Crab Waist Optics

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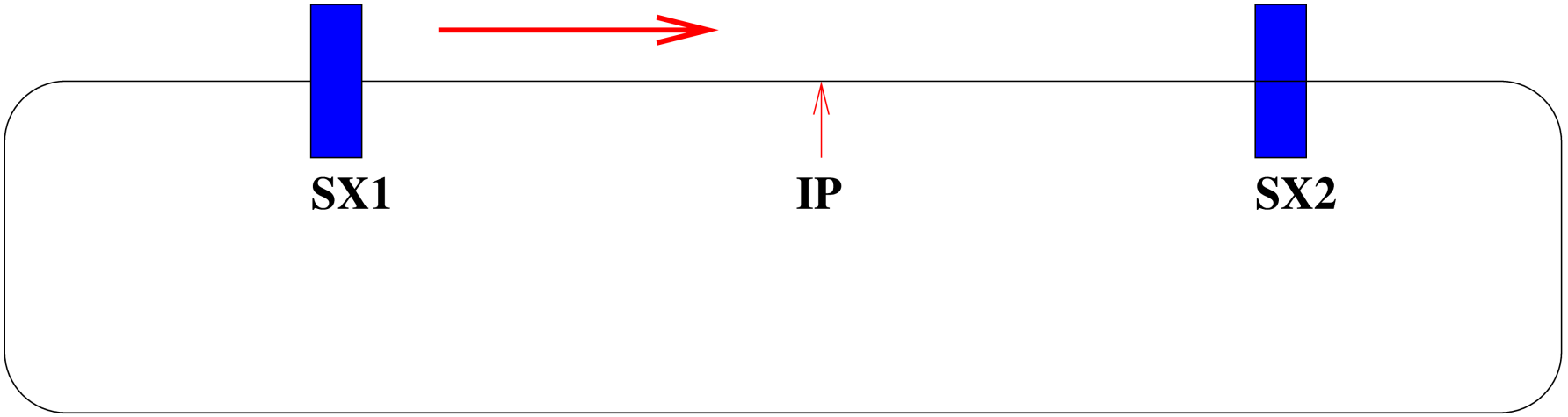
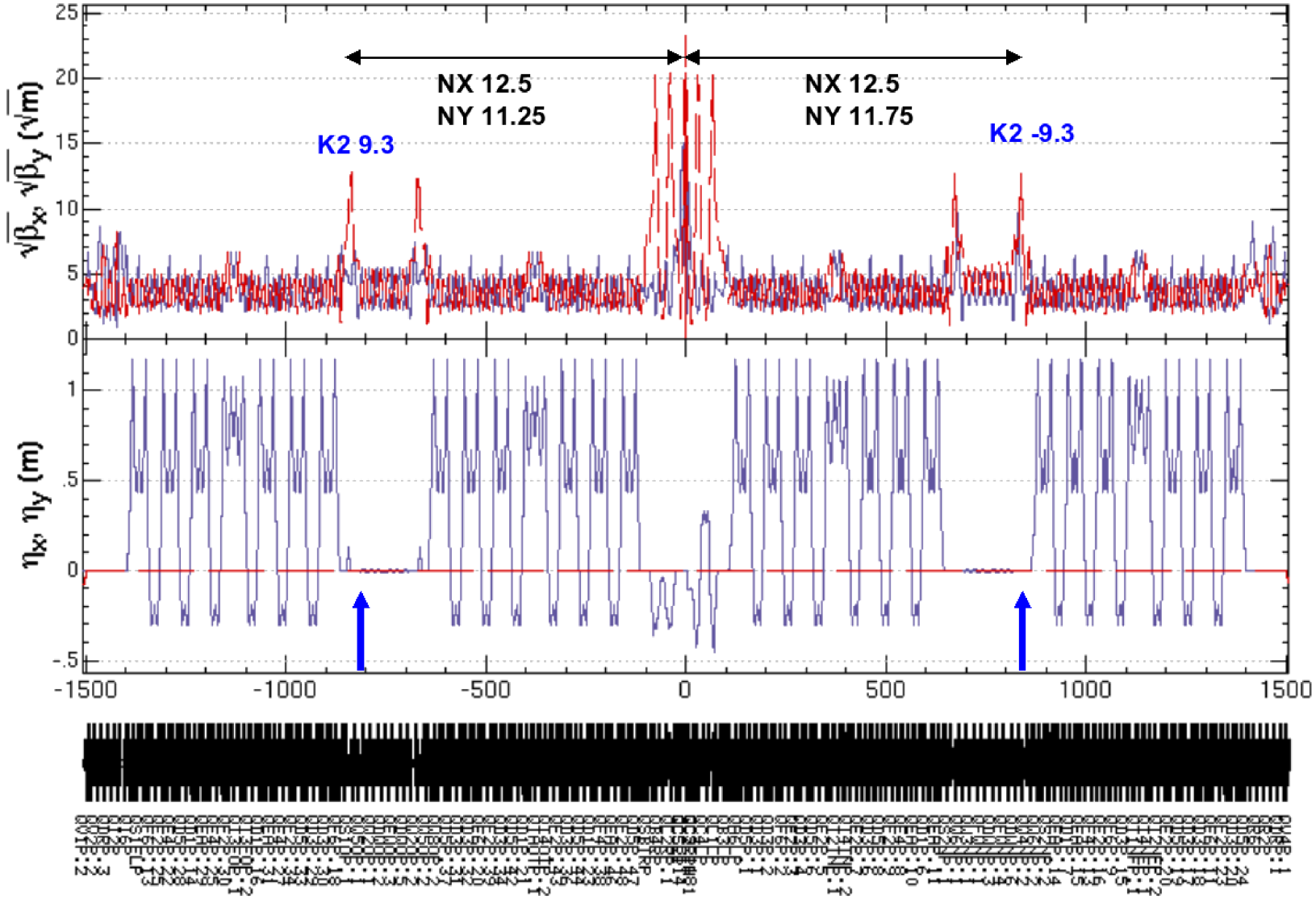
Optics Condition for Crab Waist

