Results of the optics measurements performed at June 12, 2003 at the injection energy

Lattice parameters

4D beta-functions at the beginning:

Beta_X_1=8884.15 cm Beta_X_2=3168.98 cm
Alfa_X_1=-0.231058 Alfa_X_2=0.077087
Beta_Y_1=973.078 cm Beta_Y_2=4225.19 cm
Alfa_Y_1=0.0229602 Alfa_Y_2=-0.77547
Teta_1=-72.2688 deg Teta_2=-49.9384 deg U=0.0625321

Dispersions at the beginning:

DispX=267.3 cm DispY=-10.4844 cm
DispPrX=0.0233697 DispPrY=0.00149665

Tunes:

Qx = 20.583009 Qy = 20.575048

Chromaticities

Model: $\xi x = 25$ $\xi y = 23$; Measured: $\xi x = 7.7$ $\xi y = 8.4$;

Tune split

Model: $\Delta\nu = 0.005$

Momentum compaction

$\alpha = 0.00282122$

Fudge factors

Global corrections for dipoles

Edge focusing in dipoles of 0.995 deg is corrected by +2.11%
Skew quad in main dipoles: $GdLskewUnits = 1.5 units [1]
Sextupole in main dipoles: $SdLunits = -3.35 units

Global corrections for quads

Focusing correction for quads on the main bus: $F_mq = +0.1925%

Point corrections

- GdL^2 for A22 (normal) = 3 kG; origin unknown, would require hor. displasment of +10 mm in chromaticity sextupole
- GdL for A24 (normal) = 6 kG; origin unknown, would require hor. displasment of +20 mm in chromaticity sextupole
- GdL for A46 (skew) =-6 kG; corresponds to +3.49 mm vertical displacement in mCS6A4AP
- GdL for B38 (skew) = 6 kG; origin unknown, would require hor. displasment of +13 mm in chromaticity sextupole and nearby CS1B3AP, or 39 units of A1 in a single dipole
- GdL for C46 (normal) = 8 kG; corresponds to +4.65 mm hor. displacement in mCS6A4AP
- GdL for C46 (skew) = 4 kG; corresponds to -2.32 mm vertical displacement in mCS6A4AP

B0 fudge factors;
$F_B0Q2= 0.25%; value corresponds measured difference between setting and reedback
B0 fudge factors;
$F_D0Q2 = 0.6%; value lays between setting and reedback
$F_D0Q3 = 0.5%; value lays between setting and reedback

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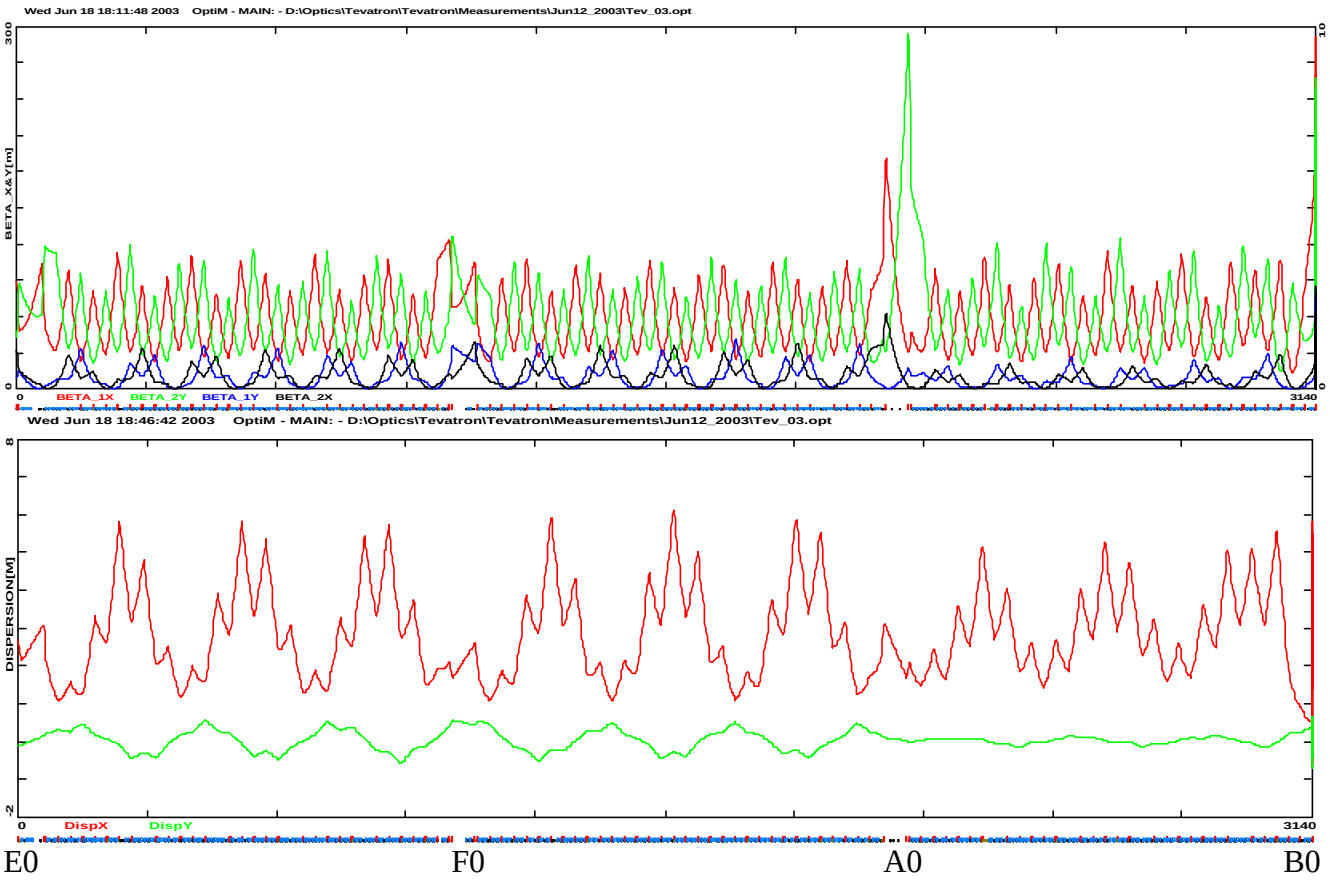
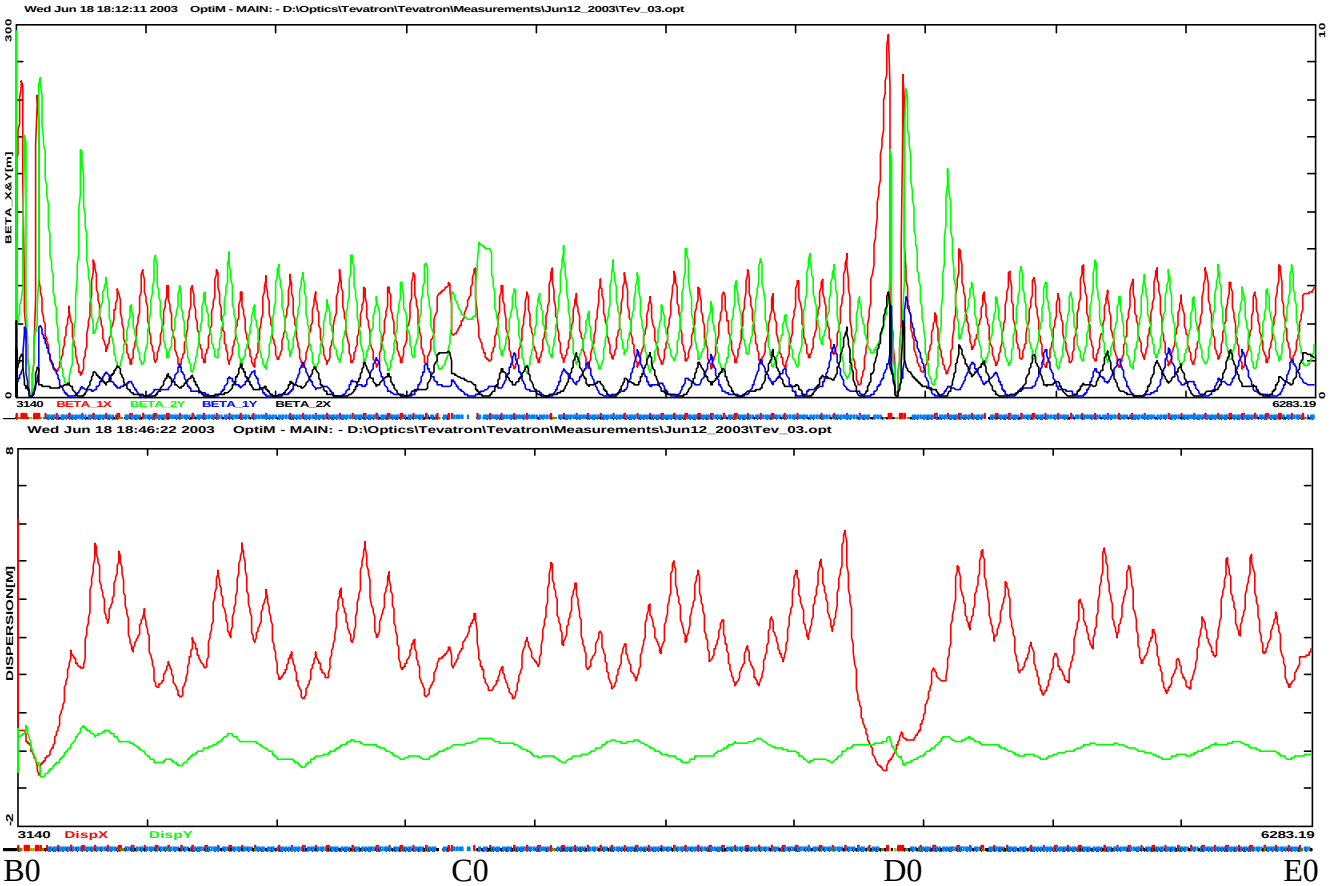
[1] 1 unit corresponds to $\Delta B/B=10^{-4}$ at 1 inch
[2] Integral strength of regular main bus quad is 191.223 kG

