SuperB Lattice and rescaling studies for CLIC-DR

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Evolution of lattice (1)

- SuperB ring lattice initially copied from the ILC-DR
- First adapted on SuperB requirements (similar emittance but longer damping time):

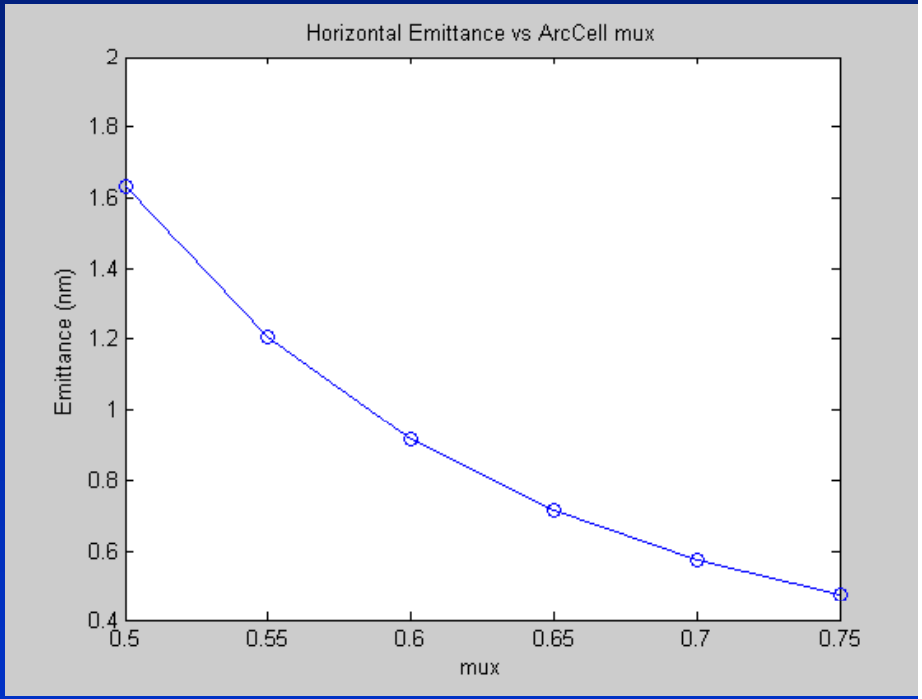
  Energy=7GeV Emi_x=20um, τ_s=20msec
- Second adjusted for reutilizing PEP-II hardware

Evolution of lattice (2)

- ILC-DR cell is a TME with the sequence:
  Qf/2-Qd-Bend-Qd-Qf/2, μ_x=0.37
- Lattice Modified to further reduce the equilibrium emittance and improve the Dynamic aperture, by adding a Qf in the middle of the Bend and having the Sfs (near the Qf_1's) at 180^o:
  Qf_1/2-Qd-Bend/2-Qf_2-Bend/2-Qd-Qf_1/2, μ_x=0.50

Evolution of lattice (3)

- Natural emittance decreases further by increasing the arc cell μ_x
- Dynamic aperture shrinks with larger μ_x



