Lattice Analysis

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KEKB Accelerator Review
Committee Meeting

March 8, 1999

Lattice for commissioning

Lattice for BEAST

- Almost same as that for Belle
- No detector solenoid
- 10 % excitation of compensation solenoid
- Make local bumps to adjust orbit and dispersion in IR

Relaxed β^* (β^*x =1 m, β^*y = 0.02 m)

- Possible to decrease β^*y to 0.008 m by adjusting only 12 quadruples in the tuning sections

Chromaticity correction

- Noninterleaved 56-family correction
- Local correction in IR only for LER (vertical direction)

Wigglers in LER

- installed but not used

Energy (dipole field)

- Adjusted to match BT line.
- Nominal values were determined so as to minimize synchrotron oscillation observed by single pass monitor.

Closed Orbit

- Global closed orbit -- Successfully corrected with conventional method (SVD or MICAD) to less than 1 mm rms.
- Local bump -- Used in fine tuning of orbit (in particular in IR) and diagnostics of machine errors.

Transverse tune

- Even after a few steps of improvement, there are still some deviations from model in both rings (largest in LER vertical tune).
- Need precise calibration between various magnet to identify error sources.

Dispersion

- Peak values of horizontal dispersion agree with model within 16% in LER and 6% in HER, assuming design α.
- Sometimes large vertical dispersion was observed.
- So far, not yet tried dispersion correction.

Chromaticity

- Not so big deviation from model .
- Necessary to adjust tunes of model lattice to measured ones in finding solution of sextupole strength.

β function

- Big mismatch of LER vertical optics was observed in response of single kick orbit and in measurement with trim coil of each quadrupole
- Matching was almost recovered by adjusting QCS strength of +0.8 %
- Vertical β functions at QC1L/RE and QC3LE agree with model in HER

Emittance / XY coupling

- Reduced vertical beam size by tuning bumps at sextupoles (reduced coupling to 20% in HER).
- Measured tune split at coupling resonance.
- Measured bump response around IP.

Beam-based measurement of BPM offset (Quad-BPM measurement)

- Measured for several BPMs in IR and helped us to find inconsistency of BPM readings.

Strength deviation of quadrupoles

- Partly checked with local bump.
- Computing tools are being developed to determine strength errors from single kick response and from globally measured β function.

Next steps

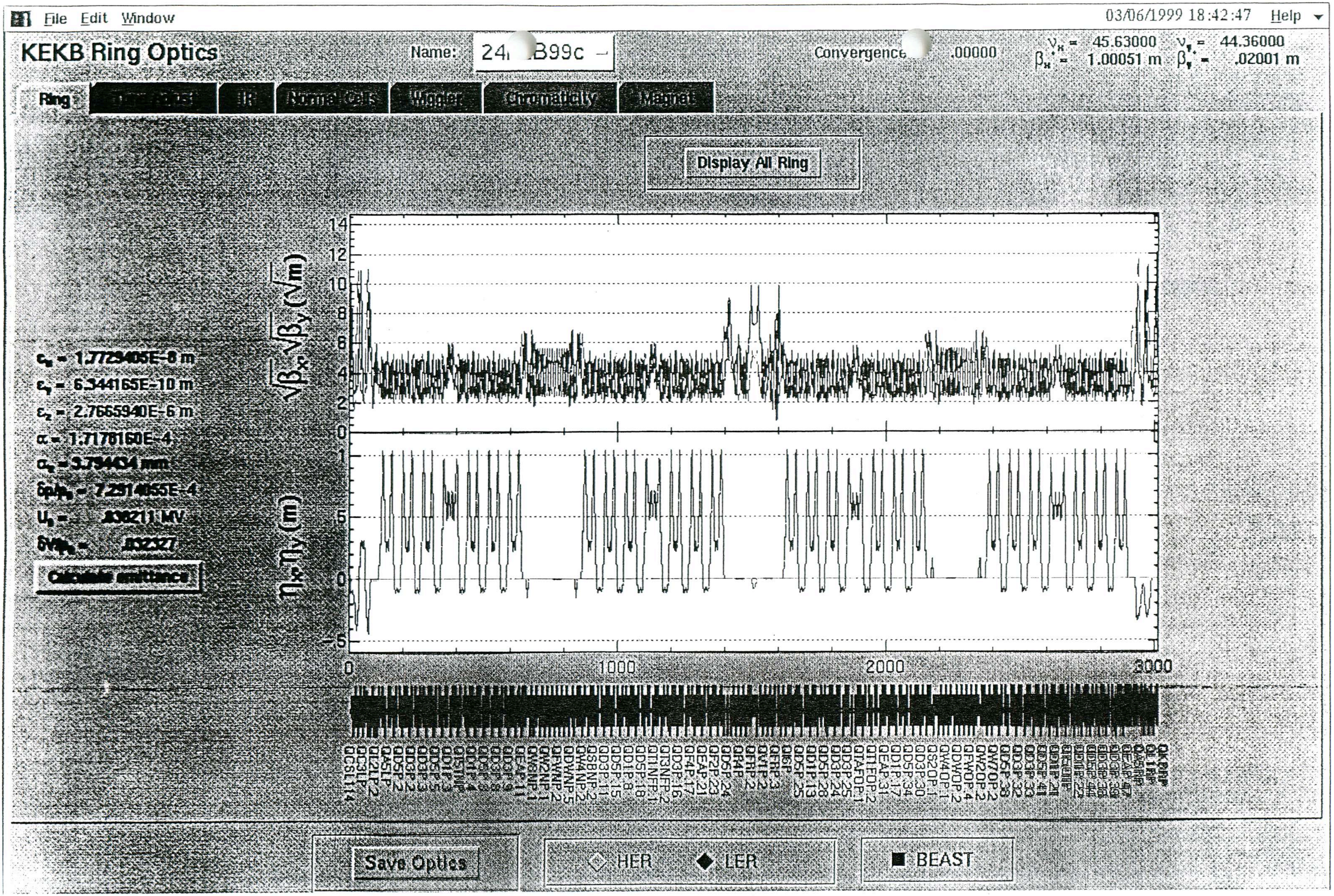
Reduce β^*y to 1 cm.

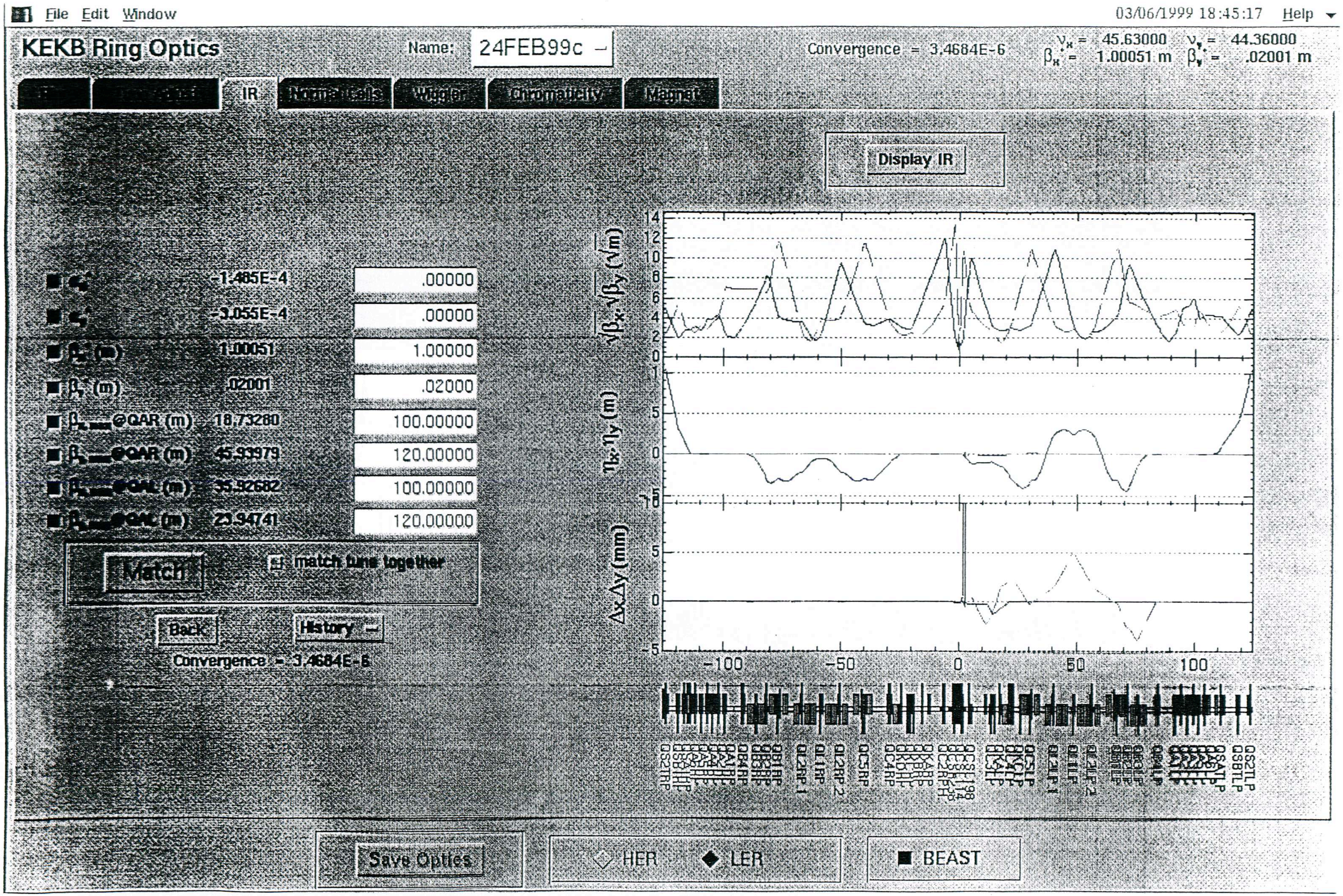
Reduce vertical emittance by bump tuning, xy coupling correction by skew quadrupoles etc.

Precise measurement of strength errors of quadrupoles by local bump to find sources of tune difference.

Measure BPM offset by quad-BPM method.

Measure sextupole offset with local bump, movers, K-modulation.


