Beam-Based Alignment for Strong Sextupoles in PEP-II

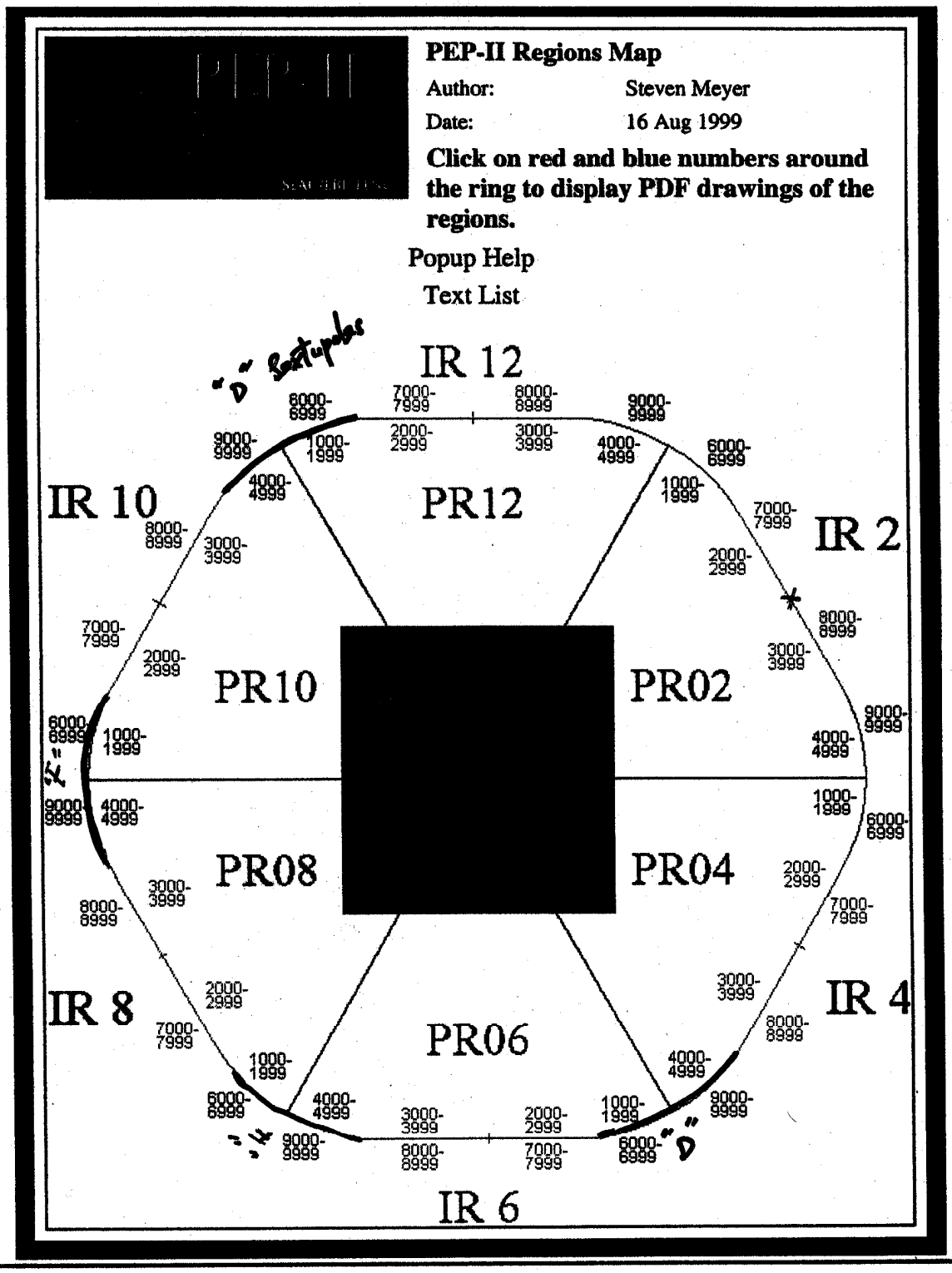
Yunhai Cai

ISG Meeting, SLAC

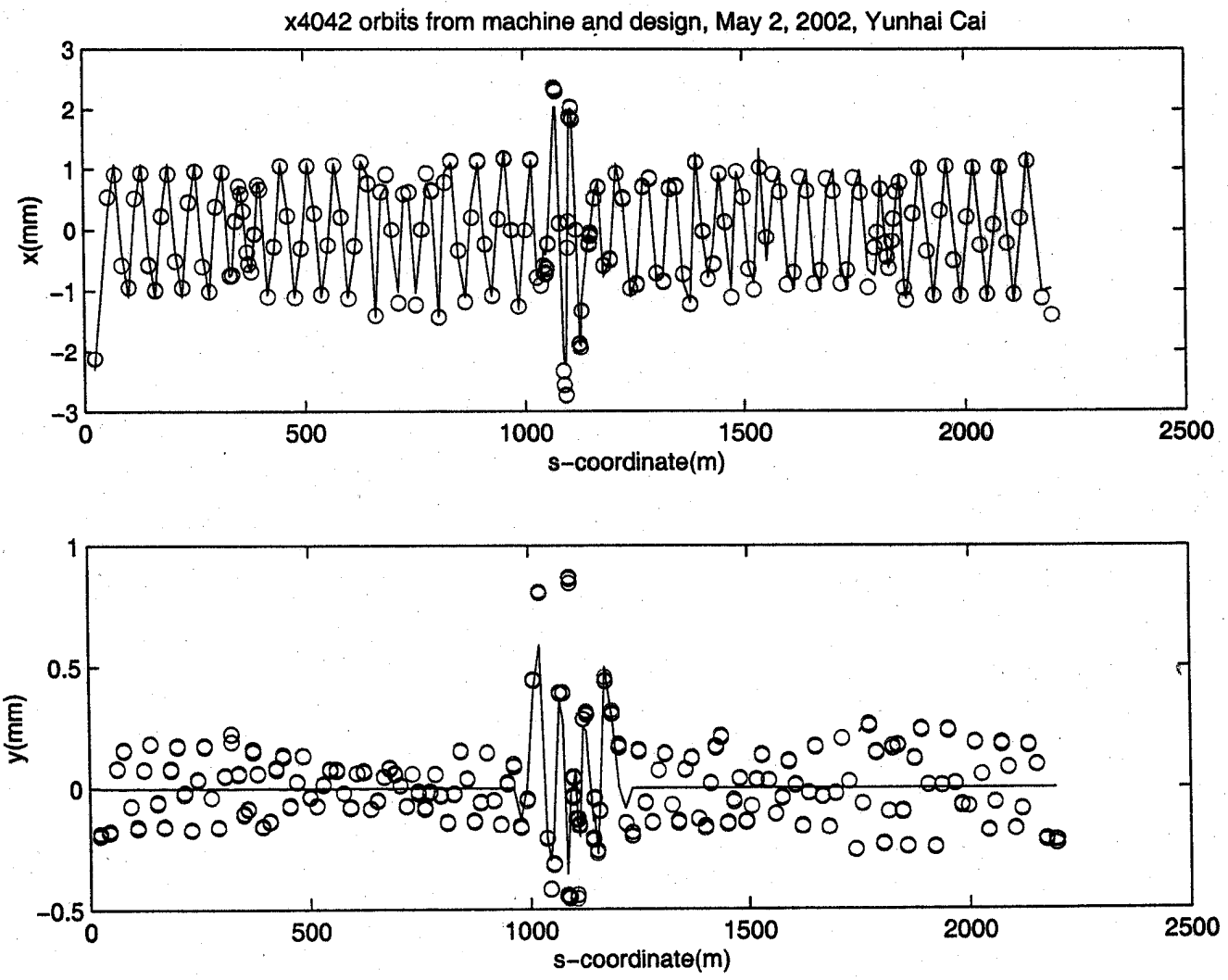
June 25, 2002

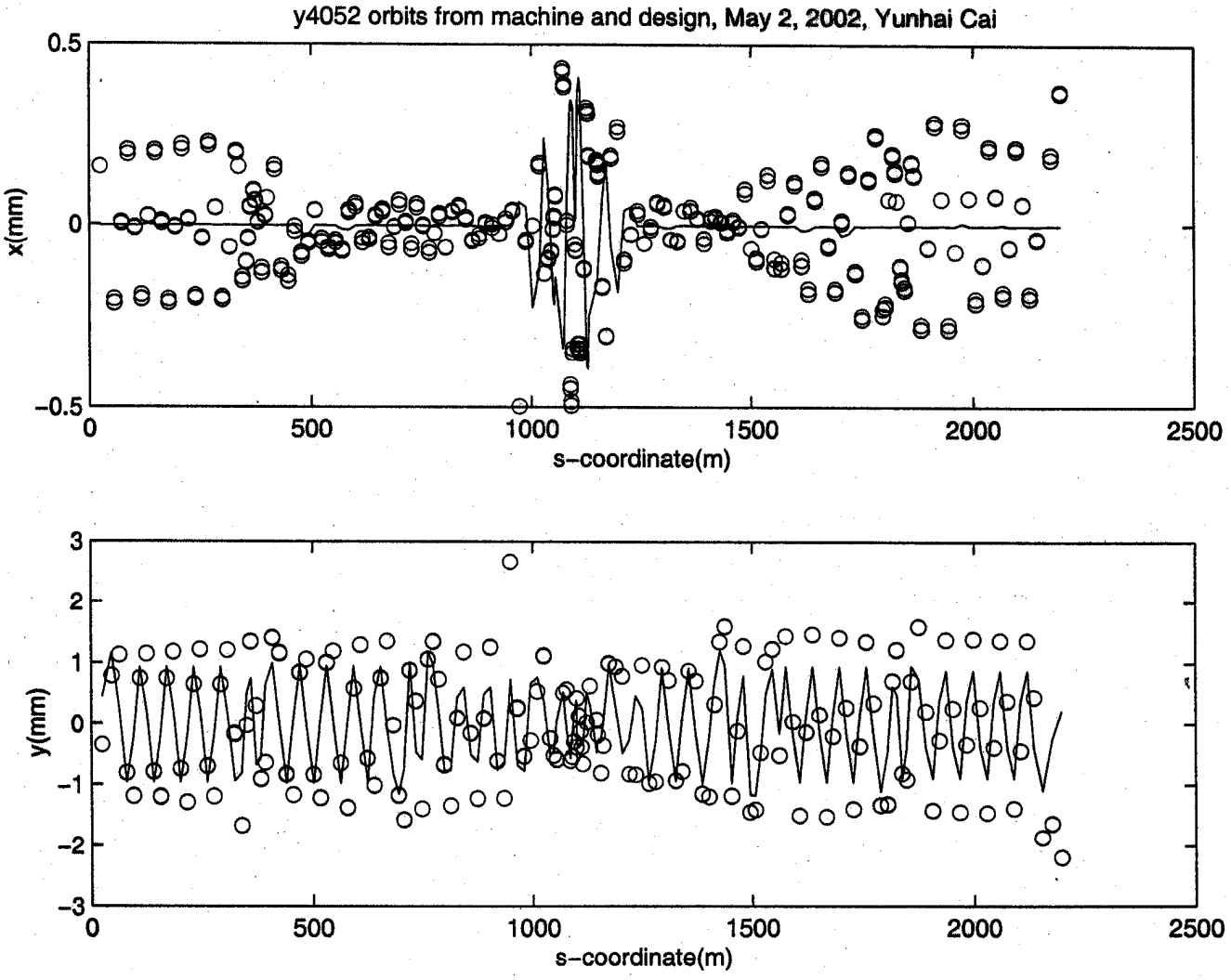
Oscillation Data

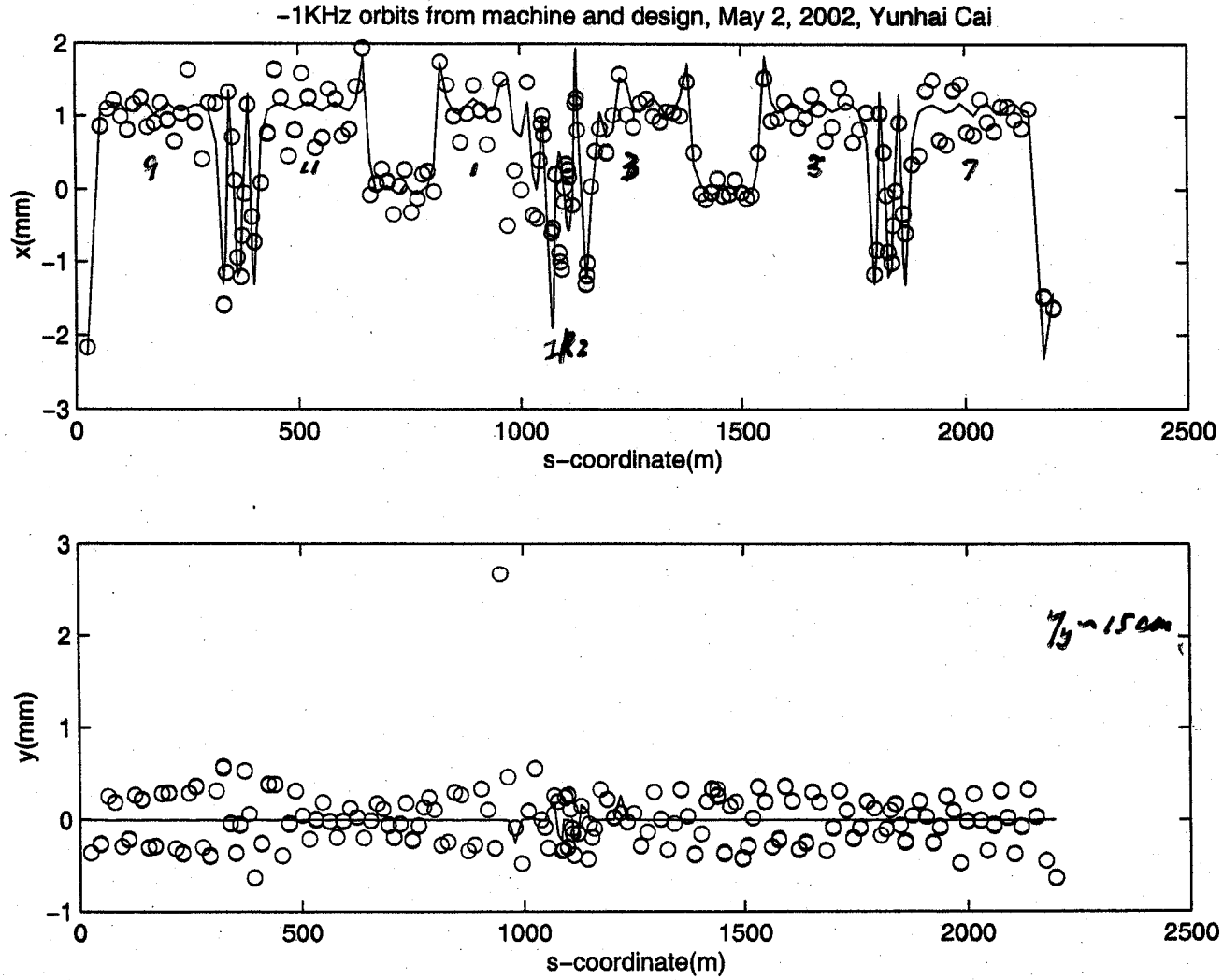
- Make a good calibration of BPM before taking the data
- Record at least three orbits generated by single corrector
- Record many reference orbits during the data taking
- BPM readings are averaged for 1024 turns
- Correctors should be outside the region of interests
- Correctors at different phases and planes
- Include dispersion