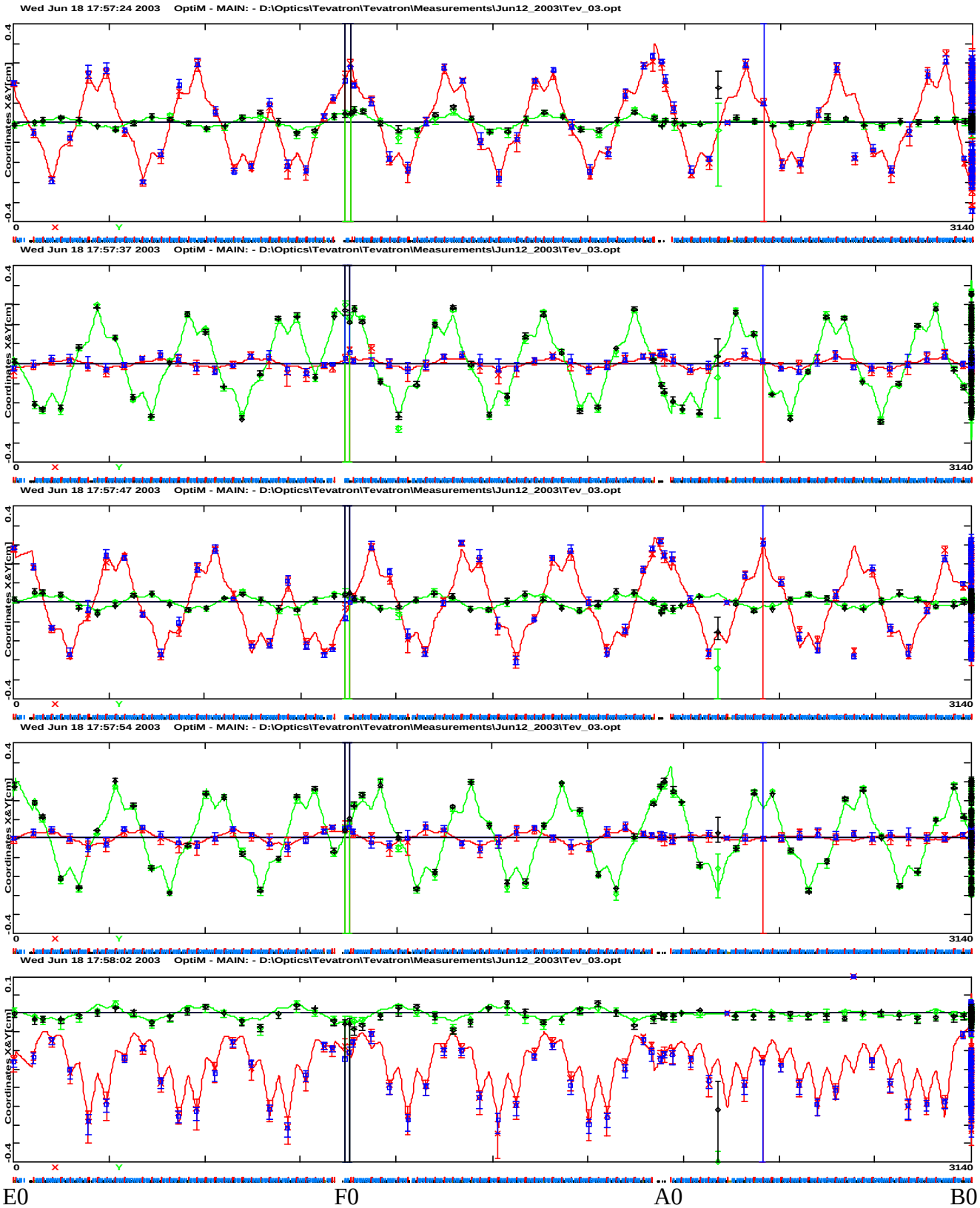


E0 F0 A0 B0

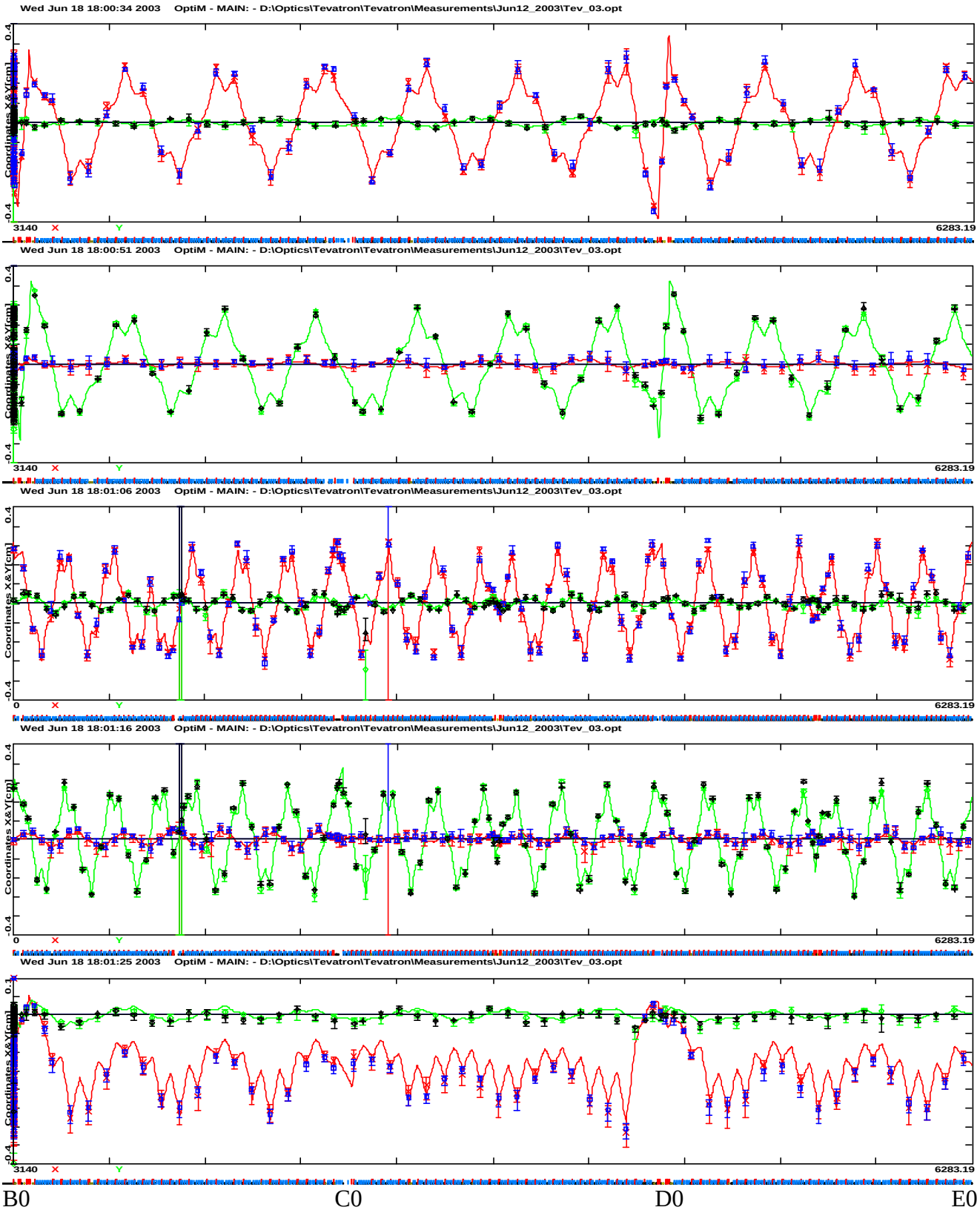


B0 C0 D0 E0

Differential orbits for the Tevatron first half at central orbit