x-emittance vs x-phase advance/cell

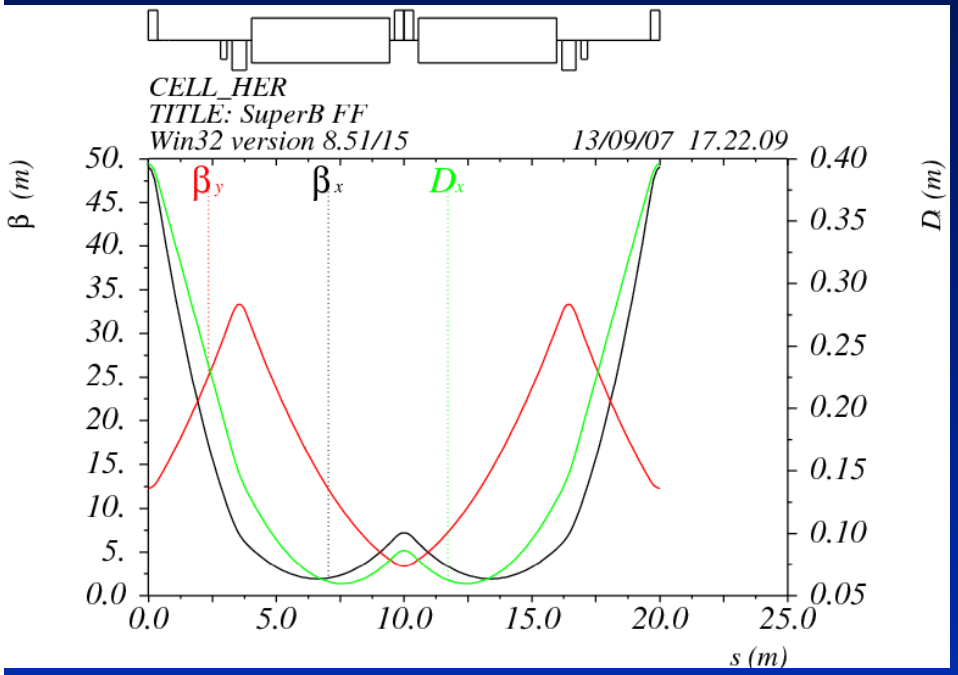
Present layout

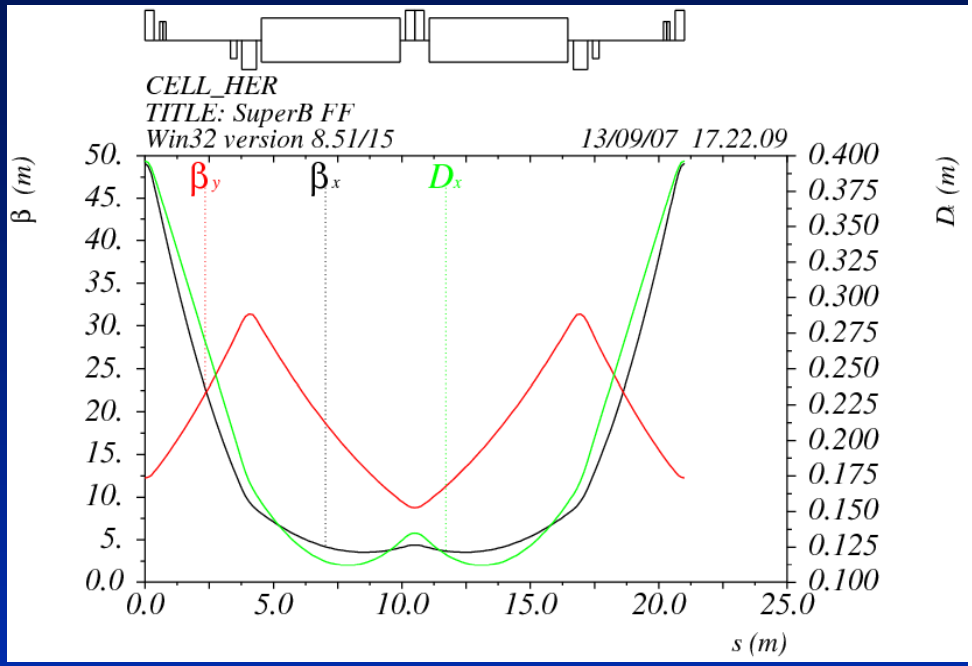
- Alternating sequence of two different arc cells: a $\mu_x = \pi$ cell, that provides the best dynamic aperture, and a $\mu_x = 0.72$ cell with much smaller intrinsic emittance which provides phase slippage for sextupoles pairs, so that one arc corrects all phases of chromaticity. Then:
  - chromatic function $W_x < 20$ everywhere
  - β and α variation with particle momentum are close to zero
  - very large dynamic aperture >100 sigmas, dE/E>2%

- Cell #1: L=20 m, $\mu_x = 0.72$, $\mu_y = 0.27$
- Cell #2: L=21 m, $\mu_x = 0.5$, $\mu_y = 0.2$
- New cell layout (double-cell wrt CDR lattice):

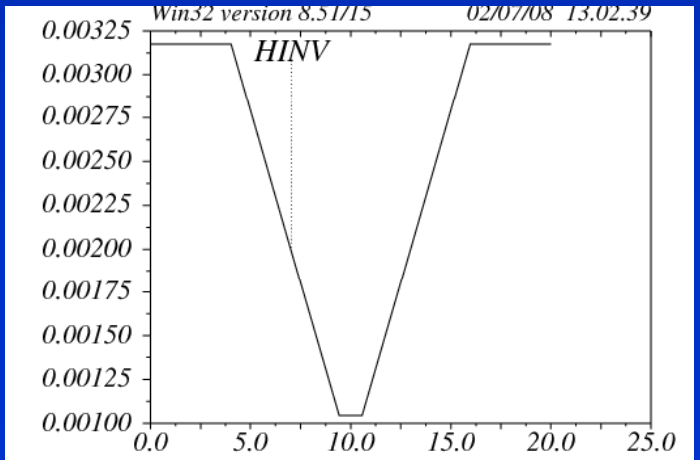
$QF_1/2\text{-}QD\text{-}B\text{-}QF_2\text{-}B\text{-}QD\text{-}QF_1/2$