Owner: Steven Meyer
Last Significant Update: 29 Sep 1999

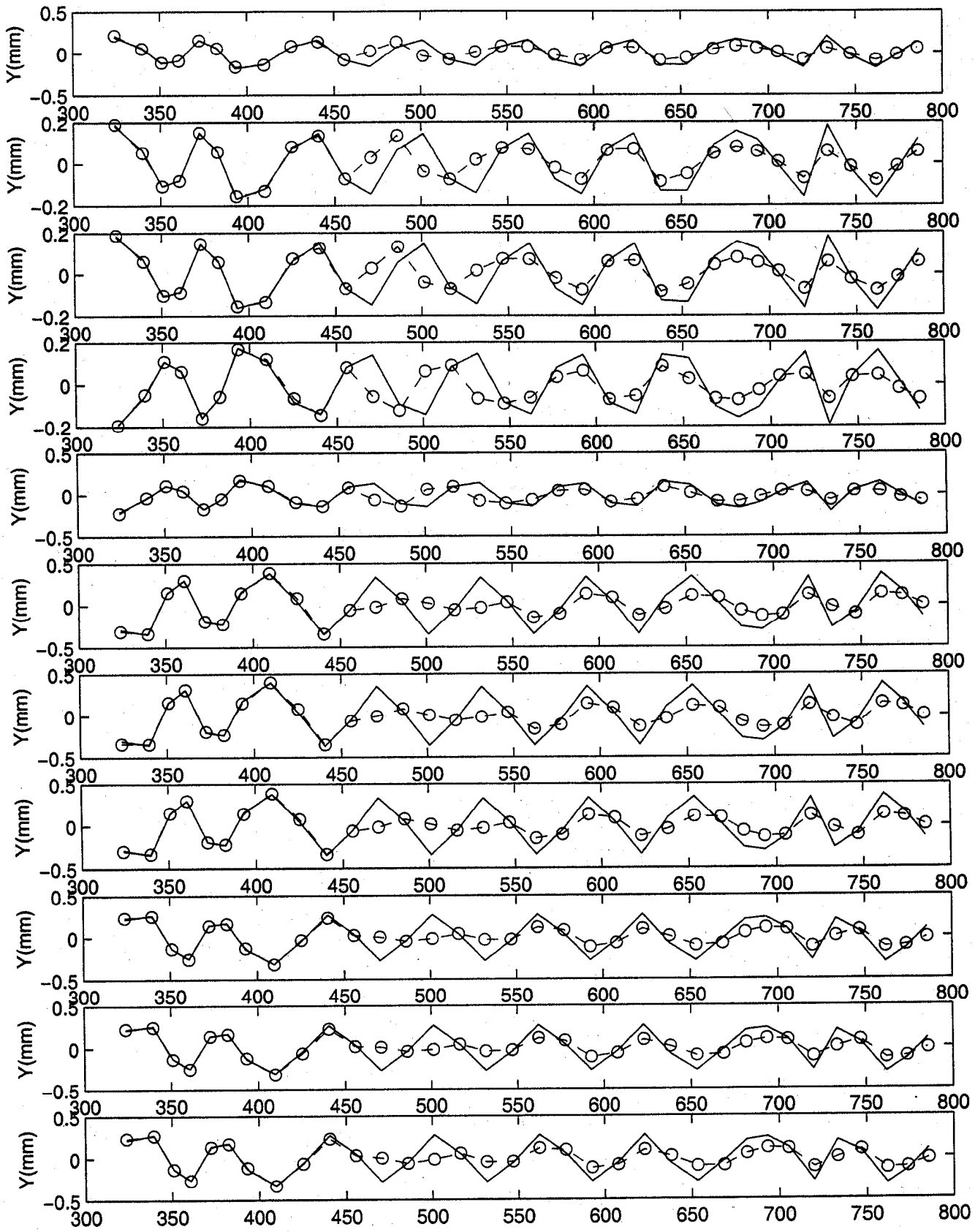

x4042 orbits from machine and design, May 2, 2002, Yunhai Cai
x(mm)
s-coordinate(m)
y(mm)
s-coordinate(m)

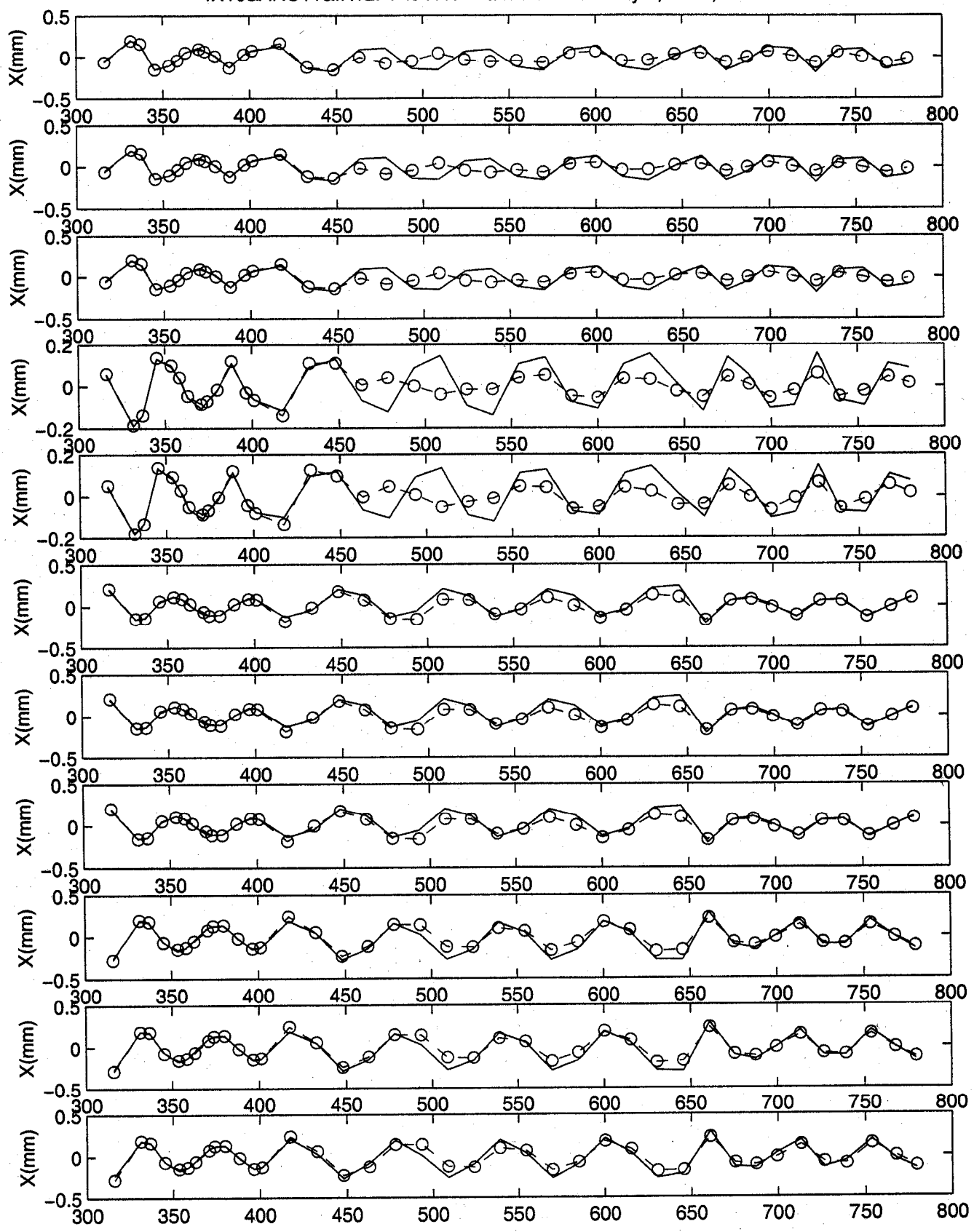

y4052 orbits from machine and design, May 2, 2002, Yunhai Cai
x(mm)
0.5
0
−0.5
0
500
1000
1500
2000
2500
s−coordinate(m)
y(mm)
3
2
1
0
−1
−2
−3
0
500
1000
1500
2000
2500
s−coordinate(m)

