

Crab Crossing Optics

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Schedule & Cavity Install Position

Upgrade Schedule

- Upgrade HER & LER NIKKO straight section in 2005 summer shutdown
 - Lattice upgrade only
 - Add 4 steering magnet to LER
 - Change Q magnet families
- Install cavity in winter shutdown between 2005 and 2006

Crab Cavity Install Position

- NIKKO straight section(HER & LER)
 - Empty RF section is available in HER
 - Empty wiggler section is available in LER
 - Super-conducting cavities are already installed in HER
 - ▶ Cryogenic system is available
 - LER needs additional weak bend at upstream of cavity

Parameter for 11mrad Crabbing

Specification of Crab Cavity

- Transverse kick: 1.44MV(HER)/1.4MV(LER)

IP horizontal β Function

- $\beta_{ip} = 0.56\text{m(HER)}/0.59\text{m(LER)}$

Required Optics Parameter at Cavity Position

- $\Delta\nu_x(\text{Crab Cavity-IP}) = 2n\pi \pm \pi/2$
- $\beta_{crab} = 200\text{m(HER)}/40\text{m(LER)}$
- $\eta_x = \eta'_x = 0$

HER & LER Lattice Structure

HER (Revised from MAC2003)

Structure: Semi-Symmetric

Cavity: QFRNE.4-QDRNE.5

Additional Power Supply

5 single-quadrupole magnet PS

1 or 3 double-quadrupole magnet PS

$\beta_{\text{crab}} = 200\text{m}/\Delta\nu_x(\text{Crab Cavity-IP}) = 2n\pi - \pi/2$

$(\Delta\nu_x, \Delta\nu_y) = (+1, -1)$ from Current Operation

Revised to reduce cost of new Q-magnet/BPM/steerings/PS...

LER (New)

Structure: Symmetric

Cavity: QW4NP.1-QW3NP.1

Exchange ZHQS1NP \leftrightarrow ZVQS1NP

Additional 4 steering magnet(BS2NP-QW8NP)

Additional 2 steering magnet PS

$\beta_{\text{crab}} = 40\text{m}/\Delta\nu_x(\text{Crab Cavity-IP}) = 2n\pi + \pi/2$

