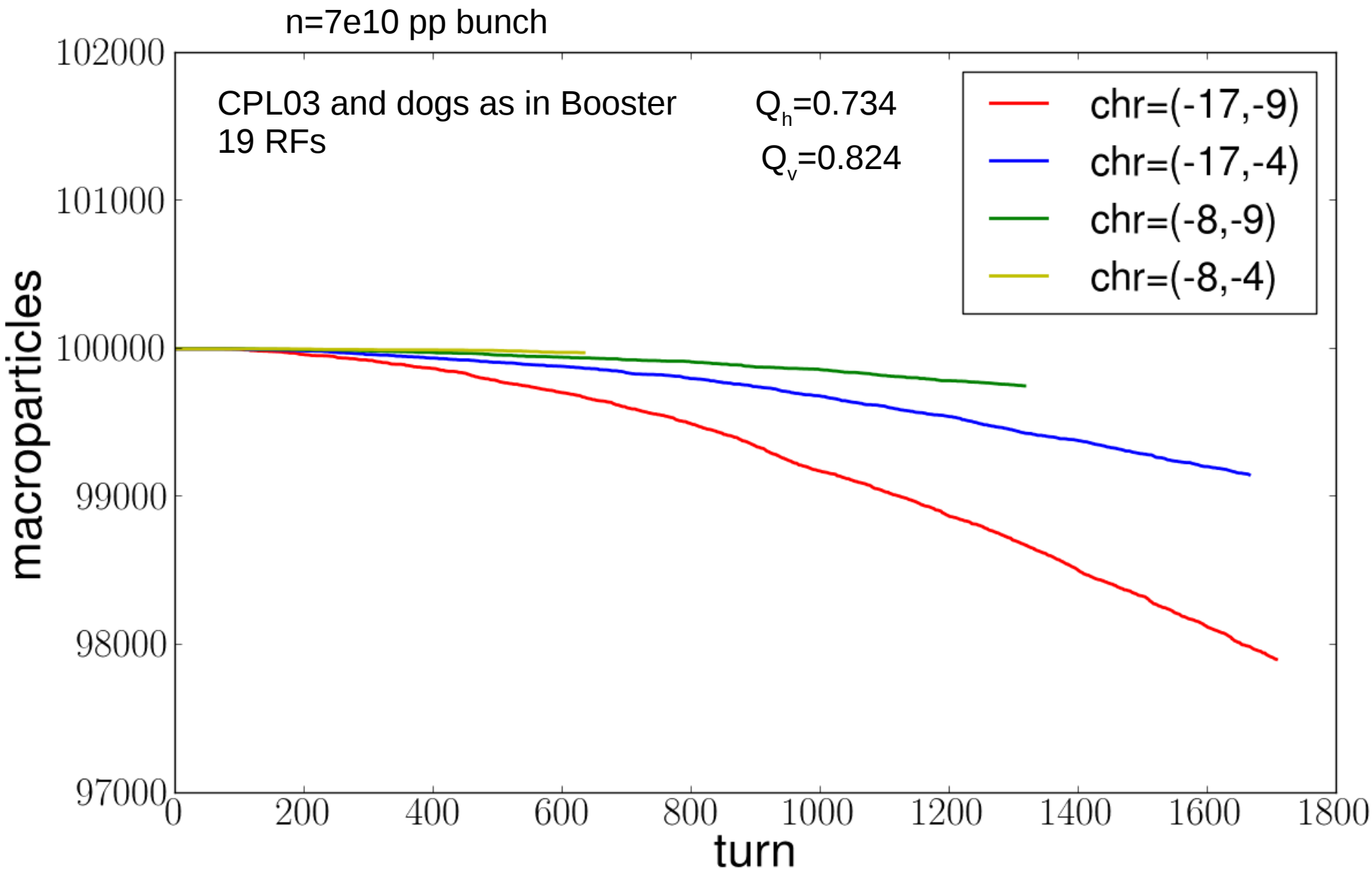


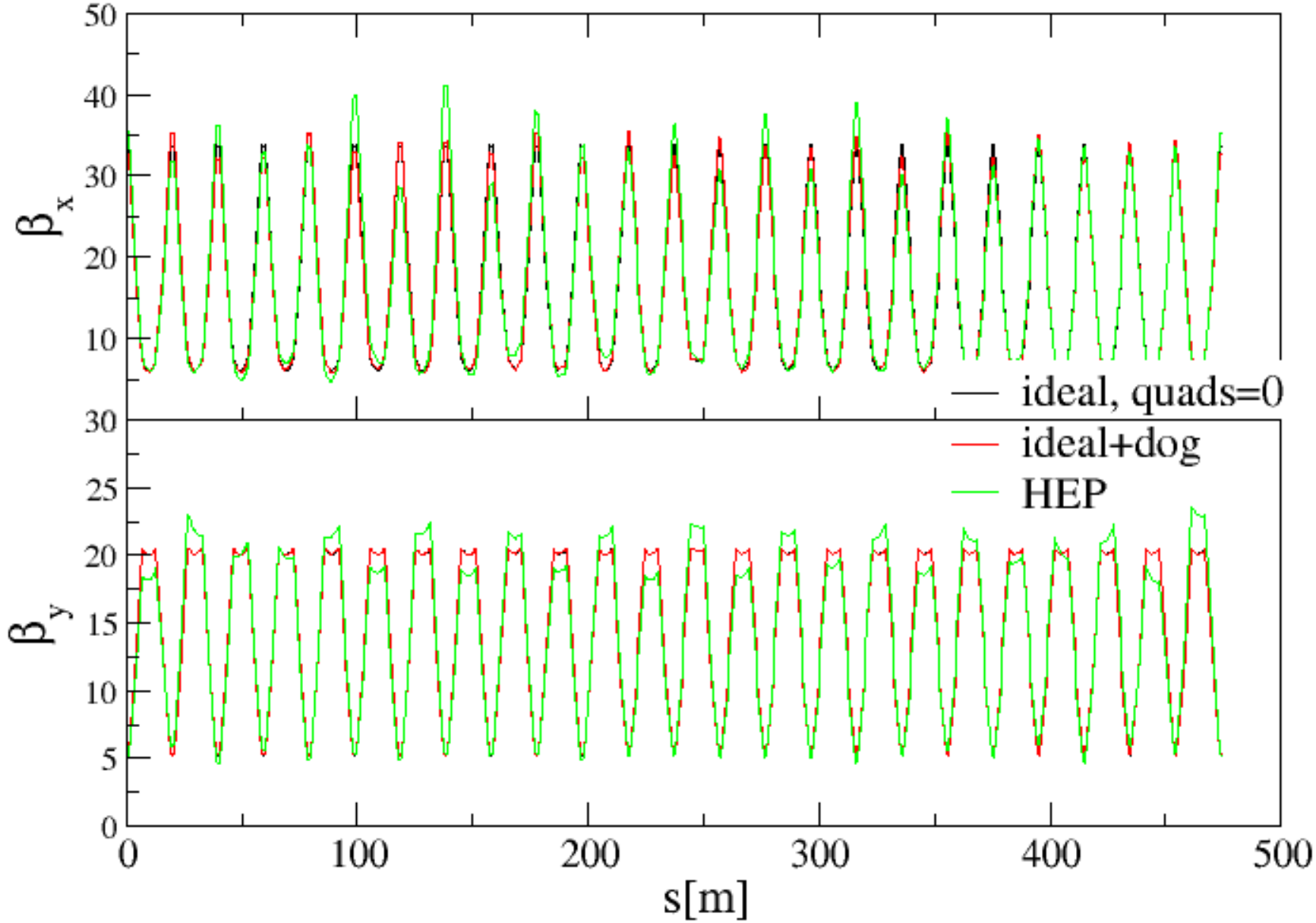
No wakes Q_h=0.744 Q_v=0.788 Chrom=(-17,-9)

