Dynamic Aperture of SuperKEKB Lattice

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Lattice Parameters

	LER	HER	
Horizontal emittance	33	33	nm
Beta function@IP	30/0.3	30/0.3	cm
Momentum compaction	2.7E-4	1.7E-4	
RF voltage	15	20	MV
Bunch length	3	3	mm

(The horizontal emittance is 18 nm in LER, 24 nm in HER at present KEKB.)

- The KEKB lattice has a wide range of flexibility on the horizontal emittance and the momentum compaction factor.

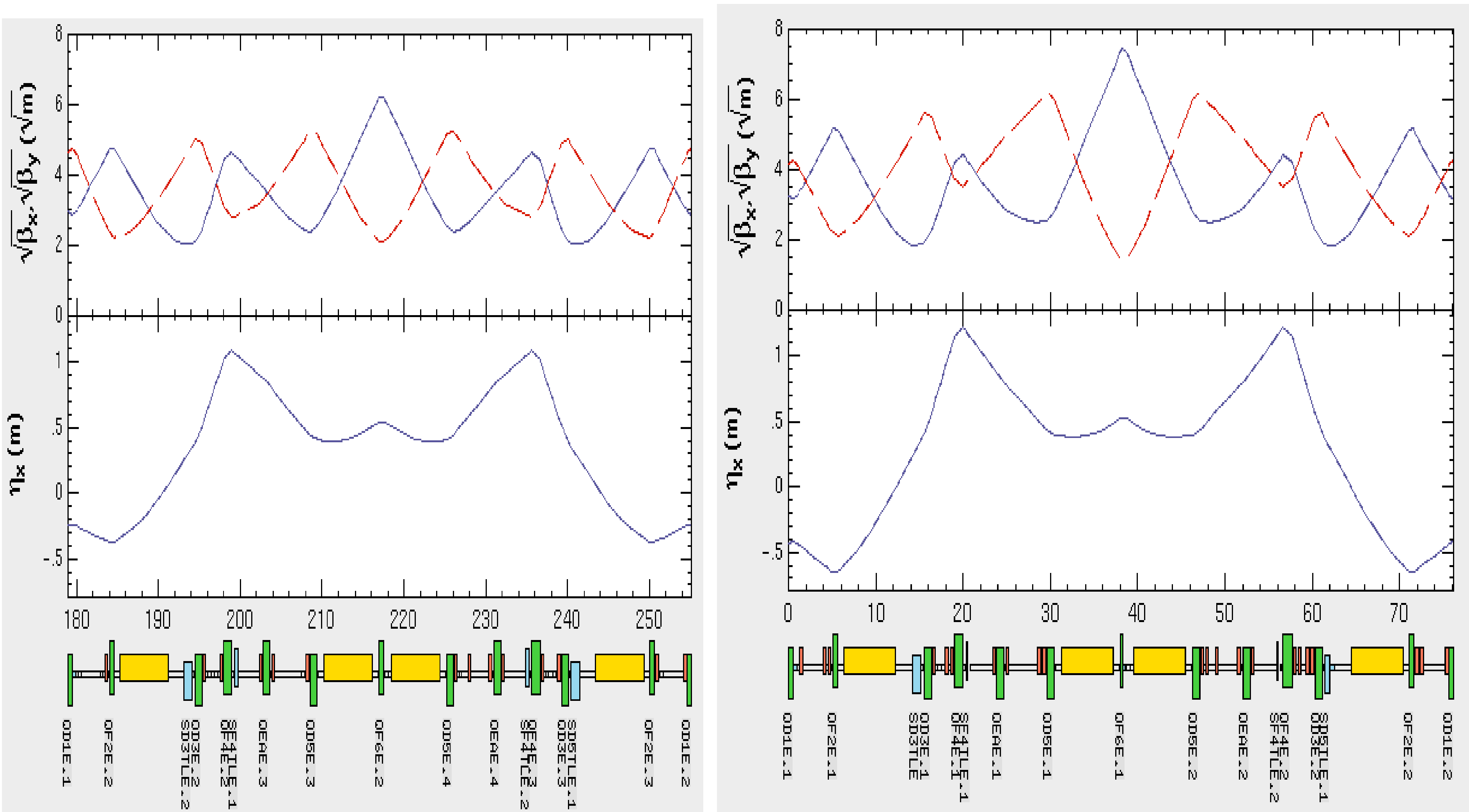
ε_x : 10 ~ 36 nm, α : - 2 ~ + 4 $\times 10^{-4}$

- The design parameters for SuperKEKB are able to be achieved without major changes in the arc lattice.
- HER has little margin for higher emittance (higher bunch current, larger bunch spacing).
- LER has a larger tuning range of ε_x, since half of the wiggler magnets will remain.