Arc cells layout

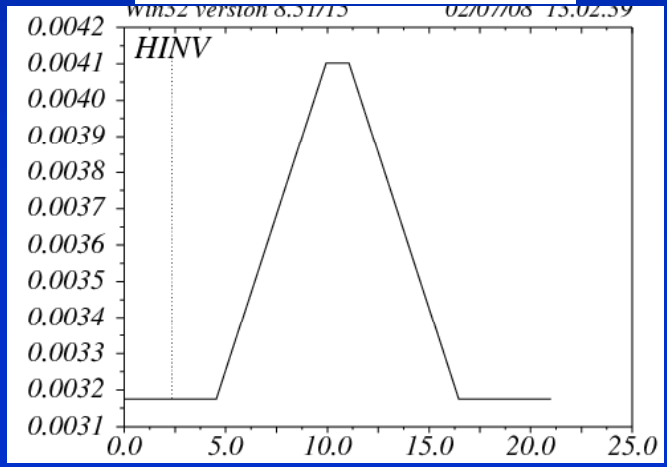




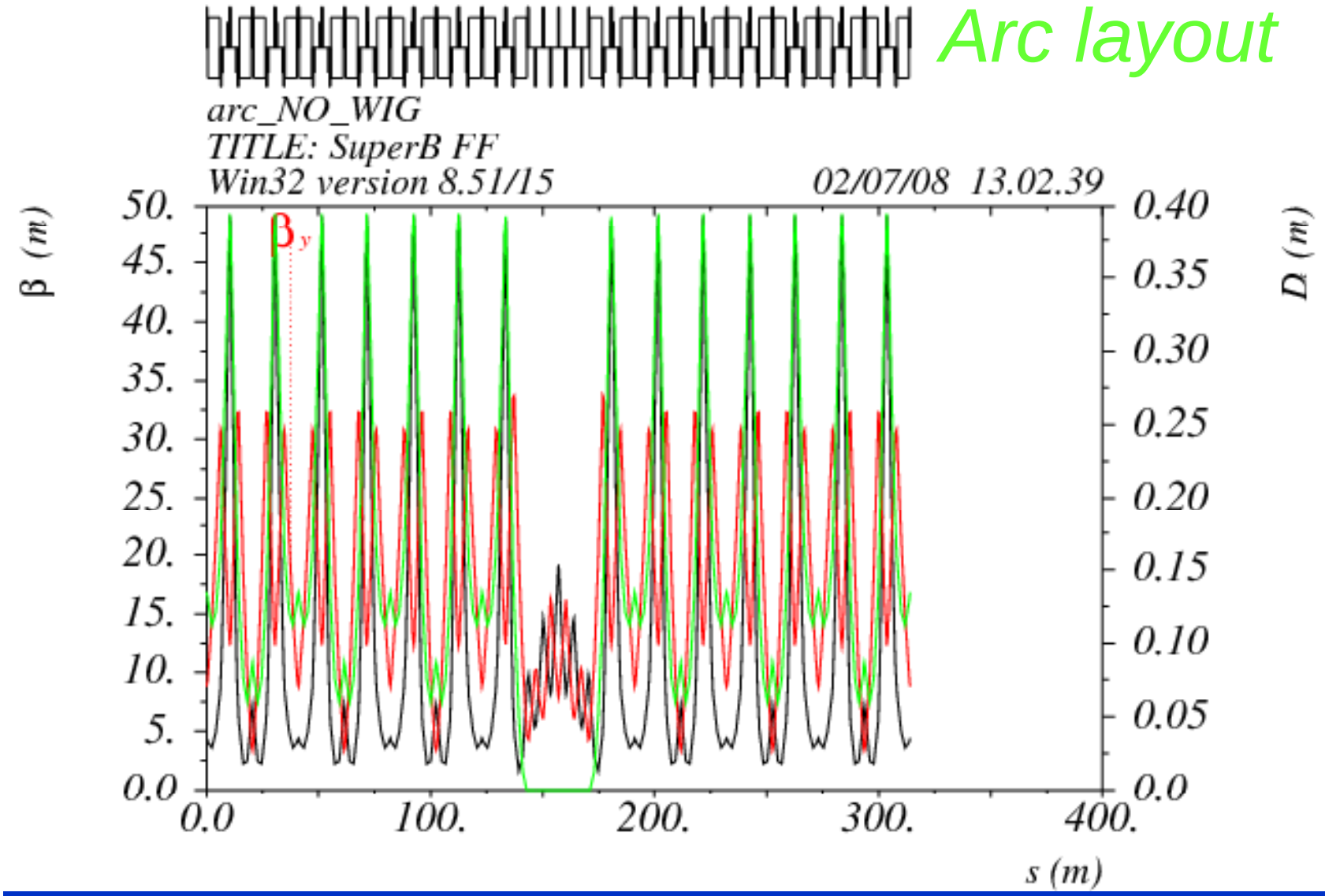
Cell #1, mux=0.75



Cell #2, mux=0.50

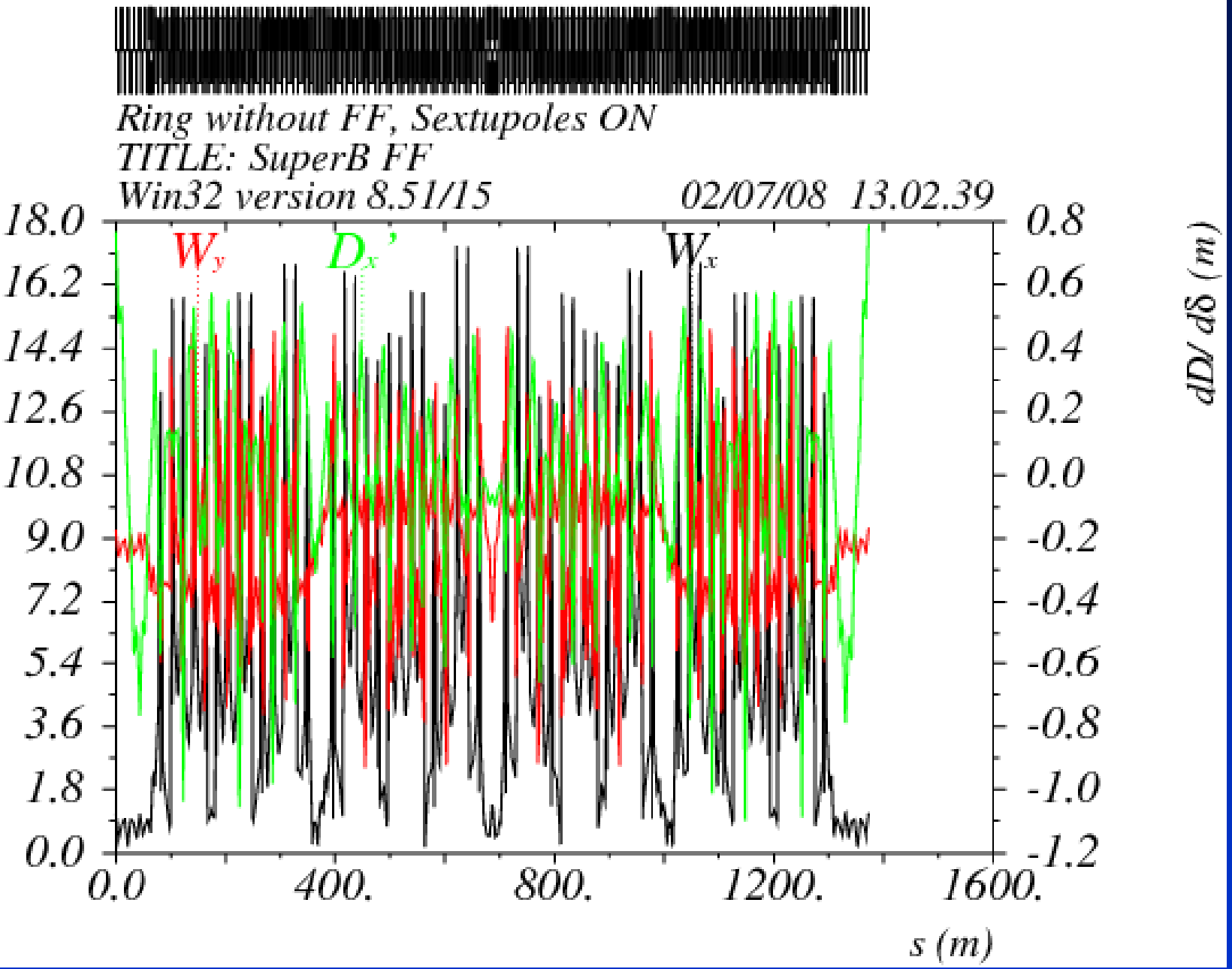


Arc layout



14 alternatig cells, mux=0.72, mux=0.50

Wiggler section in the middle (Wigglers are Off)