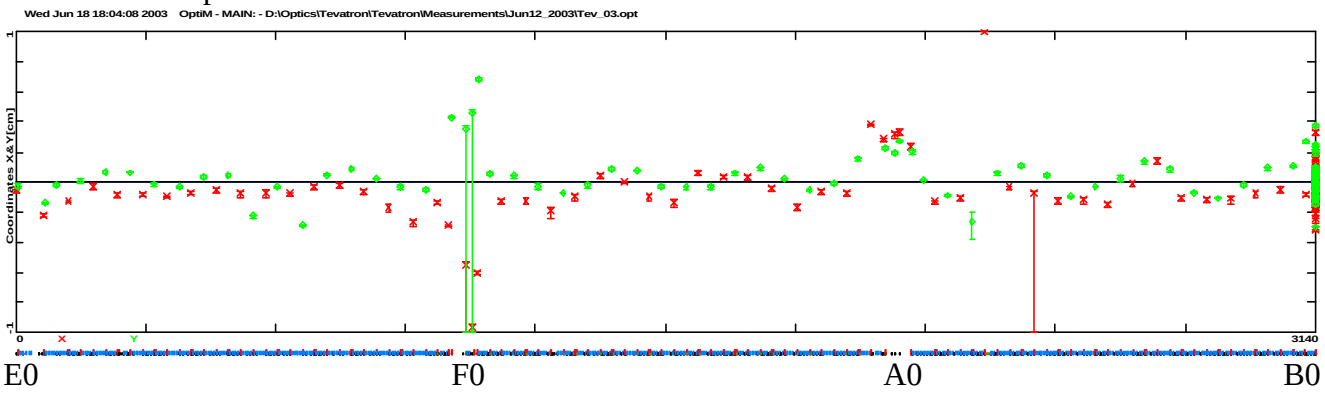


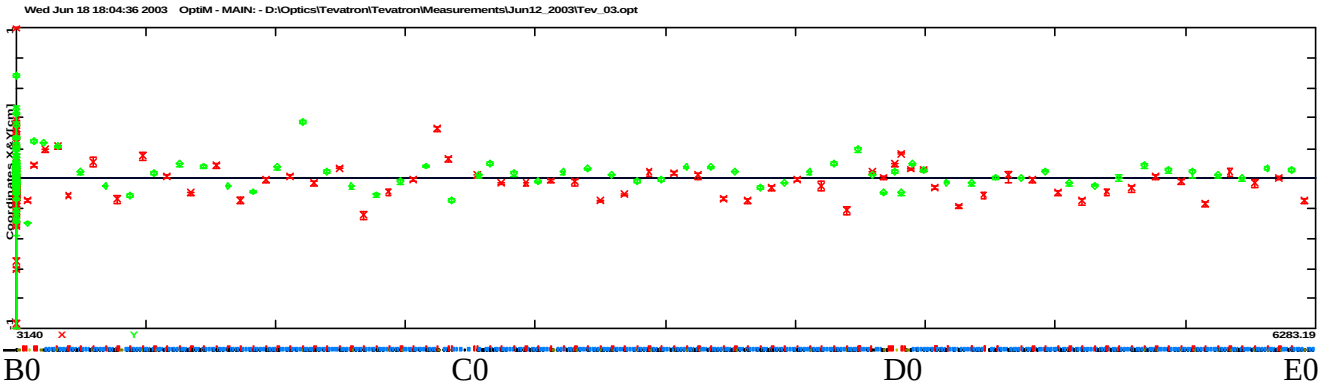
Differential orbits for the Tevatron second half at central orbit