File Edit Window
03/06/1999 18:42:47
Help
KEKB Ring Optics
Name:
Convergence
.00000
νx = 45.63000
νy = 44.36000
βx* = 1.00051 m
βy* = .02001 m
Ring
IR
Wiggler
Chromaticity
Magnet
Display All Ring
εx = 1.7729405E-8 m
εy = 6.344165E-10 m
εz = 2.7665940E-6 m
α = 1.7176160E-4
σz = 3.794434 mm
δp/p0 = 7.2914055E-4
U0 = .836211 MV
δV/p0 = .032327
Calculate emittance
√βx, √βy (√m)
ηx, ηy (m)
0
1000
2000
3000
Save Optics
HER
LER
BEAST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03/06/1999 18:45:17 Help
KEKB Ring Optics
Name: 24FEB99c
Convergence = 3.4684E-6
νx = 45.63000 νy = 44.36000
βx* = 1.00051 m βy* = .02001 m
IR
Normal Cells
Wiggler
Chromaticity
Magnet
Display IR
-1.485E-4 .00000
-3.055E-4 .00000
1.00051 1.00000
.02001 .02000
18.73280 100.00000
45.93979 120.00000
35.92682 100.00000
23.94741 120.00000
Match
match tune together
Back
History
Convergence = 3.4684E-6
√βx,√βy (√m)
ηx,ηy (m)
Δx,Δy (mm)
-100
-50
0
50
100
QS2TRP
QC5RP
QL1RP
QCS
QB4LP
QS2TLP
Save Optics
HER
LER
BEAST