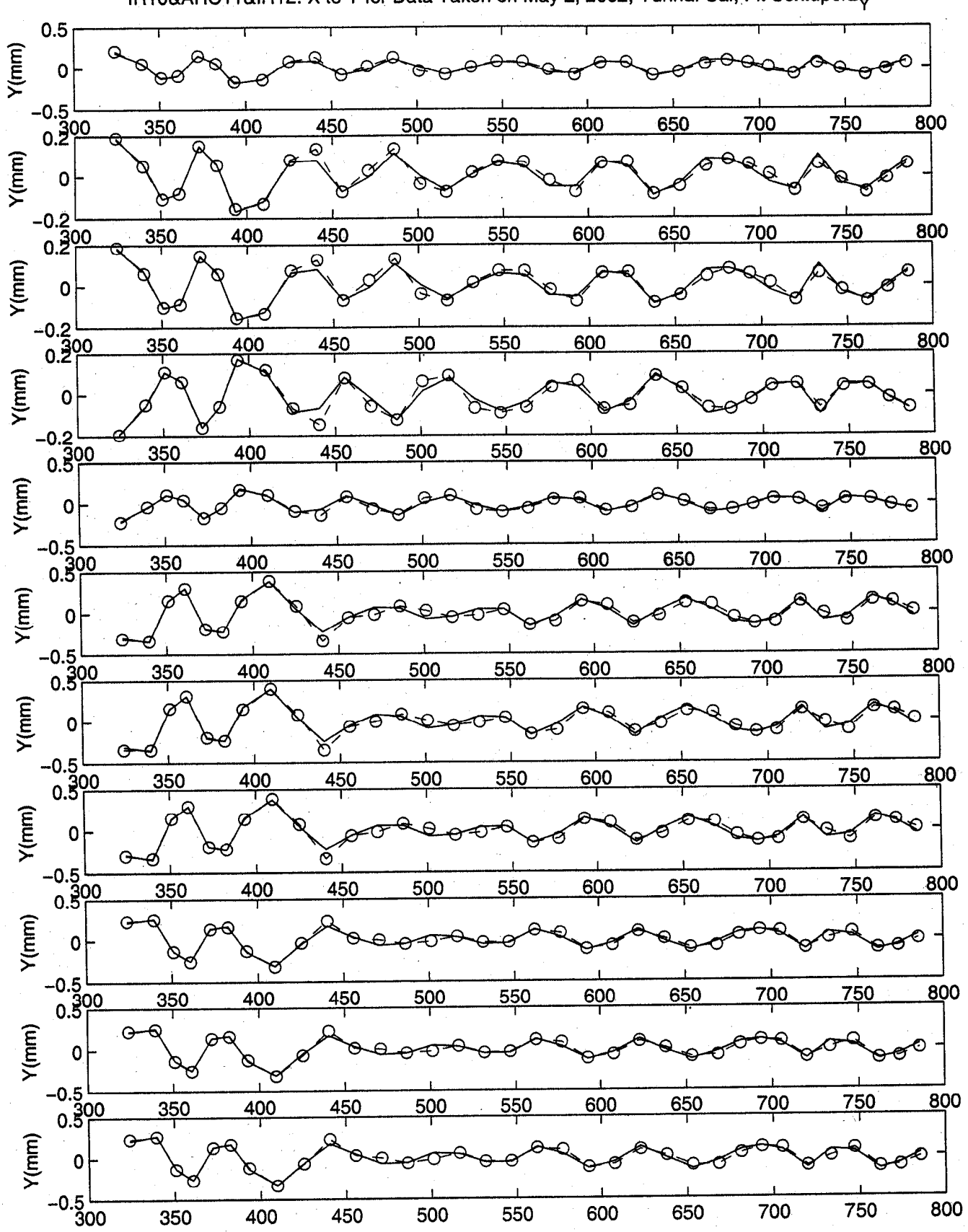

-1KHz orbits from machine and design, May 2, 2002, Yunhai Cai
x(mm)
s-coordinate(m)
y(mm)
s-coordinate(m)

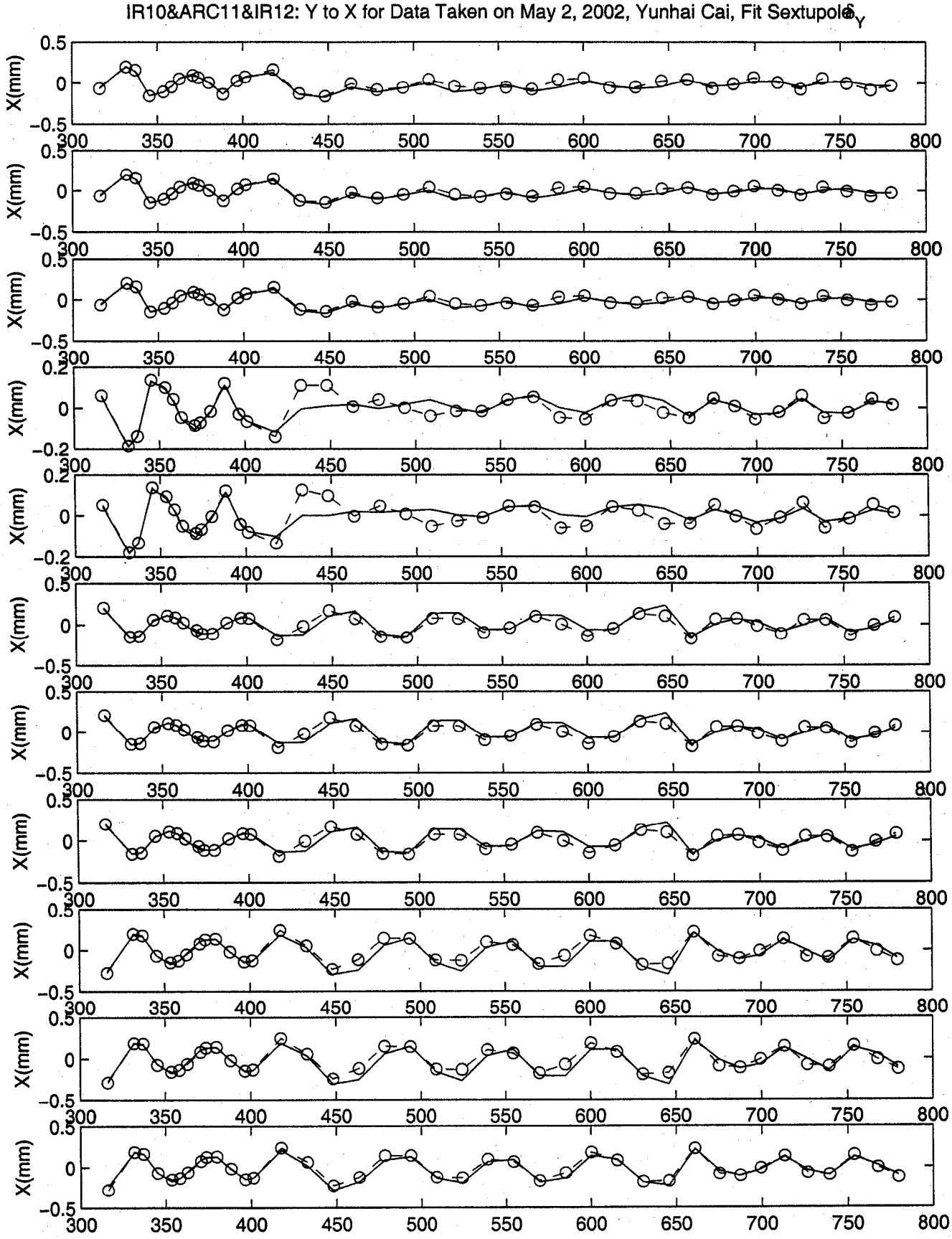
Procedure of Analysis

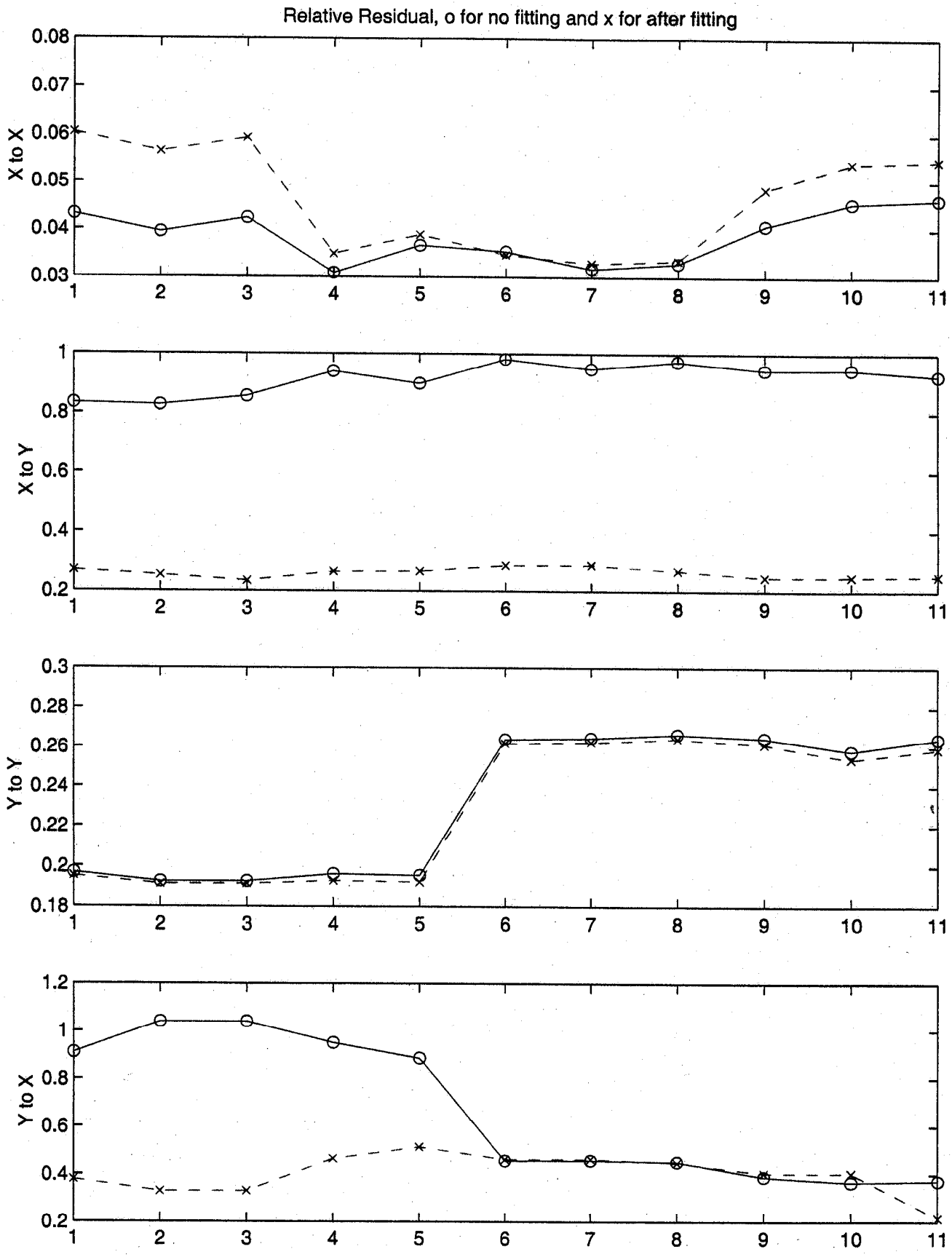
- Remove "dead" or "bad" BPMS from data
- Remove "bad" tracks from the data
- Choose a good region to fix launching
- Project the orbit trajectories into whole region to measure the differences between the machine and the model
- Choose a set of parameters in the model to minimize the differences between the machine and the model
- Estimate the uncertainty of the fitting results
- Fit "in" plane and "out" plane separately sometimes