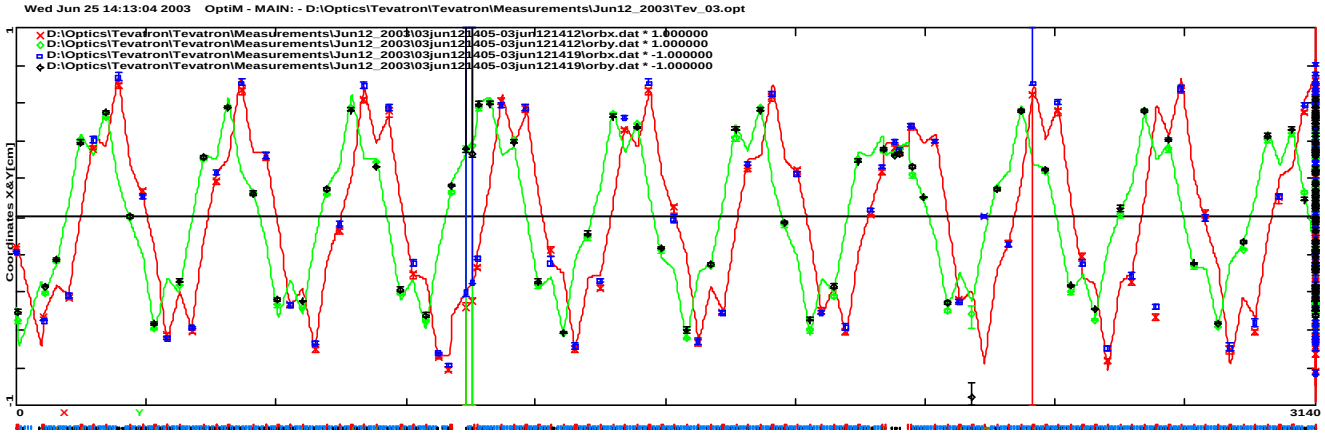
B0 C0 D0 E0

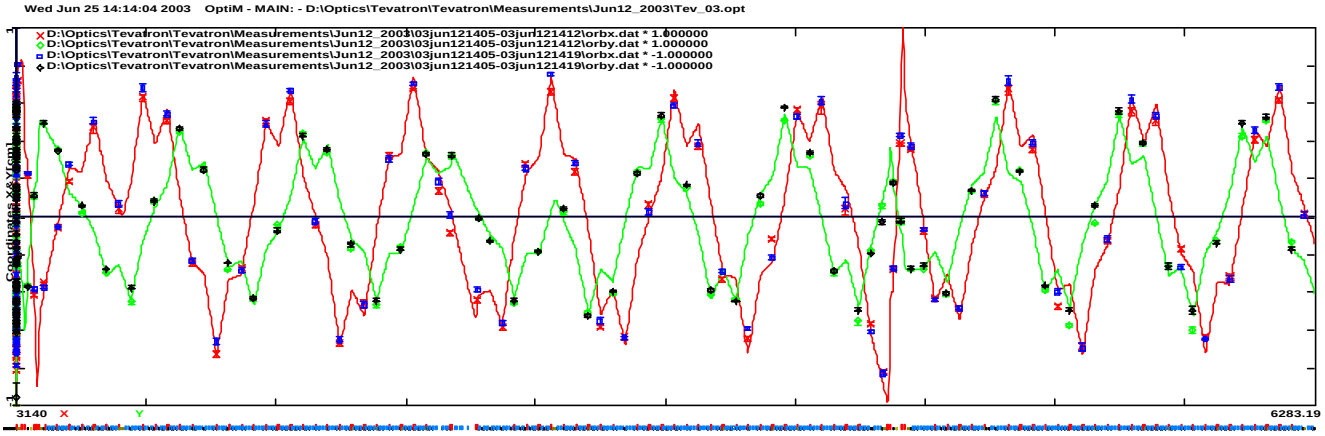
Absolute BPM positions at central orbit



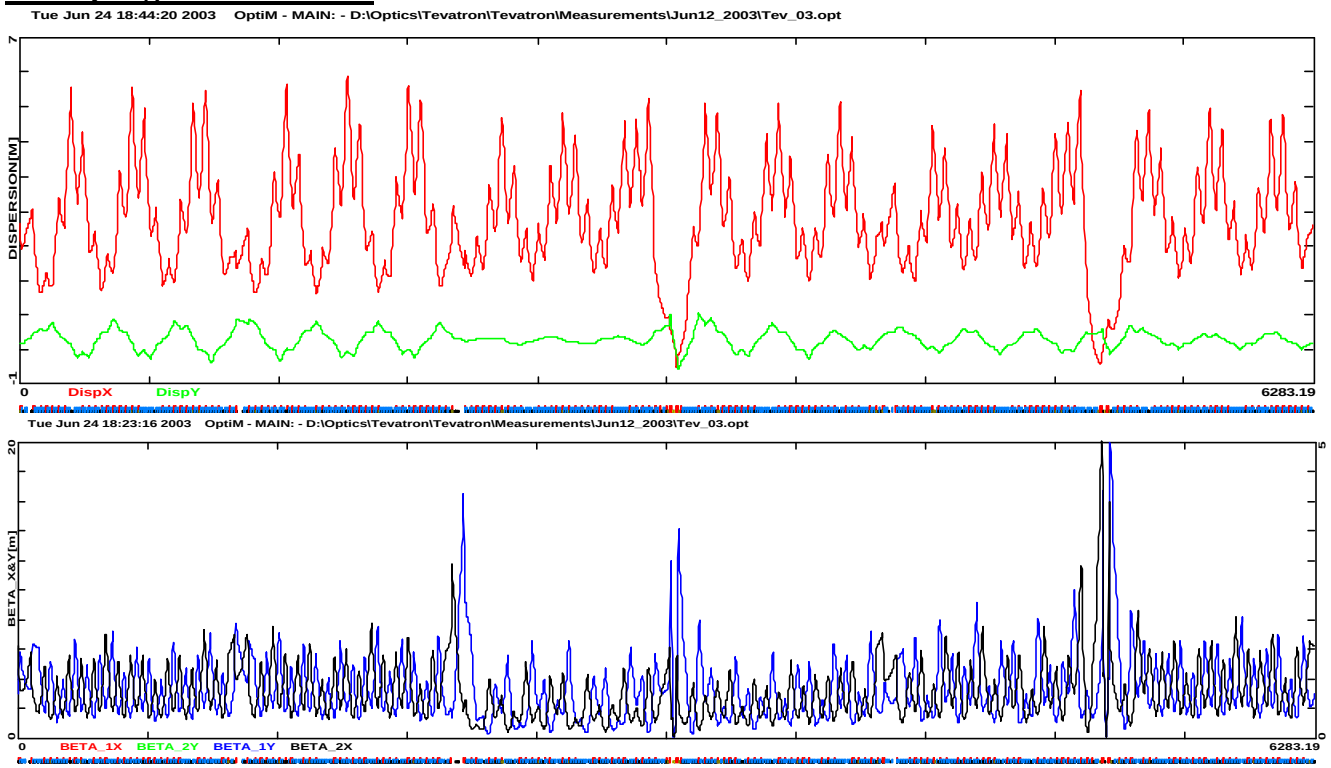


Measured and predicted proton helix (red and green crosses are the inverted data from pbar helix measurements)