File Edit Window — 03/08/1999 03:25:15 — Help

KEKB Ring Optics

Name: Temp02_24_1999_08:13:26

Convergence = .01579

ν_x = 44.50700 ν_y = 42.26500

β_x^* = .99995 m β_y^* = .02002 m

Ring | Tune Adjust | IR | Normal Cells | RF | Chromaticity | Magnet

Display All Ring

ϵ_x = 1.7801776E-8 m

ϵ_y = 1.191181E-13 m

ϵ_z = 3.3572871E-6 m

α = 1.8797913E-4

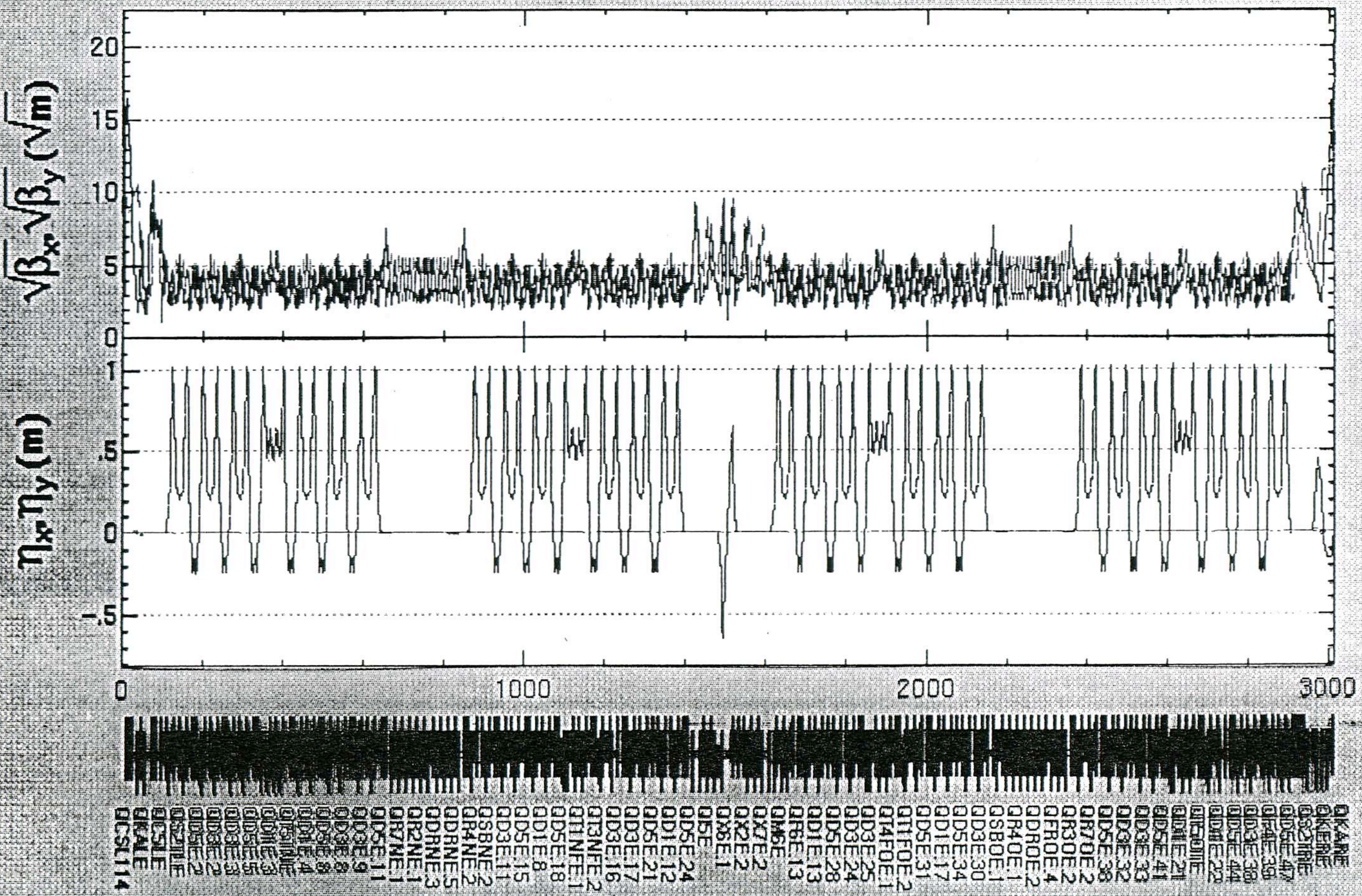
σ_z = 5.036566 mm