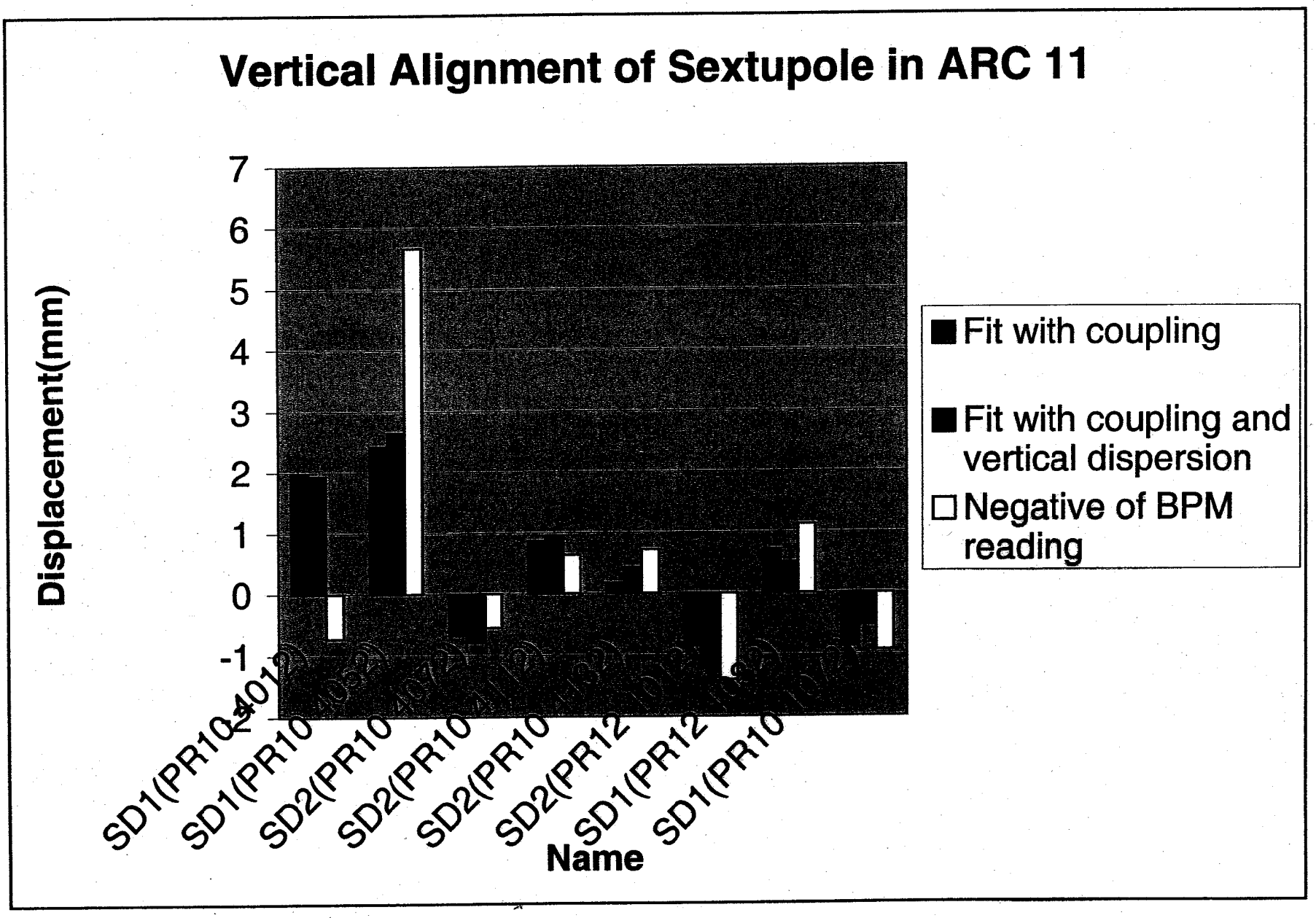

IR10&ARC11&IR12: X to Y for Data Taken on May 2, 2002, Yunhai Cai
Y(mm)
0.5
0
-0.5
0.2
-0.2
300
350
400
450
500
550
600
650
700
750
800

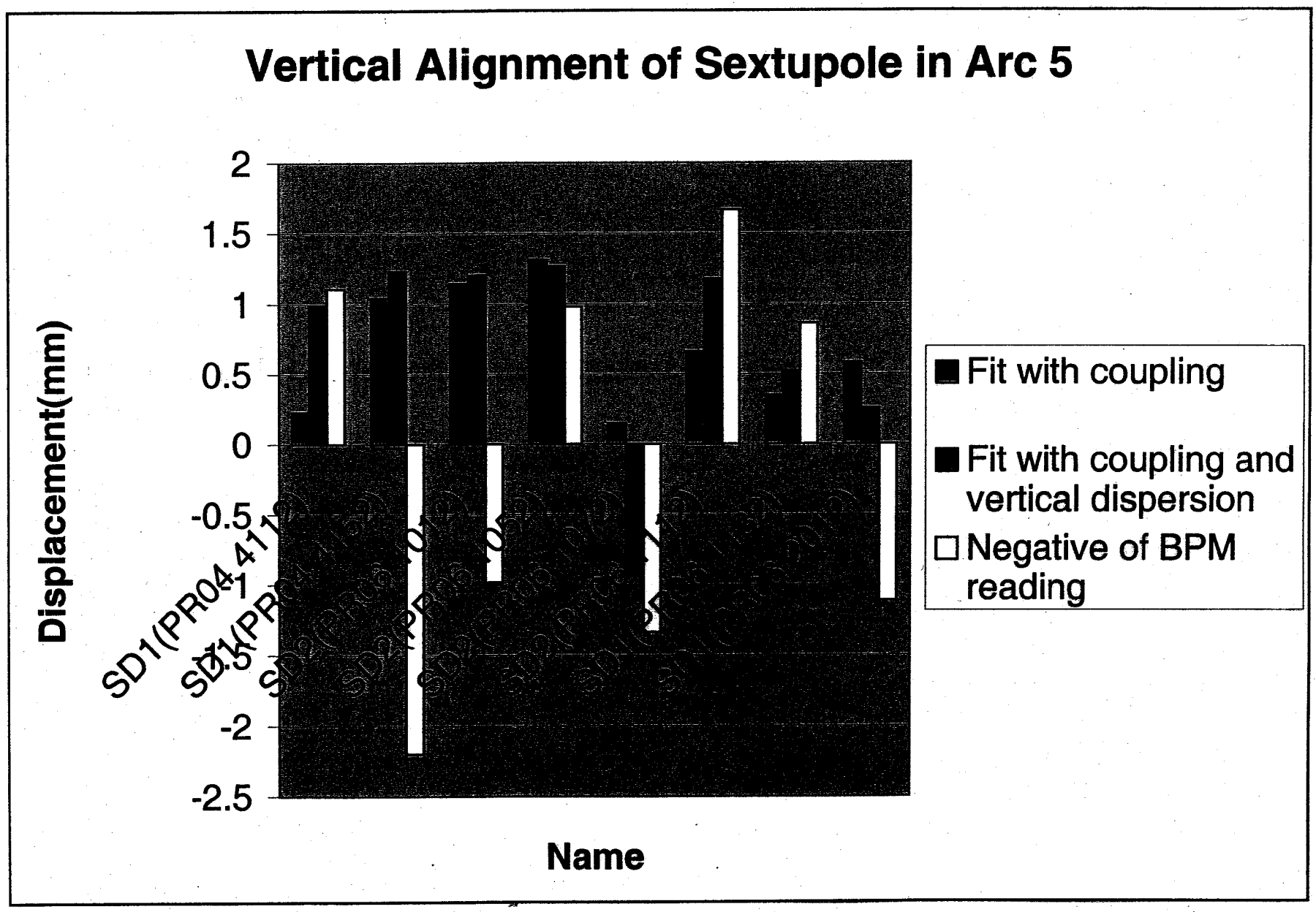

IR10&ARC11&IR12: Y to X for Data Taken on May 2, 2002, Yunhai Cai
X(mm)
0.5
0
−0.5
0.2
−0.2
300
350
400
450
500
550
600
650
700
750
800