$$\varepsilon_x = (L_{arc}\varepsilon_{arc} + L_{wig}\varepsilon_{wig}) / (L_{arc} + L_{wig}) \qquad L_{wig} \sim 1/2\ L_{arc}$$

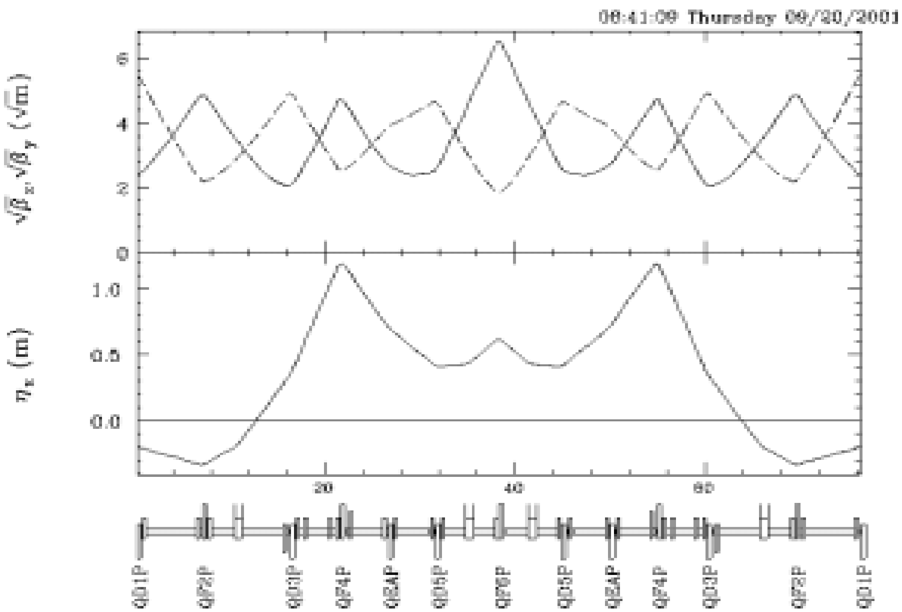
- Negative α lattice may be useful to suppress the bunch-lengthening.

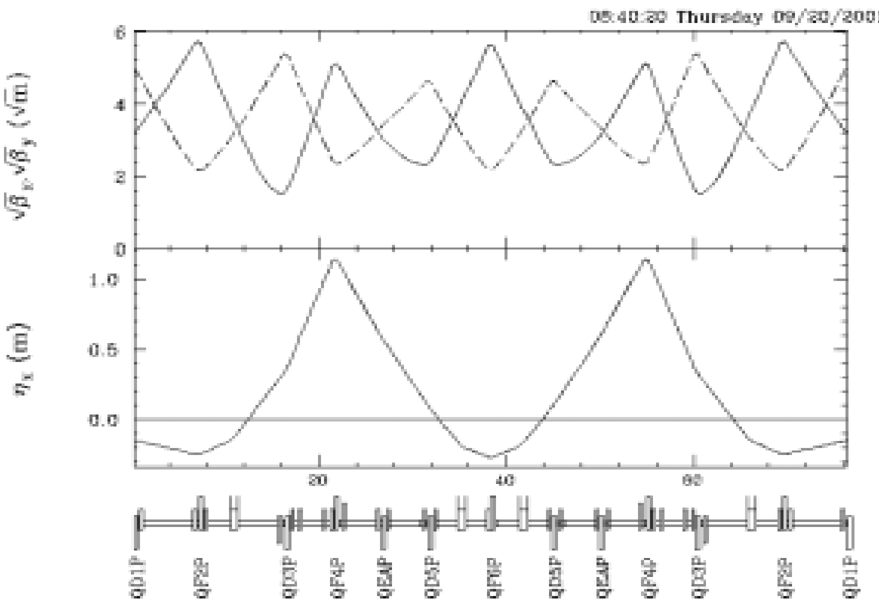
HER cell ε_x = 24 (left: KEKB), 33(right: SuperKEKB) nm



