

Lattice Design for Crab Cavity

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- HER Optics for Crab Cavity
- Dynamic Aperture(Before/After)

Purpose of Crab Cavity Install

Final Goal

- 'Head-on' collision by crabbing
- Improve luminosity

First Milestone

- Install single crab cavity into HER in 2005 or 2006
 - Cavity test by high current beam
 - Study of crabbing bunch's dynamics

Where do we install cavity?

- NIKKO Section
 - Super-conducting cavities are already installed
 - Empty RF section is available

Crab Cavity Specification

Specification

- Transverse kick: 1.44MV(HER)/1.4MV(LER)
- Optics parameter for cavity design
 - $\Delta v_x(\text{Crab Cavity-IP})=2n\pi+\pi/2$
 - $\beta_{ip}=0.33\text{m}$
 - $\beta_{crab}=100\text{m(HER)}/20\text{m(LER)}$
- Location: Left/Right side of TSUKUBA IR

β_{ip} of current optics: 0.61m

- Parameter for single crab cavity
 - $\beta_{crab}=200\text{m(HER)}/40\text{m(LER)}$

Request to HER Crab Optics

■ from Beam Line

- Install cavity in NIKKO section [QFRNE.4, QDRNE.5]
- Don't move existing Q-magnet
- Minimize additional Q-magnet and power supply

■ from Crab Cavity

- β_x at crab cavity: 200m
- Horizontal phase advance(Crab Cavity-IP): $2n\pi + \pi/2$

■ from Ring Operation

- Keep phase advances of NIKKO section
- Can use low β optics for the case of crab cavity OFF

Rearrangement of HER Lattice

■ Lattice Rearrangement

- Prepare 6 matching parameter at both side
- Symmetrize optics at CC1NE(center of [QFRNE.4, QDRNE.5])
- Add QD at center of [QR5NE.2, QR6NE.2]