- Condition for Crab Waist
  - $\Delta \nu_{x\ SX1\text{-}IP} = \pm \pi + 2n\pi$
  - $\Delta \nu_{y\ SX1\text{-}IP} = \pm \pi/2 + 2n'\pi$
- Condition for Closing Sextupole Kick
  - $\Delta \nu_{x\ SX1\text{-}SX2} = \pm \pi + 2m\pi$
  - $\Delta \nu_{y\ SX1\text{-}SX2} = \Delta \nu_{x\ SX1\text{-}SX2} + 2m'\pi$
  - $\beta_{x\ SX1} = \beta_{x\ SX2}$
  - $\beta_{y\ SX1} = \beta_{y\ SX2}$

n, n', m, and m' are arbitrary integer number.

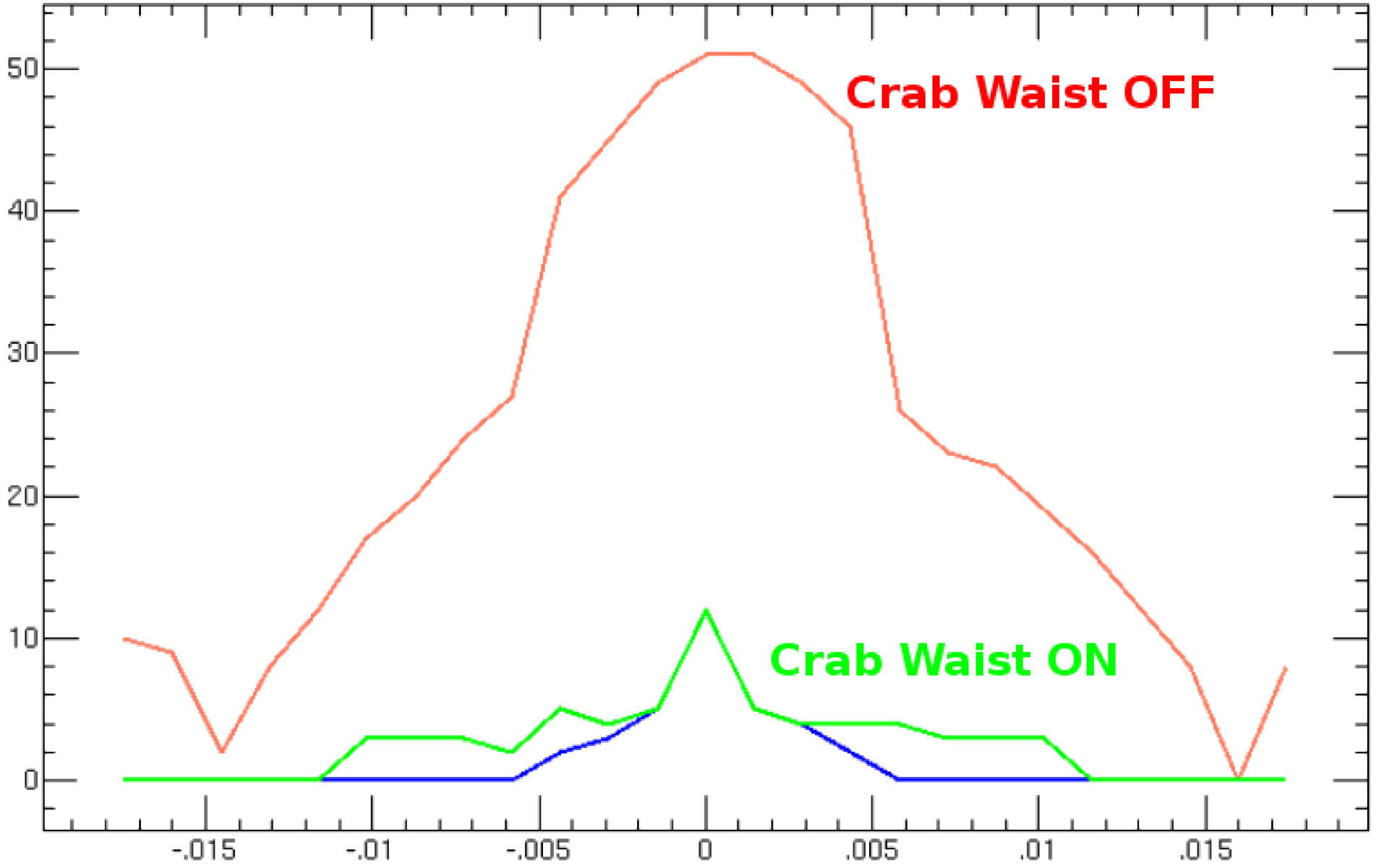


LER Model Optics for Crab Waist



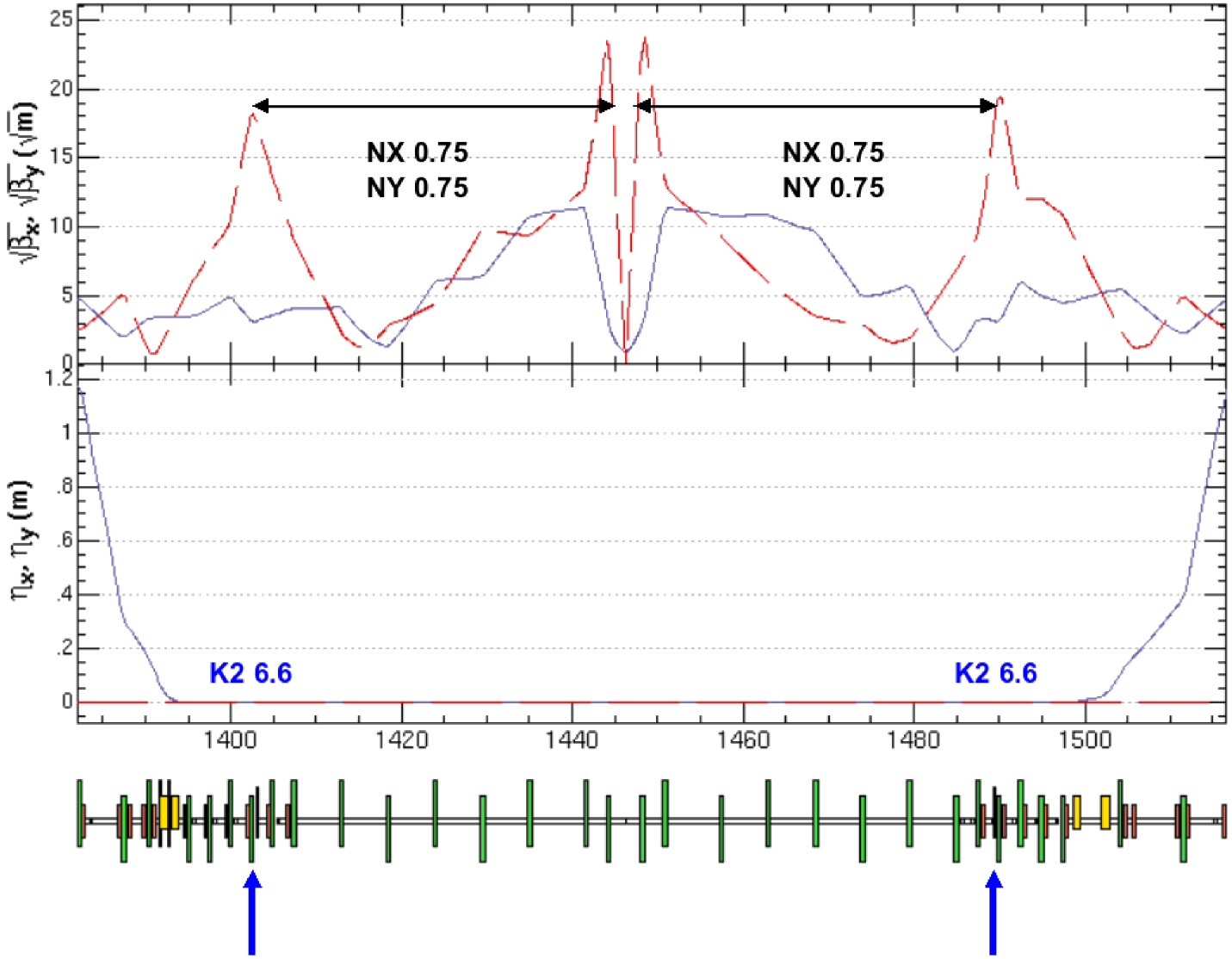
- Insert thin sextupole pair into NIKKO and OHO section
- Transfer between crab waist sextupole pair is I'