Operation Tune is Not Changed

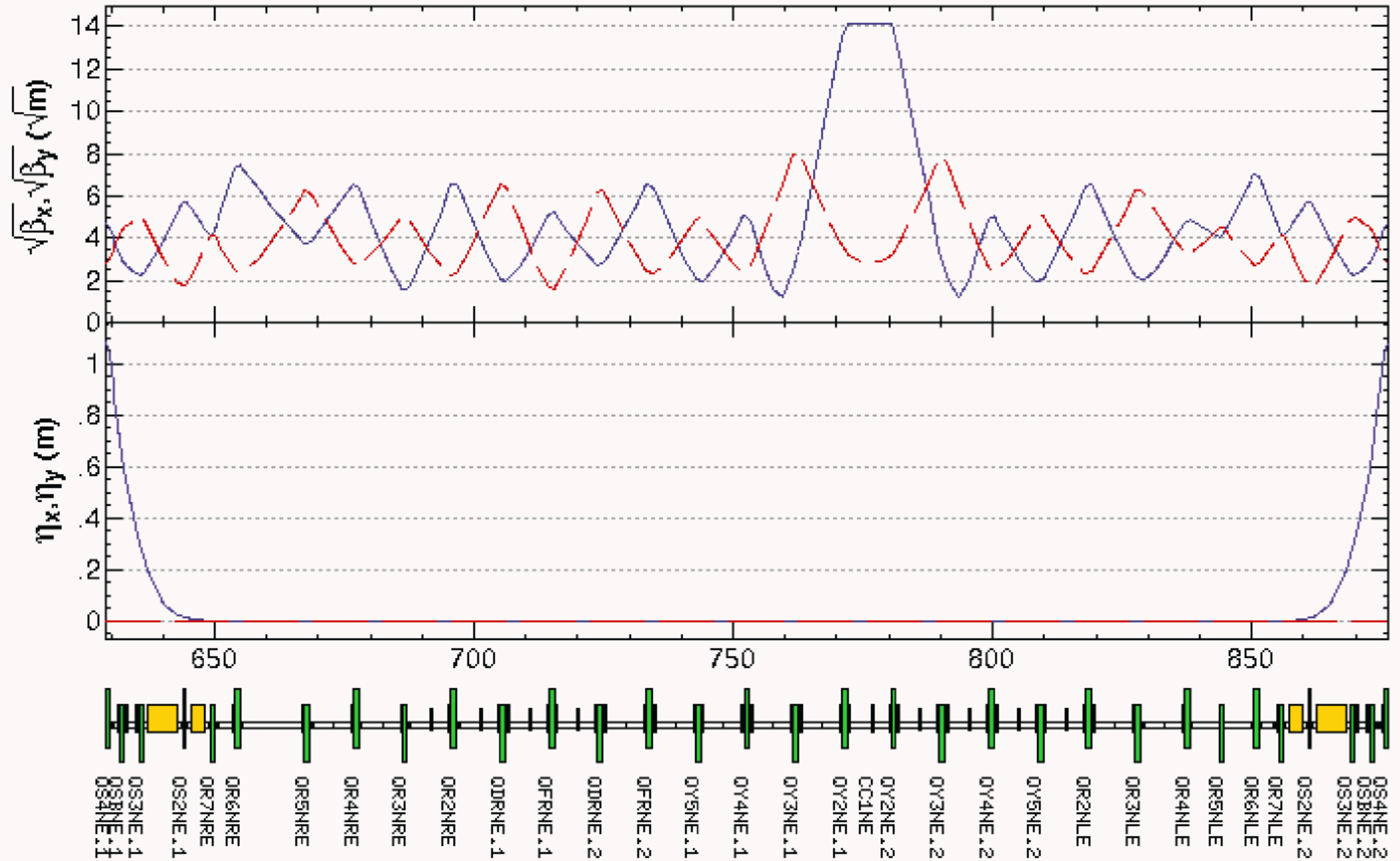
Weak Bend

Bending angle 2×0.9 mrad ($\rho \sim 380\text{m}$)

