Emittance growth study with MADX

—Follow-up of A. Morita's study, LCU meeting on 23/09/2008

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  - Dependence on CC frequency and voltage

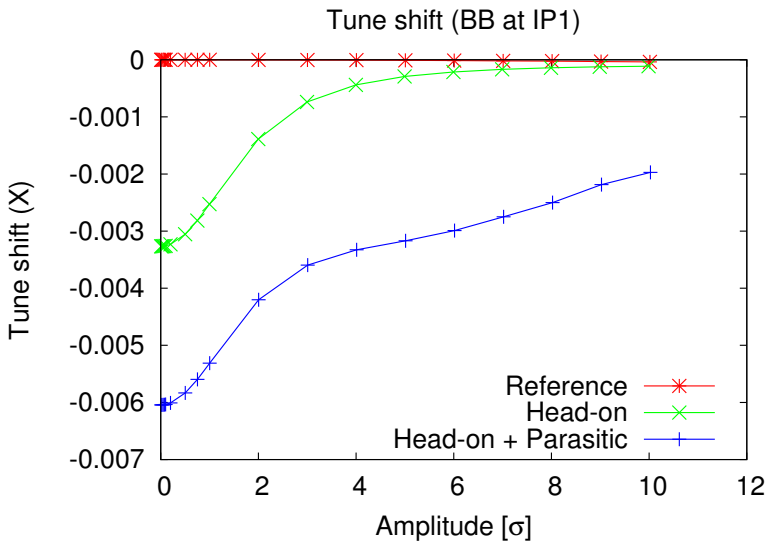
Tracking condition

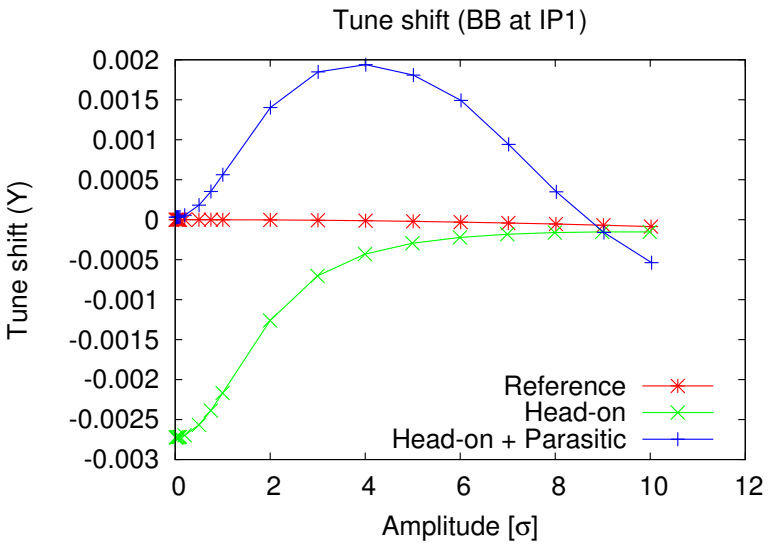
- Modified MADX Thintrack module
- 10,000 particles in 6D Gaussian distribution
  - /afs/cern.ch/eng/lhc/optics/V6.500/V6.5.thin.seq(V6.5.thin.coll.str)
  - $\sigma_x = \sigma_y$ = 16.6e-6 m; σ_z = 0.07 m
  - Longitudinal cut on 'cT' and 'δ_p' at 2.5 σ
- Sextupole + Crab cavity (ramping)
  - CC ramped up from beginning, for 1 (5, 10, 100, 1k) turns
  - CC ramped down between 2000 and 2100 turns

Dtune

- Dtune from octupole (Crossing at IP OFF, 0 closed orbit), thin sequence (1 σ_x + 1 σ_y) (Different from Akio's results)
  - KOD = KOF = 16 m^{-4}
    Dtune(x) = 1.76E-5, Dtune(y) = 2.02E-5
  - KOD = KOF = 100 m^{-4}
    Dtune(x) = 1.09E-4, Dtune(y) = 1.27E-4
- Dtune from Beam-beam (thick sequence+makethin) (Crossing ON, Seperation OFF) (0.01 σ_x + 0.01 σ_y)
  - Dtune(x) = -3.3E-3, Dtune(y) = -2.7E-3 (Head-on only IP1)
  - Dtune(x) = -6E-3, Dtune(y) = -3.1E-5 (Head-on + Parasitic only IP1)

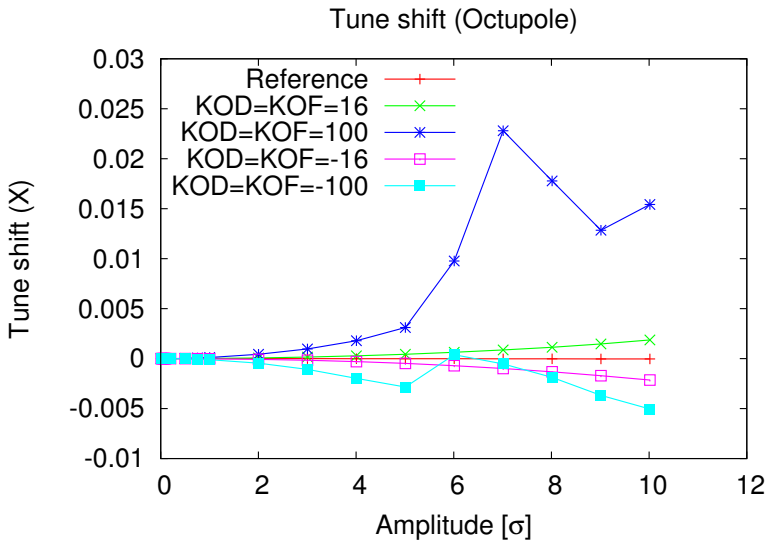
Dtune (BB)

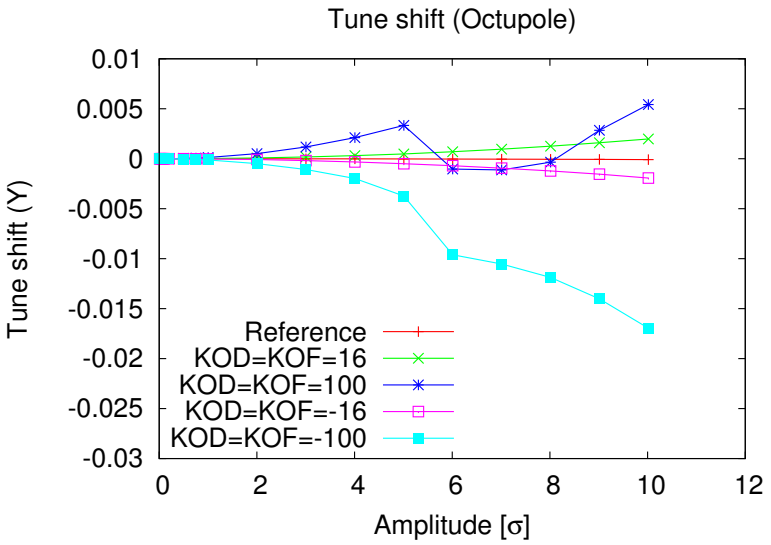




Head-on (IP1) .VS. Head-on + Parasitic (IP1)
Left: Horizontal detune; Right: Vertical detune

Dtune (Octupole)

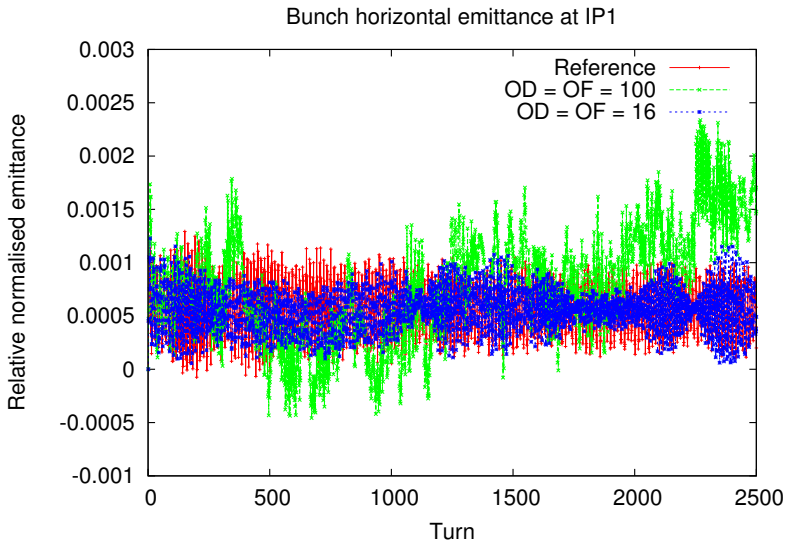


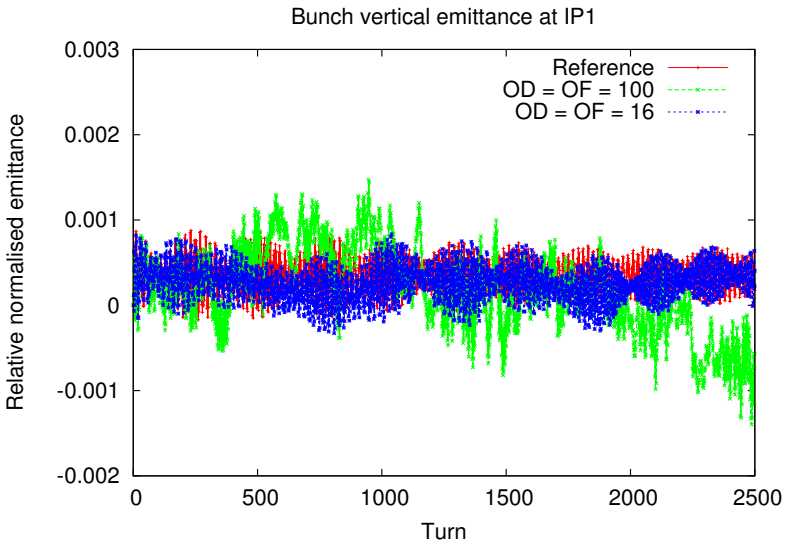


Left: Horizontal detune; Right: Vertical detune

Crossing at IP OFF, 0 closed orbit

Emittance growth from OD+OF (+)