■ Matching Condition

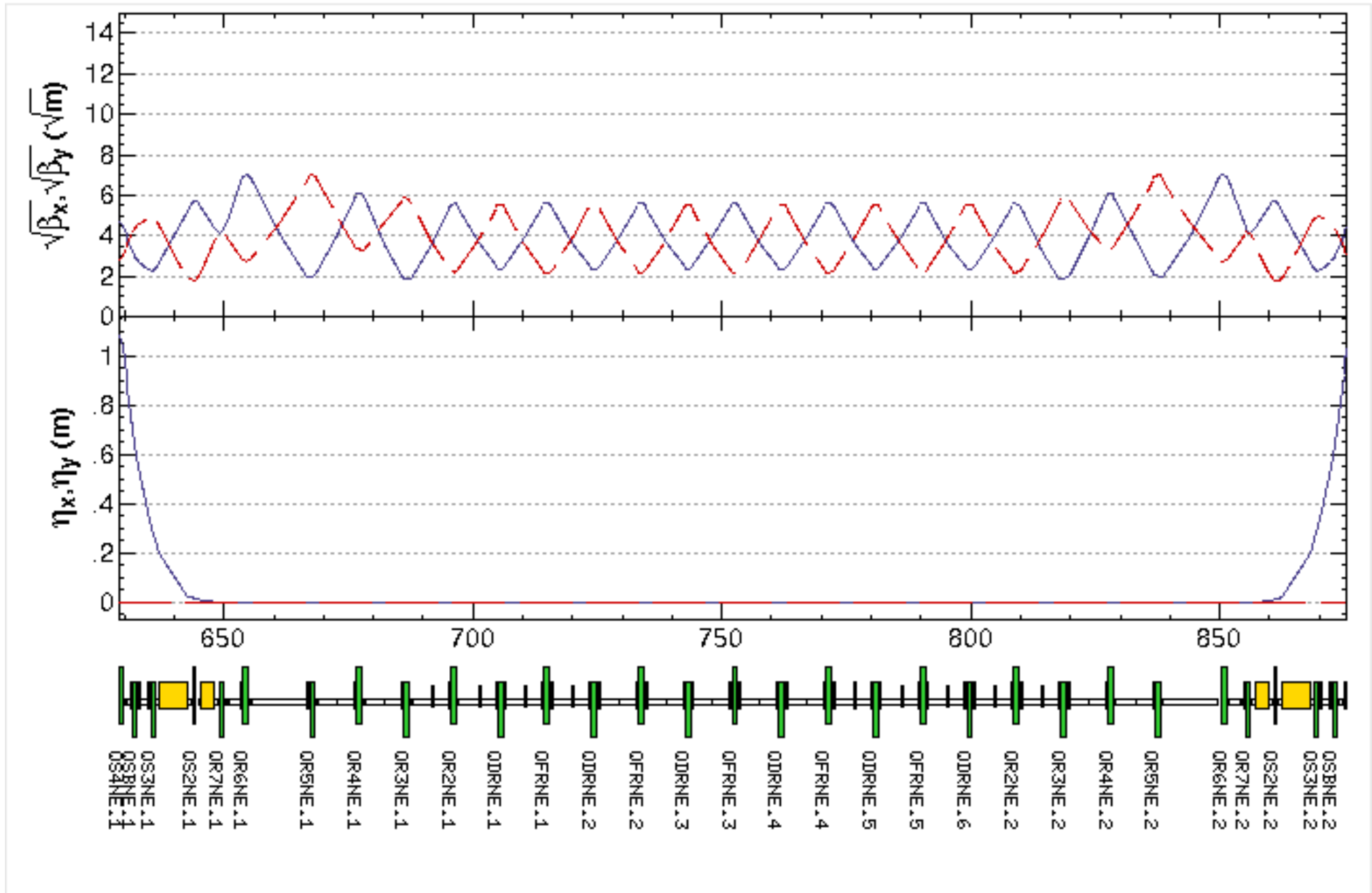
- Keep Optics Function at Boundary($\alpha, \beta, \eta \dots$)
- Crab Cavity: $\beta_x = 200\text{m}, \Delta v_x(\text{CC1NE-IP}) = n + 0.25$
- Symmetry at Crab Cavity: $\alpha_x, \alpha_y(\text{CC1NE}) = 0$
- Keep Vertical Phase Advance(Unbind Horizontal)
- β_{max} at RF Cavity $< 45\text{m}$