n=7e10 pp bunch



Loss dependence on chromaticity



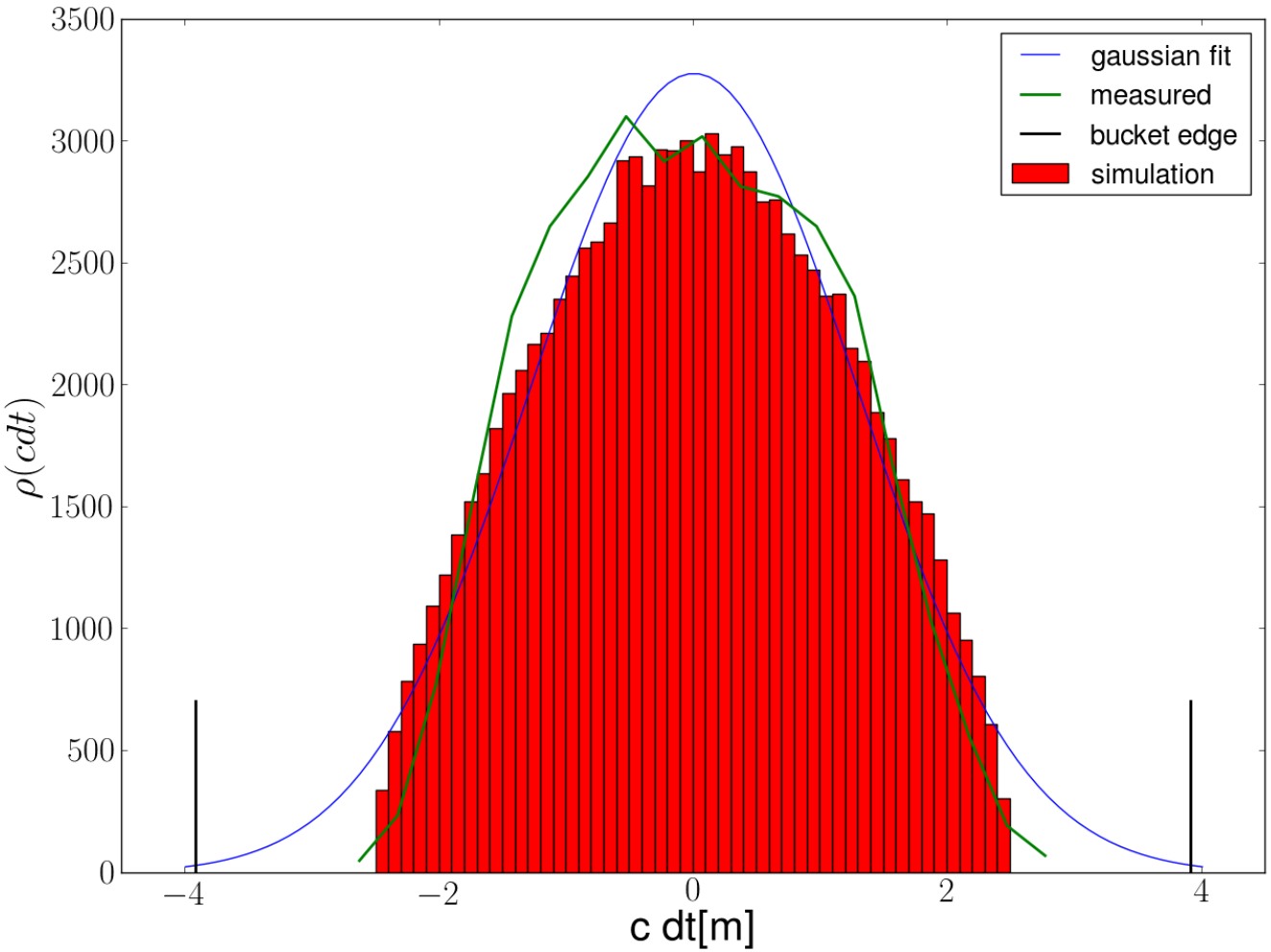

50
40
30
20
10
β_x
ideal, quads=0
ideal+dog
HEP
30
25
20
15
10
5
0
β_y
0
100
200
300
400
500
s[m]

Gaussian beams?
What is the meaning of the rms given by the measurements?
Is it the rms of the distribution or it is the sigma of the Gaussian fit?

Cutting the tails:

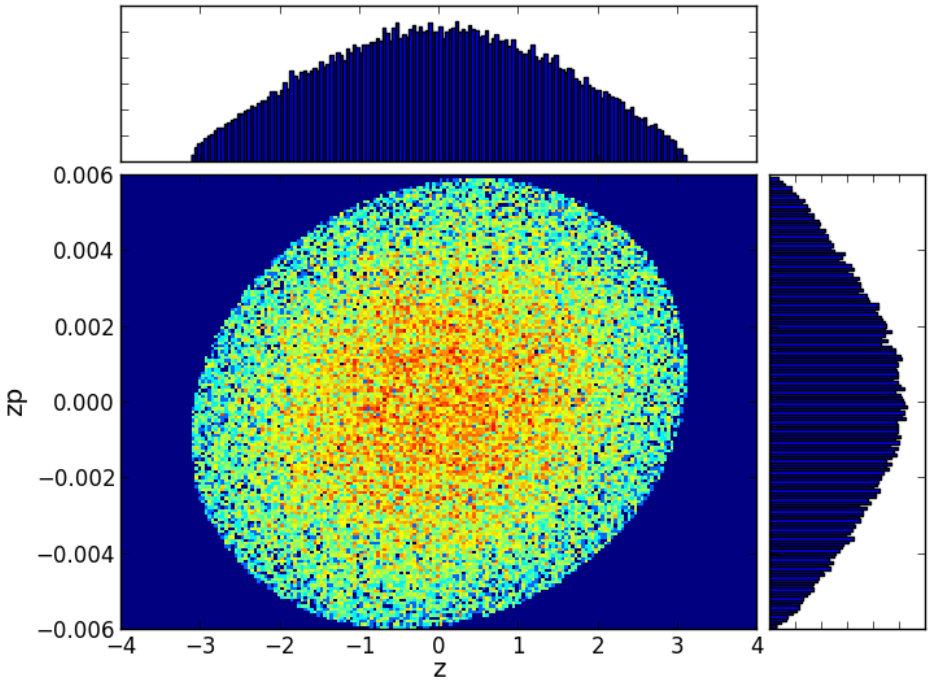
$$\rho(z, z_p) = \rho(J, \Phi) = \begin{cases} e^{-J/\epsilon} & J \leqslant J_c \\ 0 & J > J_c \end{cases}$$

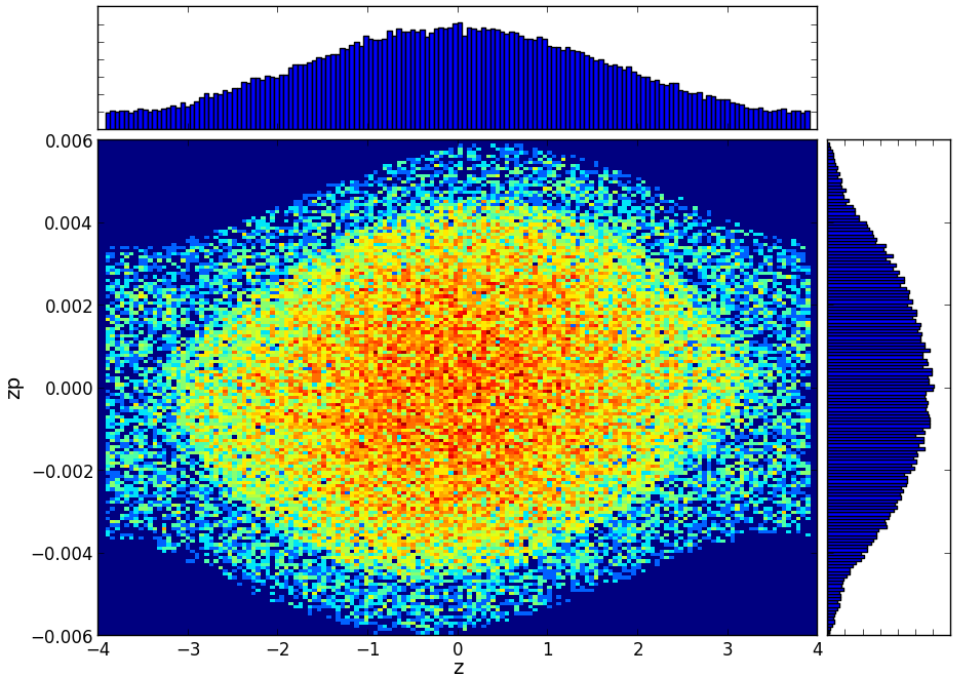
$$\rho(z) = e^{-z^2/2\sigma^2} erf\left(\sqrt{J_c - z^2}\right)$$