Dynamic Aperture of LER Model Optics



- Tracking Condition: XY-Coupling 10%, RFSW ON

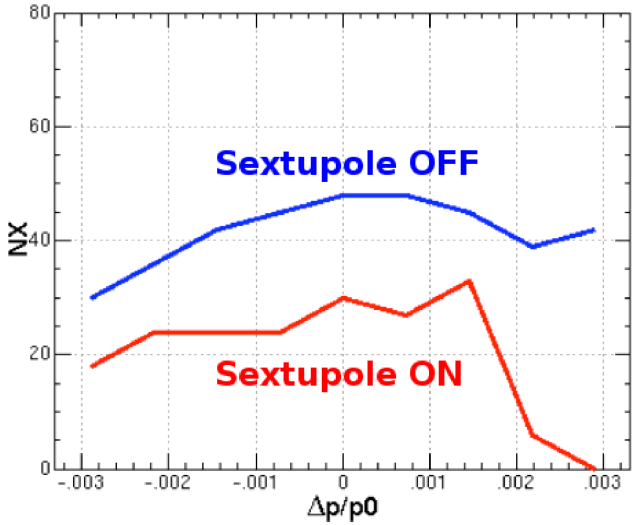
Simple IR Model Optics

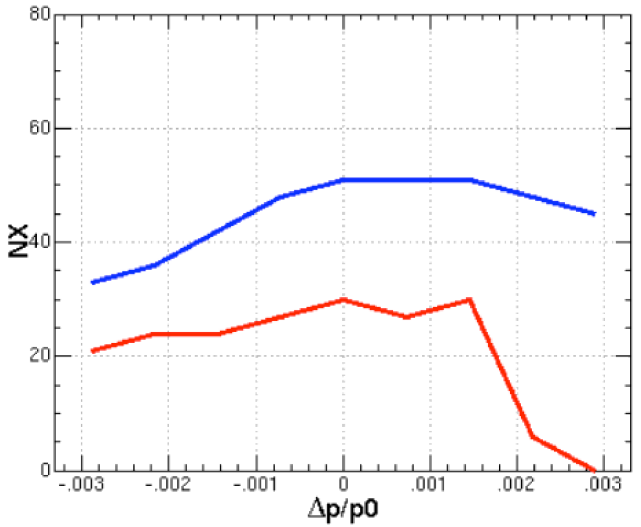


- Replace IR section by simple IR with sextupole pair
- Quadrupole only between sextupole pair
- Outside of IR section is not modified