■ Original Lattice

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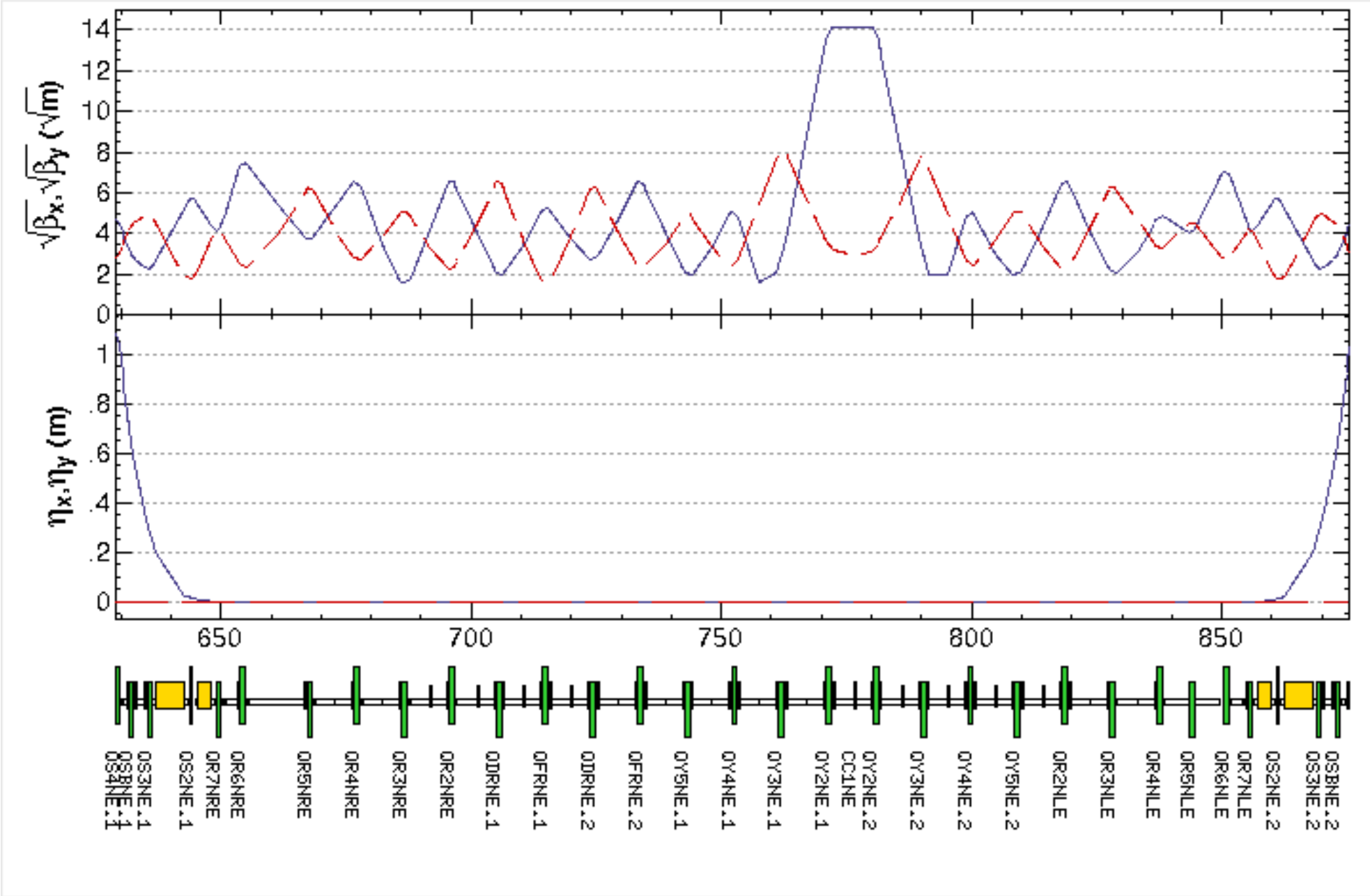
Before Rearrangement

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After Rearrangement

CrabBase20030206



Crab Lattice - Magnet & Power Supply

- Split QR{234567}NE family
 - into QR{234567}NRE, QR{234567}NLE
 - New Element: QR5NLE
- Rearrange Q{DF}RNE.{345}, QDRNE.6, QR2NE.2
- Horizontal Phase Advance 2.9159 2.9711
 - Adjust total tune by FUJI Section (-0.0552)

Power Supply

- QR{234567}NRE 6 magnet
- Q{DF}NE 4 magnet (2 family)
- QY{2345}NE 8 magnet (4 family)
- QR{234567}NLE 6 magnet

Total 18 family [Currently 8 family]

Crab Lattice - Mask & Variable Range

Mask Phase(IP-Mask)

- Vertical Mask: Not Changed
- Horizontal Mask
 - D12H1 ~ D12H4: Not Changed
 - D09H1 ~ D09H4: shift 19.8deg