$\delta p/p_0$ = 6.6558283E-4

U_0 = 3.487384 MV

$\delta V/p_0$ = .017001

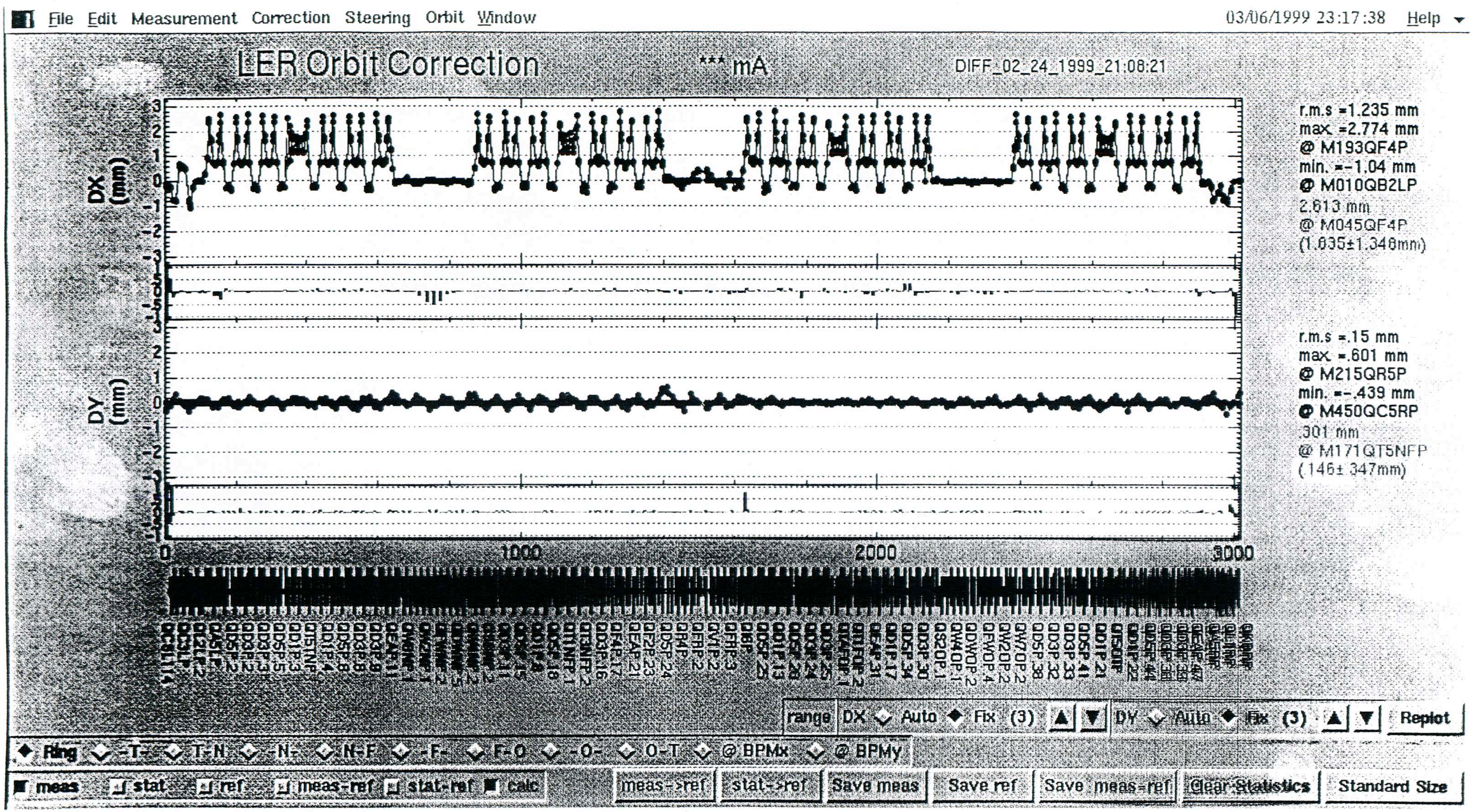
Calculate emittance



Save Optics

◆ HER ◇ LER

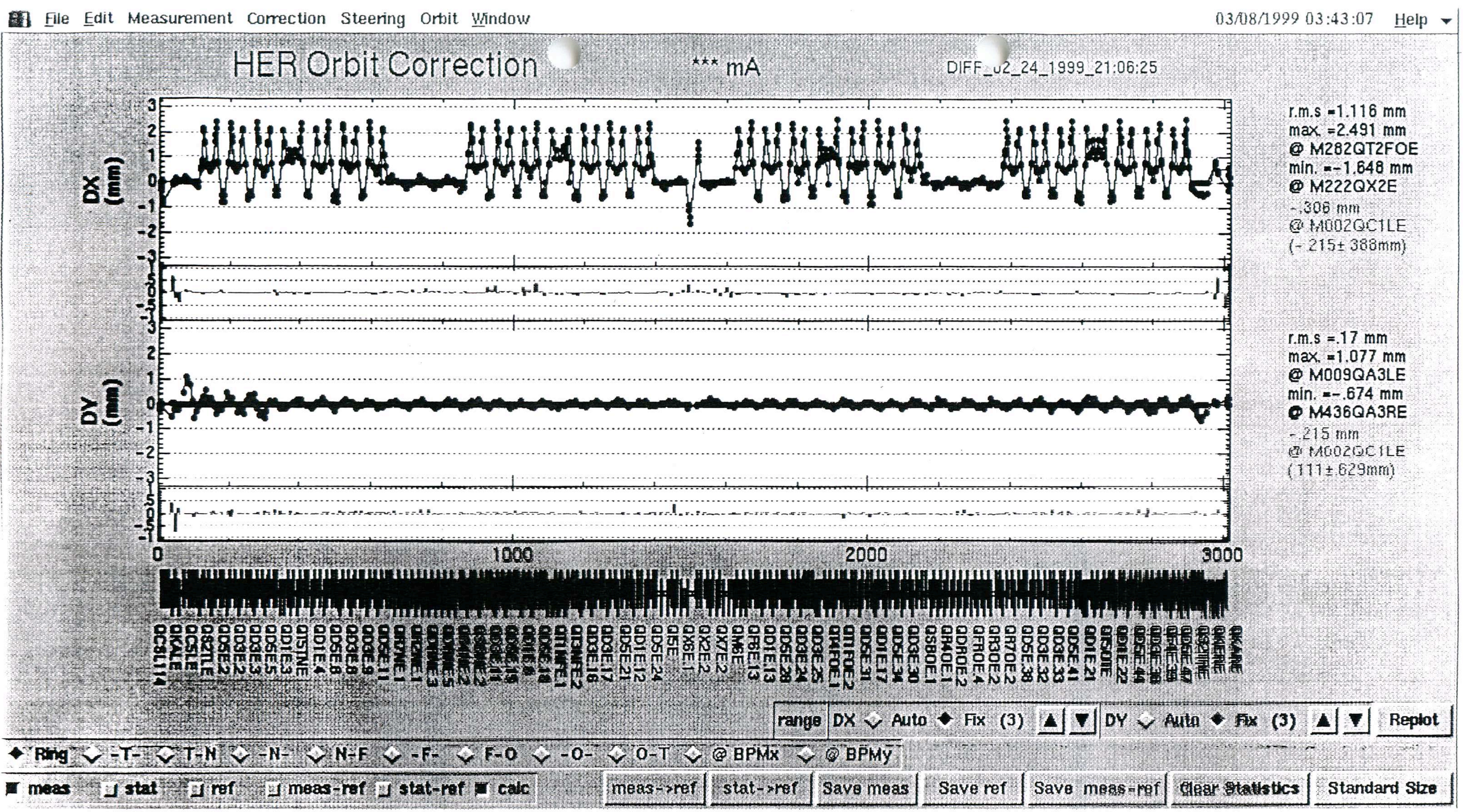
■ BEAST



Δf_{RF} (−200 Hz) − (0 Hz)

$\frac{\Delta p}{p}$ +0.23 % − 0 %

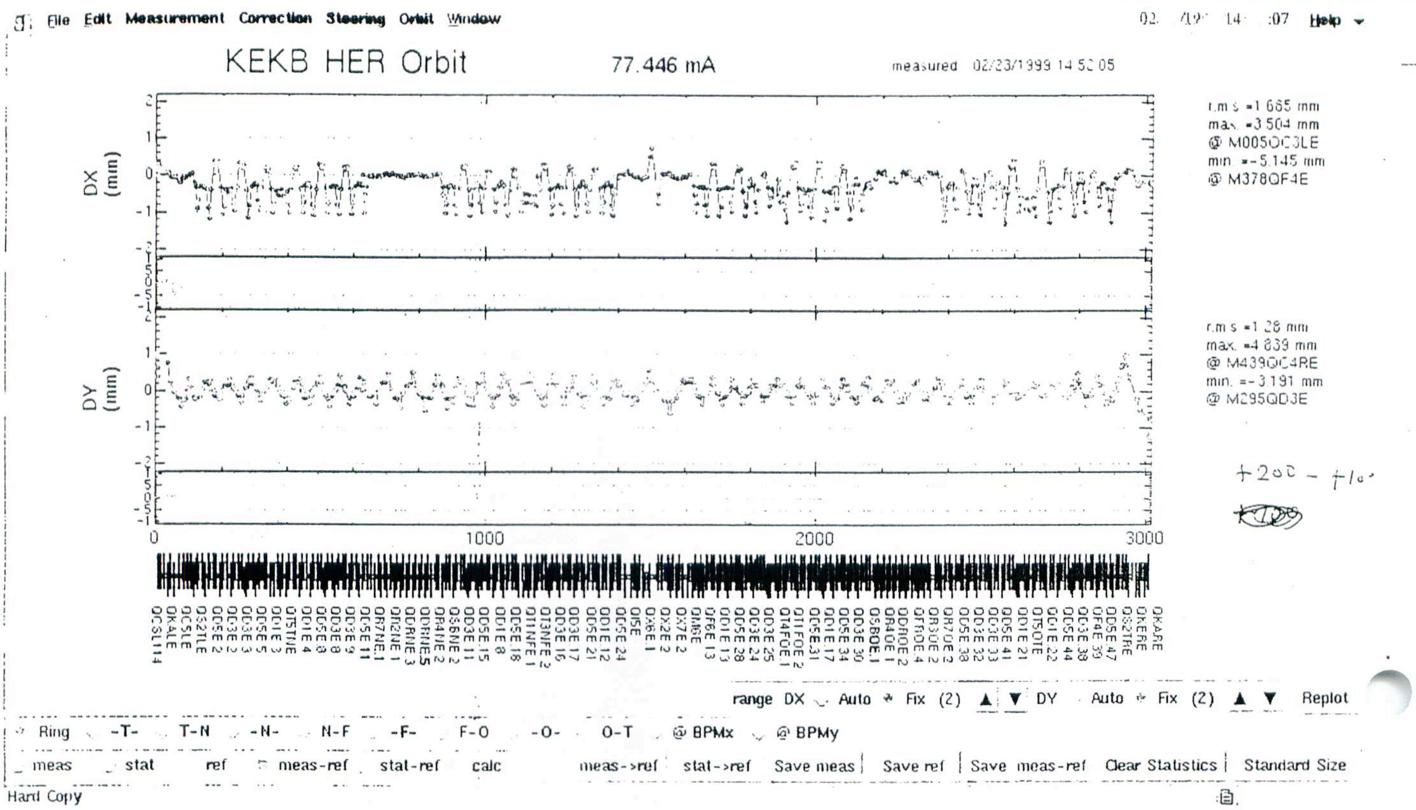
$\frac{\text{meas}}{\text{model}} = 1.16$

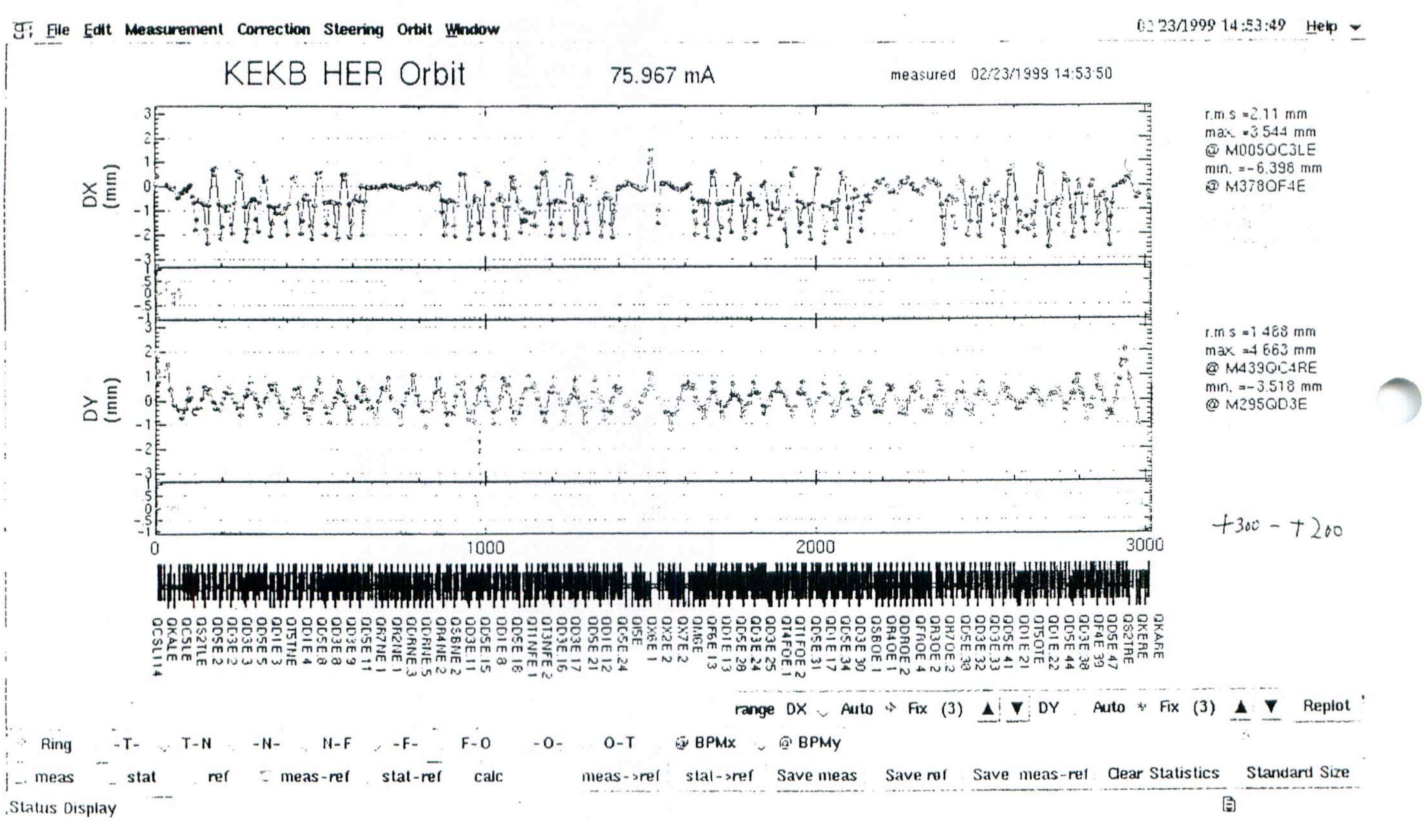


Δf_{RF} (−200 Hz) − (0 Hz)