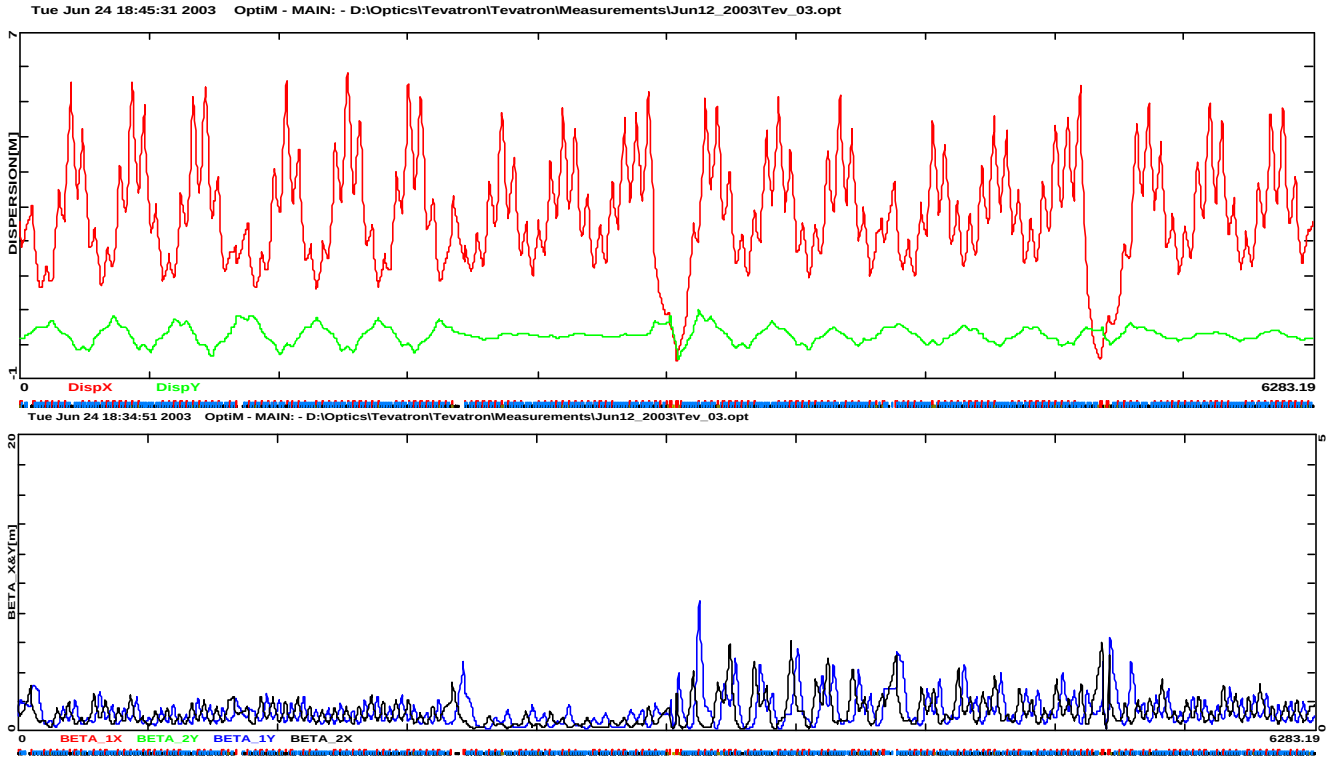




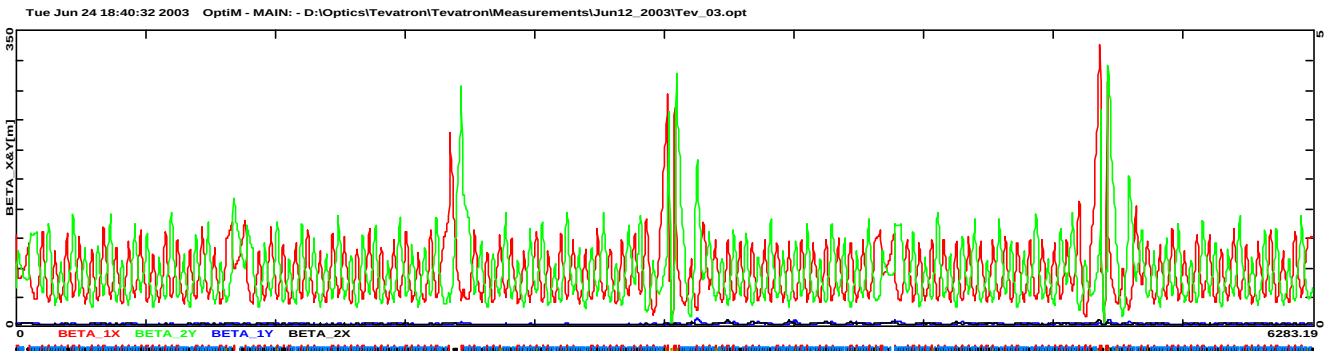
Decoupling at central orbit



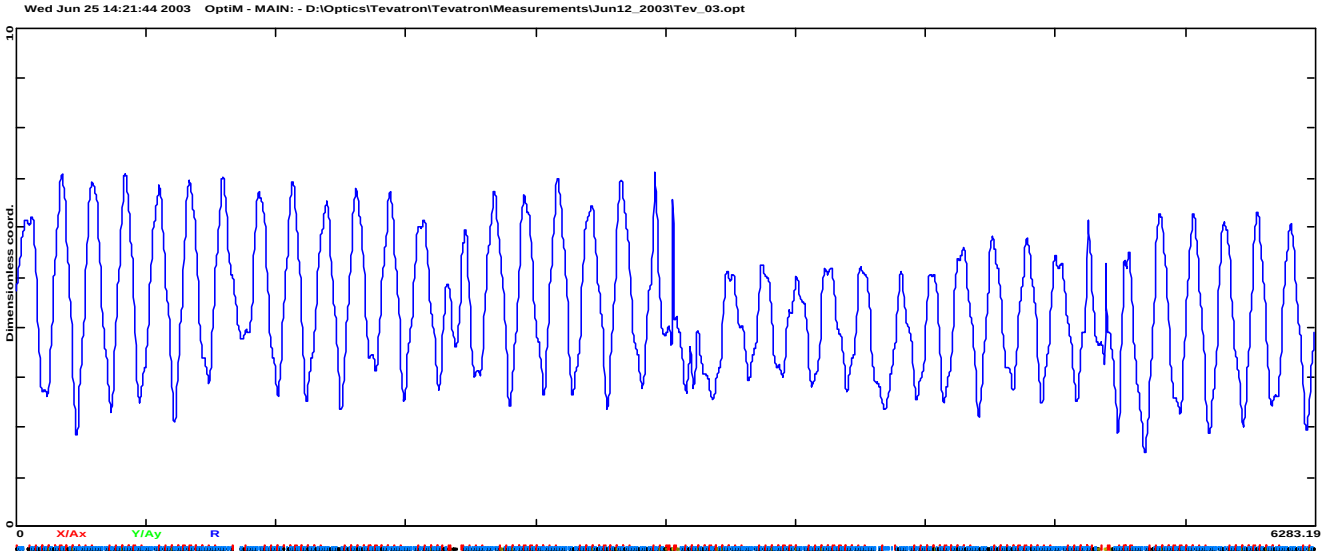
Limited decoupling with use of KSQ and KSQA0 only (SQ = -2.85817 A, SQA0 = 3.892595 A, SQA4 = -5.172729 A, SQB1 = 0.018311 A, SQD0= 0; SQE0 = 1.481628 A).