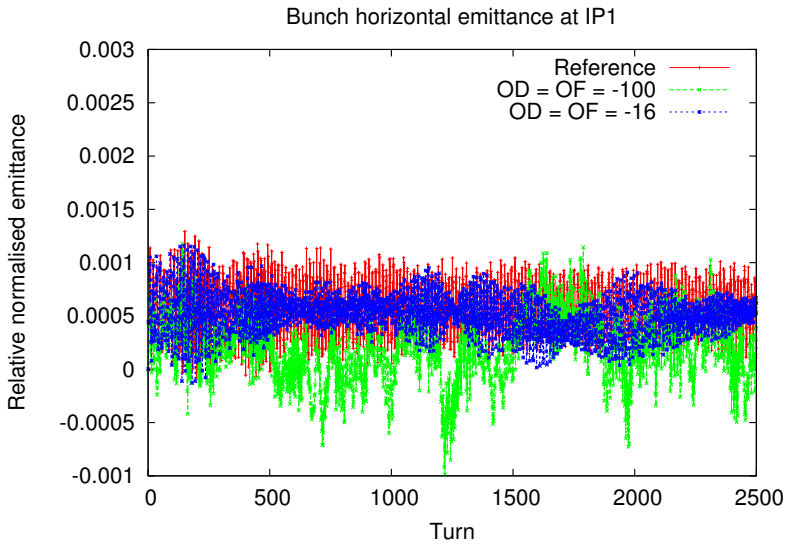


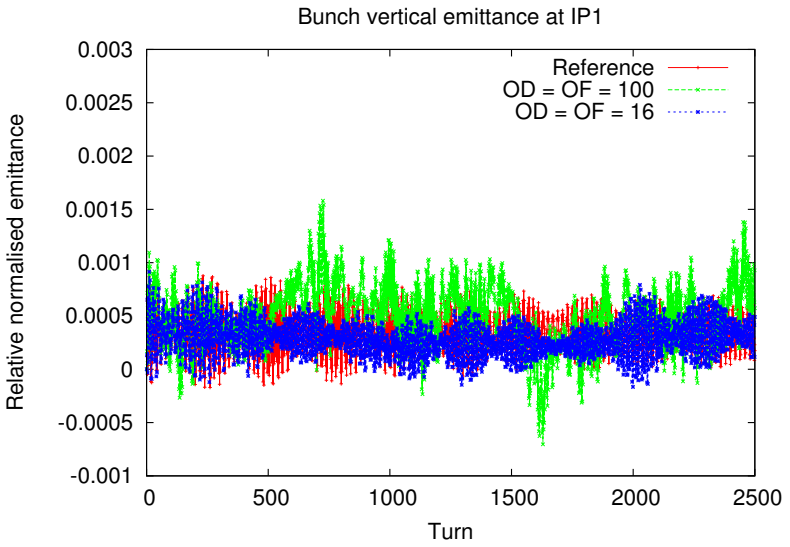
Left: Horizontal; Right: Vertical

Crossing at IP OFF, 0 closed orbit

KOD = KOF = 16 (100) m^{-4}

Emittance growth from OD+OF (-)