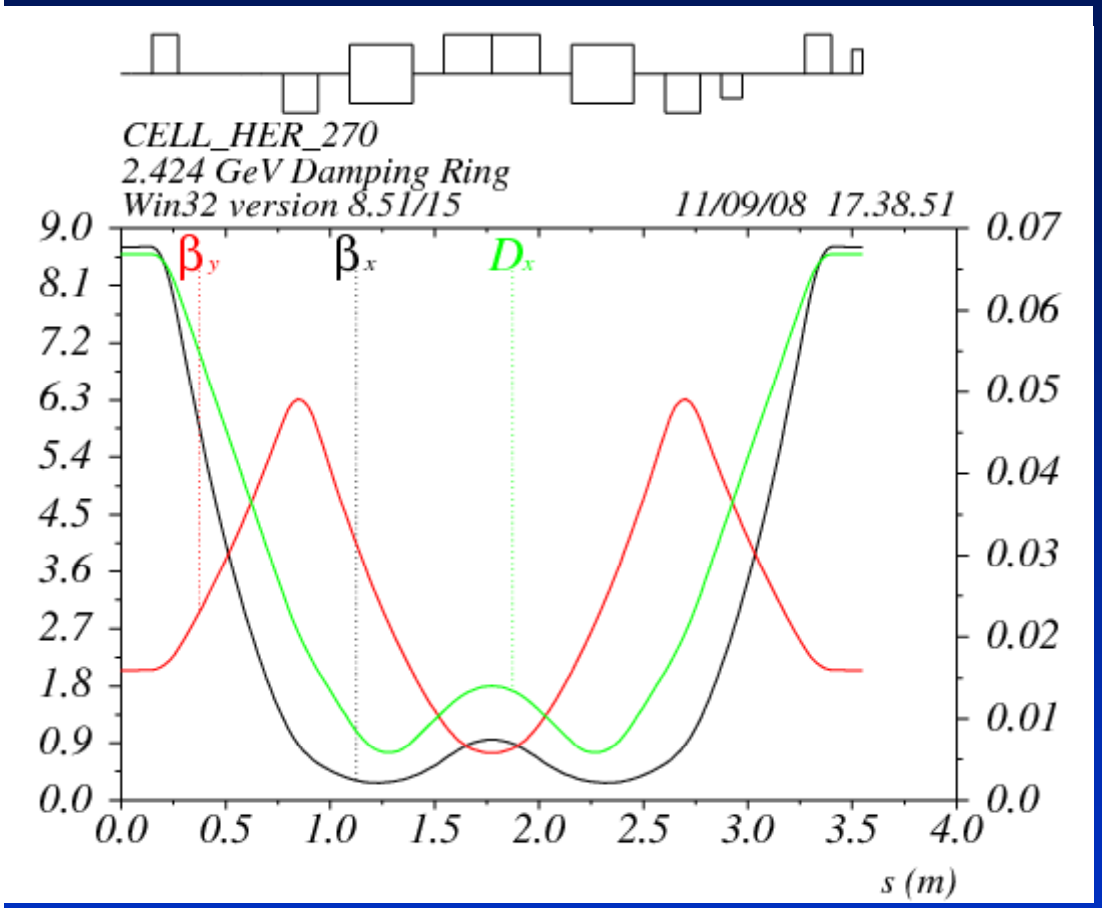
Chromatic functions

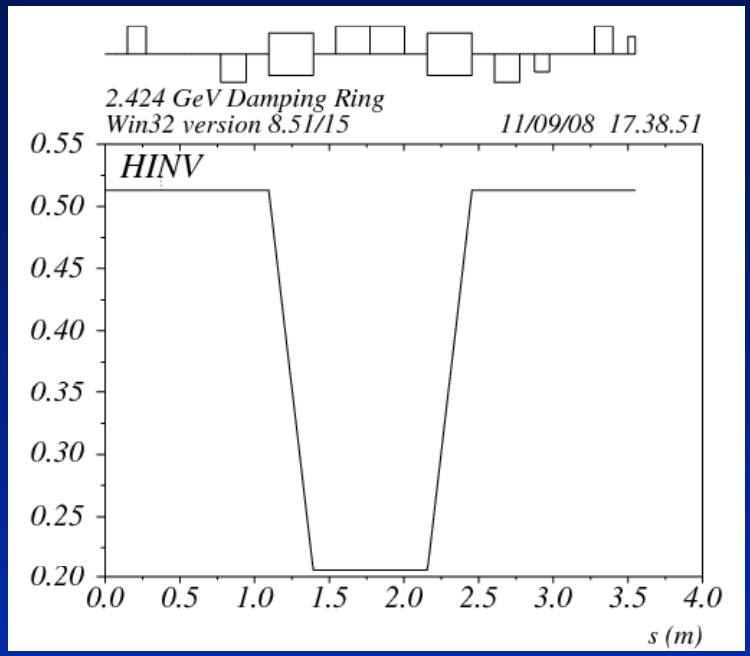
Lattice scaling to CLIC-DR (1)

- Extremely challengining
- Emittance has to be very small
- Damping time < 2msec
- Adopted the solution with just one type of cell with mux=0.75, muy=0.25 to reduce the emittance as much as possible
- Sextupoles are missing in some cells (one third) to ensure that they are all paired at –I to get the best dynamic aperture:

  sext-nosext-sext-sext-nosext-sext ...etc.