$\Delta s(\text{weak bend - crab}) \sim 36\text{m}$

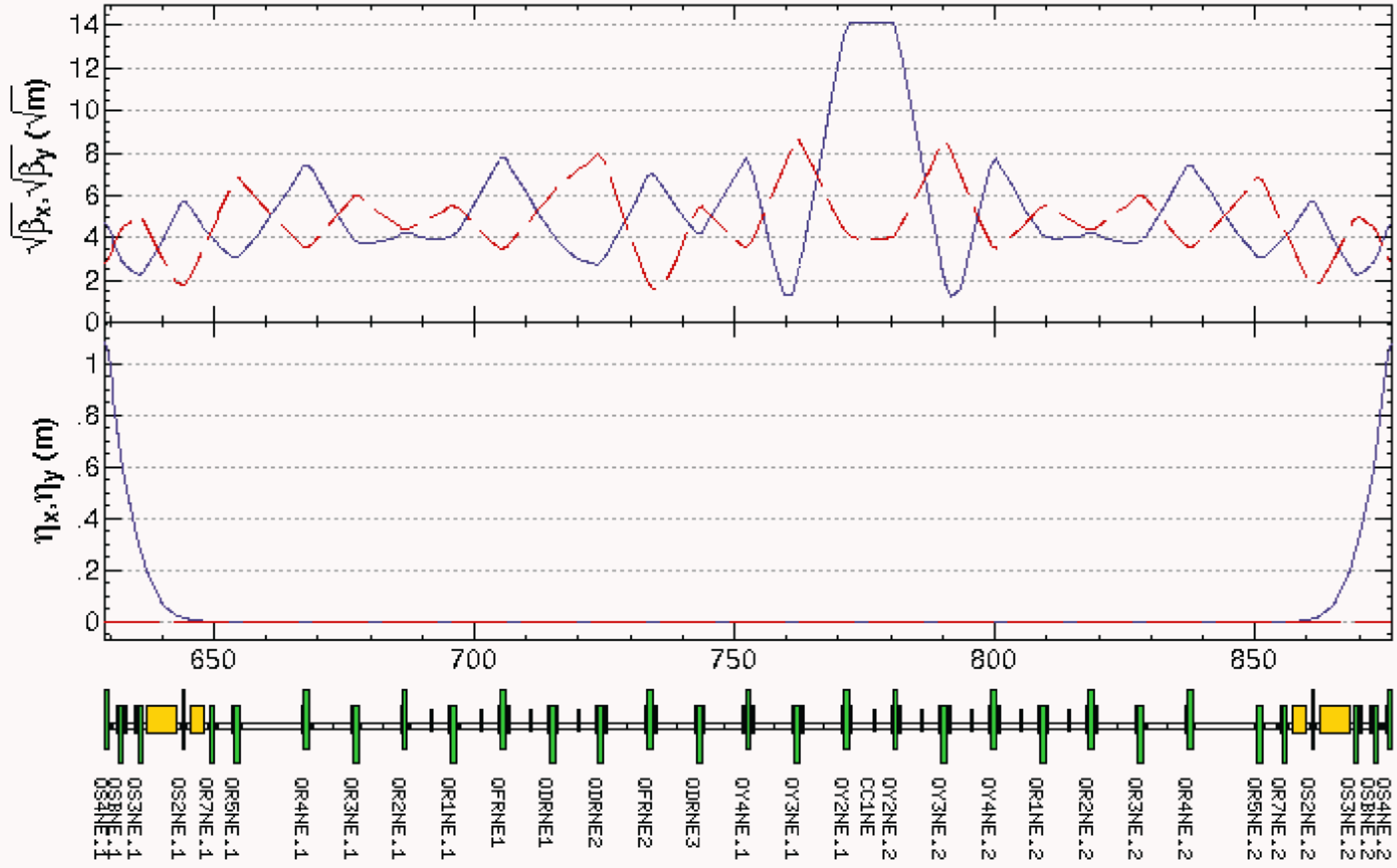
HER Asymmetric Lattice(MAC2003)

CrabBase20030206



HER Semi Symmetric Lattice(New)

herfq270CrabSSa



Magnet & Power Supply(HER)