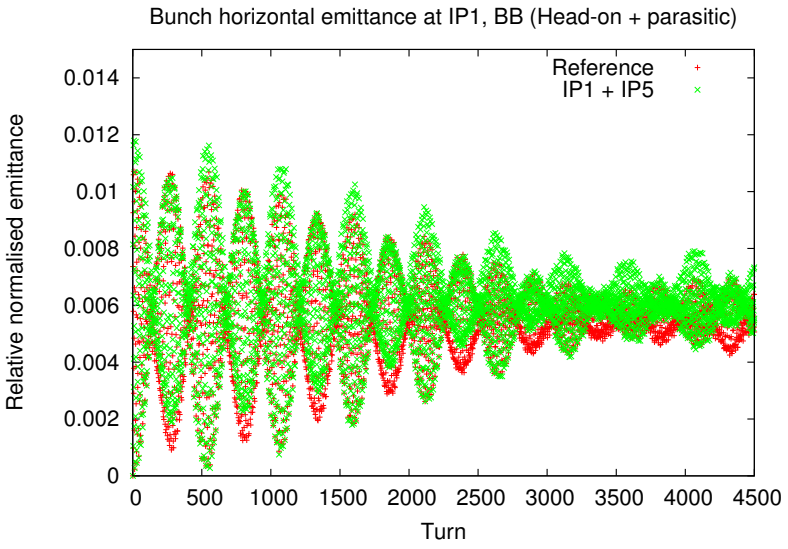


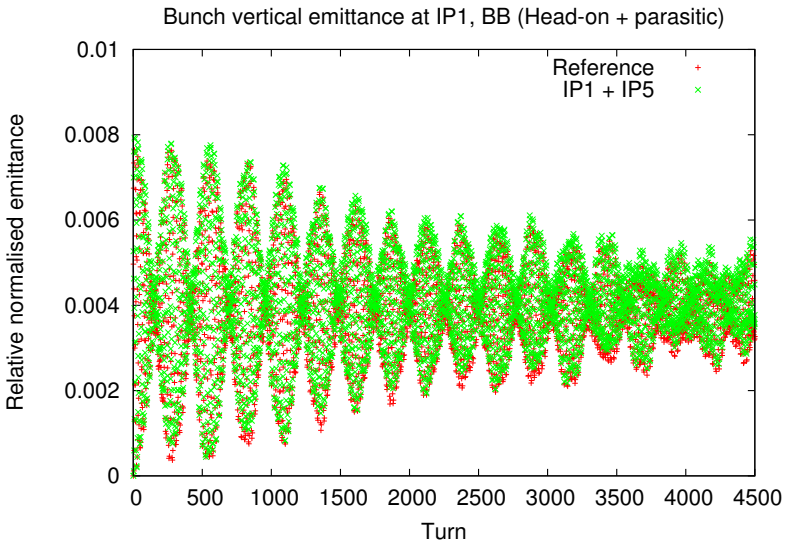
Left: Horizontal; Right: Vertical

Crossing at IP OFF, 0 closed orbit

KOD = KOF = -16 (-100) m^{-4}

Emittance growth from BB



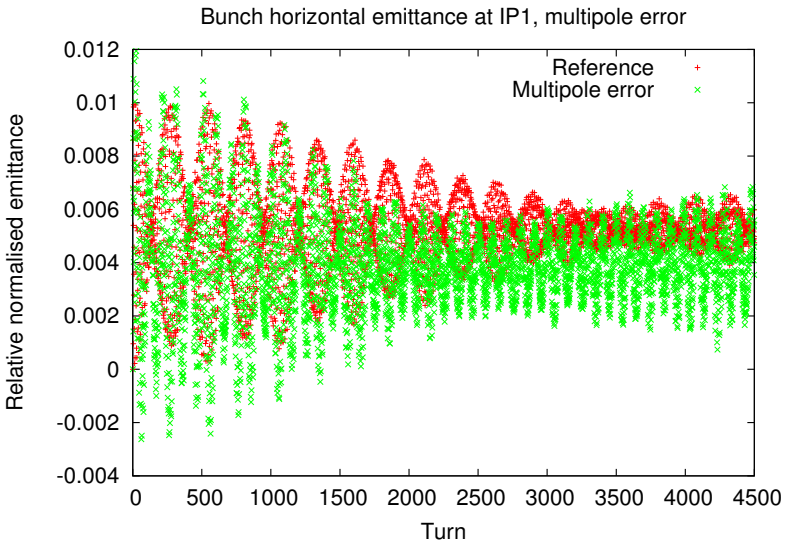


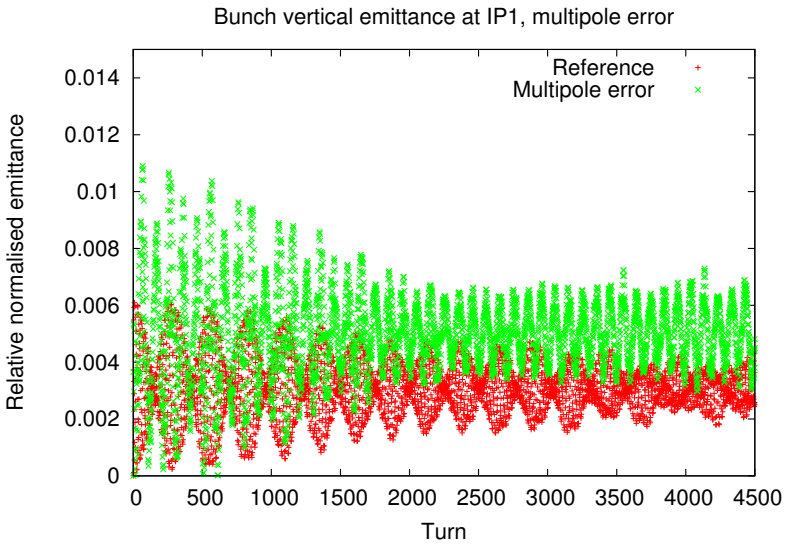
Left: Horizontal; Right: Vertical

Crossing at IP ON, Seperation at IP OFF

Head-on + Parasitic at IP1+IP5

Emittance growth from Multi error



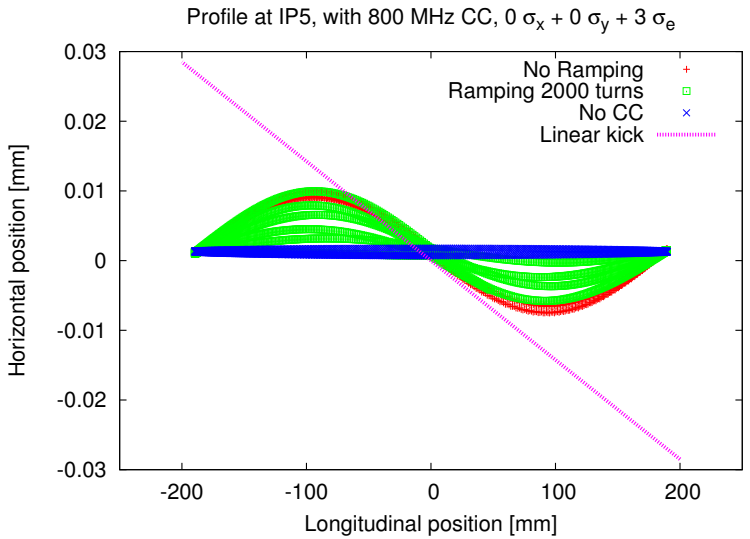


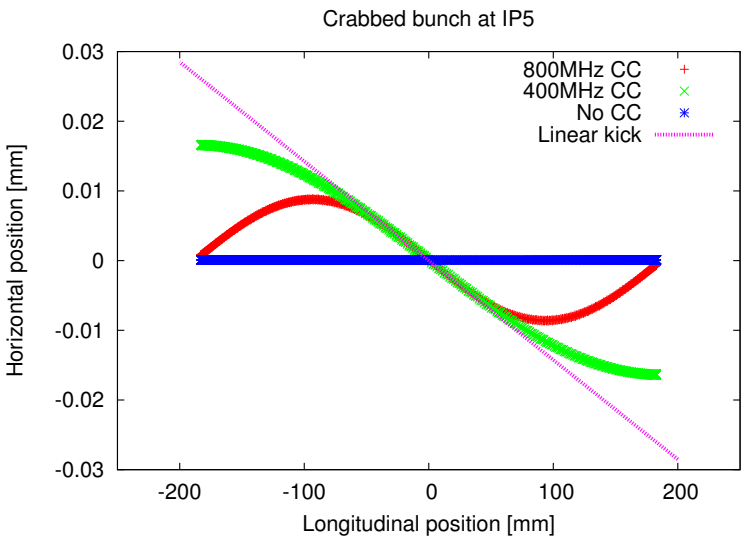
Left: Horizontal; Right: Vertical

Multipole errors for Dipoles and Quadrupoles

/afs/cern.ch/user/r/rdemaria/dott/pool/errors/collision_errors-1.tfs

CC Frequency & Ramping

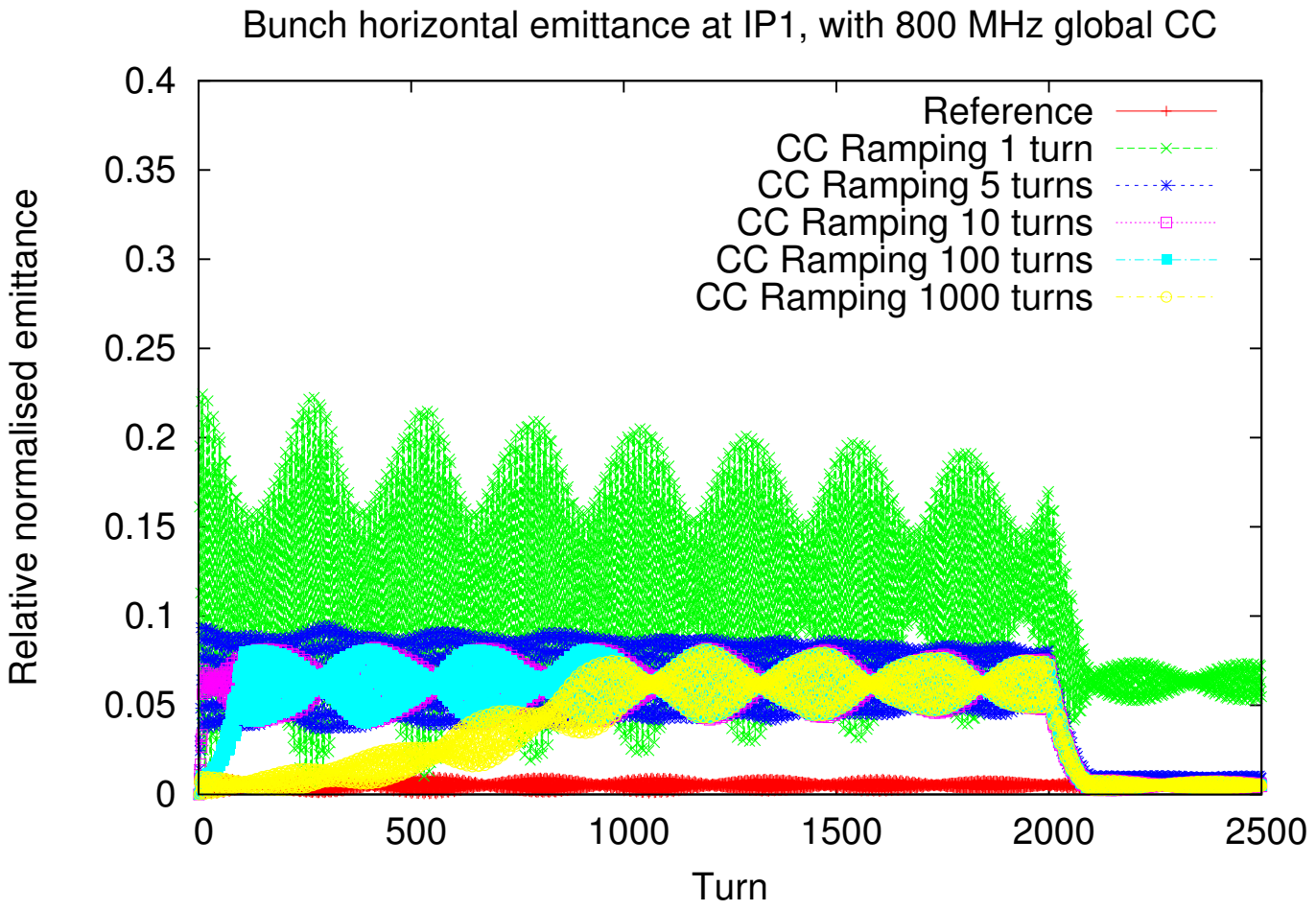




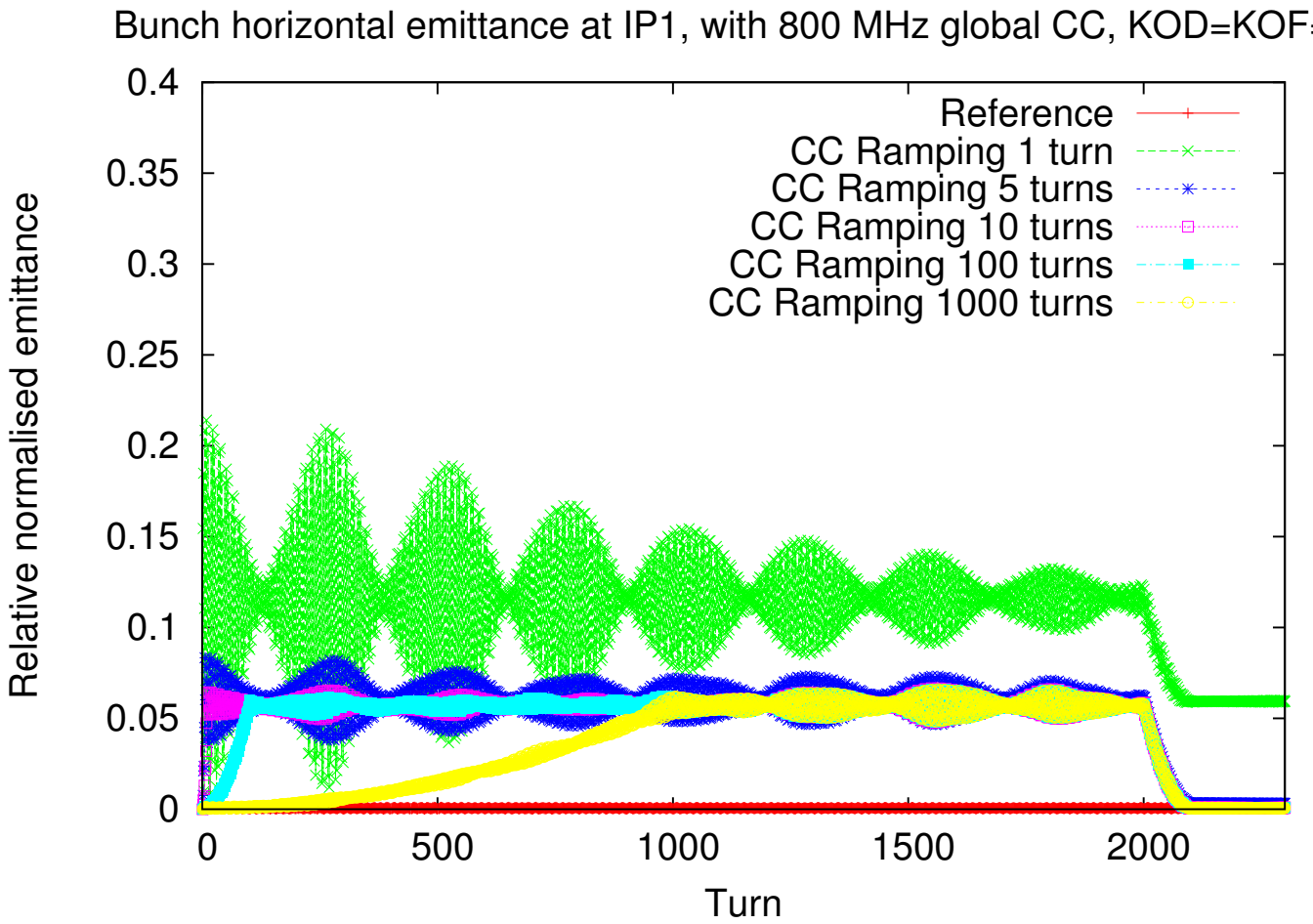
One particle with 3 δ_p, 2000 turns

Left: Ramping of 800 MHz CC; Right: 400 & 800 MHz CC

Horizontal emittance, 800 MHz CC (1)