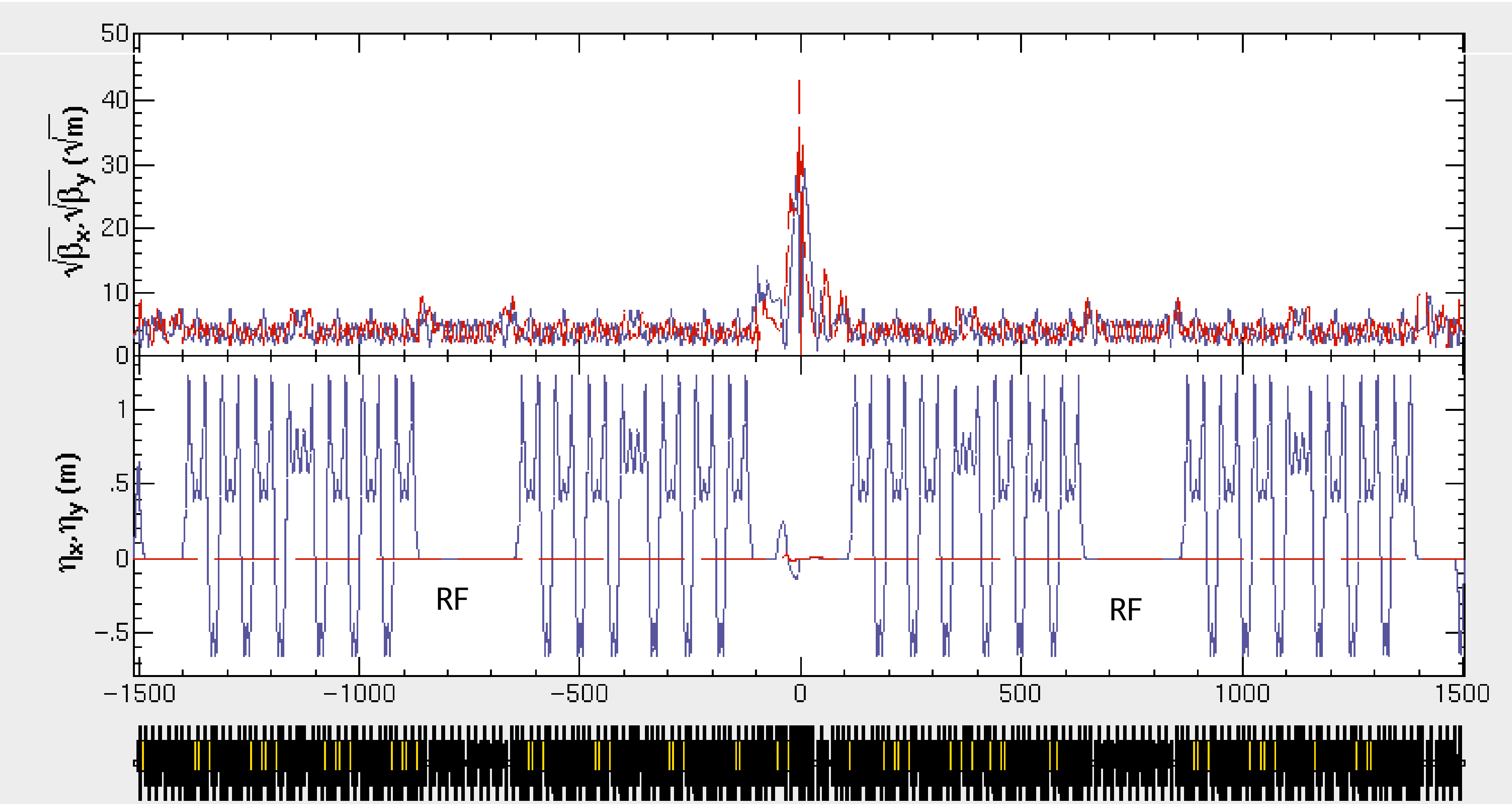
Negative Alpha Optics

LER Cell (emitx = 31nm, α = 3.7E-4) **negative α (emitx = 22nm, α = -4.7E-4)**

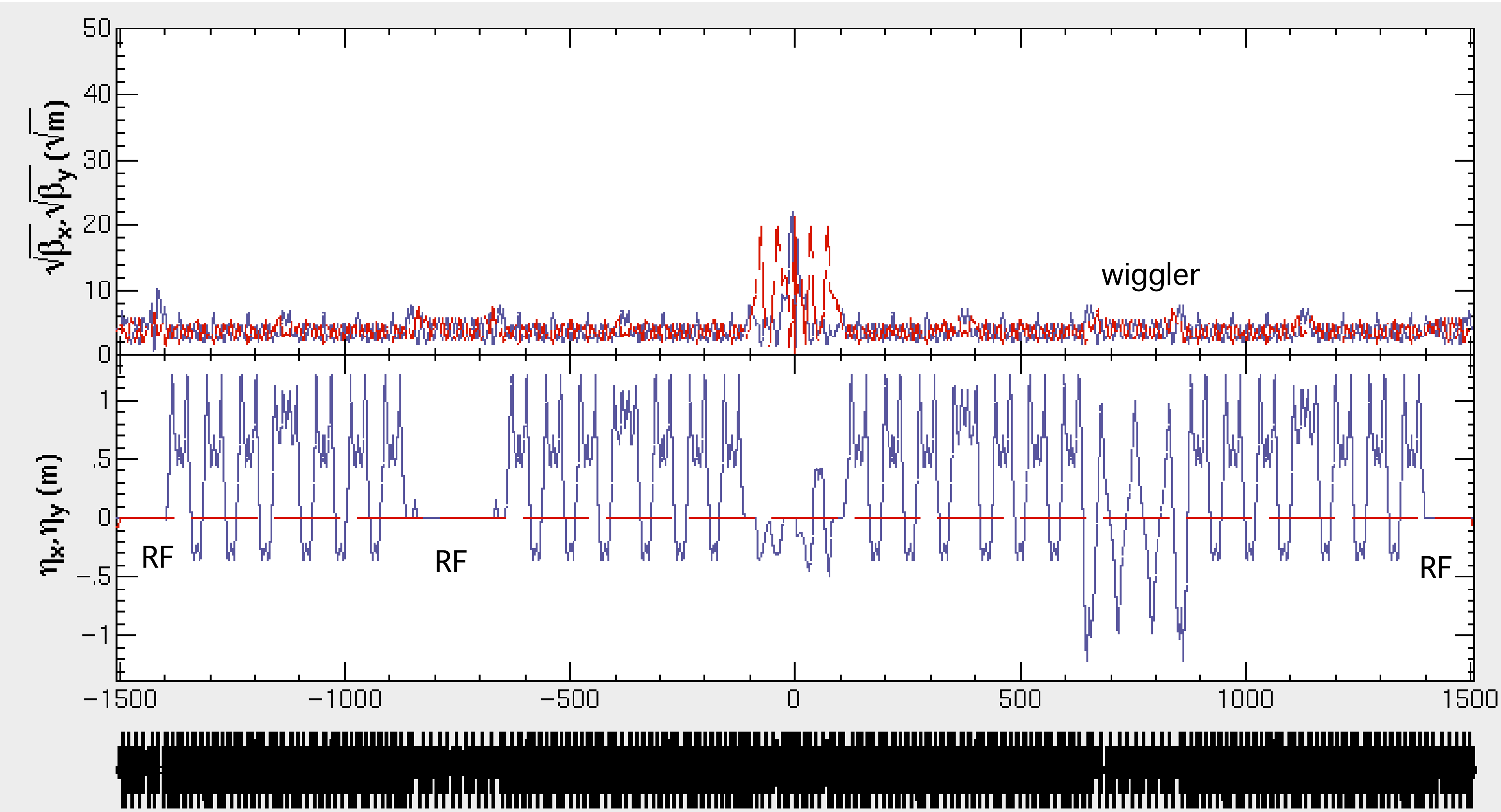




HER Lattice



LER Lattice



50
40
30
20
10
0
√βx, √βy (√m)
wiggler
1
.5
0
-.5
-1
ηx, ηy (m)
RF
RF
RF
-1500
-1000