Maximum decoupling with use of all available skew-quads (SQ = -3.04617 A, SQA0 = 2.387595 A, SQA4 = 2.827271 A, SQB1 = -1.181689 A, SQD0 = -0.8 A, SQE0 = 1.481628 A).



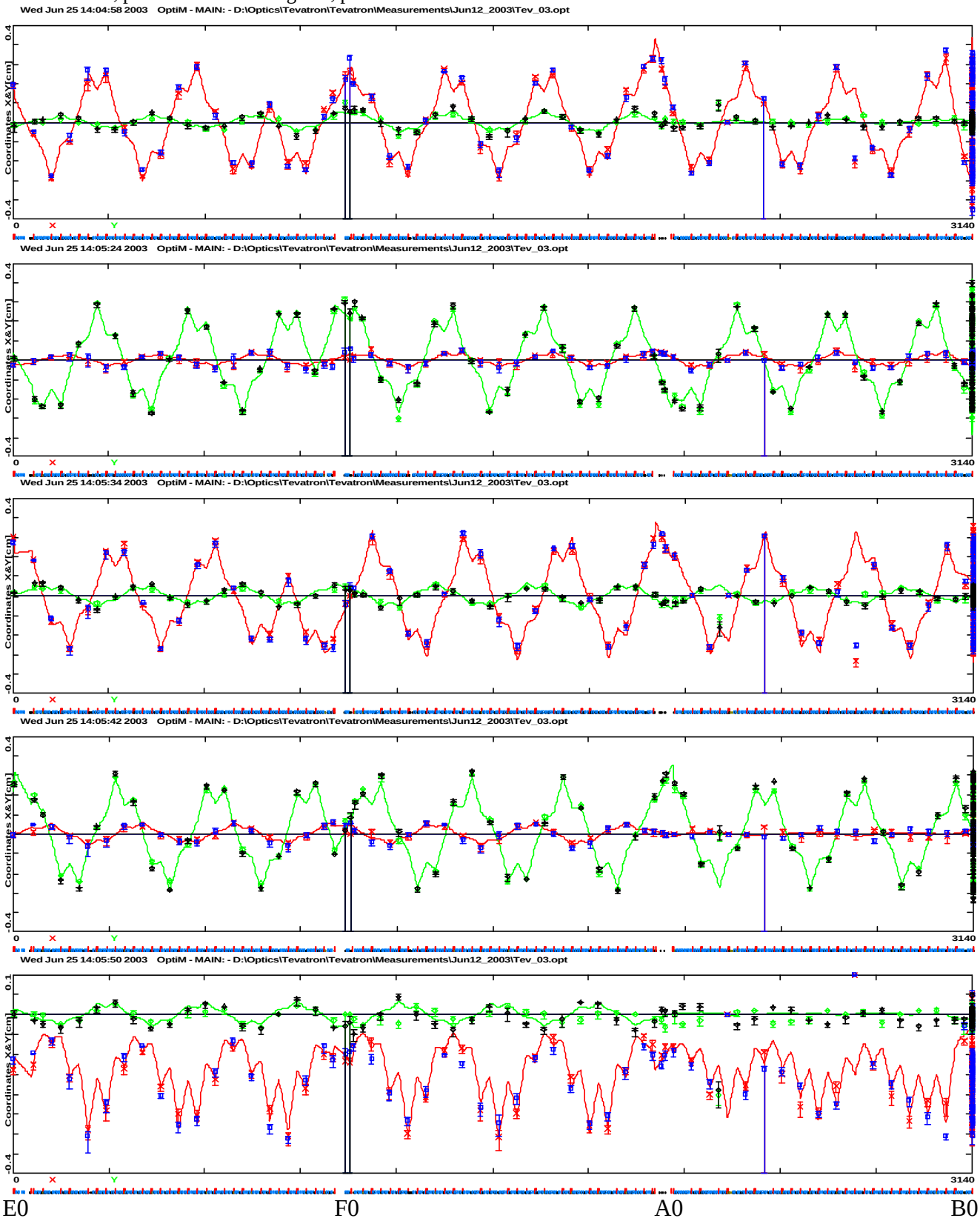
Full set of 4D beta-functions for the picture above.