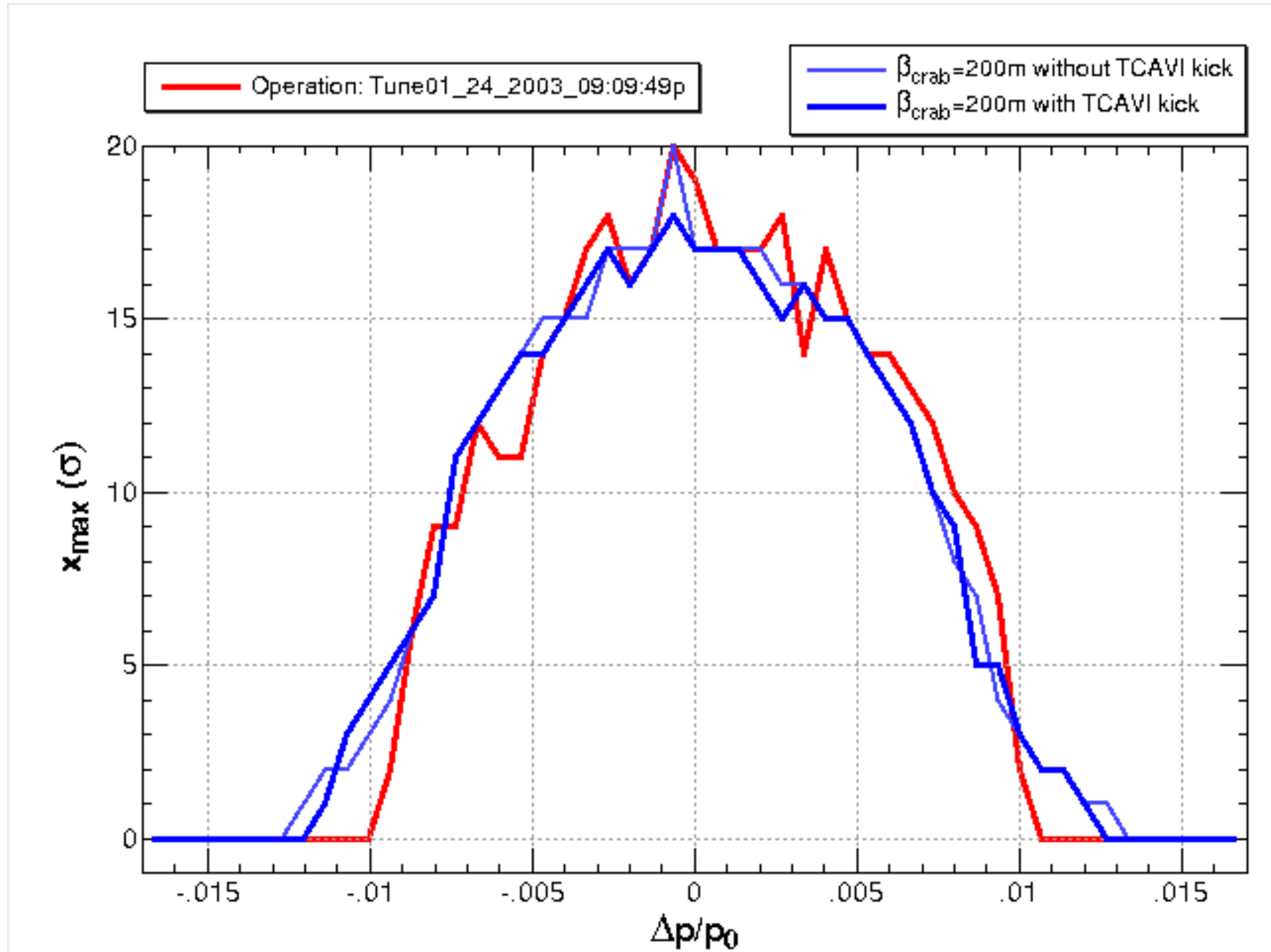
Variable range of Δv_x (IP-Crab)

- $n + .25 \pm 0.08$ (28.8deg)

Variable range of β_{crab}

- 70 ~ 800m

Dynamic Aperture(10% Coupling)



Summary & TODO

Summary

- HER single crab cavity optics is now available
- No problem in single particle dynamic aperture

TODO

- Survey dynamics of crabbing bunch
 - Head-Tail transverse wake kick
 - Beam-Beam kick
- Design LER single crab cavity optics