-500
0
500
1000
1500

Modeling of IR Lattice

- Field distributions of the detector and compensation solenoids and QCSs along the longitudinal direction are given by 4 cm-thick slices of a constant field.

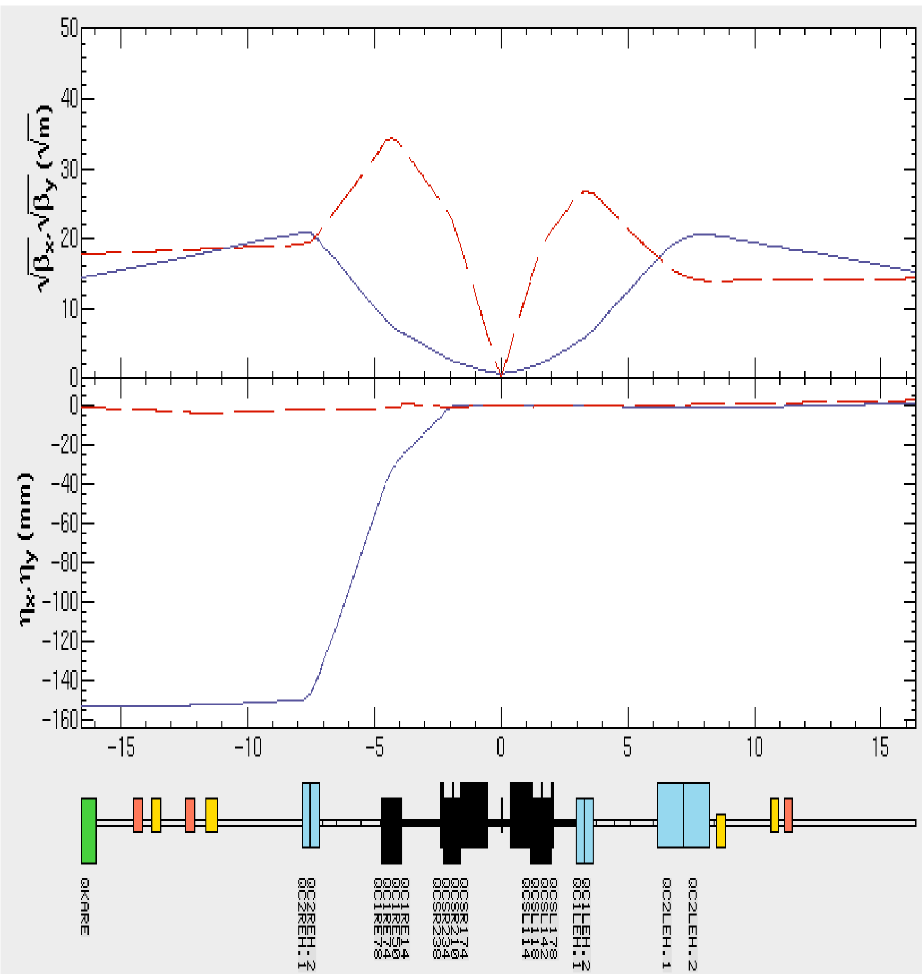
- Multipole components have not yet been included.