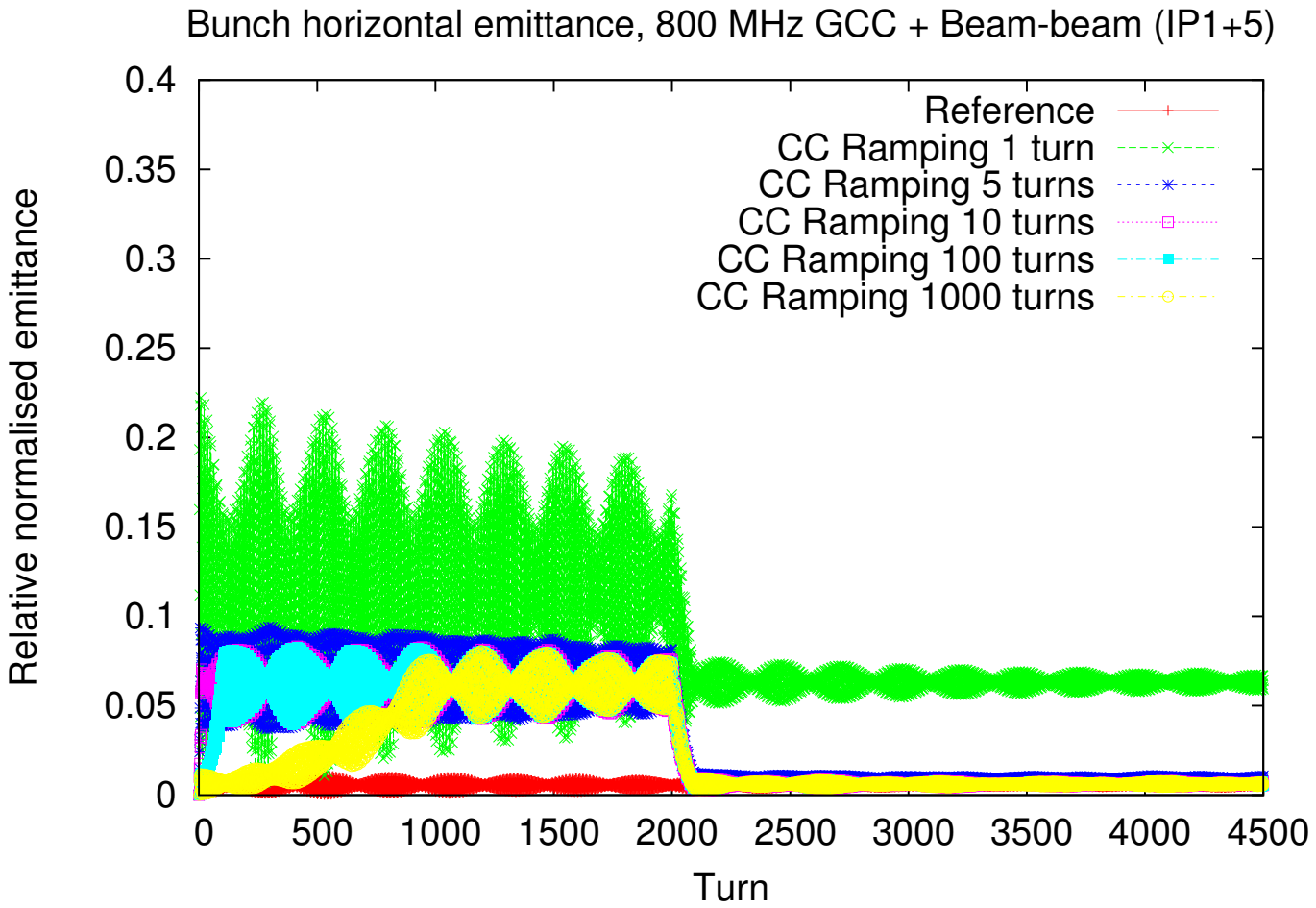


Horizontal emittance, 800 MHz CC (2)



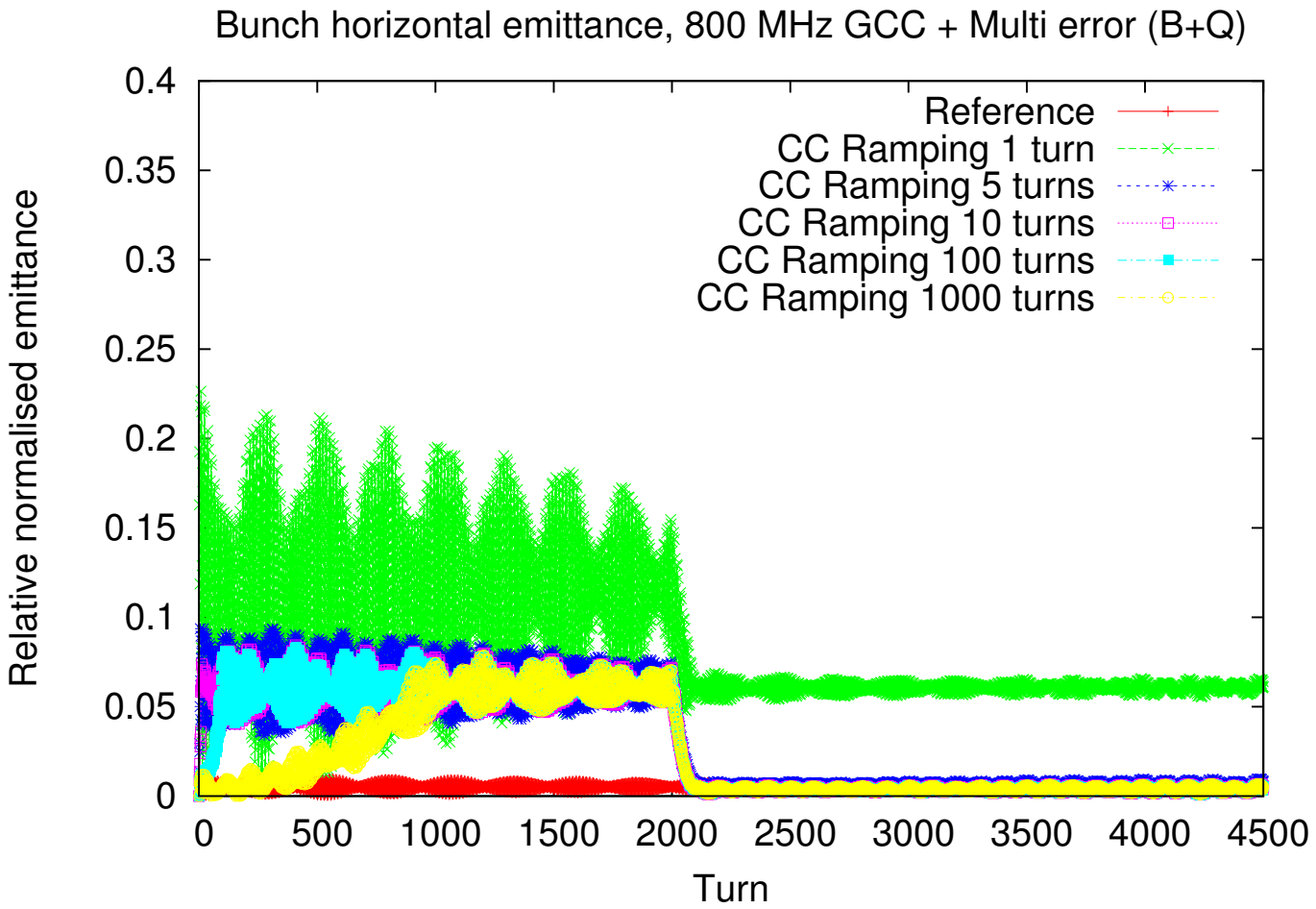
KOD=KOF=16

Horizontal emittance, 800 MHz CC (3)



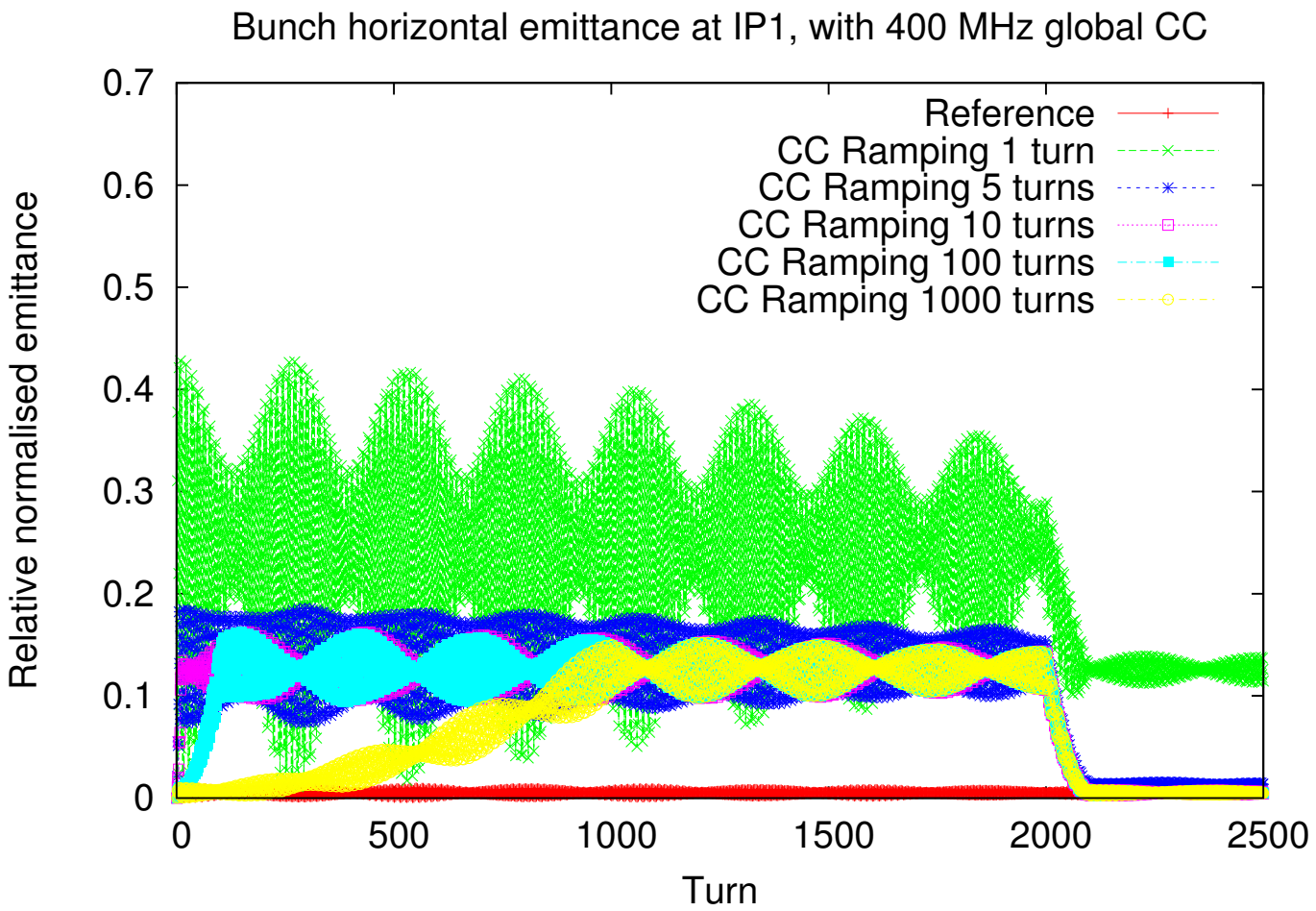
With beam-beam at IP1 and IP5, Head-on + Parasitic