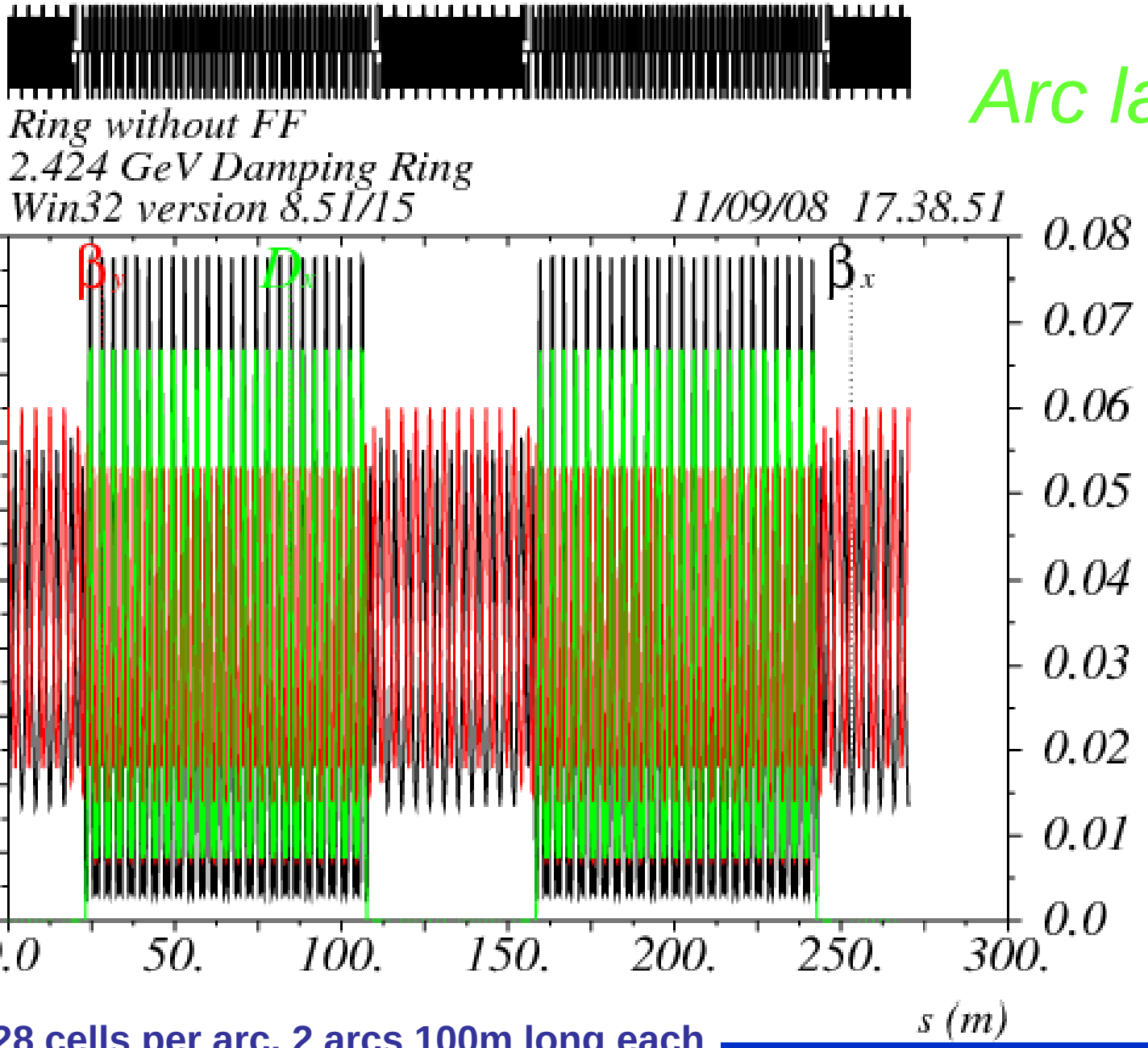
Arc cells layout scaled to DR





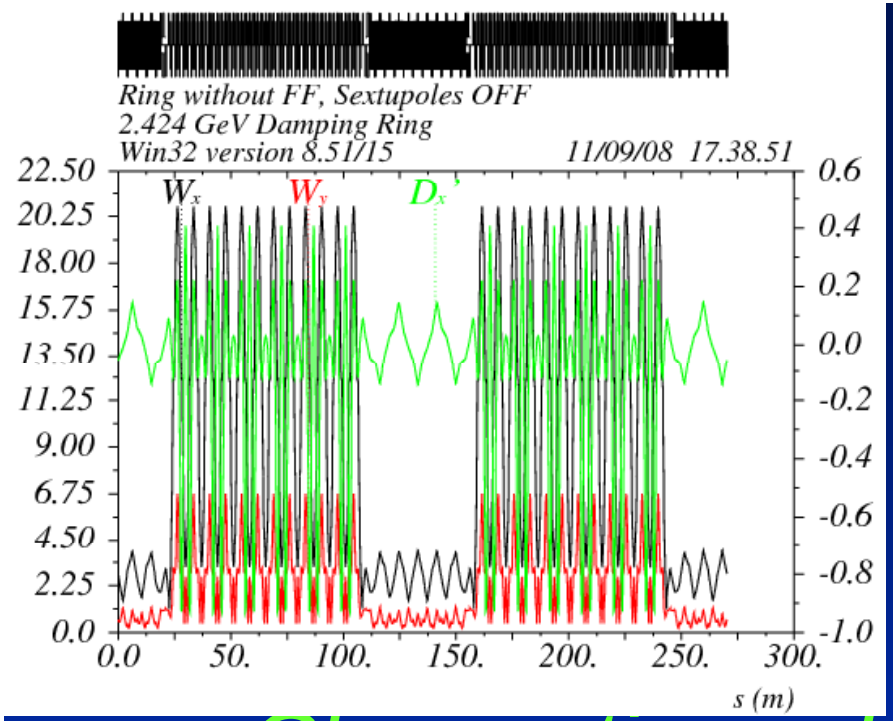
mux=0.75, muy=0.25

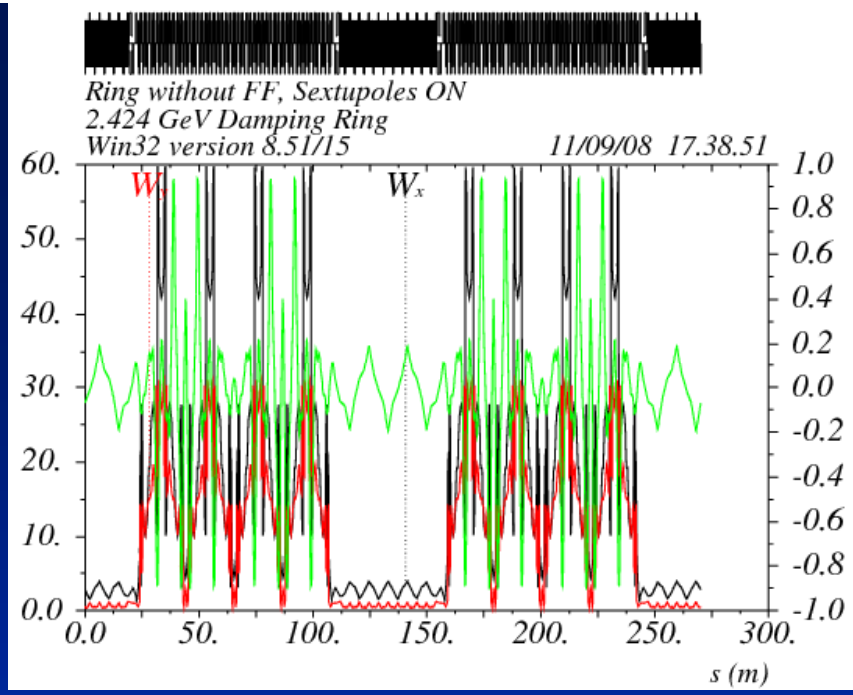
Arc layout