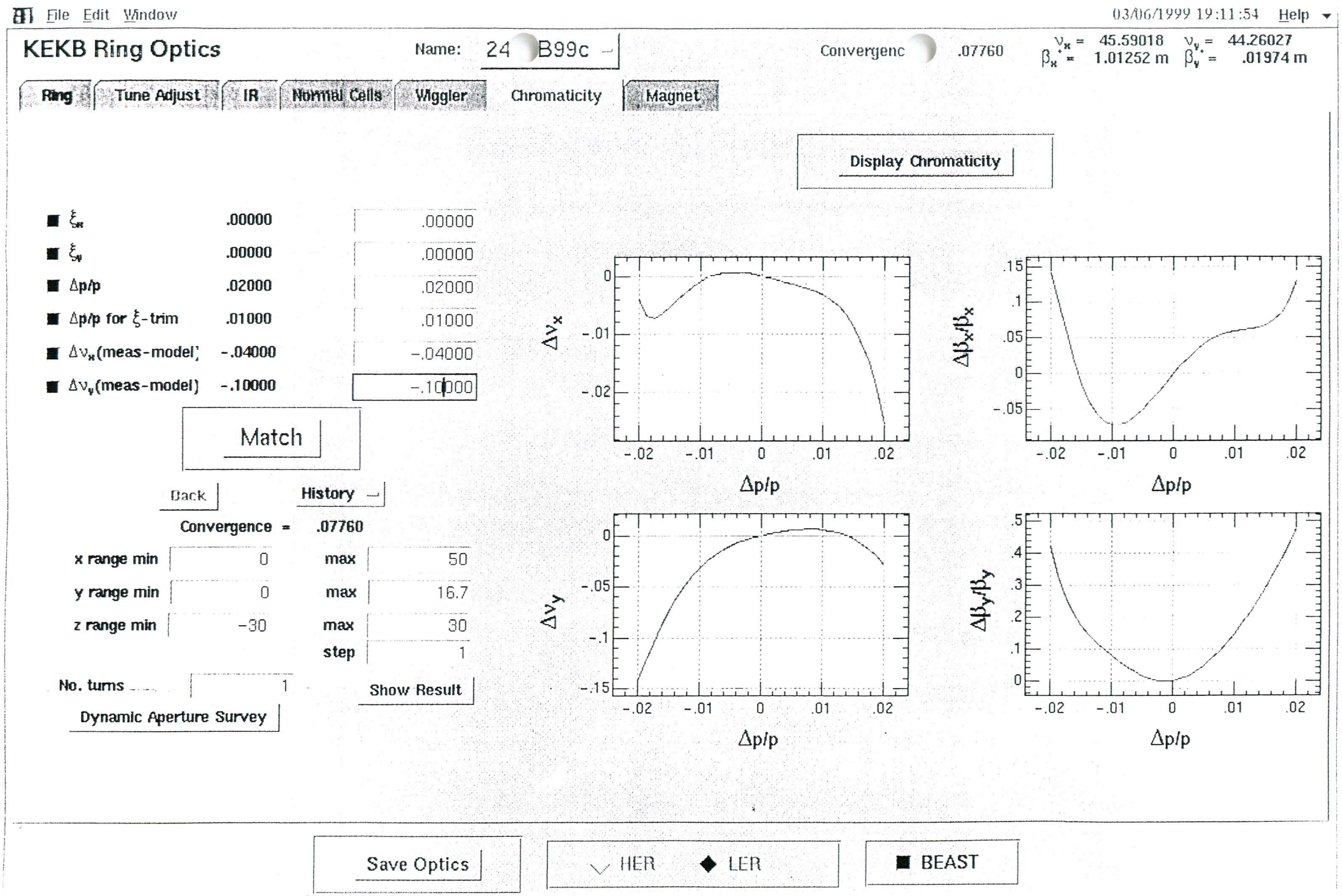
$\frac{\Delta p}{p}$ +0.21% − 0%

$\frac{meas}{model} = 1.06$





↑ HER dispersion DIFF_02_23_1999_14:55: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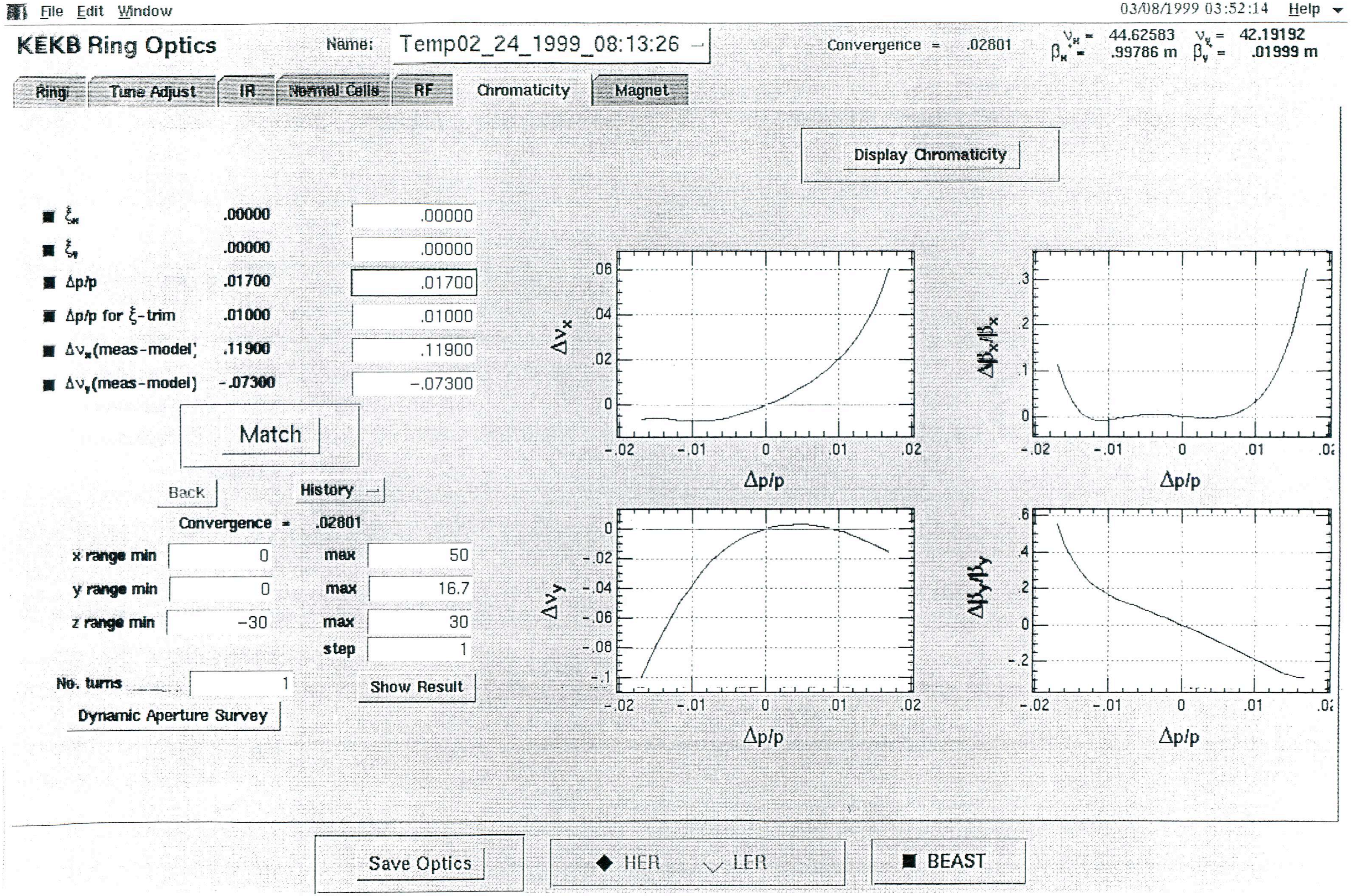
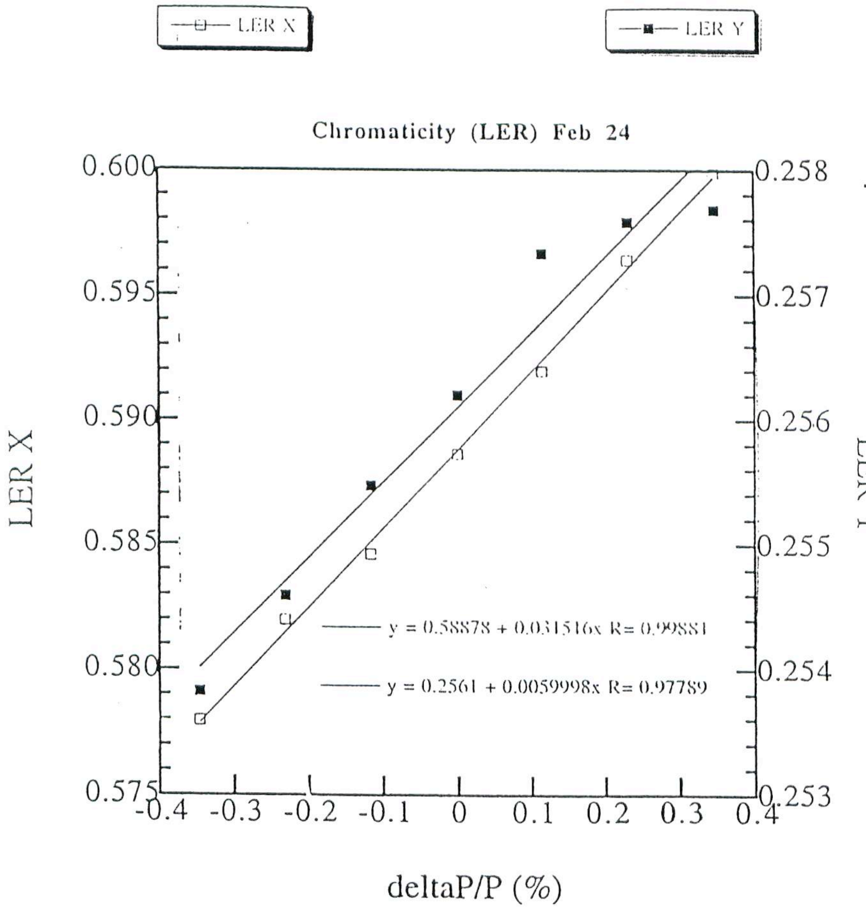
03/06/1999 19:11:54 Help
KEKB Ring Optics
Name: 24 B99c
Convergenc .07760
ν_x = 45.59018 ν_y = 44.26027
β_x^* = 1.01252 m β_y^* = .01974 m
Ring
Tune Adjust
IR
Normal Cells
Wiggler
Chromaticity
Magnet
Display Chromaticity
ξ_x .00000 .00000
ξ_y .00000 .00000
Δp/p .02000 .02000
Δp/p for ξ-trim .01000 .01000
$\Delta\nu_x$(meas-model) -.04000 -.04000
$\Delta\nu_y$(meas-model) -.10000 -.10000
Match
Back
History
Convergence = .07760
x range min 0 max 50
y range min 0 max 16.7
z range min -30 max 30
step 1
No. turns 1
Show Result
Dynamic Aperture Survey
$\Delta\nu_x$
$\Delta\nu_y$
$\Delta\beta_x/\beta_x$
$\Delta\beta_y/\beta_y$
Δp/p
Save Optics
HER
LER
BEAST