Horizontal emittance, 800 MHz CC (4)



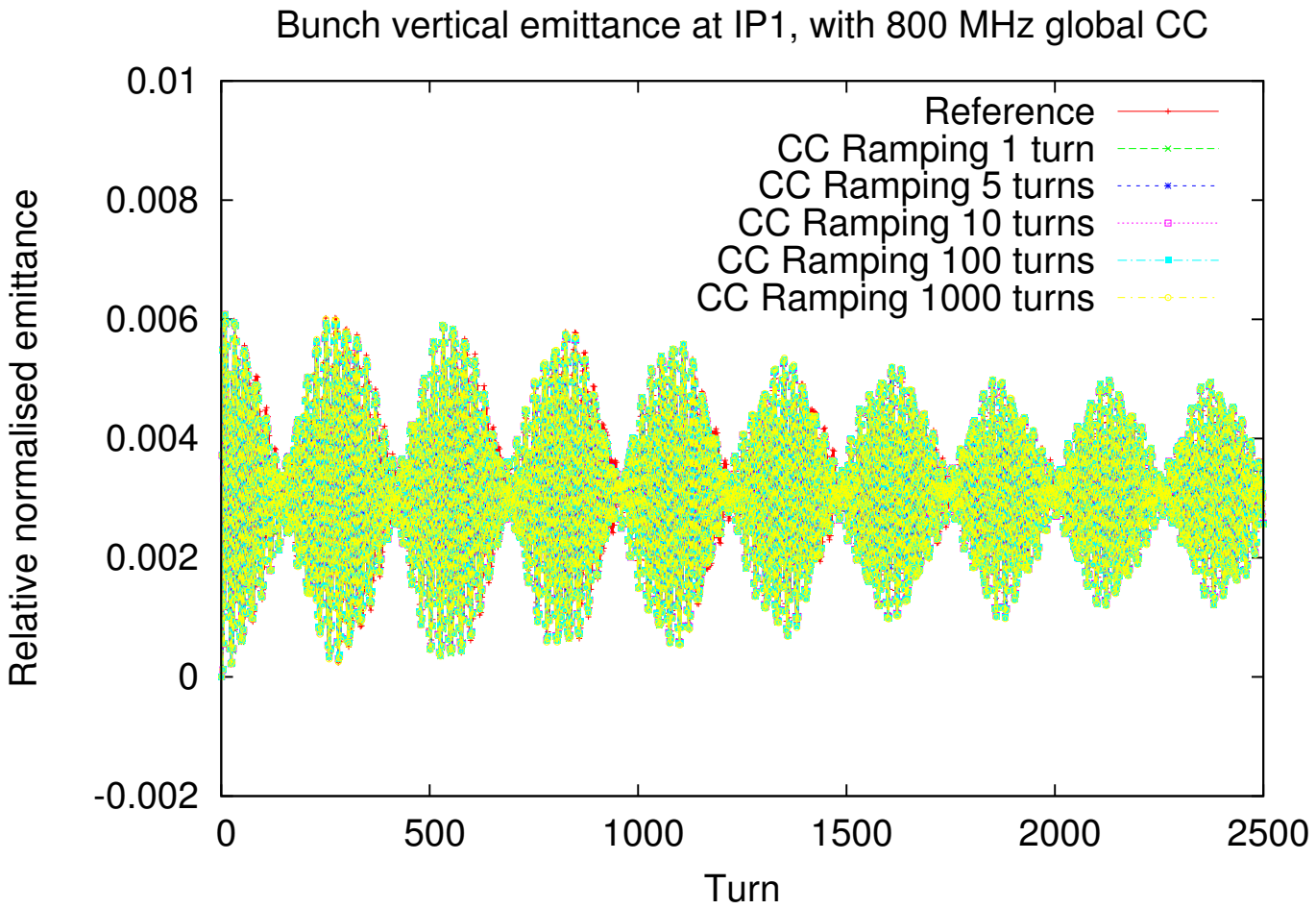
Multipole errors /afs/cern.ch/user/r/rdemaria/dott/pool/errors/collision_errors-1.tfs

Horizontal emittance, 400 MHz CC

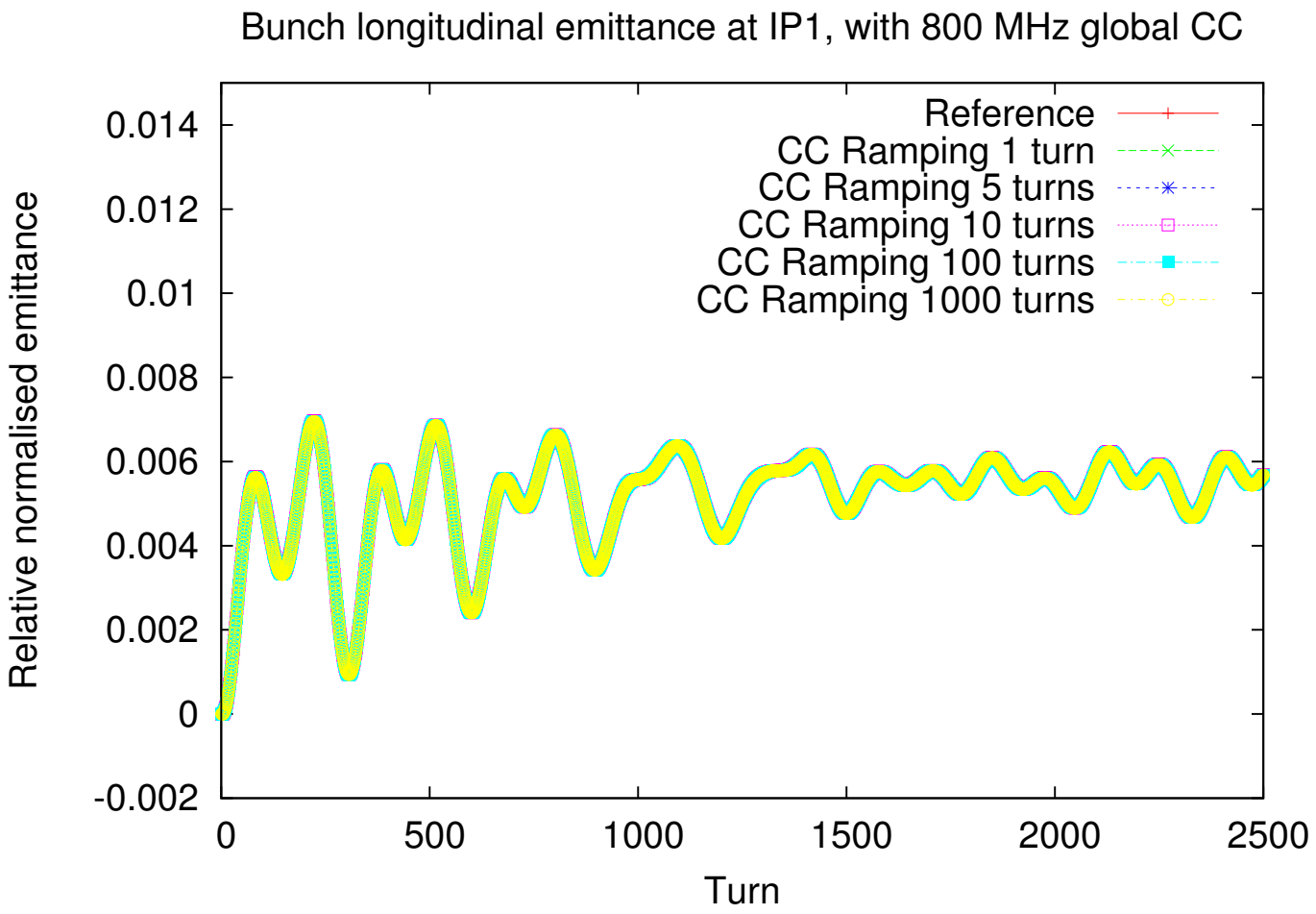


Agree with Aiko's (using physical coordinates)