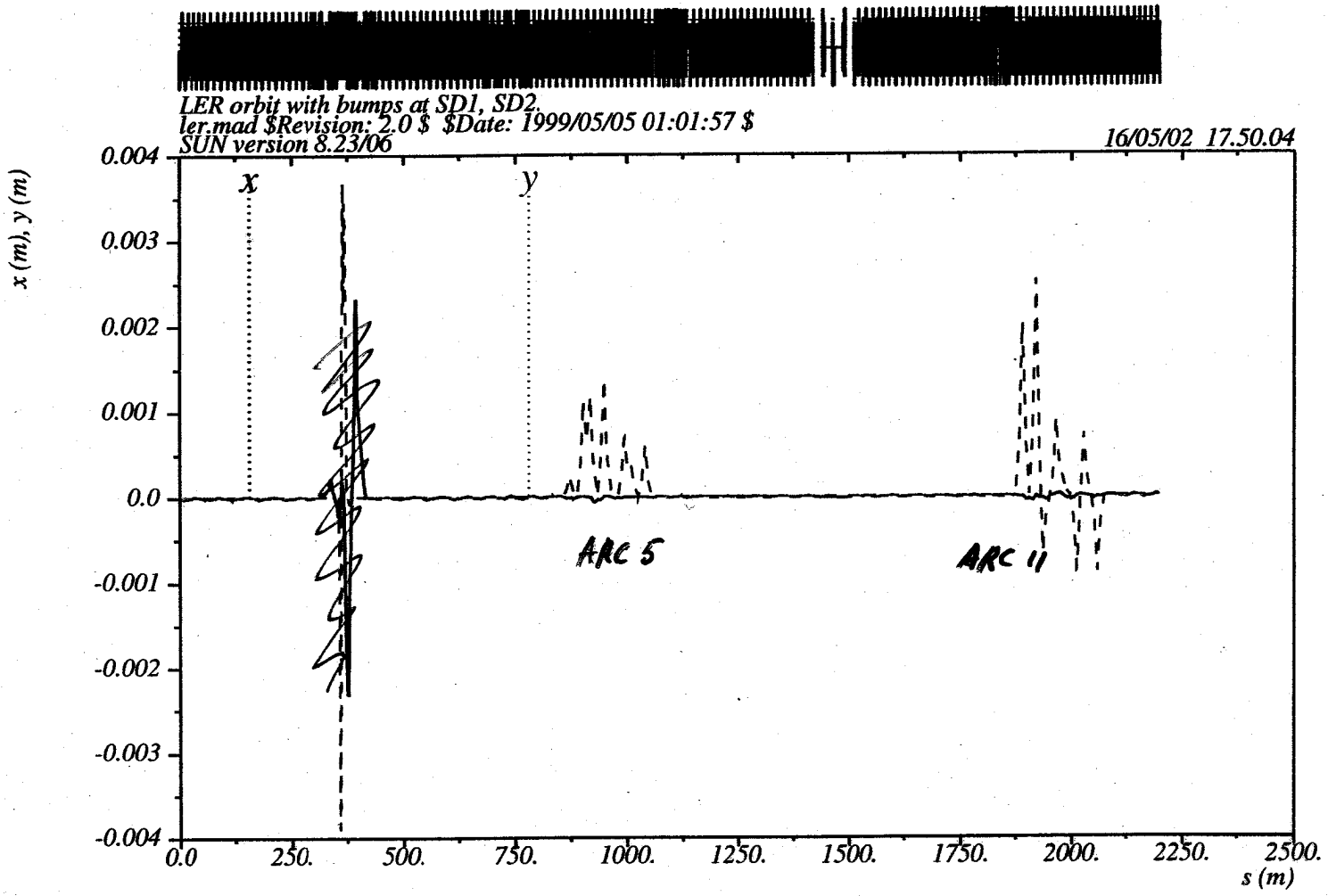

IR10&ARC11&IR12: X to Y for Data Taken on May 2, 2002, Yunhai Cai, Fit Sextupole δ_Y
Y(mm)
300
350
400
450
500
550
600
650
700
750
800


IR10&ARC11&IR12: Y to X for Data Taken on May 2, 2002, Yunhai Cai, Fit Sextupole δ_Y
X(mm)
0.5
0
−0.5
0.2
−0.2
300
350
400
450
500
550
600
650
700
750
800

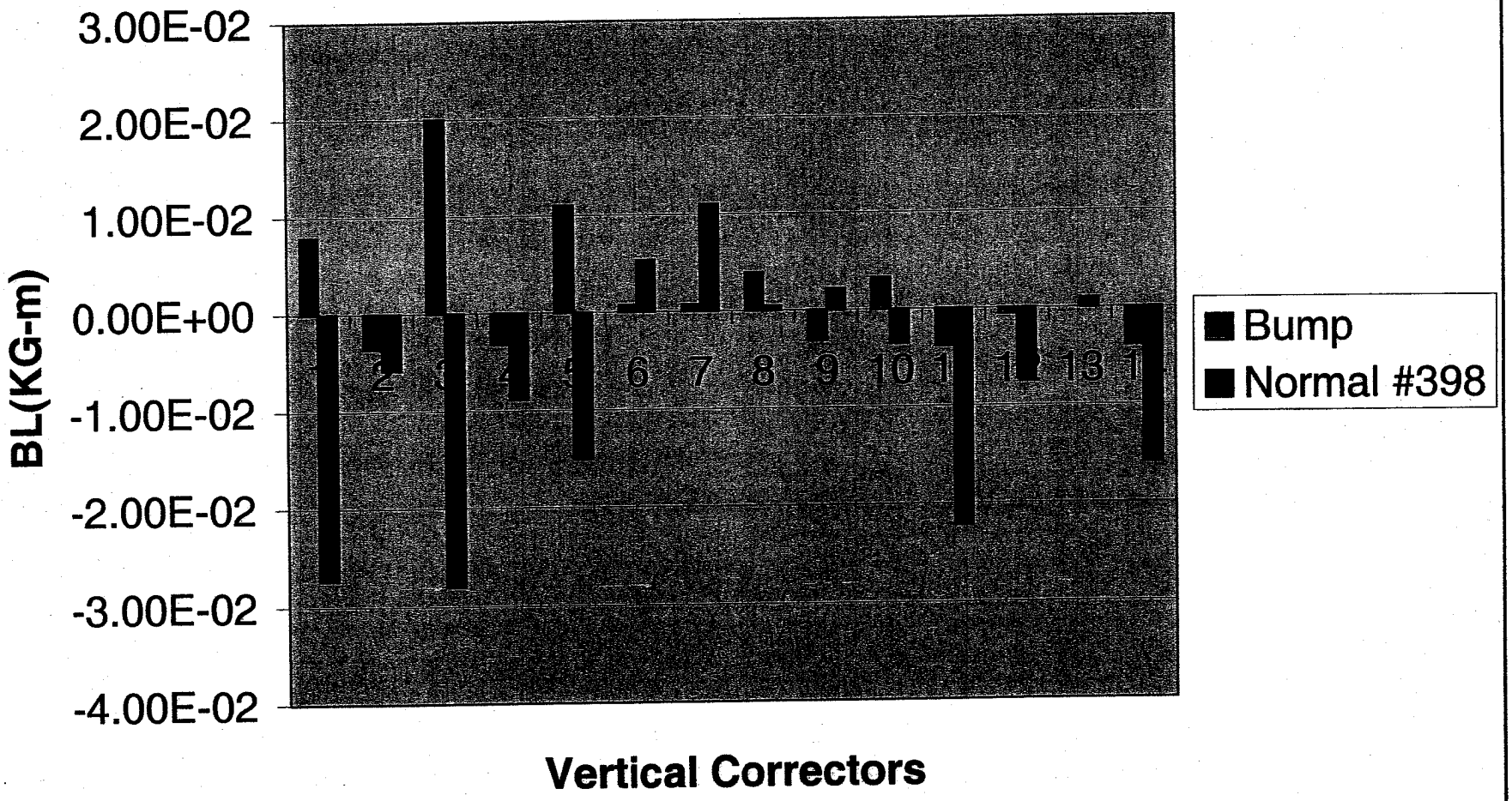

Relative Residual, o for no fitting and x for after fitting
X to X
0.08
0.07
0.06
0.05
0.04
0.03
1 2 3 4 5 6 7 8 9 10 11
X to Y
1
0.8
0.6
0.4
0.2
1 2 3 4 5 6 7 8 9 10 11
Y to Y
0.3
0.28
0.26
0.24
0.22
0.2
0.18
1 2 3 4 5 6 7 8 9 10 11
Y to X
1.2
1
0.8
0.6
0.4
0.2
1 2 3 4 5 6 7 8 9 10 11