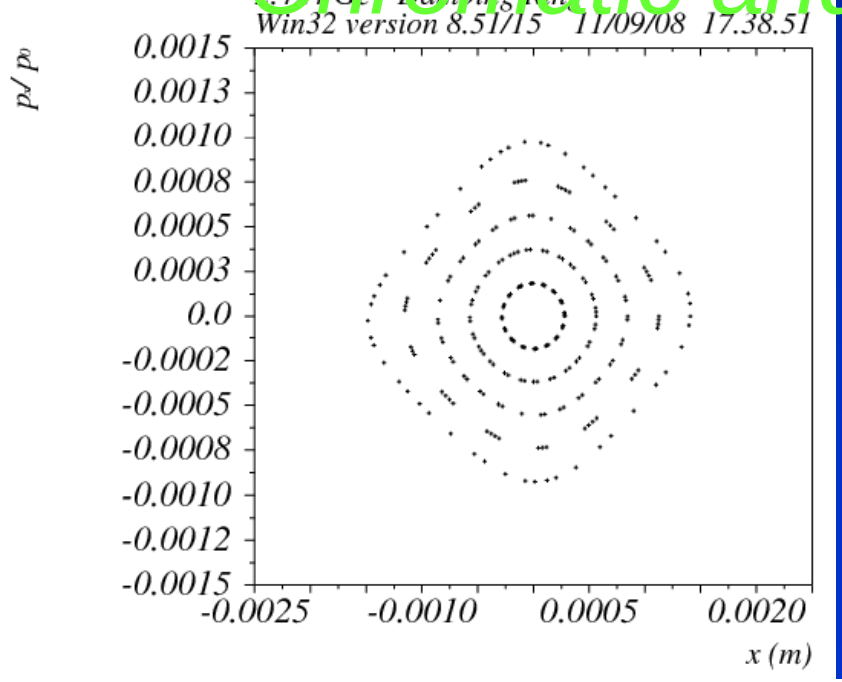
28 cells per arc, 2 arcs 100m long each

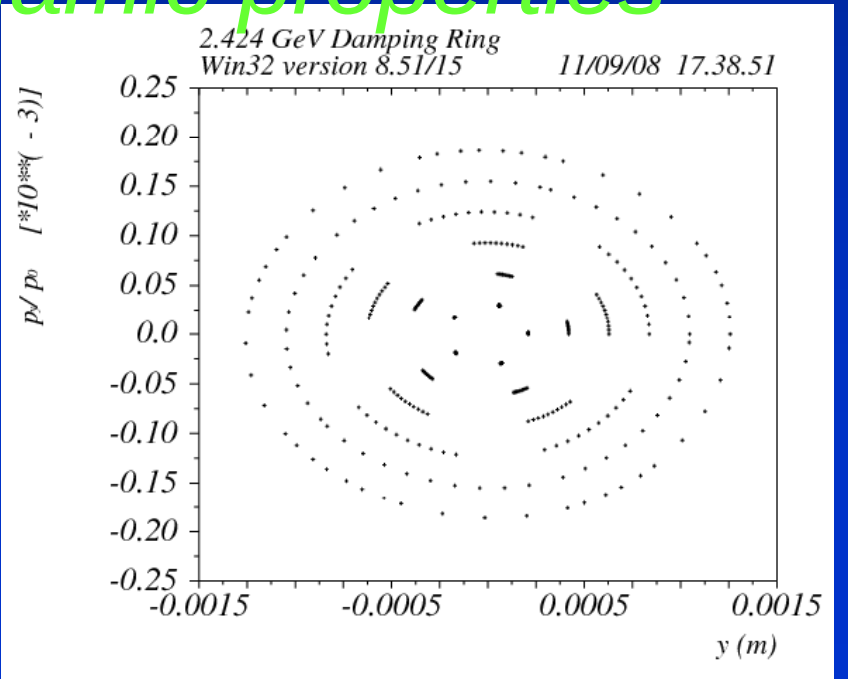
2 Wiggler sections 40m long each



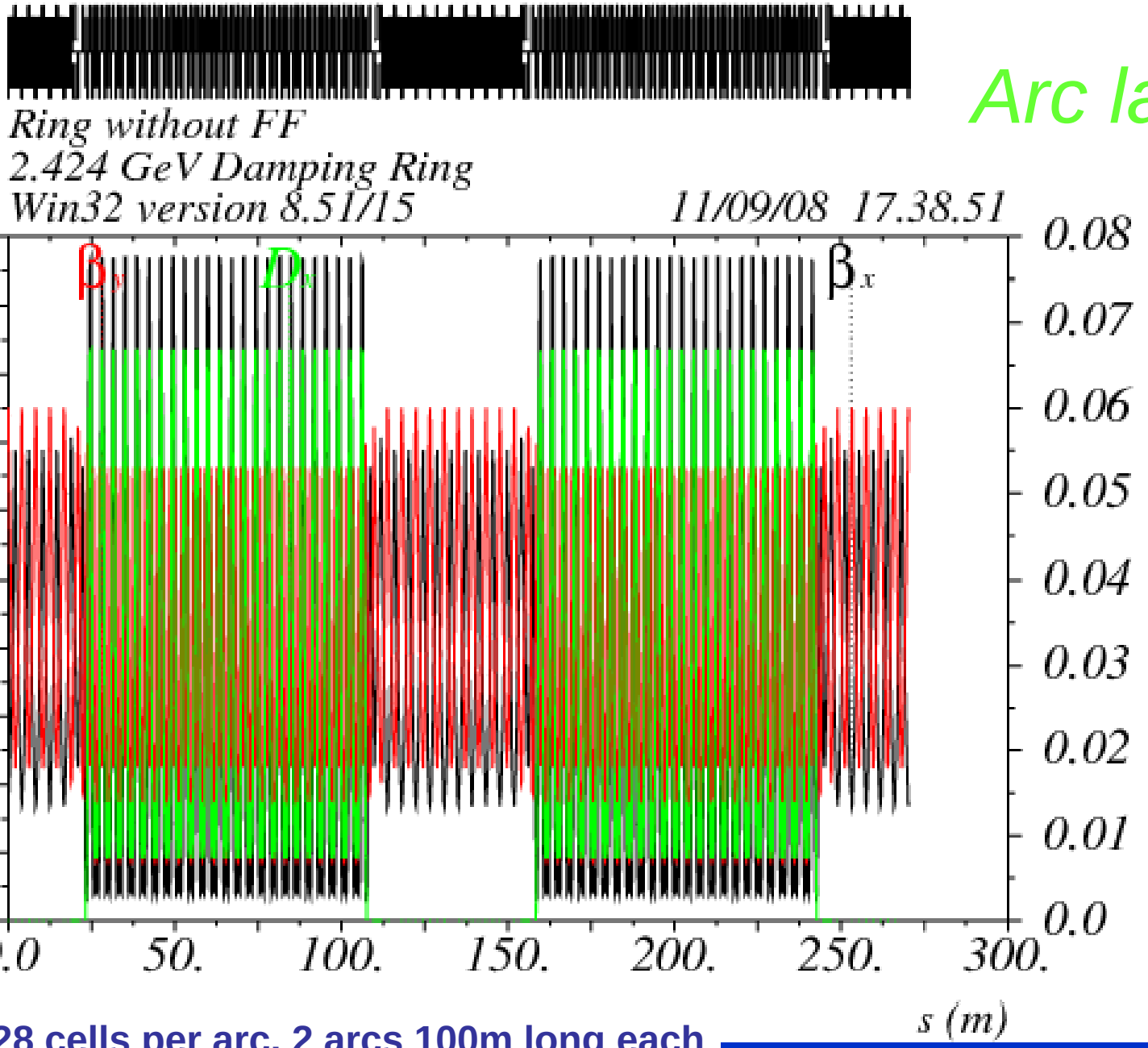