Original
8 family

QDRNE.6
QFRNE.5
QR2NE.2
QR3NE.2
QR4NE.2
QR5NE.2
QR6NE.2
QR7NE.2

SemiSymmetric
6 + 3 + 5 family

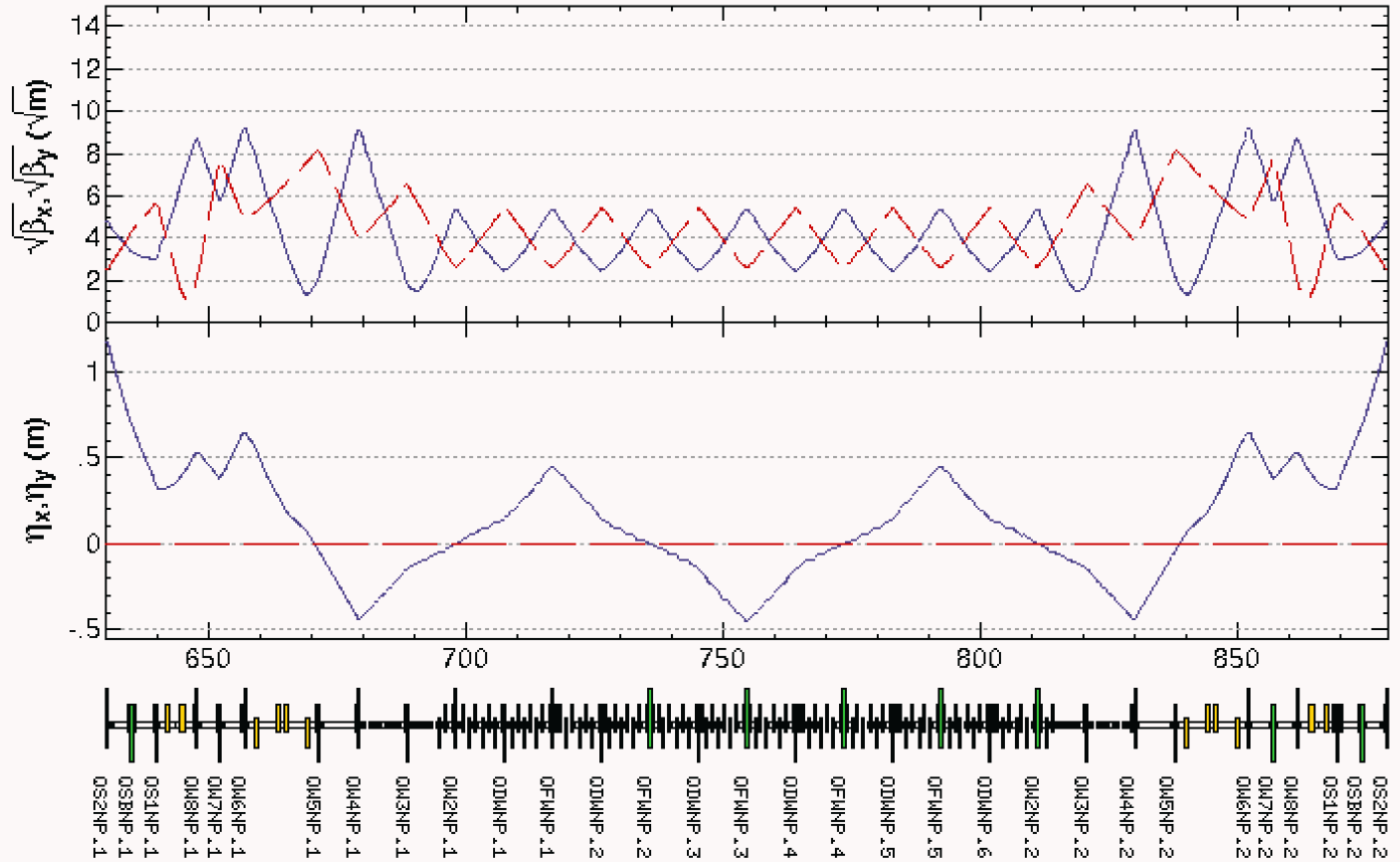
QY2NE.2
QY3NE.2
QY4NE.2
QDRNE1.1
QDRNE2.1
QDRNE3.1
QFRNE1.1
QFRNE2.1
QR1NE.2
QR2NE.2
QR3NE.2
QR4NE.2
QR5NE.2
QR7NE.2