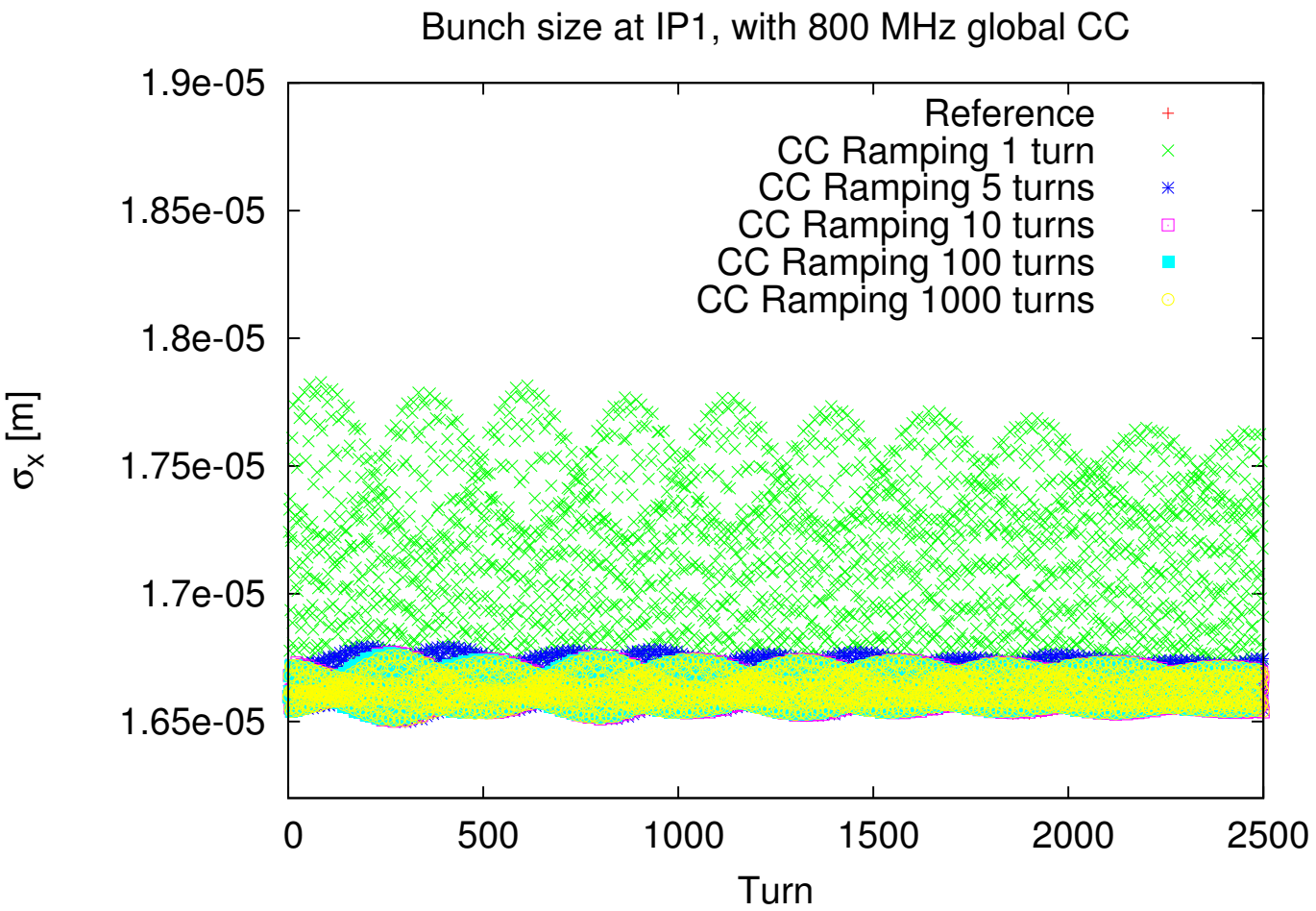
Vertical emittance, 800 MHz CC



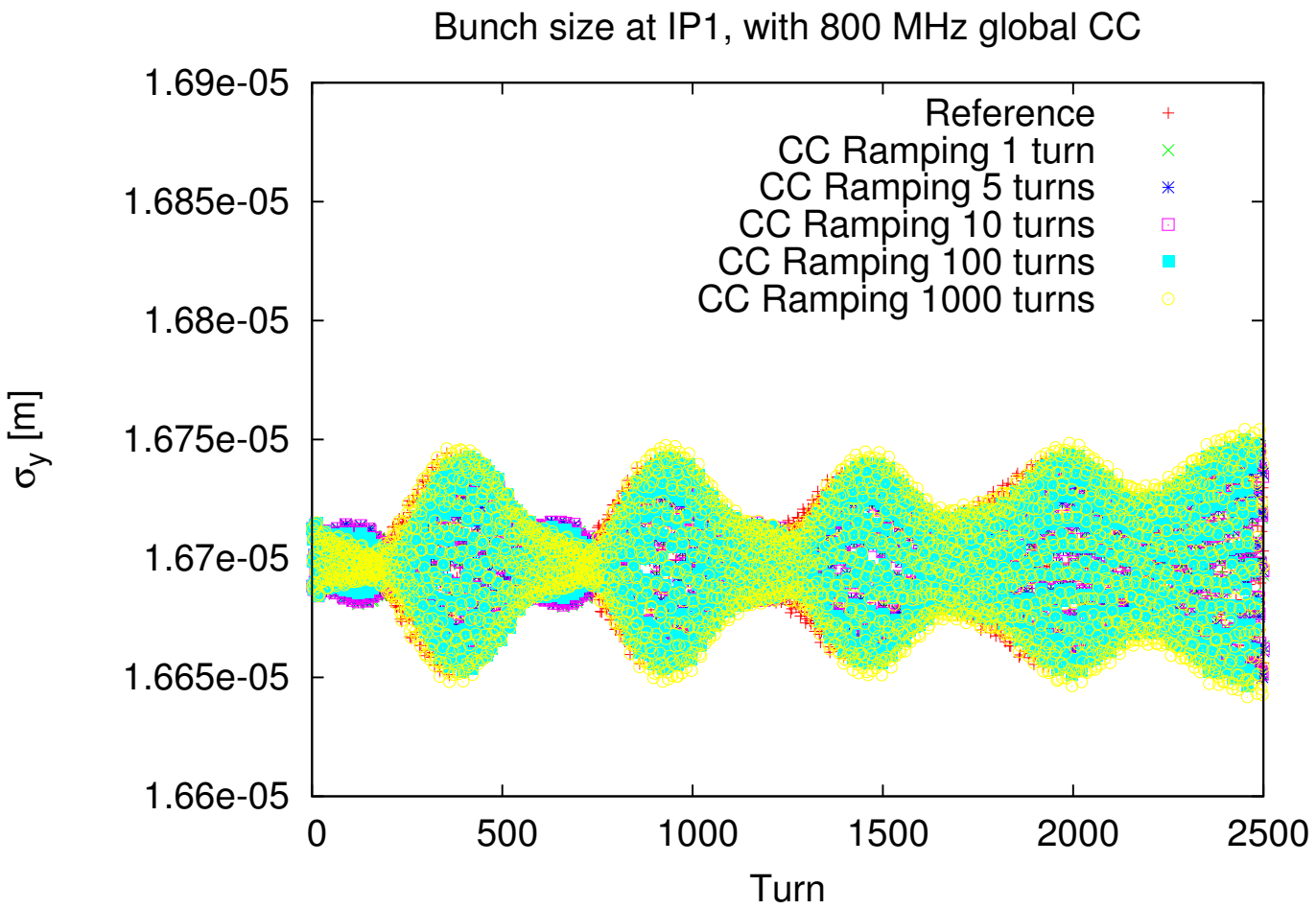
Longitudinal emittance, 800 MHz CC



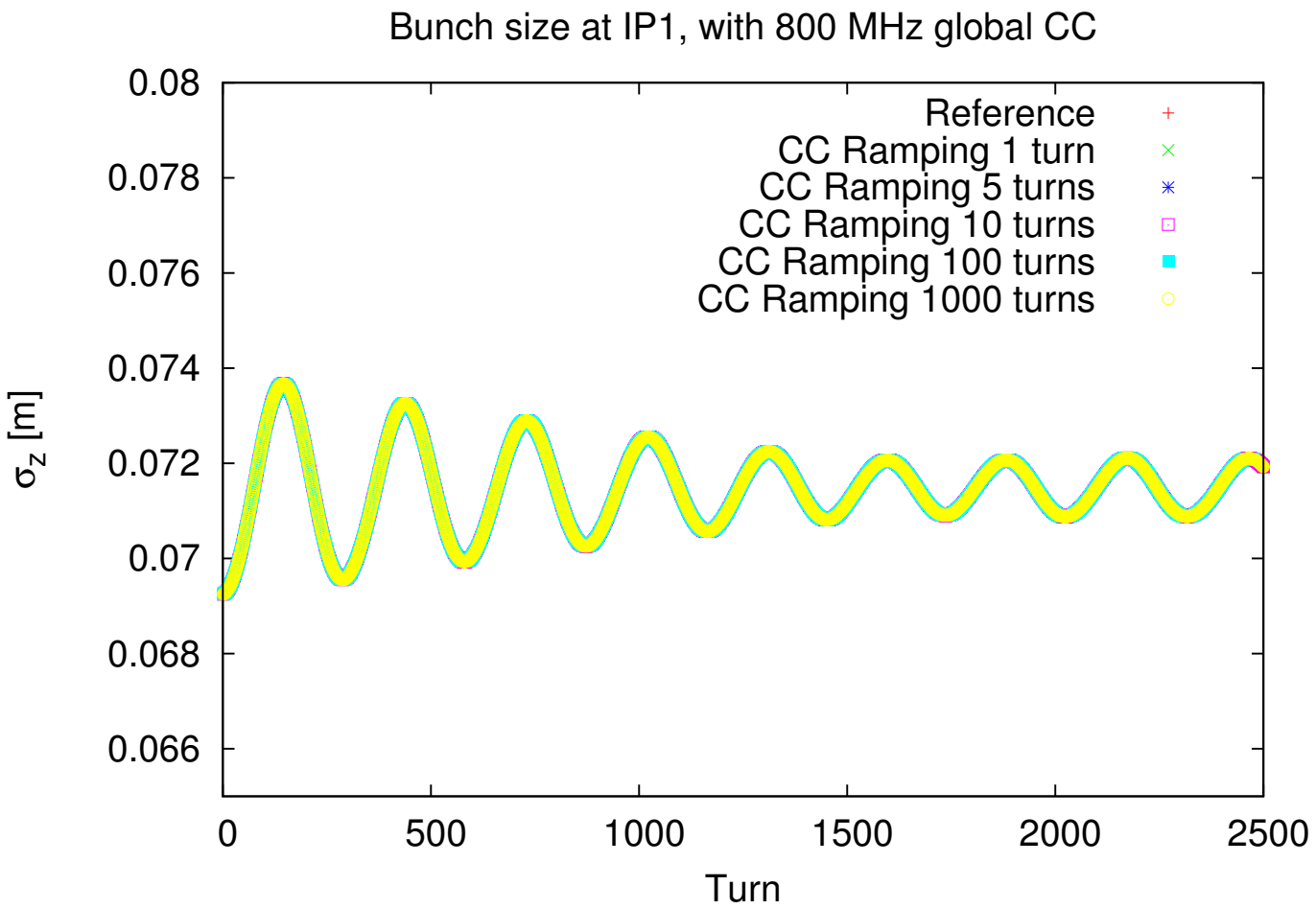