- The dynamic aperture of LER was estimated by 6-dimensional tracking with SAD during 1000 turns. The LER chromaticities are larger than in the present KEKB lattice (Bx/By@IP = 59/0.62 cm) as

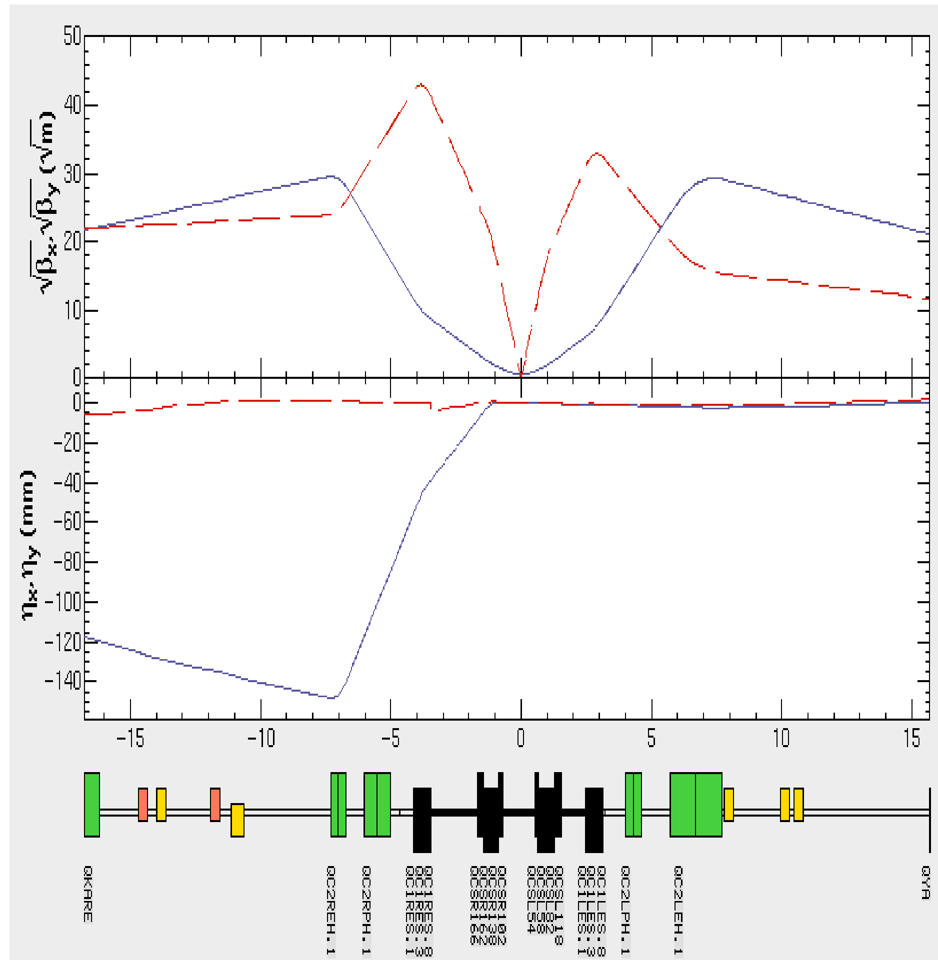
(H) -74.8 -> -87.9, (V) -125.5 -> -132.2

HER IR

KEKB (Bx/By=61/0.7 cm)