Relative (measured in sigmas of 20 mm mrad beam) half separation at injection

Differential orbits for the Tevatron first half at pbar and proton helices

Positive kicks, pbar helix – red and green, proton helix – blue and black



Differential orbits for the Tevatron second half at pbar and proton helices

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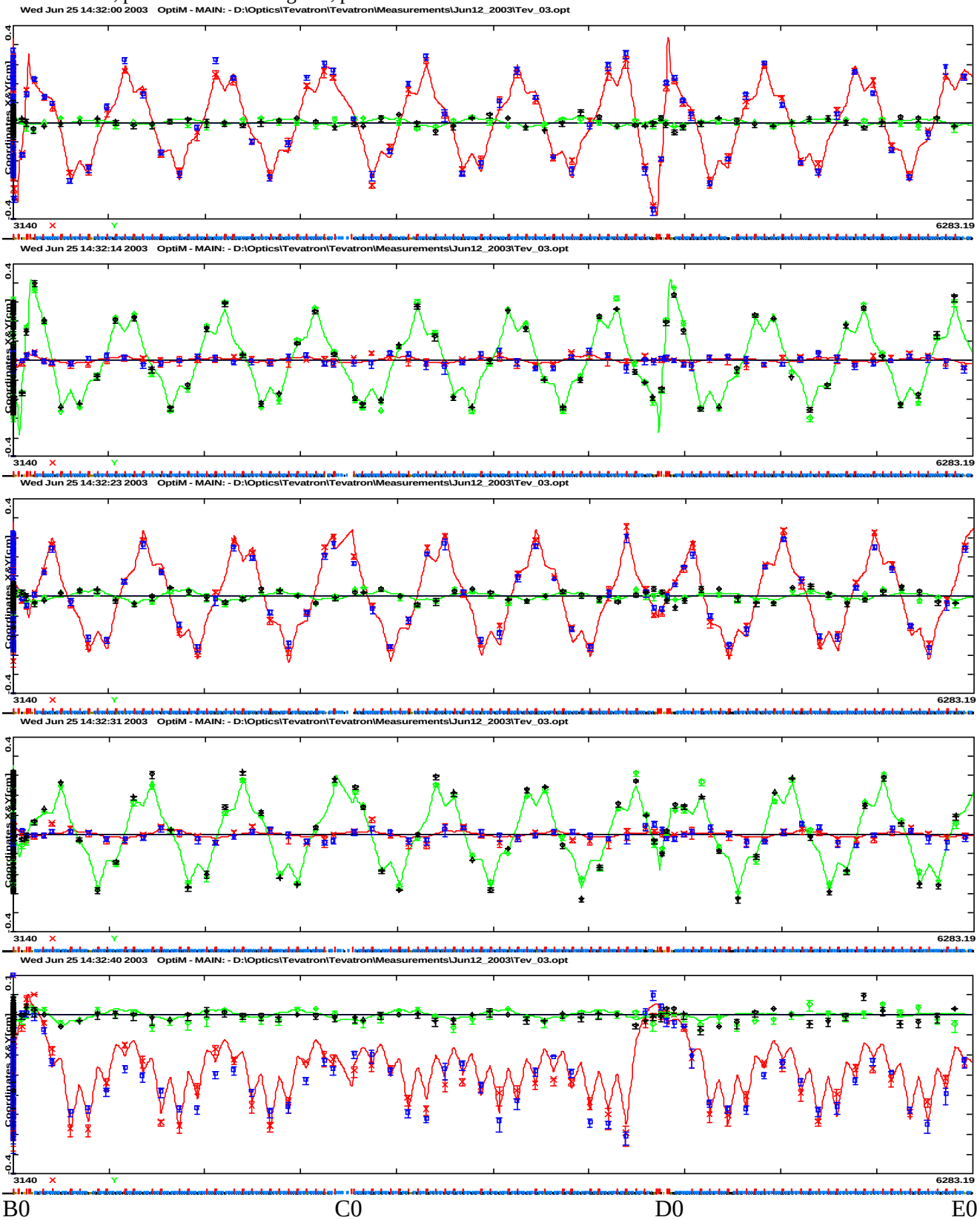
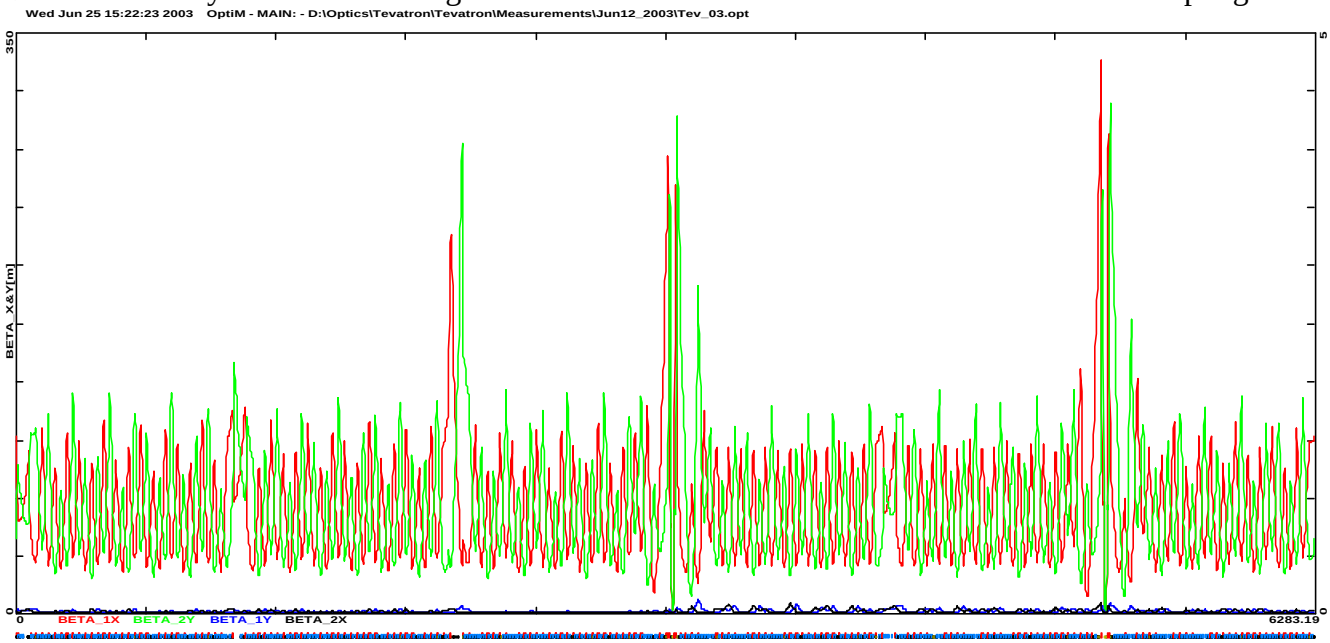
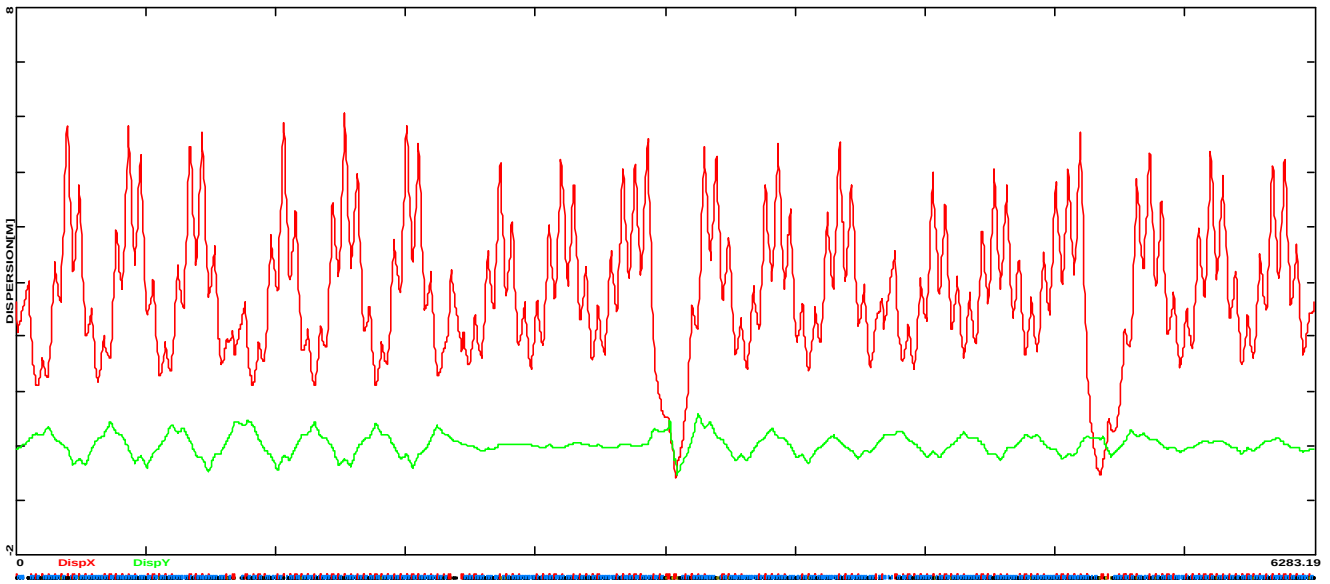