σ_x, 800 MHz CC



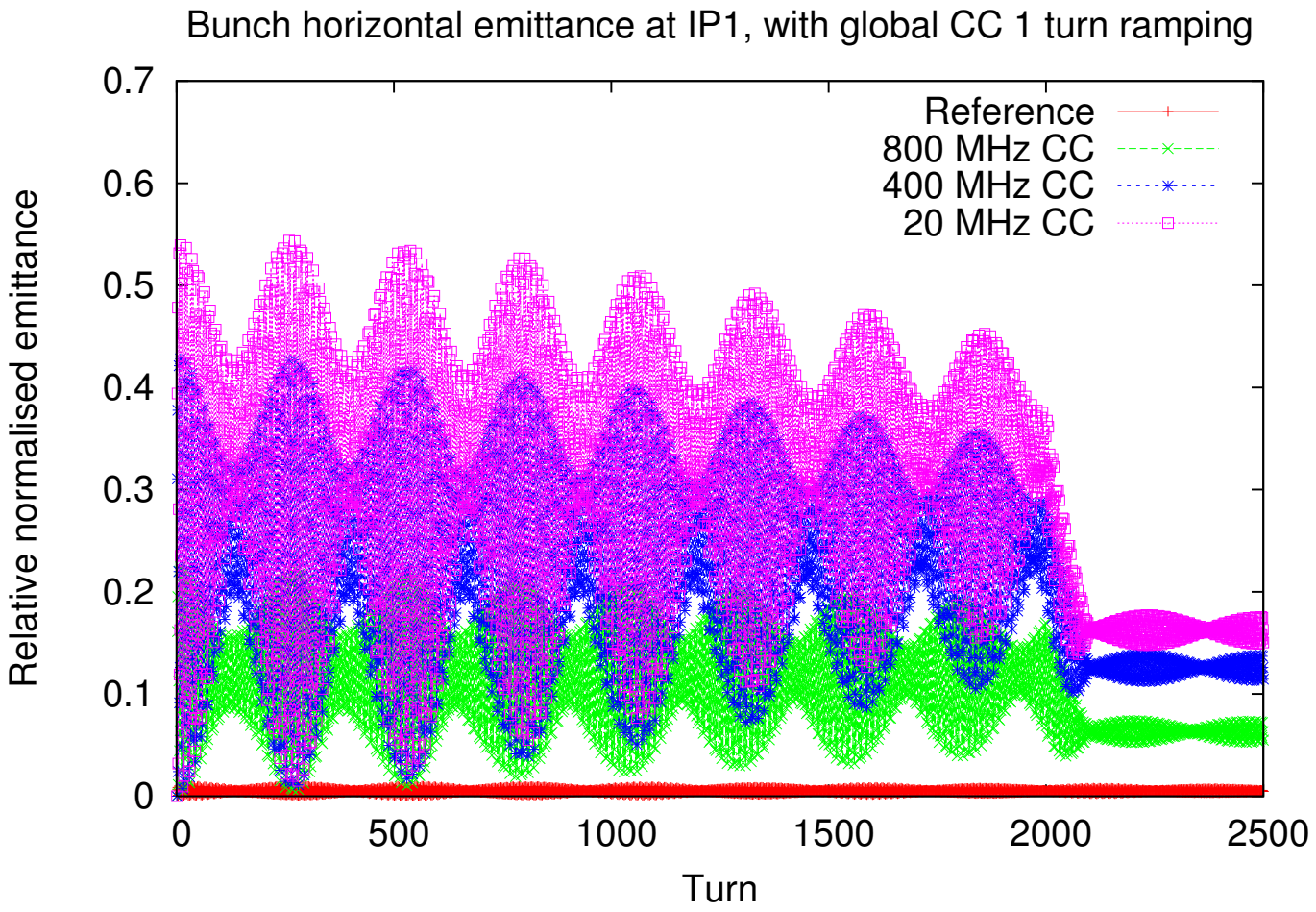
σ_y, 800 MHz CC



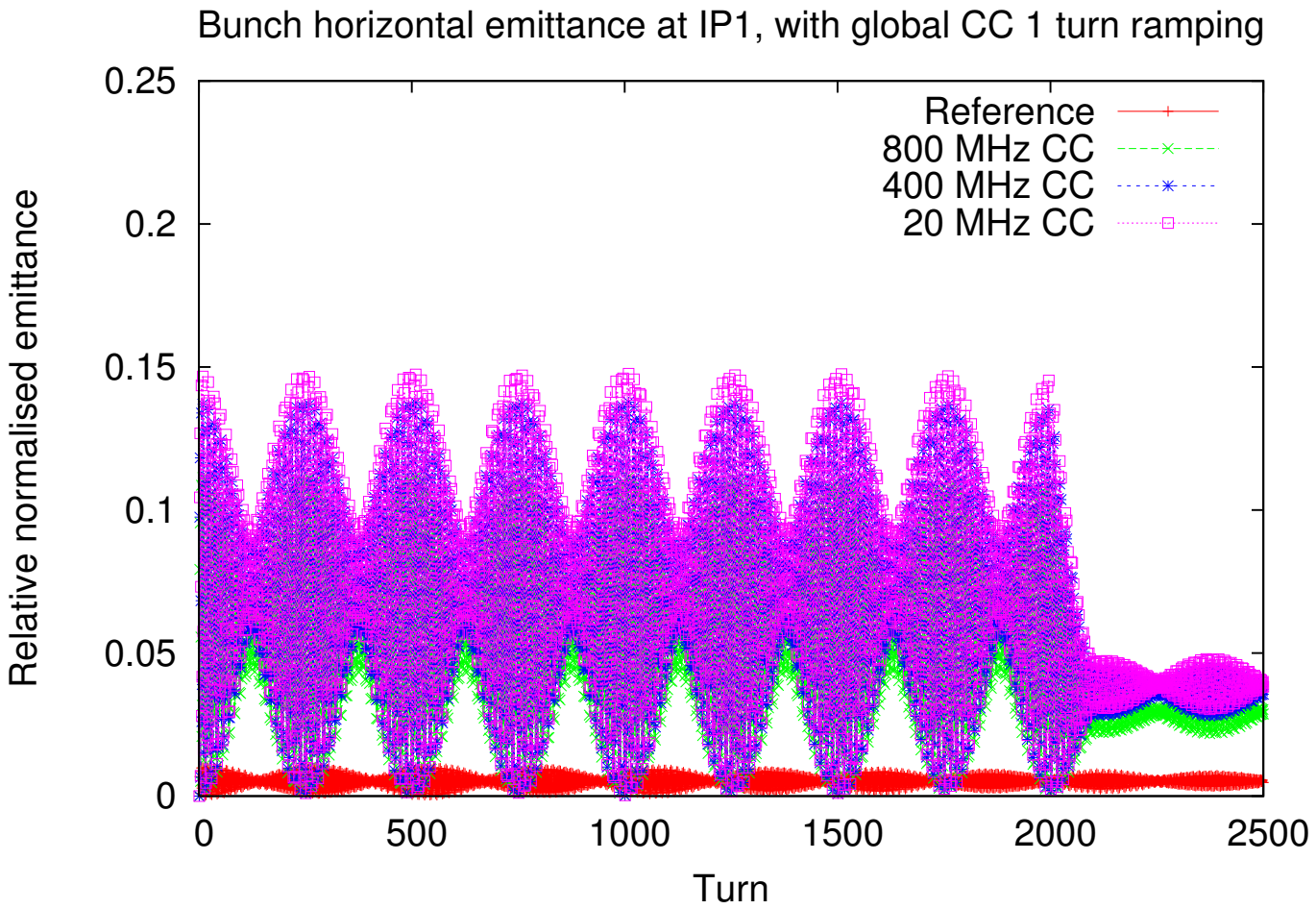
σ_z, 800 MHz CC



Horizontal emittance .VS. CC Frequency(1)