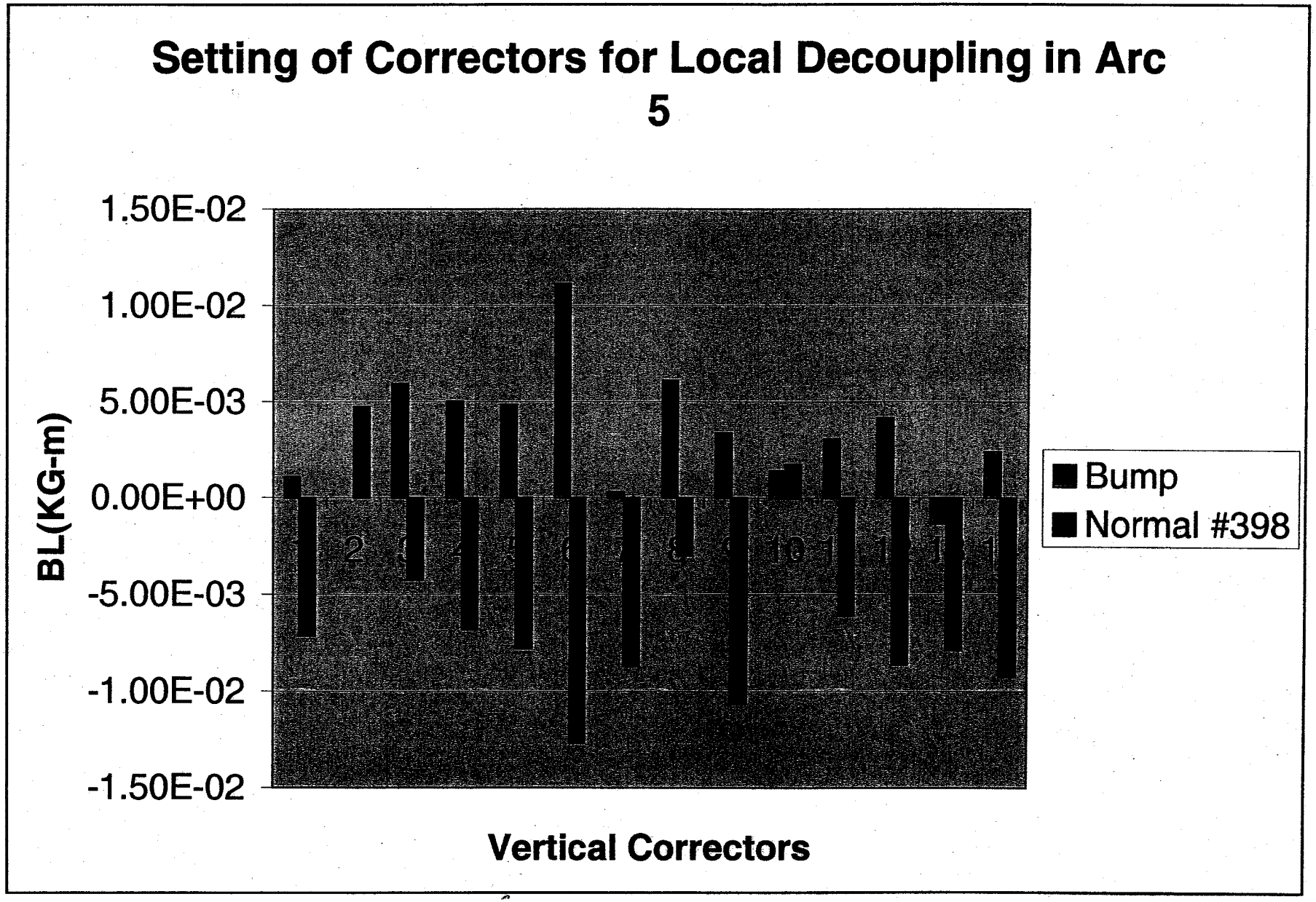

Vertical Alignment of Sextupole in ARC 11
Displacement(mm)
7
6
5
4
3
2
1
0
-1
-2
SD1(PR10
SD1(PR10
SD2(PR10
SD2(PR10
SD2(PR10
SD2(PR12
SD1(PR12
SD1(PR10
Name
Fit with coupling
Fit with coupling and vertical dispersion
Negative of BPM reading

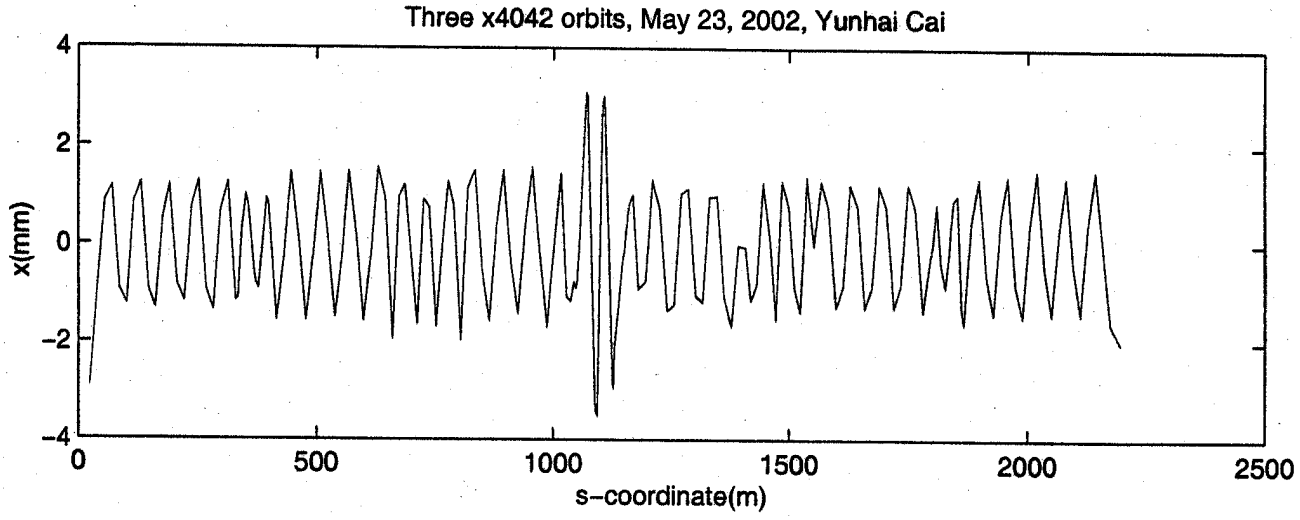

Vertical Alignment of Sextupole in Arc 5
Displacement(mm)
2
1.5
1
0.5
0
-0.5
-1
-2
-2.5
Name
Fit with coupling
Fit with coupling and vertical dispersion
Negative of BPM reading

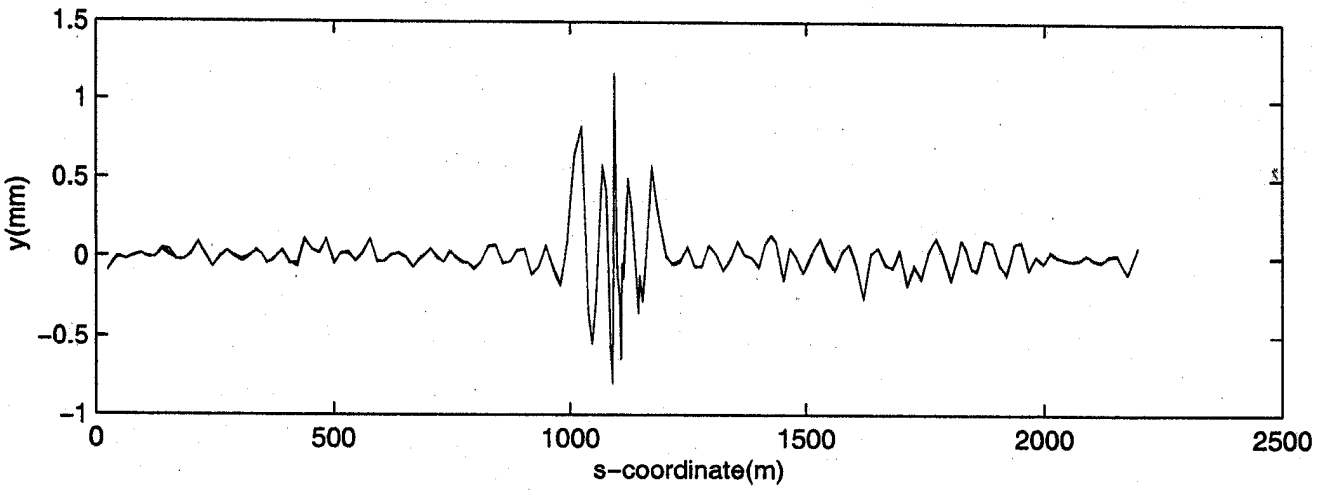

LER orbit with bumps at SD1, SD2.
ler.mad $Revision: 2.0 $ $Date: 1999/05/05 01:01:57 $
SUN version 8.23/06
16/05/02 17.50.04
x (m), y (m)
x
y
0.004
0.003
0.002
0.001
0.0
-0.001
-0.002
-0.003
-0.004
ARC 5
ARC 11
0.0
250.
500.
750.
1000.
1250.
1500.
1750.
2000.
2250.
2500.
s (m)
δE/ poc = 0.
Table name = TWISS