Asymmetric
6 + 2 x 6 family

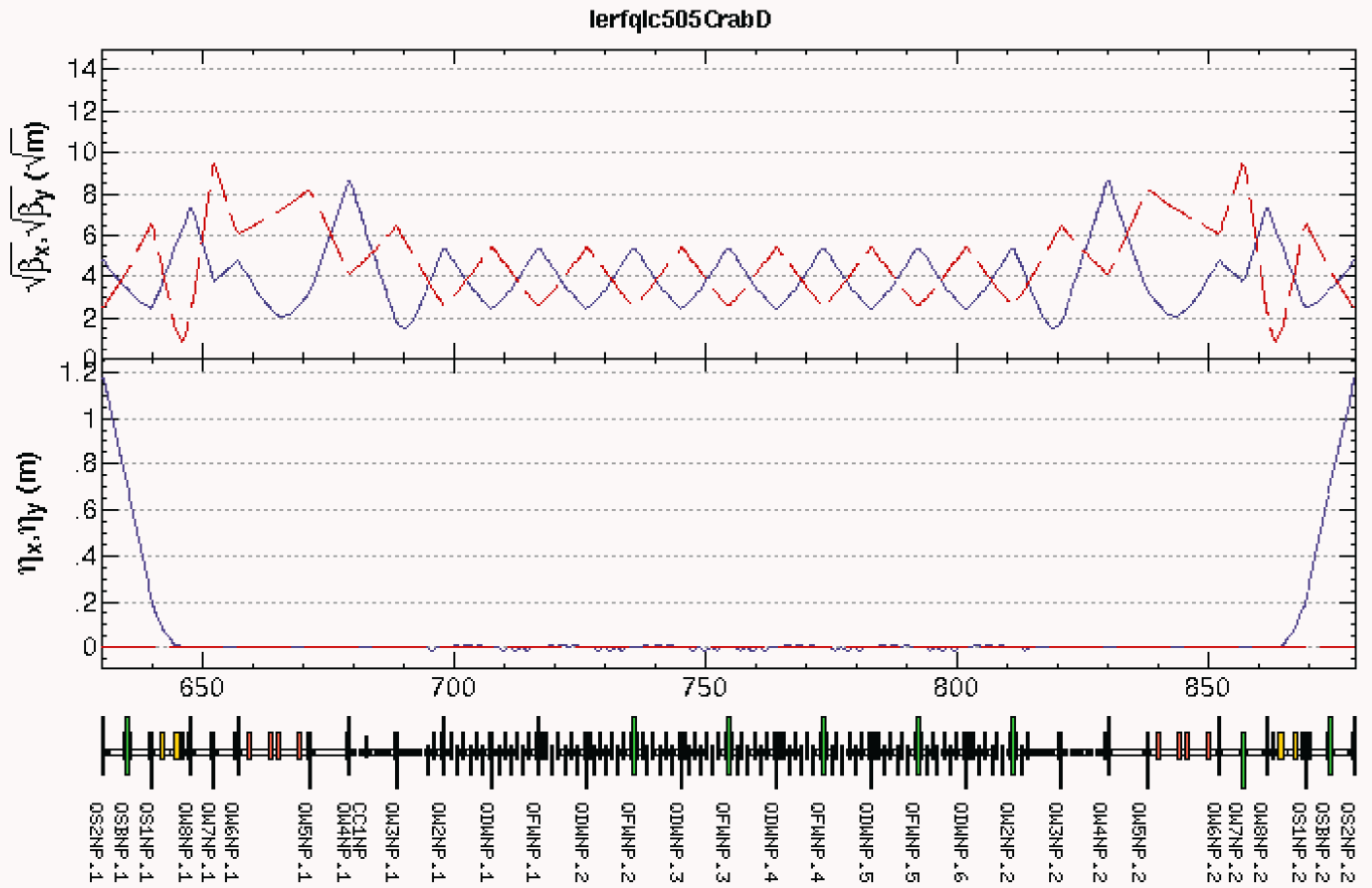
QDRNE.2
QFRNE.2
QY2NE.2
QY3NE.2
QY4NE.2
QY5NE.2
QR2N{LR}E.1
QR3N{LR}E.1
QR4N{LR}E.1
QR5N{LR}E.1
QR6N{LR}E.1
QR7N{LR}E.1