Chromatic and dynamic properties





Arc layout



28 cells per arc, 2 arcs 100m long each

2 Wiggler sections 40m long each

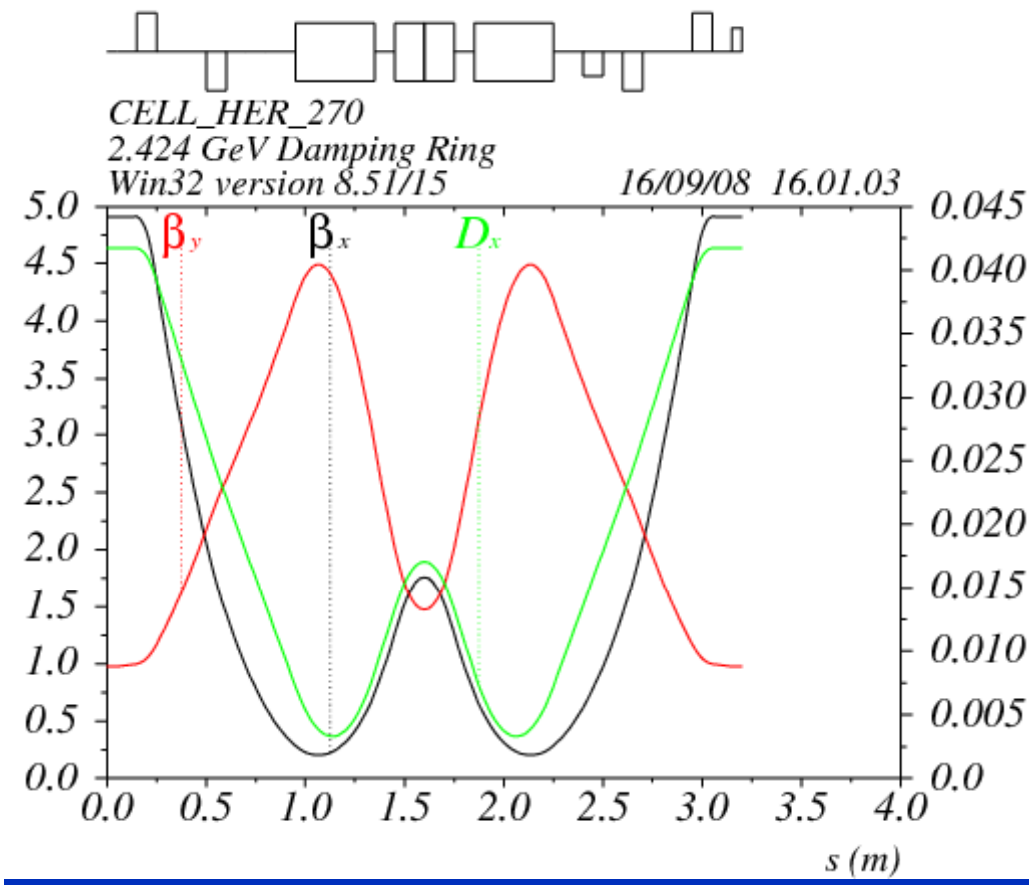
Lattice scaling to CLIC-DR (2)