File Edit Window
03/08/1999 03:52:14 Help
KEKB Ring Optics
Name: Temp02_24_1999_08:13:26
Convergence = .02801
ν_x = 44.62583 ν_y = 42.19192
β_x^* = .99786 m β_y^* = .01999 m
Ring
Tune Adjust
IR
Normal Cells
RF
Chromaticity
Magnet
Display Chromaticity
ξ_x .00000 .00000
ξ_y .00000 .00000
Δp/p .01700 .01700
Δp/p for ξ-trim .01000 .01000
$\Delta\nu_x$(meas-model) .11900 .11900
$\Delta\nu_y$(meas-model) -.07300 -.07300
Match
Back
History
Convergence = .02801
x range min 0 max 50
y range min 0 max 16.7
z range min -30 max 30
step 1
No. turns 1
Show Result
Dynamic Aperture Survey
$\Delta\nu_x$
$\Delta\nu_y$
$\Delta\beta_x/\beta_x$
$\Delta\beta_y/\beta_y$
Δp/p
Save Optics
HER
LER
BEAST



LER

measured

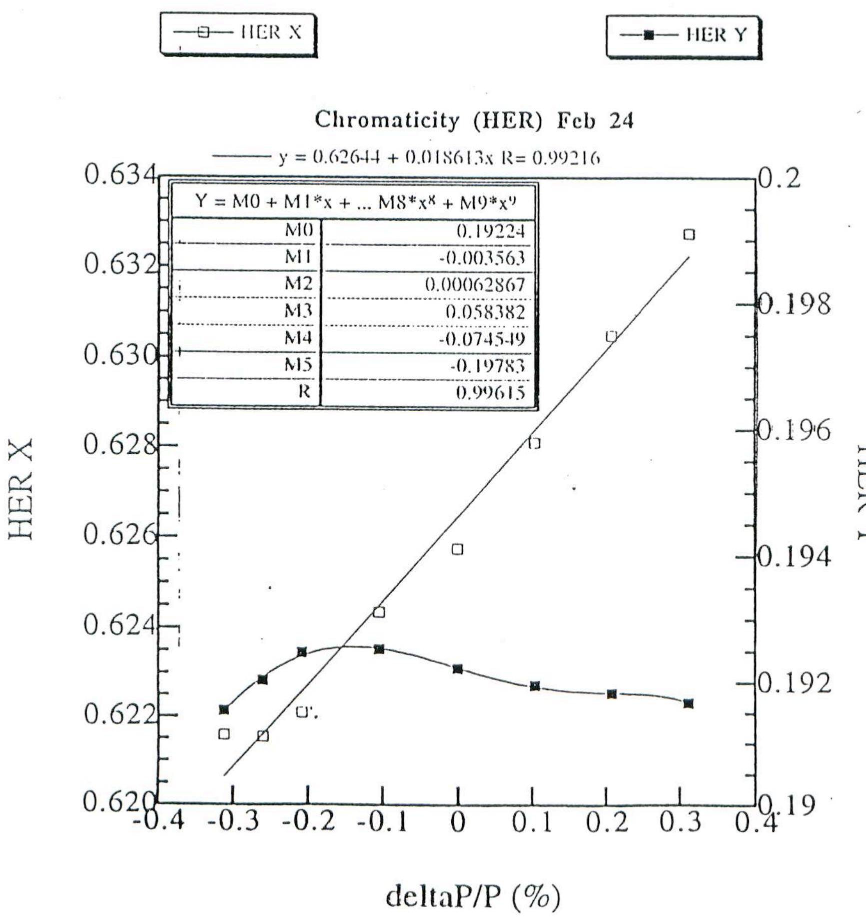
$\xi_x = 3.15$

$\xi_y = 0.6$

model

$\xi_x = -0.2$

$\xi_y = +1.0$



HER

measured

$\xi_x = 1.86$

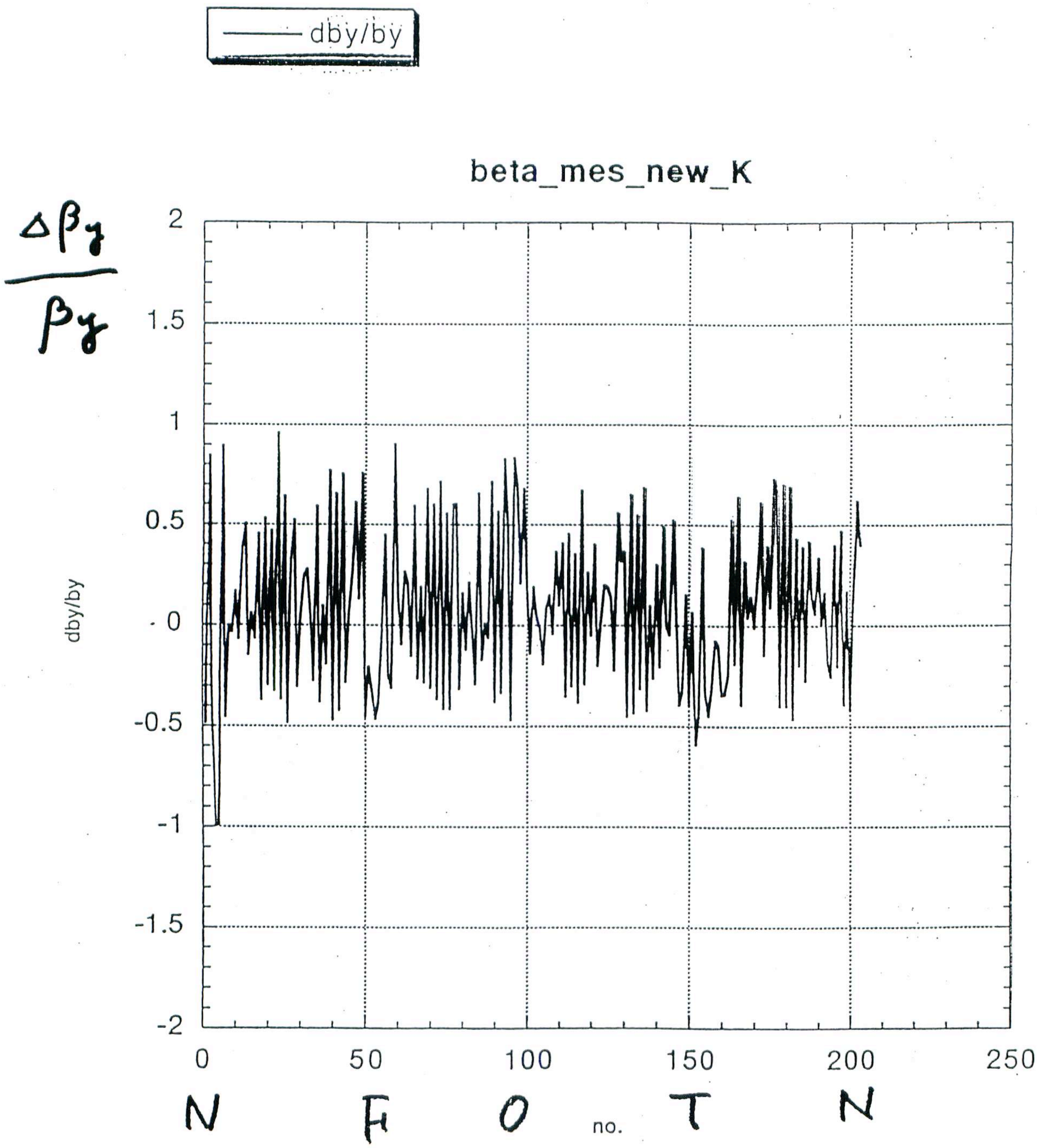
$\xi_y = -0.28$

model

$\xi_x = +1.4$

$\xi_y = +1.3$

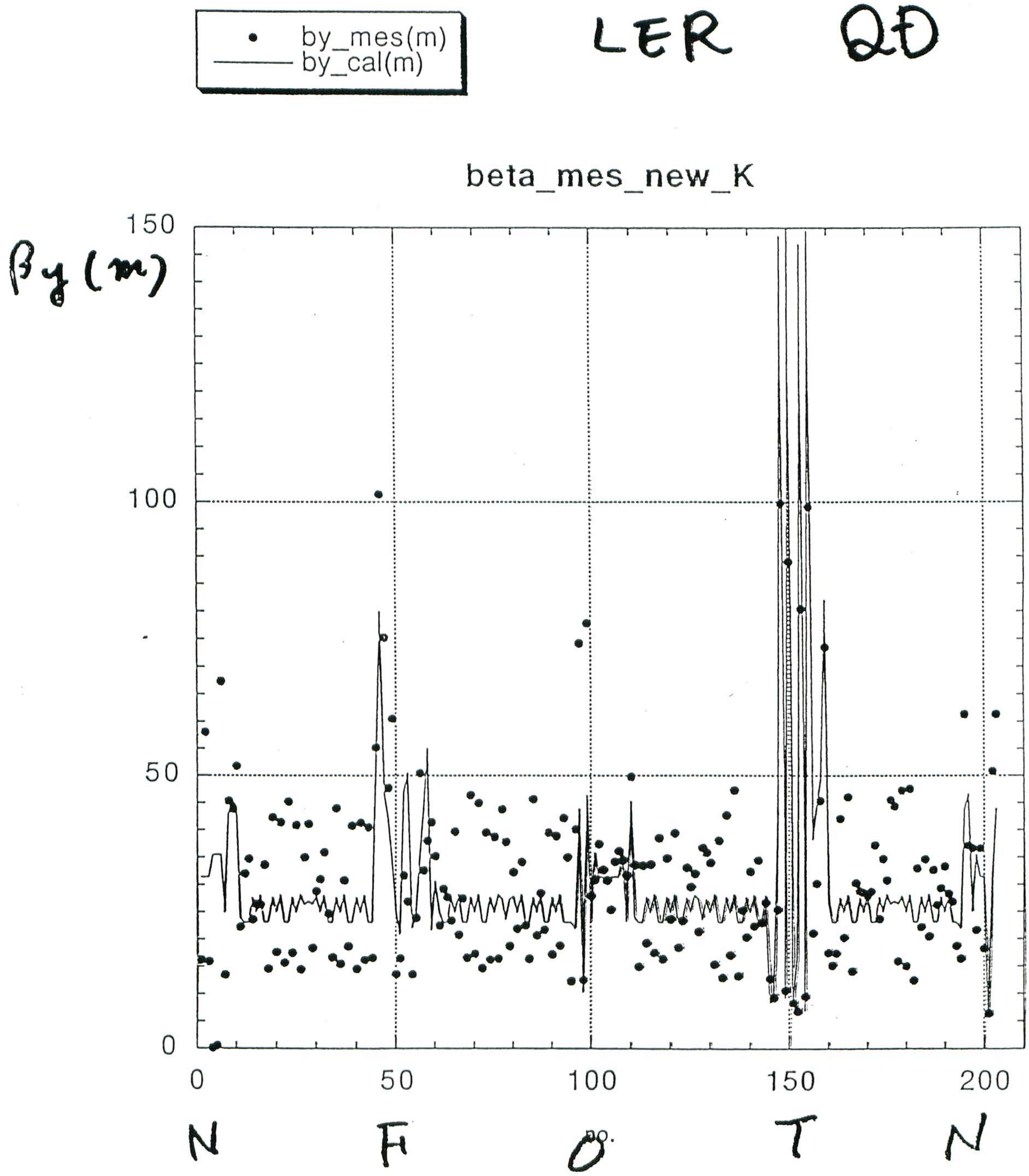
Chromaticity



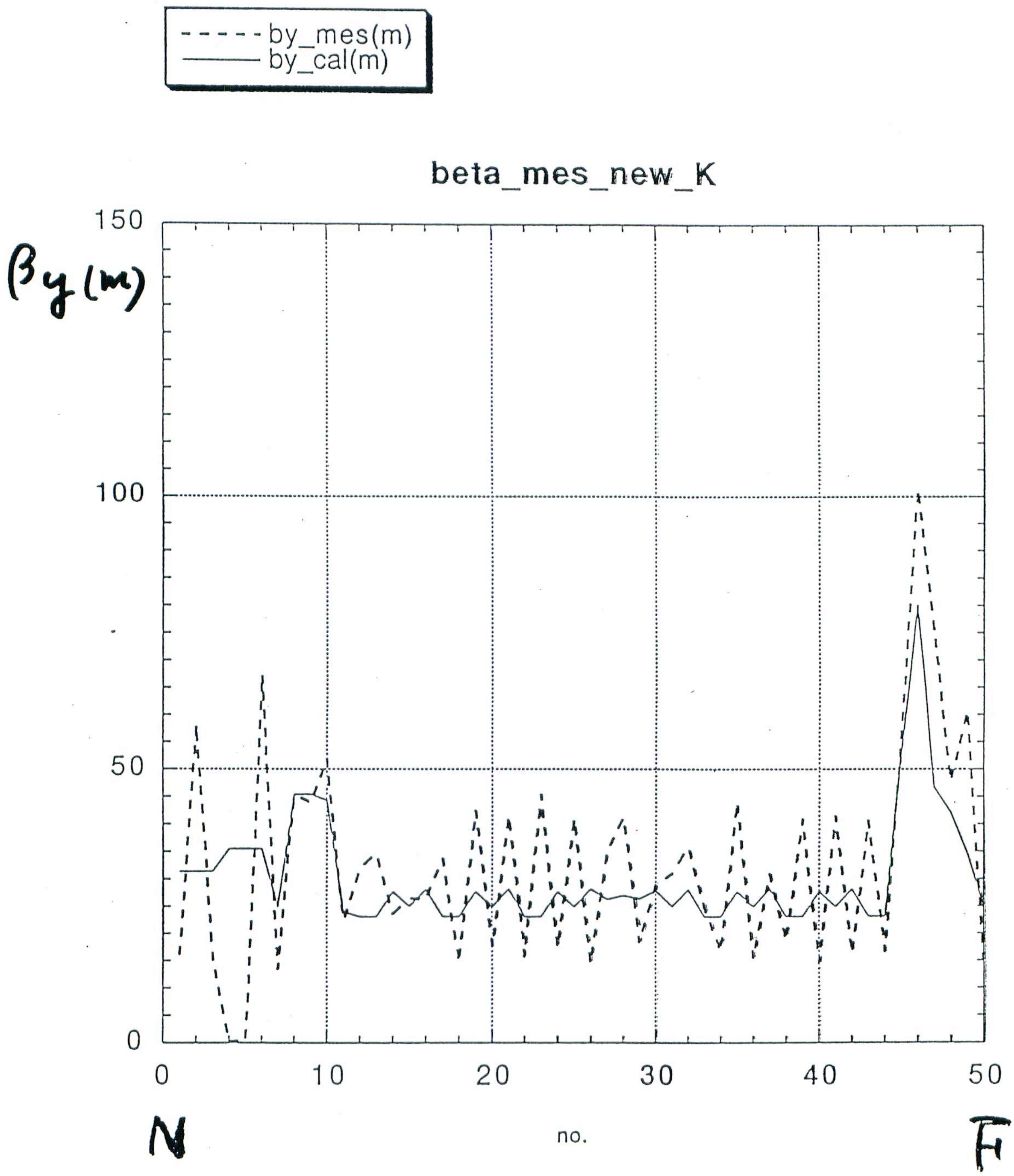
$$\frac{\Delta\beta}{\beta} = \frac{1}{2\sin 2\pi\nu}\oint k\beta \cos(2\pi\nu + 2\Delta\psi)\, ds$$