LER Original Lattice

Tune07_01_2003_08:02:22pRef

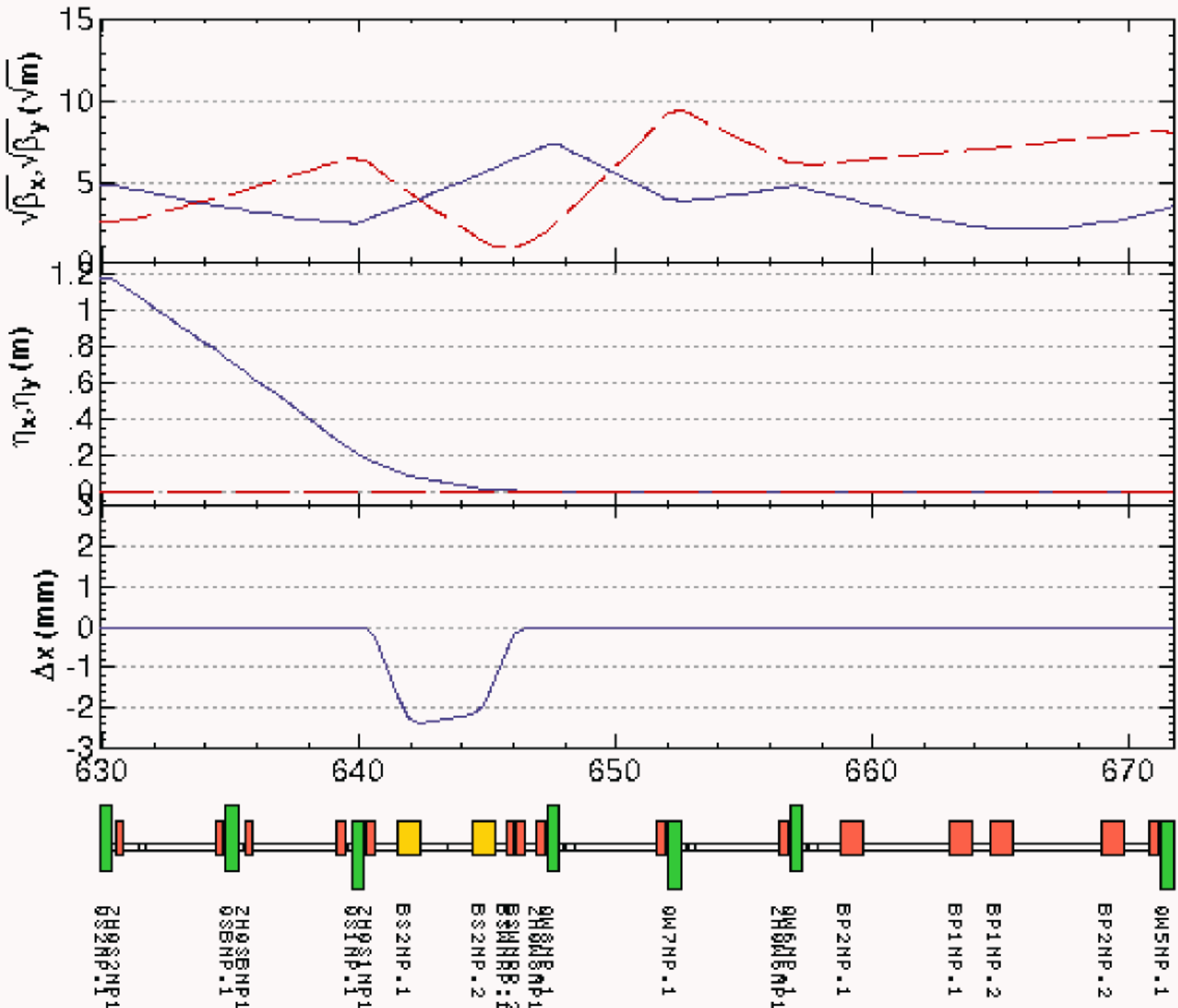


LER Crab Lattice



LER Crab Lattice(Upstream Zoom)

lerfqlc505CrabD



Magnet & Power Supply(LER)

Original 9 family

QW5NP.2
QW6NP.2
QW7NP.2
QW8NP.2
QS1NP.2
QSBNP.2
BS2NP.4
BP1NP.4
BP2NP.4

Symmetric 9 + 2 family

QW5NP.2
QW6NP.2
QW7NP.2
QW8NP.2
QS1NP.2
QSBNP.2
BS2NP.4
BSWNLP.2
BSWNRP.2
BP1NP.4
BP2NP.4

Tuning Range

HER

■ Mask Phase(IP-Mask)

- Horizontal D12H1~D12H4/ Vertical Mask: **Not Changed**
- Horizontal D09H1~D09H4 Mask: **+108deg**

■ Maximum β ($\Delta\nu_{\text{crab}} \pm 0.04 / \beta_{\text{crab}} = 100 \sim 300\text{m}$)