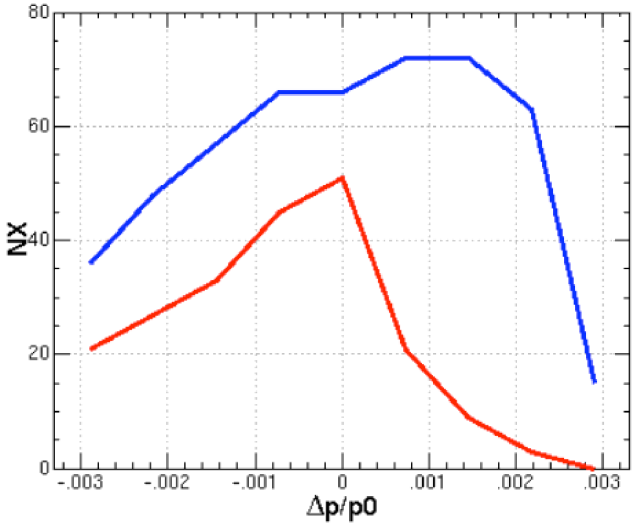
Dynamic Aperture of Simple IR Model

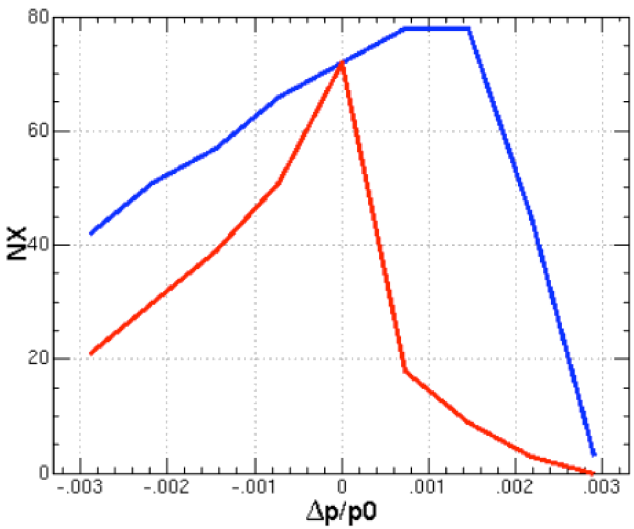
diskin





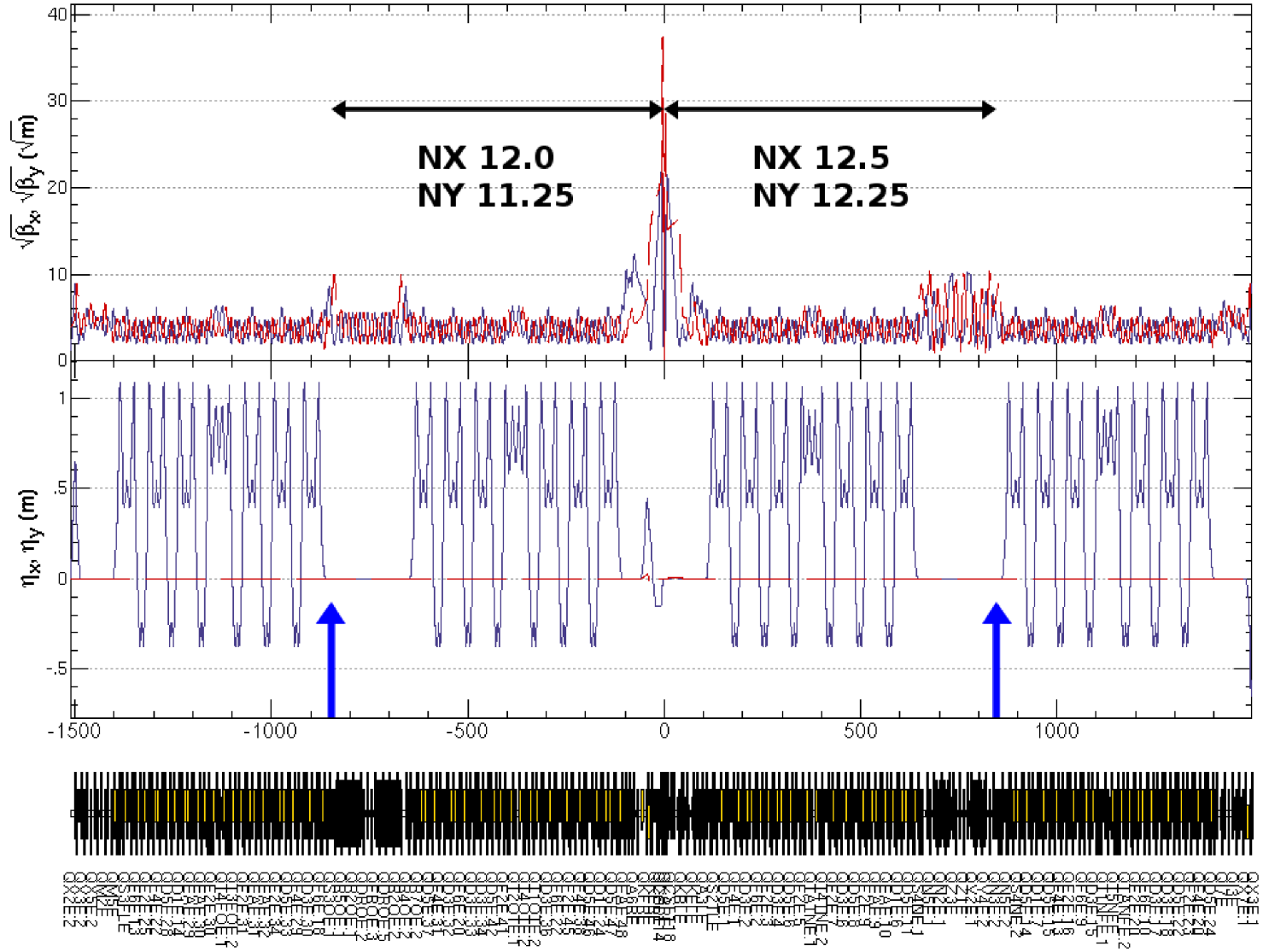
disfring





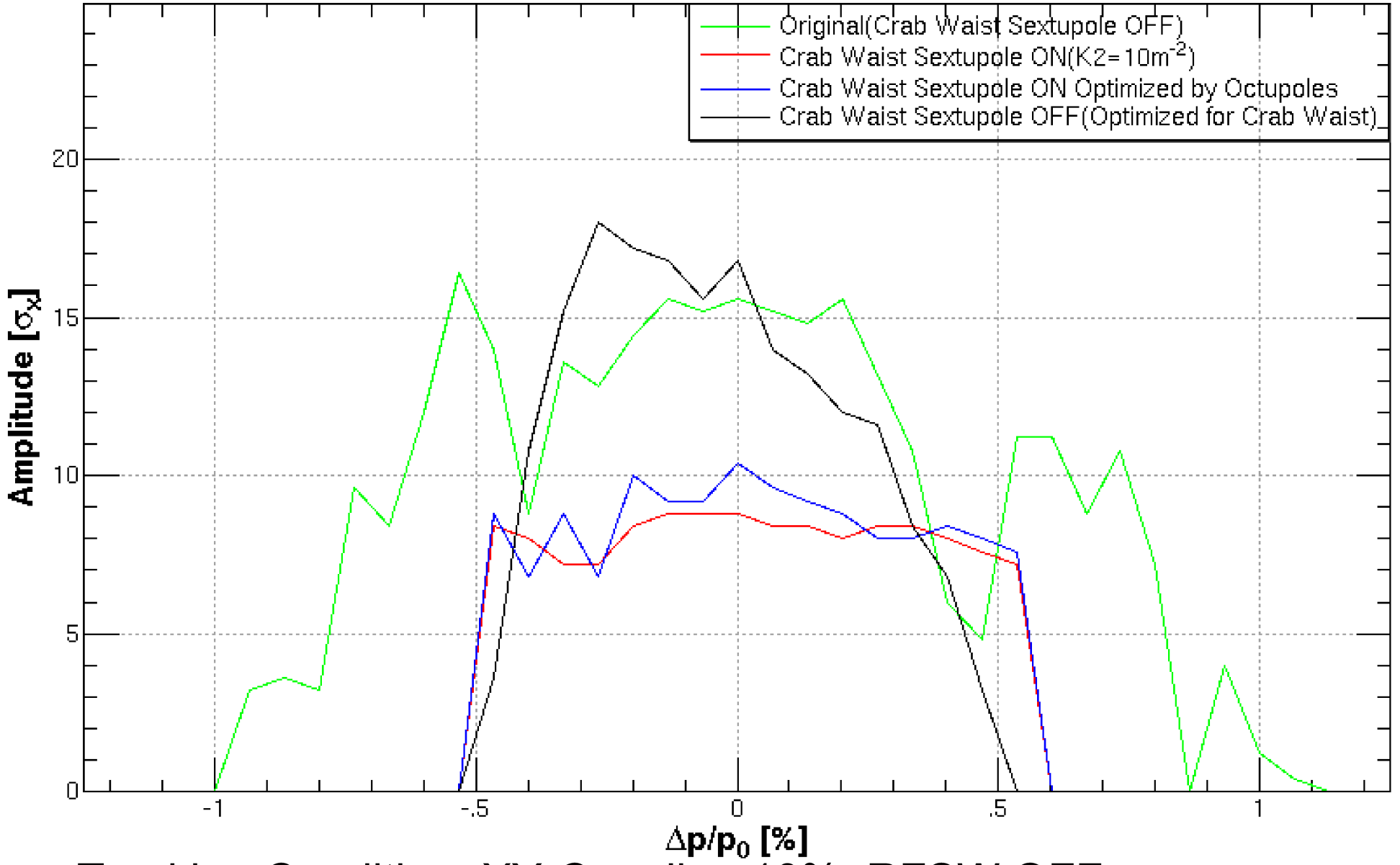
- Tracking Condition: XY-Coupling 10%, RFSW OFF
- disfrin and diskin are applied to quadrupole between sextupole pair

HER Model Optics for Crab Waist



- Insert thin sextupole pair into NIKKO and OHO section
- Transfer between crab waist sextupole pair is -I'

Dynamic Aperture of HER Model Optics



- Tracking Condition: XY-Coupling 10%, RFSW OFF
- K2 and K3 parameters are optimized by TPSA/AN

Summary

- Dynamic aperture is reduced by turning on crab waist sextupole.
  - Transverse aperture reduction is correlated with strength of crab waist sextupole.
- Transverse aperture reduction (on momentum) is caused by both non-linear fringe and kinematic non-linear term of quadrupoles between crab waist sextupole pair.
- Transverse aperture reduction can't be cured by using distributed octupole correctors within reasonable time.
  - We use 1 weeks on 4 core PowerPC G5 system to optimize distributed octupole by TPSA/AN.