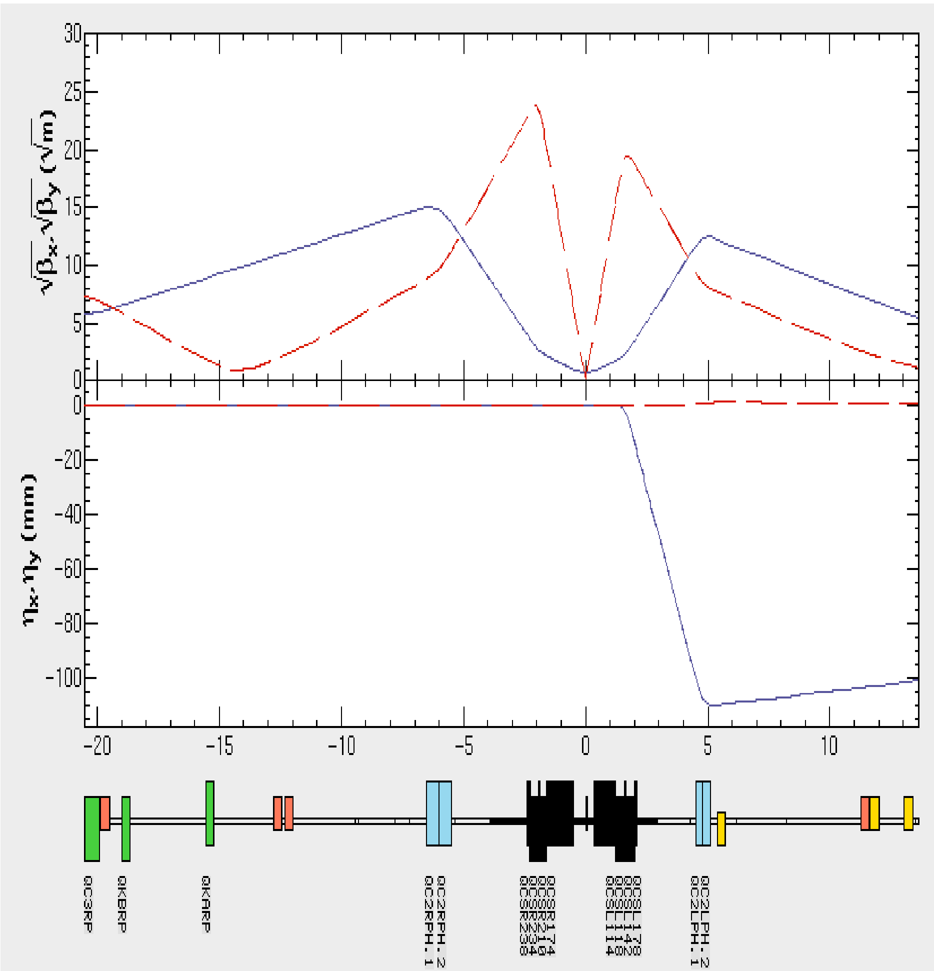


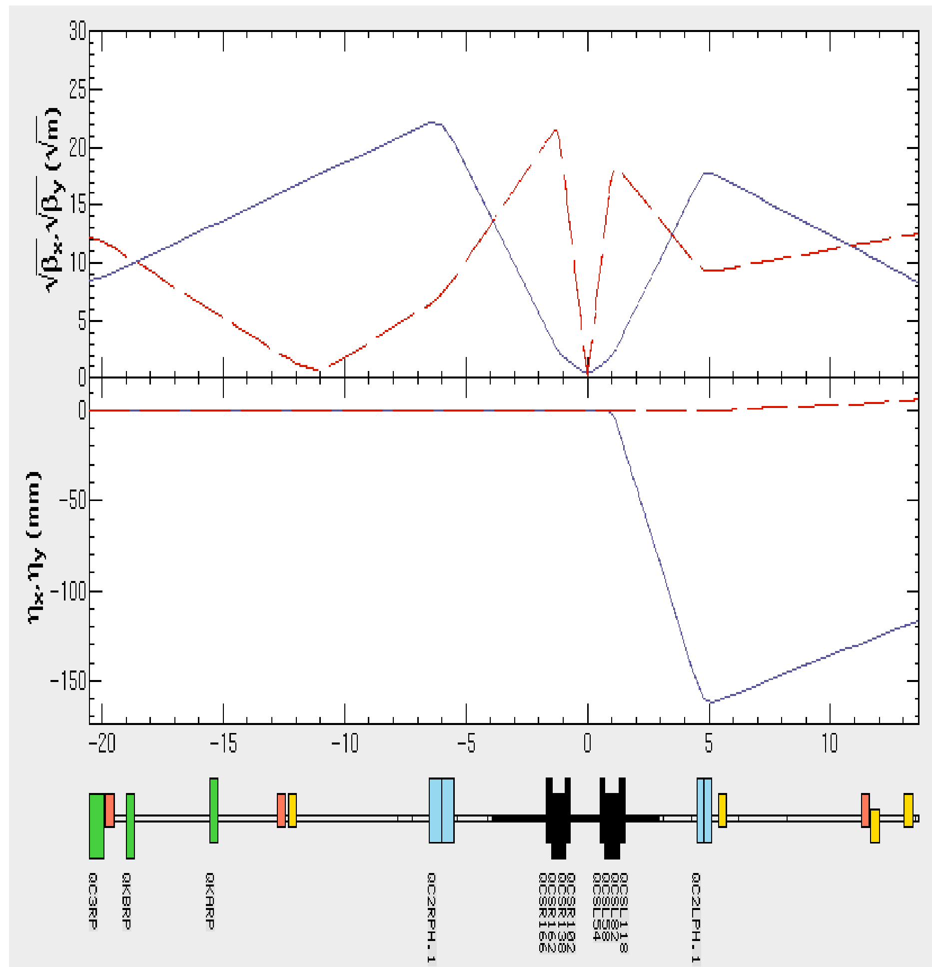
SuperKEKB(Bx/By=30/0.3 cm)