$\beta_{\text{max}}(\text{H/V})$

Matching-R 71/83

RF Sect.-R 70/77

RF Sect.-L 70/44

Matching-L 71/83

LER

■ ν_{crab} range at $\beta_{\text{crab}} = 40\text{m}$

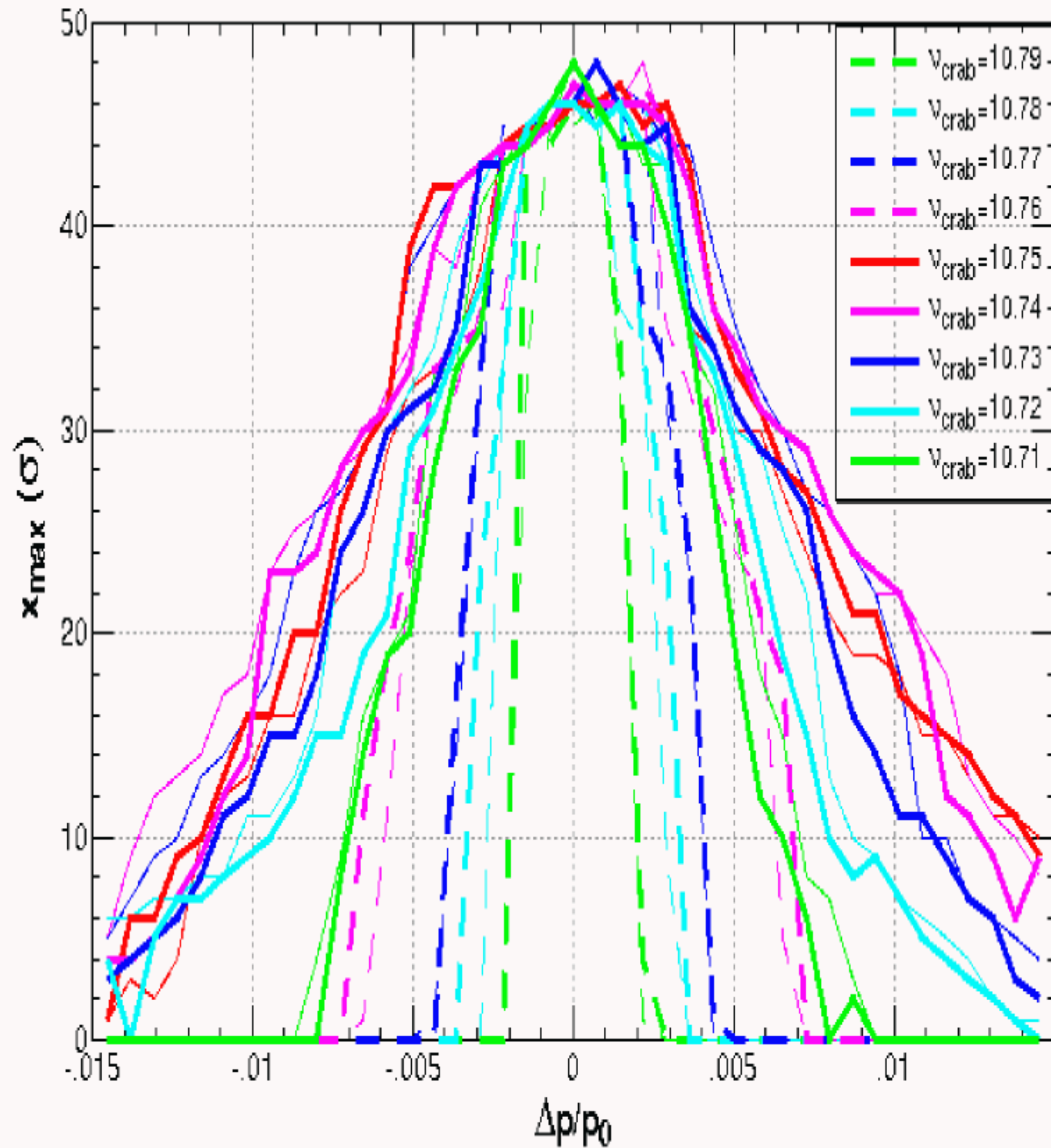
- $10.25 \pm 0.04 [\beta_x < 130\text{m} / \beta_y < 130\text{m}]$