by H Fukuma

LER QD



by H Fukuma

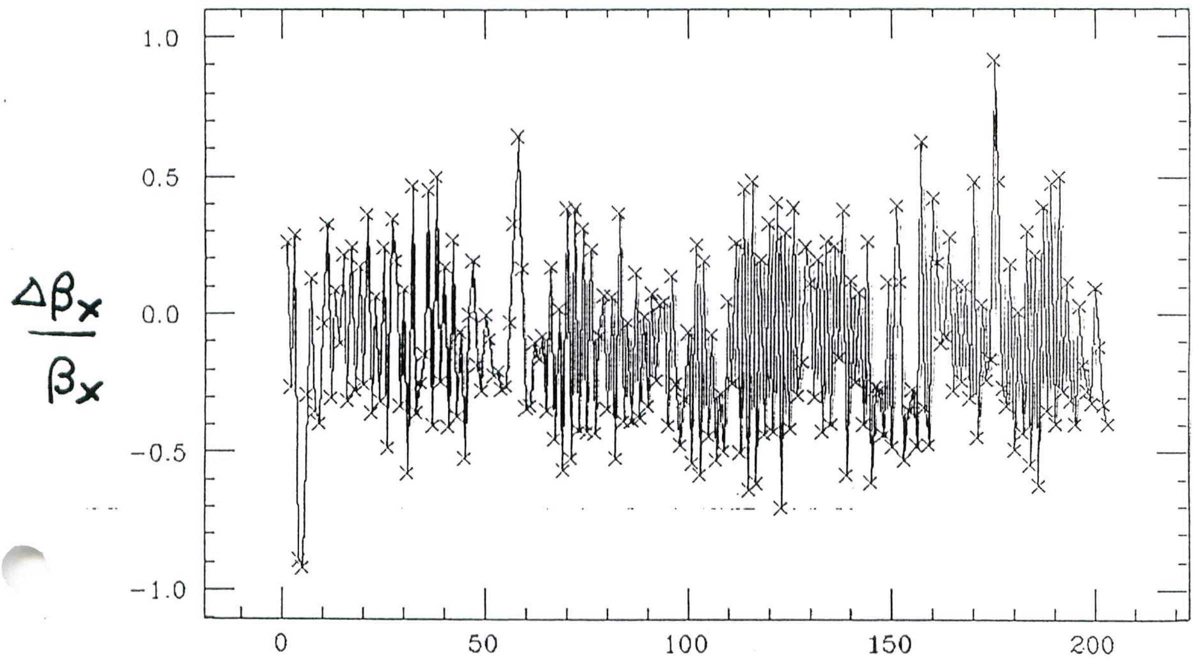


by_mes(m)
by_cal(m)
beta_mes_new_K
βy(m)
150
100
50
0
0
10
20
30
40
50
N
no.
Fi

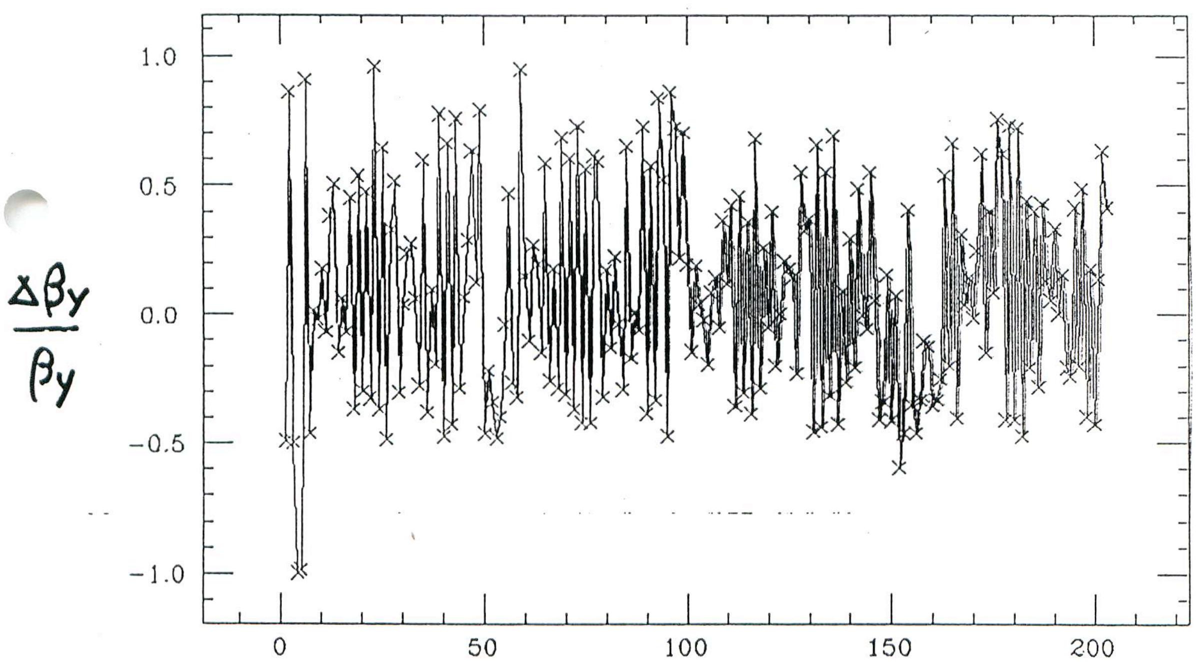
by H Fukuma

measured

x data



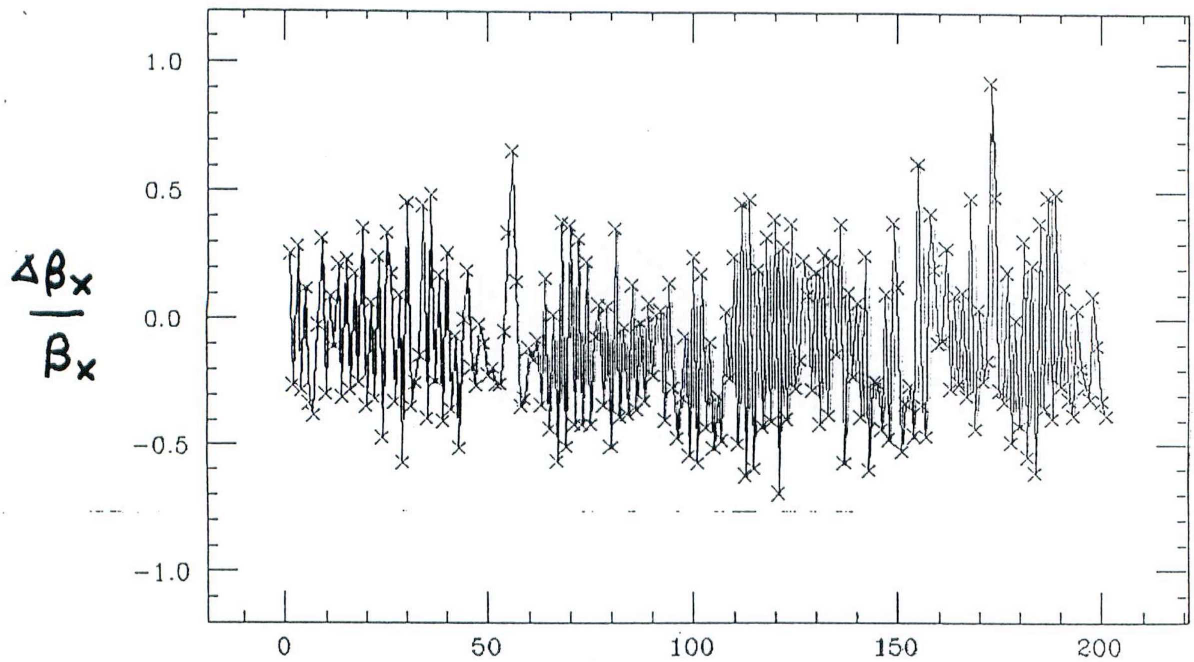
y data



yのみ補正

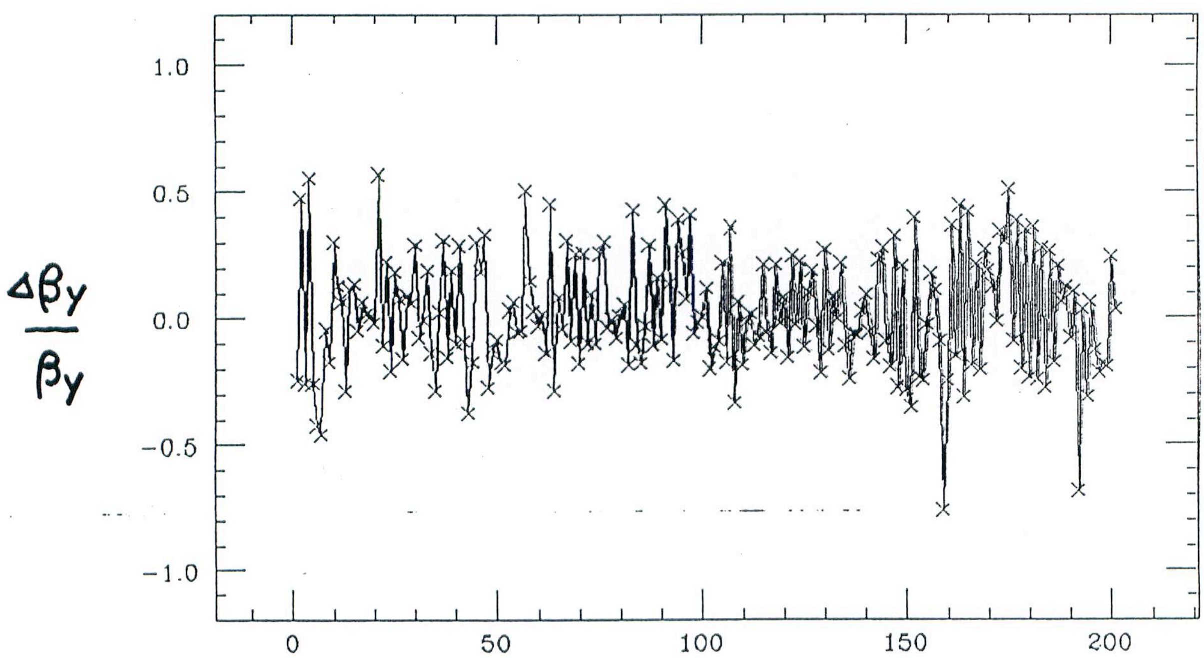
βx n=1 QCSR 0.0066

expected after correction

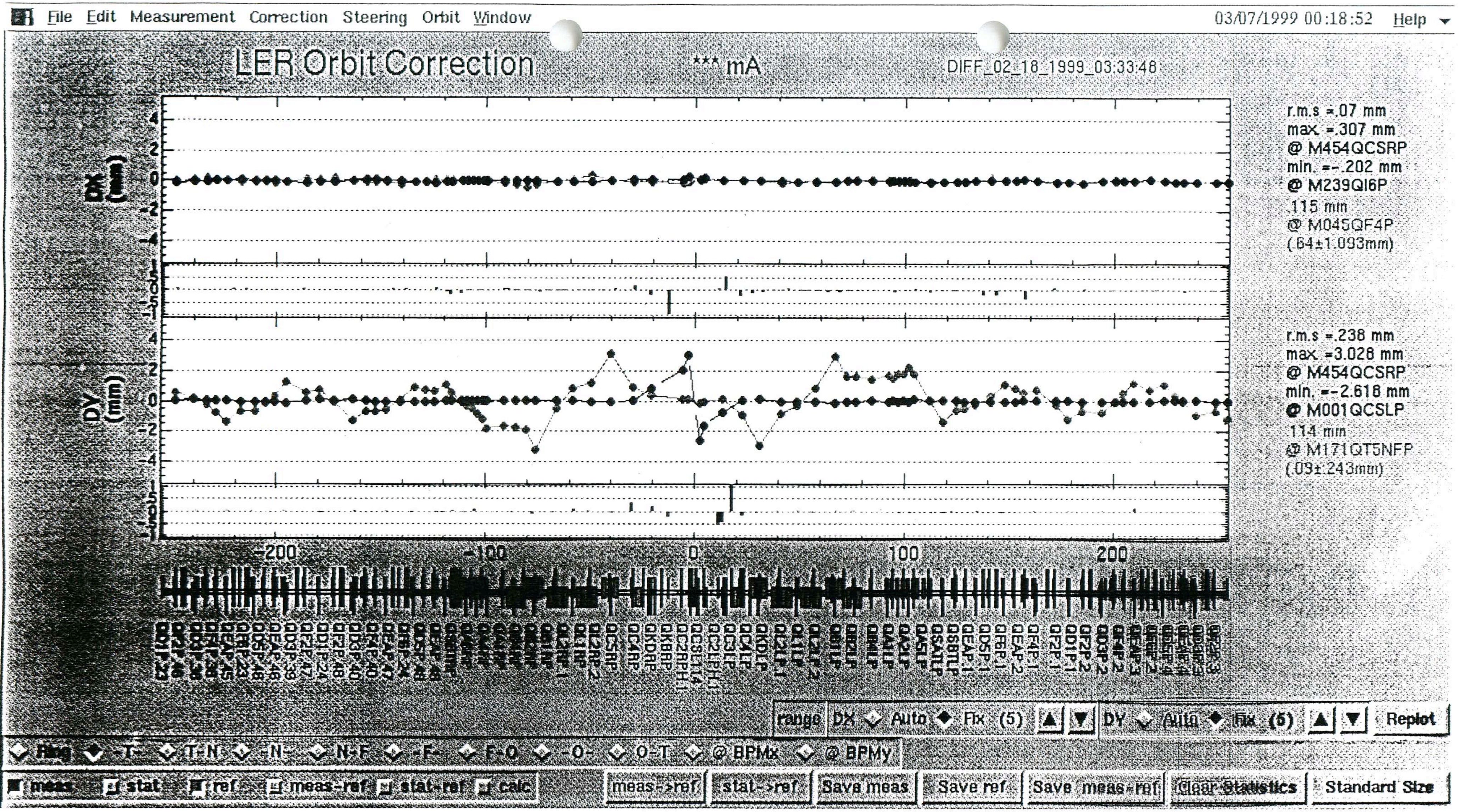


yのみ補正

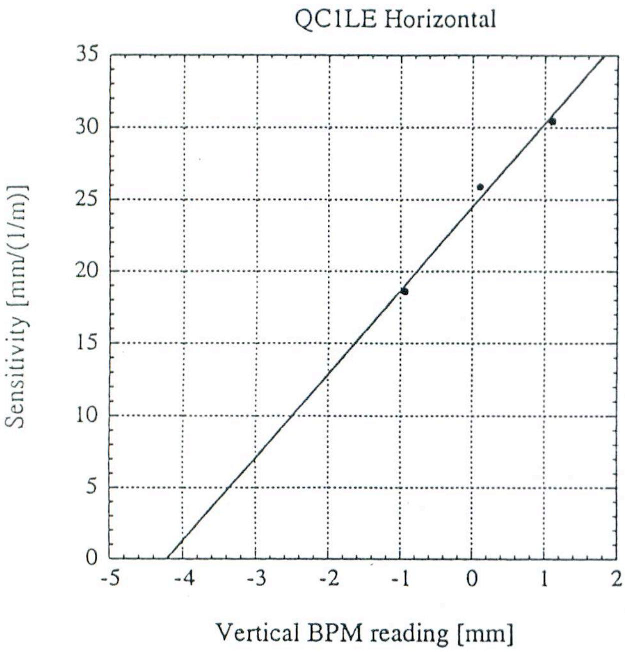
βy n=1 QCSR 0.0066

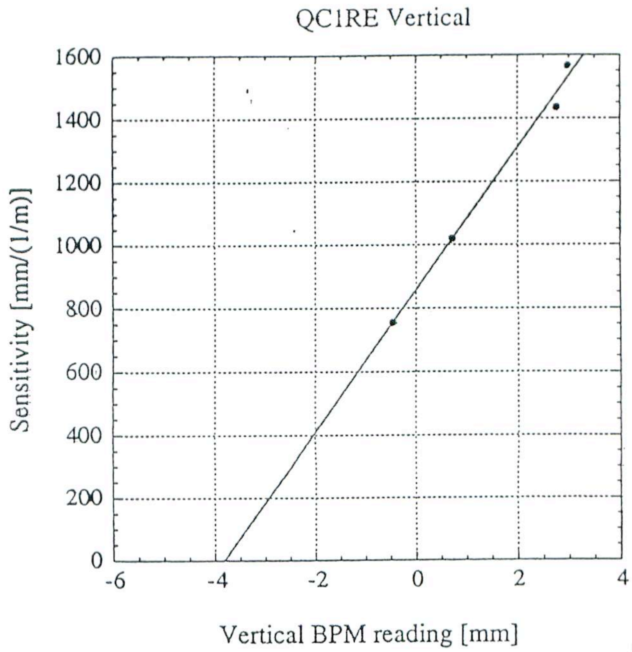


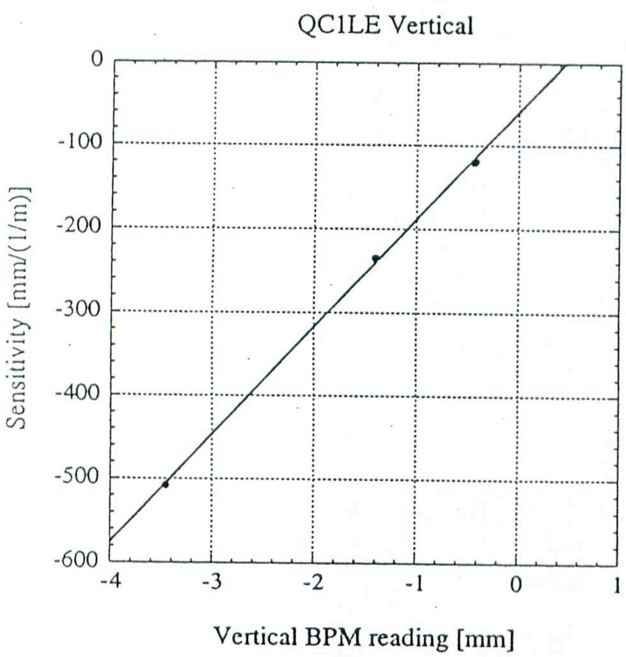
by M. Kikuchi

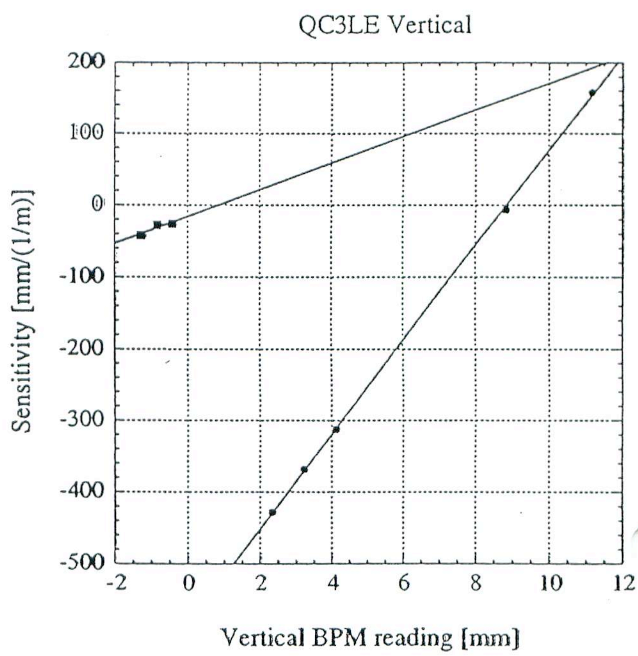


local bump at QCSR
QCSL



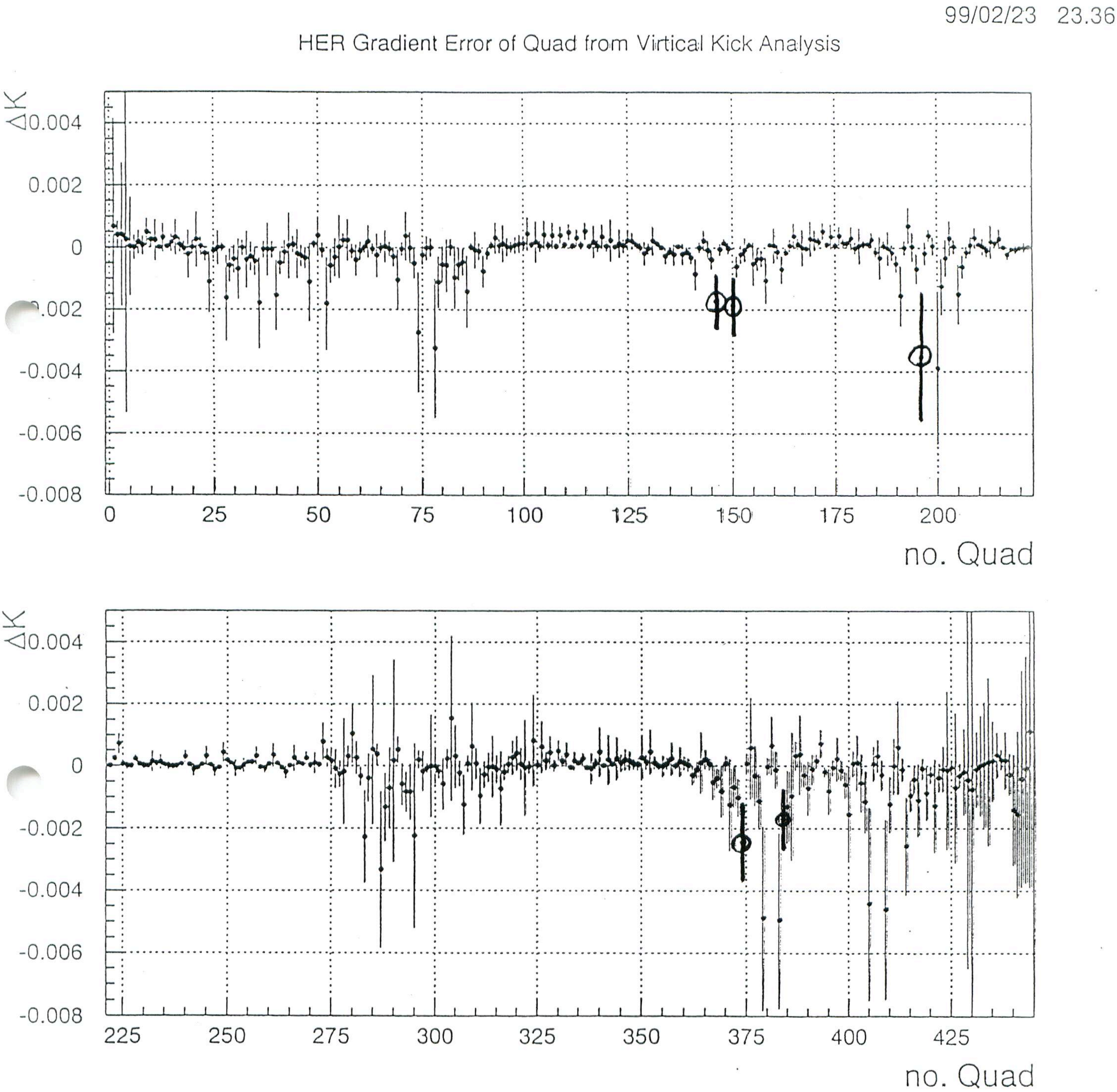






Beam-based measurement of BPM offset

by N. Akasaka
M. Masuzawa



Single kick Analysis (HER)

by Y. Onishi

Model of LER Bend

3/4/1999 K. Oide

	Tune shift
Flat rectangular bend	
Maxwellian hard fringe	$\Delta\nu_y = 0.40$
Slope of B_y, $B_y = B_y(s)$	$\Delta\nu_y = -0.037$
Integrated quadrupole	$\Delta\nu_y = -0.056$, $\Delta\nu_x = +0.057$
Sextupole, $\int B_y''(s)x(s)ds$	$\Delta\nu_y = -0.112$, $\Delta\nu_x = +0.114$

HER

$\Delta\nu_x$ (meas-model) = -0.135 ~~+0.13~~ +0.12

$\Delta\nu_y$ (meas-model) = -0.198 ~~-0.1~~ -0.08

$\frac{0.198}{44} \sim 0.4\% \sim \frac{3.5-3.485}{3.5}$

Tune deviations from model

	LER	HER
adjust energy, QCS	-0.01 -0.30	+0.12 -0.08
LER dipole model I + fudge factor	+0.04 -0.10	
LER dipole model II	-0.14 -0.20	
change by unknown reason	-0.14 -0.23	