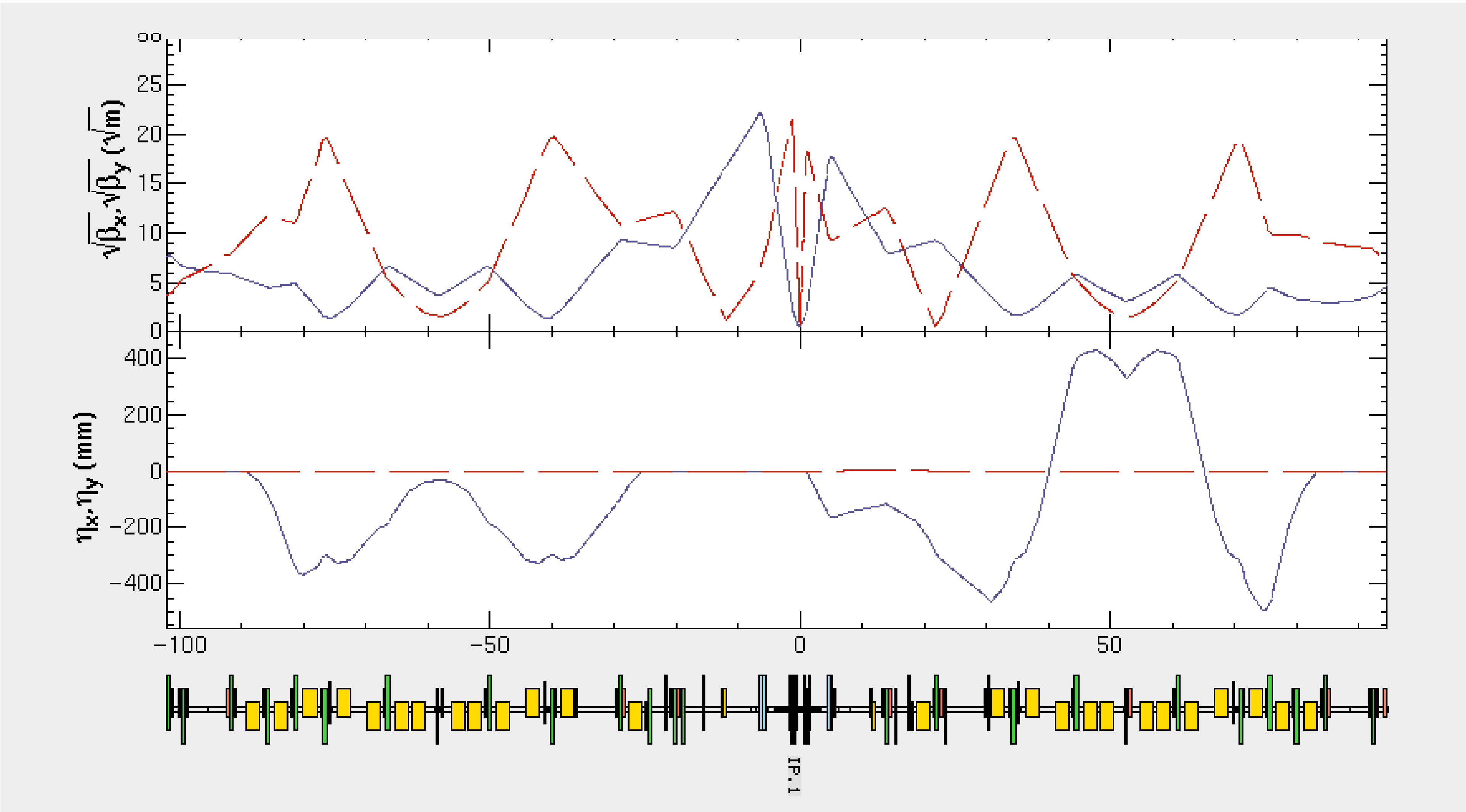
LER IR (I)