Gaussian fit zrms=1.2 m
zrms=0.83 m

1 order match

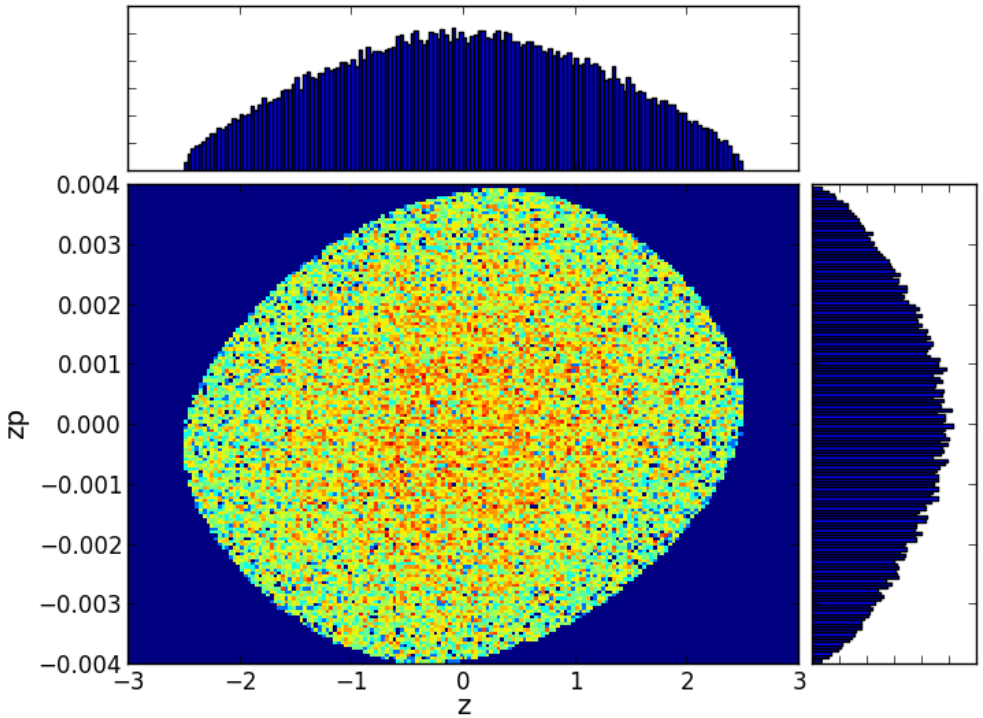


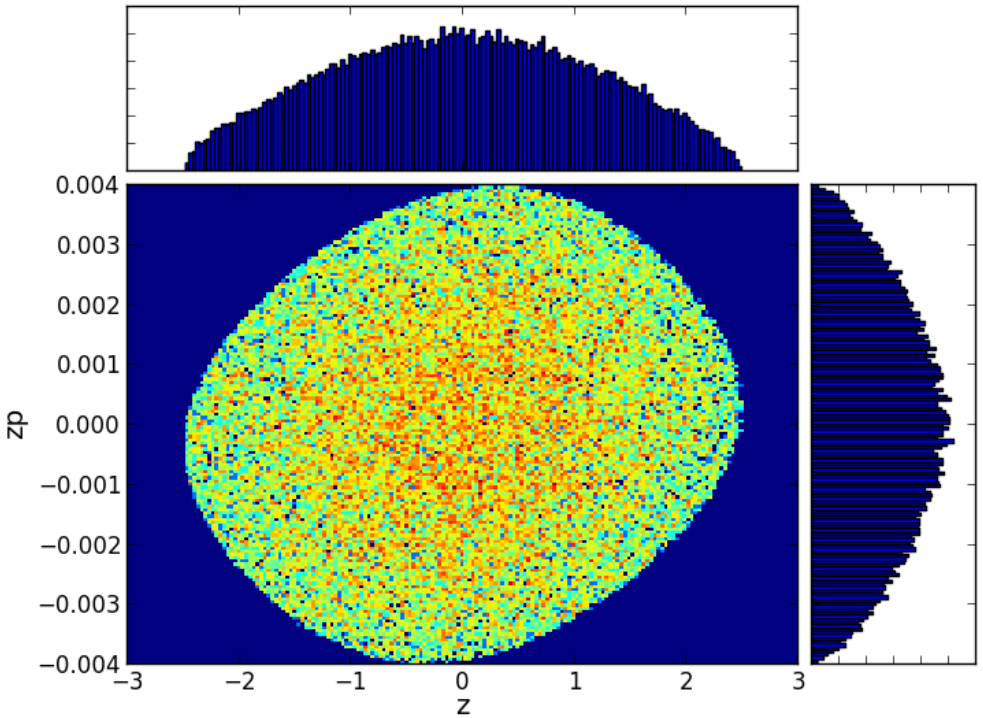


Input distribution

Turn 500

7 order match for the ideal lattice





Input distribution

Turn 1000