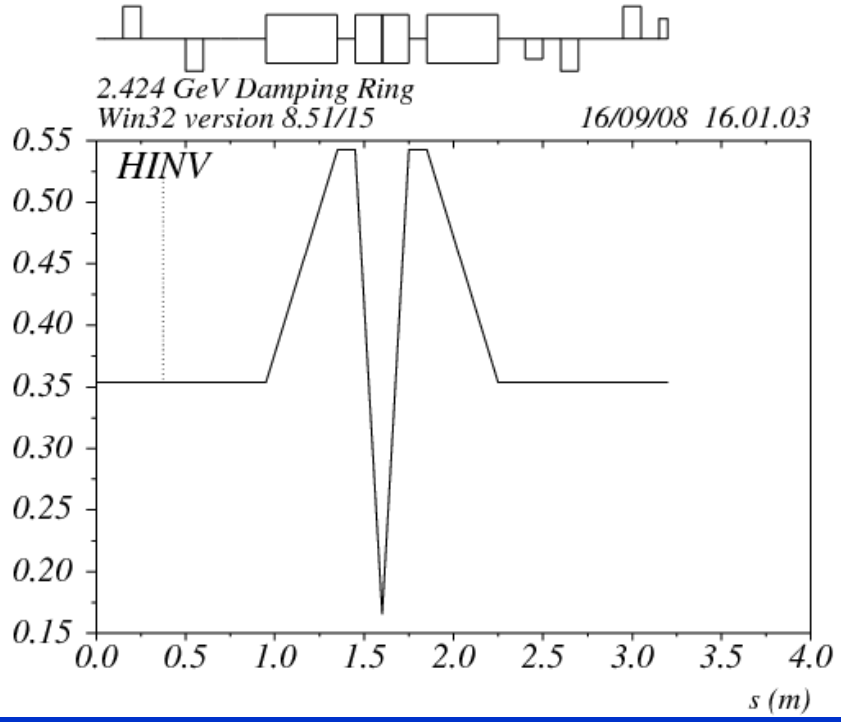
- Quads Gradients around 100T/m
- Sexts Gradients around 10^3T/m^2
- Transverse Damping time about 2msec
- Emix= 0.6um (no collective effects studies at all), Alfac=1.3e-4
- Natural chromaticity csix=-80,csiy=-50

Extreme Lattice scaling to CLIC-DR

- Arcs could be further shortened if you can build combined functions magnets
  - bends with gradient (1)
  - quads with sextupoles (2)
- A ring with cells of this type could produce an equilibrium emittance emix=0.6um and a vertical damping time of about 3.0msec, without wigglers

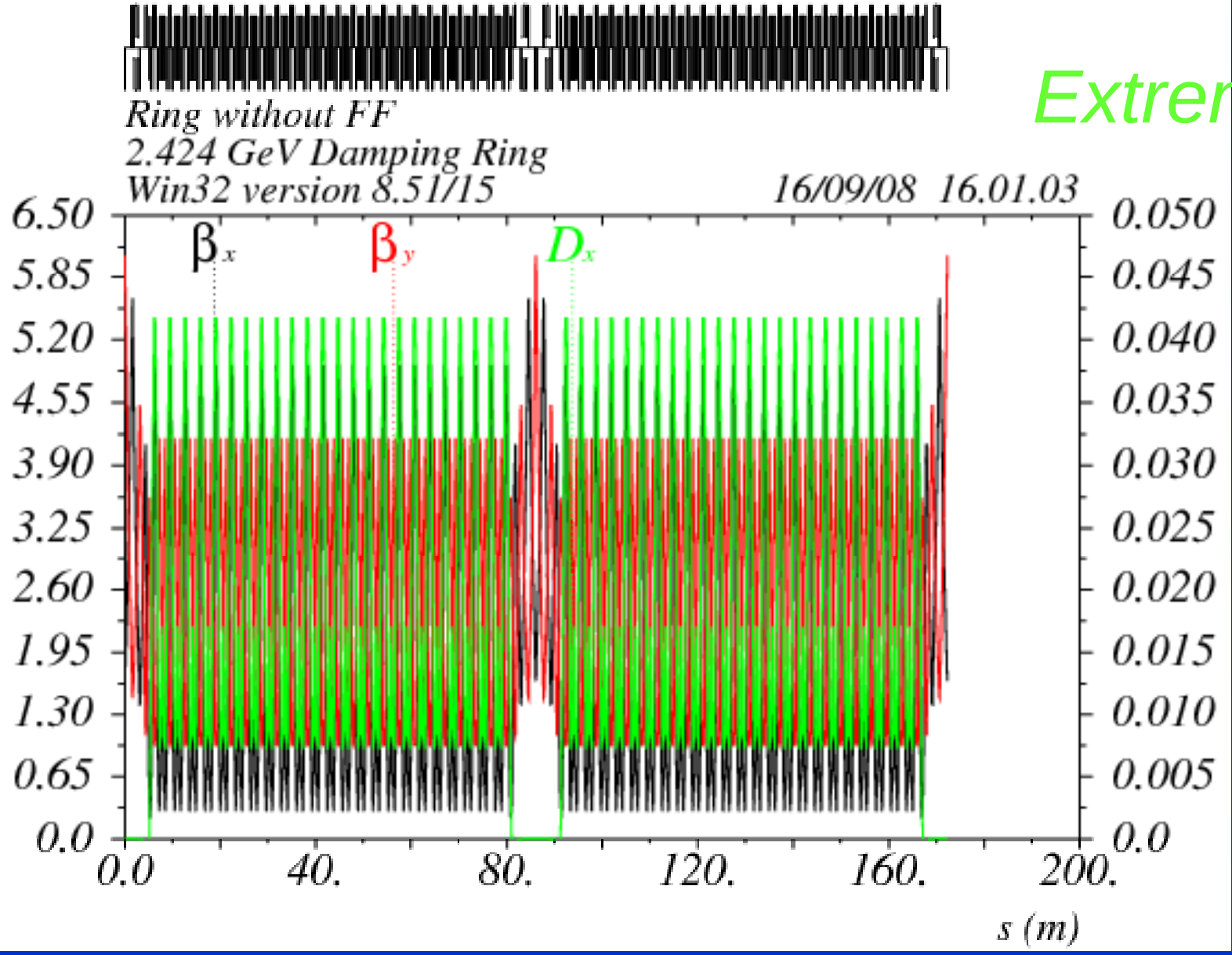
Extreme Arc Cell





mux=0.75, muy=0.25

Extreme DR



28 cells per arc, 2 arcs 75m long each

No Wigglers

Conclusions

- Basic SuperB-like Arcs performace should be compared with other cells:
  - emittance and damping
  - dynamic aperture
  - magnets gradients
  - collective effects
- Extreme cells require close collaboration and R&D with magnets experts, but might lead to better solutions