KEKB (Bx/By=59/0.62 cm) SuperKEKB(Bx/By=30/0.3 cm)

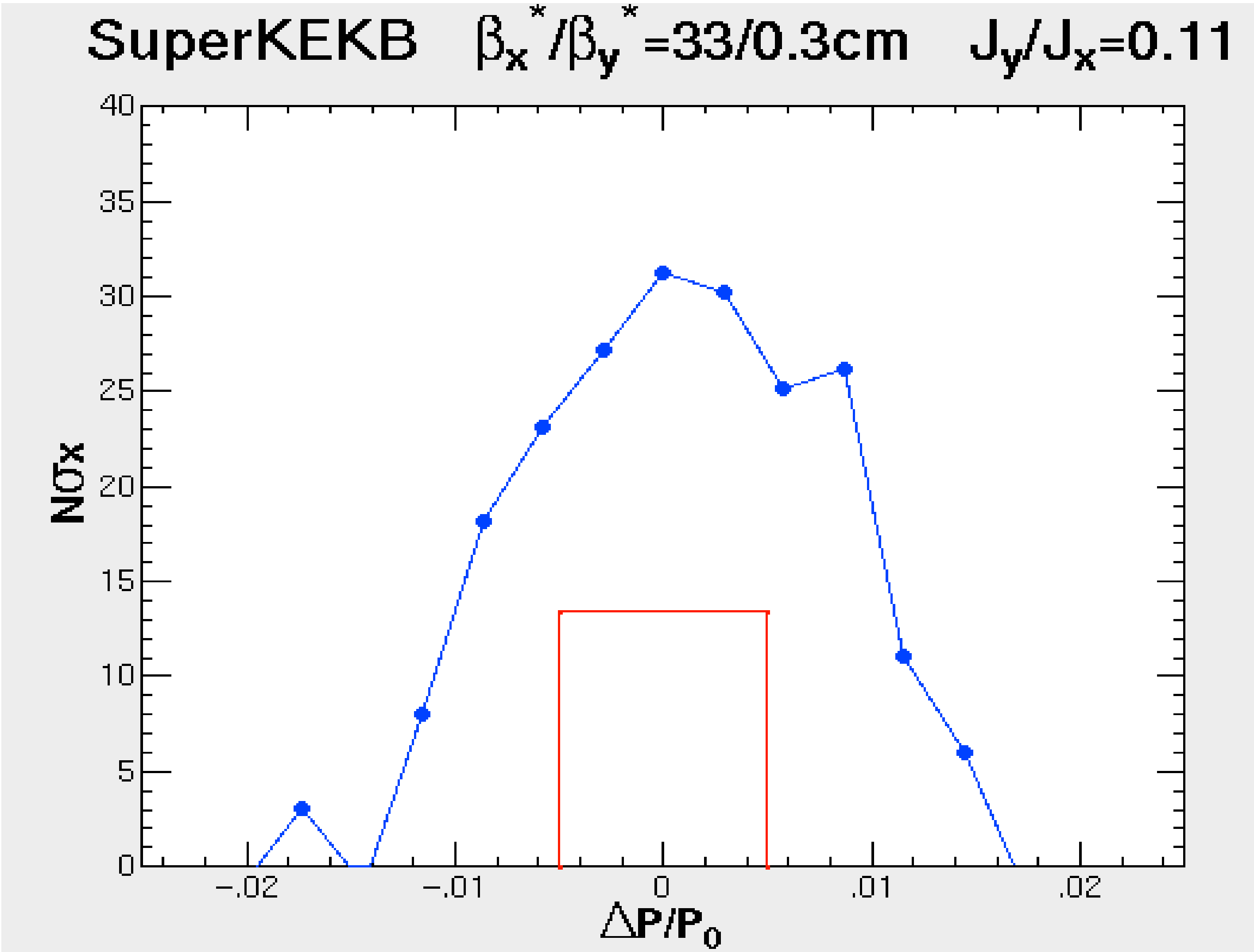




LER IR (II) local chromaticity correction



Dynamic Aperture of LER Bare Lattice (no multipoles, no errors)



Summary

- The dynamic aperture of LER bare lattice satisfies requirements for the beam injection and the lifetime.

  Momentum aperture >0.5%

  Transverse aperture 6E-6 (H) /7E-7 (V) m

  Touschek lifetime ~230 min

- The multipole components of final quadrupoles (QCSs, QC1s(HER), QC2s) will limit the transverse aperture. The aperture study with a more realistic model of IR is now under way for both rings.