B0 C0 D0 E0

Conclusions for helices

- Changes in differential orbits from correctors are quite small and only slightly exceed noise in the measurements
  - There are about 2 mm orbit displacements due to helix in A46 and C46. That causes moderate ~3 kG focusing correction due to strong S6 feeddowns (SdL=17.2 kG/cm) which is verified by fitting of differential orbits. Other nonlinearities are less pronouncing
- There are much stronger affect of helices on the horizontal dispersion
- The model yields the following 4D Twiss functions at the central orbit after local decoupling in F0





4D beta-functions:

Beta_X_1[cm]=10671.4 Beta_X_2[cm]=165.806
Alfa_X_1=-0.177529 Alfa_X_2=-0.00658187
Beta_Y_1[cm]=96.0635 Beta_Y_2[cm]=4484.45
Alfa_Y_1=-0.0188862 Alfa_Y_2=-0.639208
Teta_1[deg]=-5.63212 Teta_2[deg]=-6.61718 U=-0.0190696

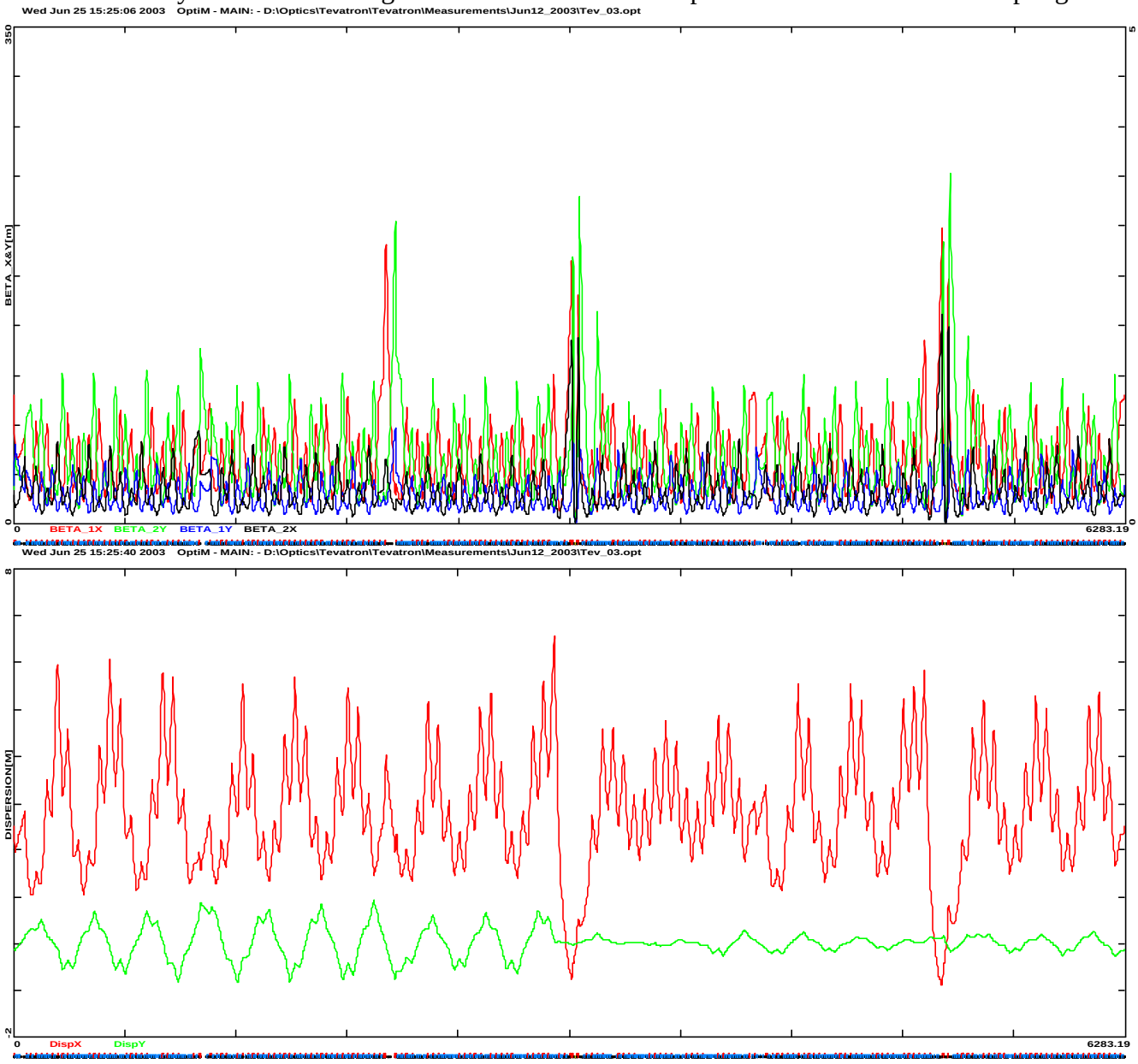
Dispersions:

DispX[cm]=262.192 DispY[cm]=-6.80203
DispPrX=0.0231542 DispPrY=$7.50095\ 10^{-4}$

Tunes:
Qx=20.588094 Qy=20.580235

Momentum compaction=0.00282129

♦ The model yields the following 4D Twiss functions at the proton helix after local decoupling in F0



4D beta-functions:

Beta_X_1[cm]=9031.19	Beta_X_2[cm]=2016.14	
Alfa_X_1=-0.154899	Alfa_X_2=-0.0607786	
Beta_Y_1[cm]=2720.33	Beta_Y_2[cm]=2371.48	
Alfa_Y_1=-0.466416	Alfa_Y_2=-0.274533	
Teta_1[deg]=8.39929	Teta_2[deg]=160.664	U=0.340631

Dispersions:

DispX[cm]=249.589	DispY[cm]=-13.0878
DispPrX=0.0216152	DispPrY=0.00187003

Tunes:

Qx=20.575154 Qy=20.586776

Momentum compaction=0.00282046

Path lengthening for excited orbit[cm]=0.0661726

This path length change corresponds to the energy correction $-3.7 \cdot 10^{-5}$ at proton helix

Initial trajectory parameters for RING

x=-0.138784 cm teta_x=-0.072383 mrad
y=-0.484294 cm teta_y=-0.085809 mrad
s=-0.133757 cm Dp/p*1000=0.000000