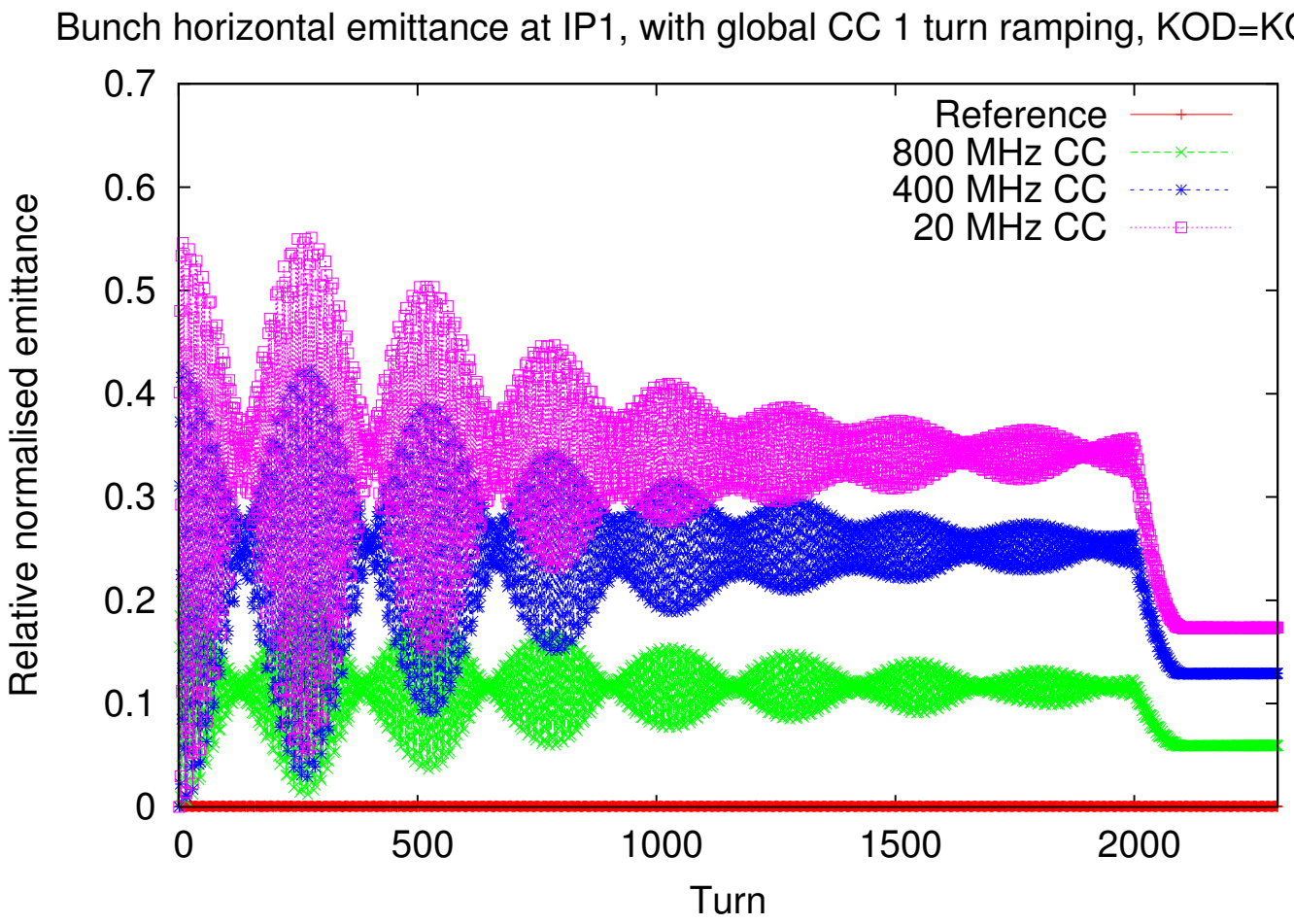


Horizontal emittance .VS. CC Frequency(2)



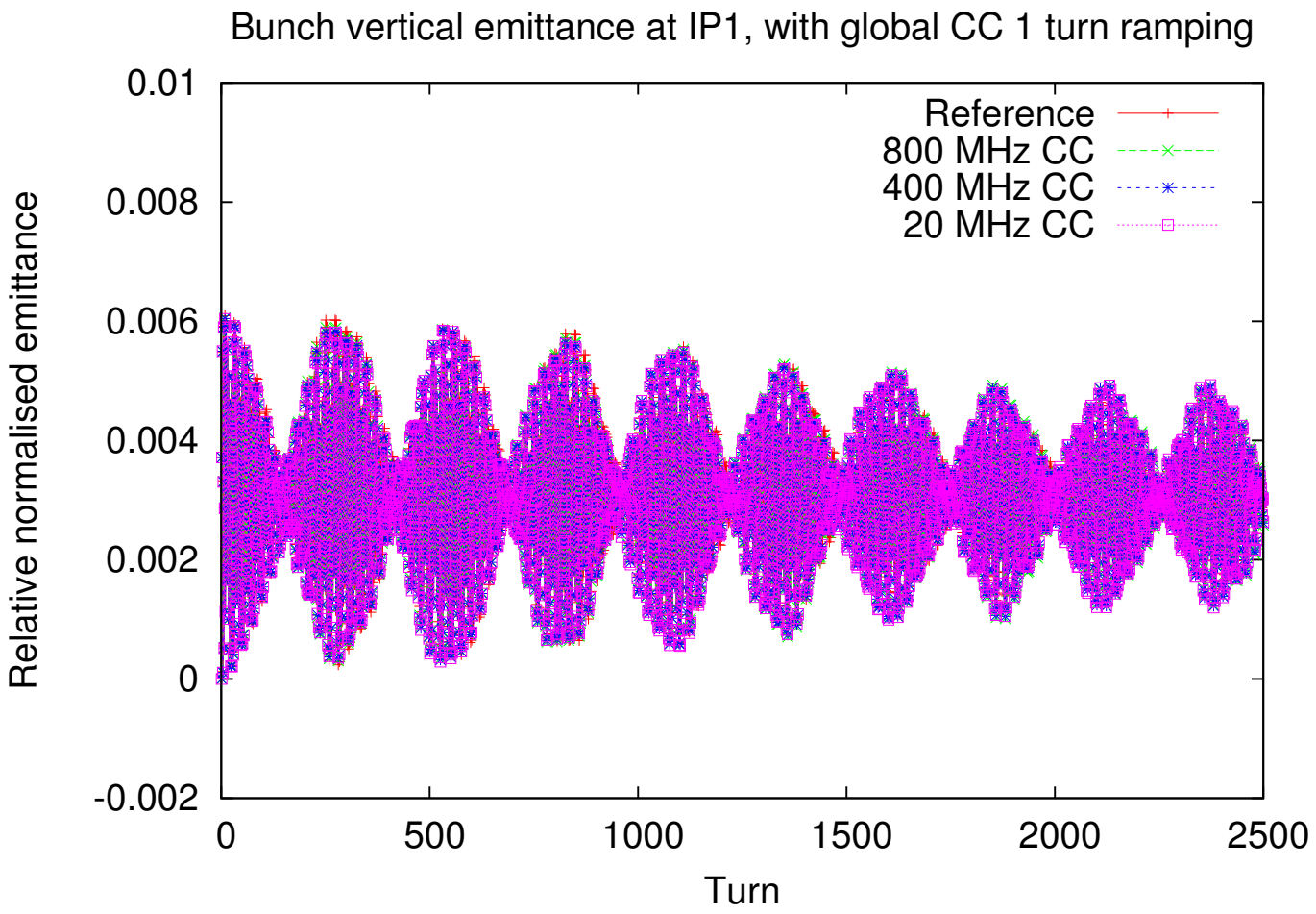
Longitudinal cut on ’cT’ and ’δ_p’ at 1 σ (linear part)

Horizontal emittance .VS. CC Frequency(3)

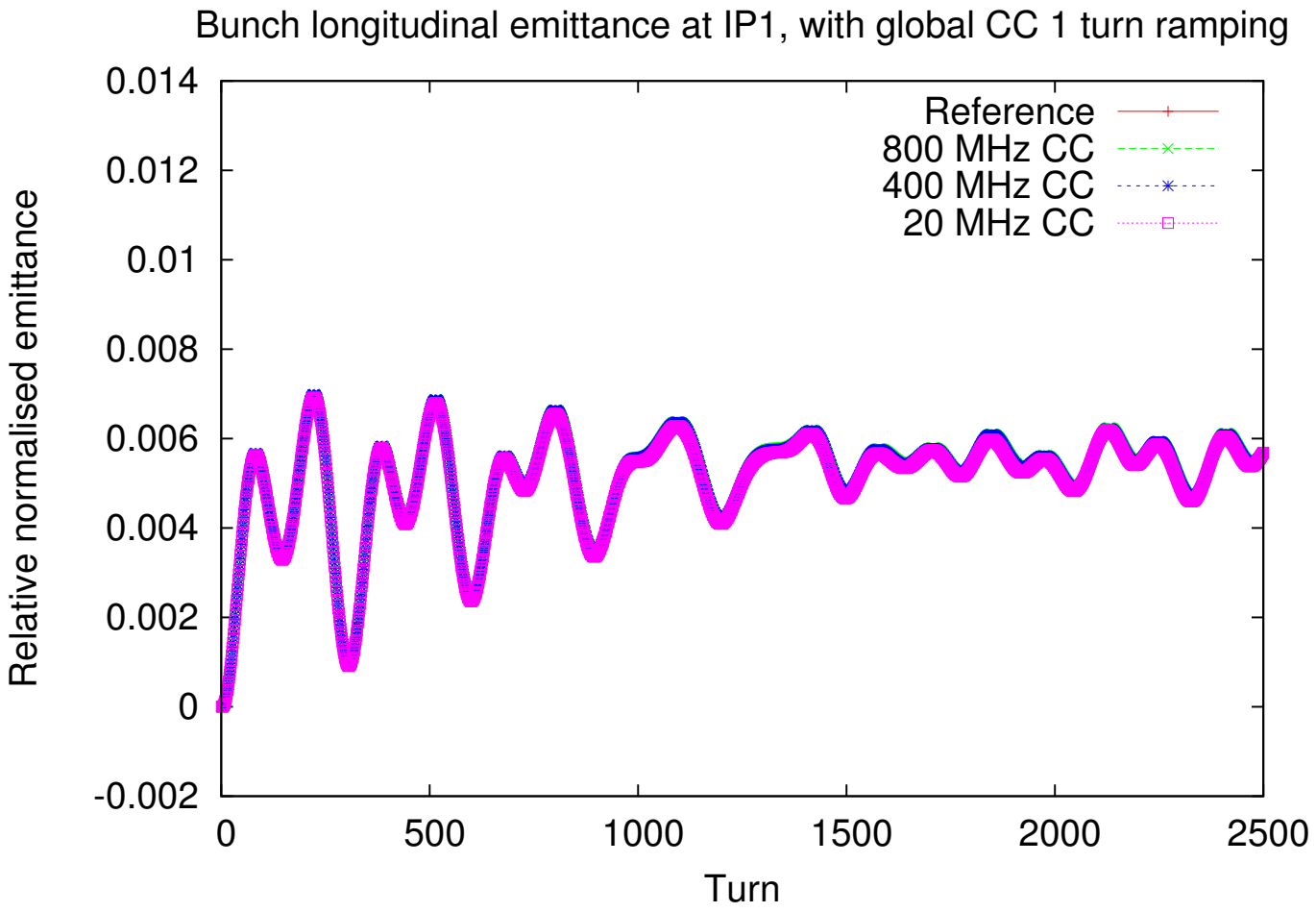


KOD=KOF=16

Vertical emittance .VS. CC Frequency



Longitudinal emittance .VS. CC Frequency



Conclusion

- Crab cavity ramping period should be longer than 10 turns (Agree with Akio)
- Beam-beam, octupoles and multipole errors give no obvious effect (both alone, and together with crab cavity ramping)
- Some artificial emittance growth due to mismatch of initial distribution (and/or optics)