■ β_{crab} range at $\nu_{\text{crab}} = 10.25$

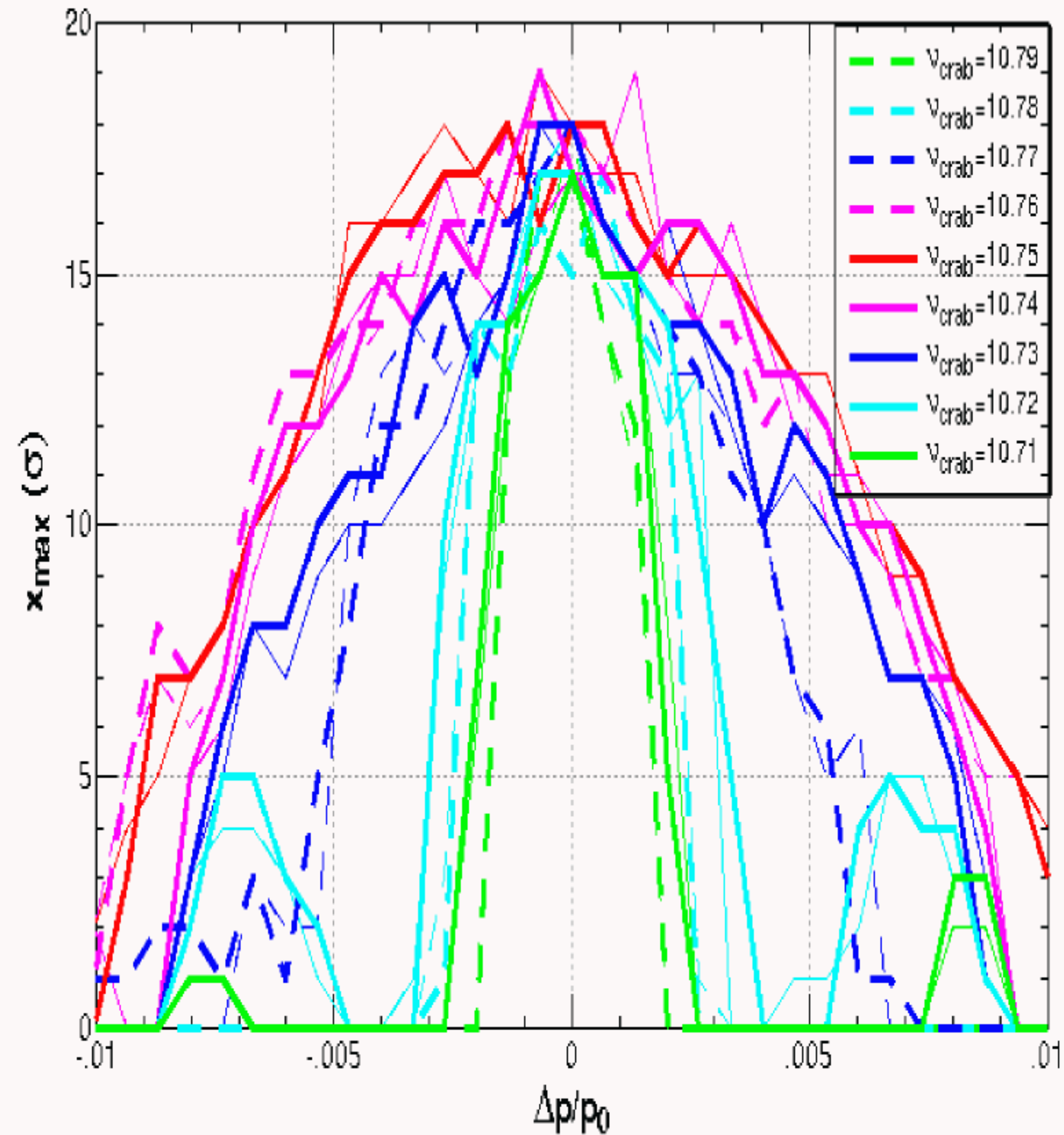
- $20 \sim 60\text{m} [\beta_x < 109\text{m} / \beta_y < 130\text{m}]$

Dynamic Aperture(4000 turns)

LER Symmetric



HER Semi-Symmetric



Summary & TODO

Summary

- HER & LER crabbing optics is now available
- No problem in single particle dynamic aperture
 - Need chromaticity matching to cure momentum aperture reduce by changing betatron phase

TODO

- Check instability caused by crabbing bunch
 - Crabbing bunch with linear transverse wake (under studying)