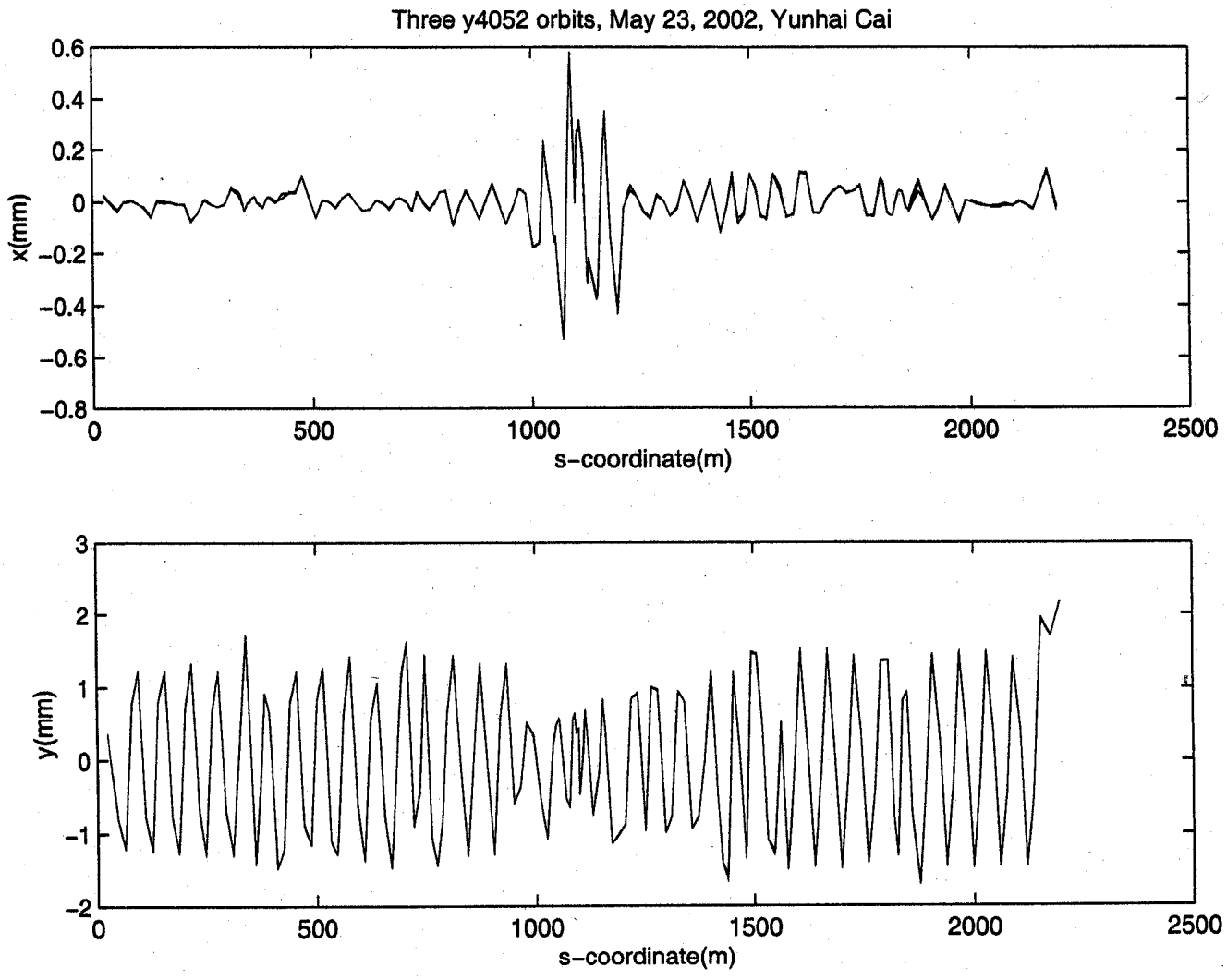
Setting of Corretors for Local Decoupling in Arc 11




Setting of Correctors for Local Decoupling in Arc 5
1.50E-02
1.00E-02
5.00E-03
0.00E+00
-5.00E-03
-1.00E-02
-1.50E-02
BL(KG-m)
Bump
Normal #398
Vertical Correctors

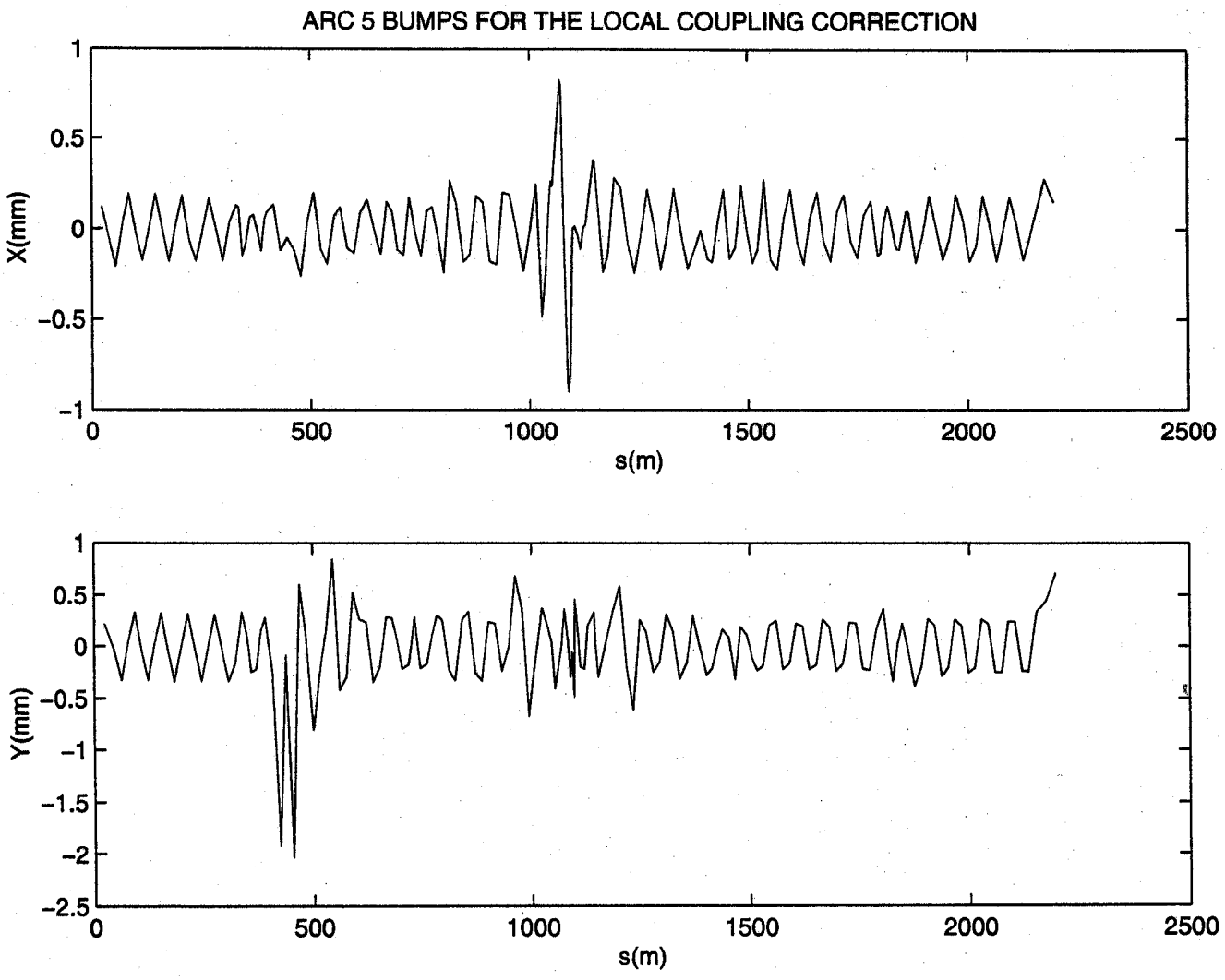

Three x4042 orbits, May 23, 2002, Yunhai Cai
x(mm)
s−coordinate(m)
4
2
0
−2
−4
0
500
1000
1500
2000
2500

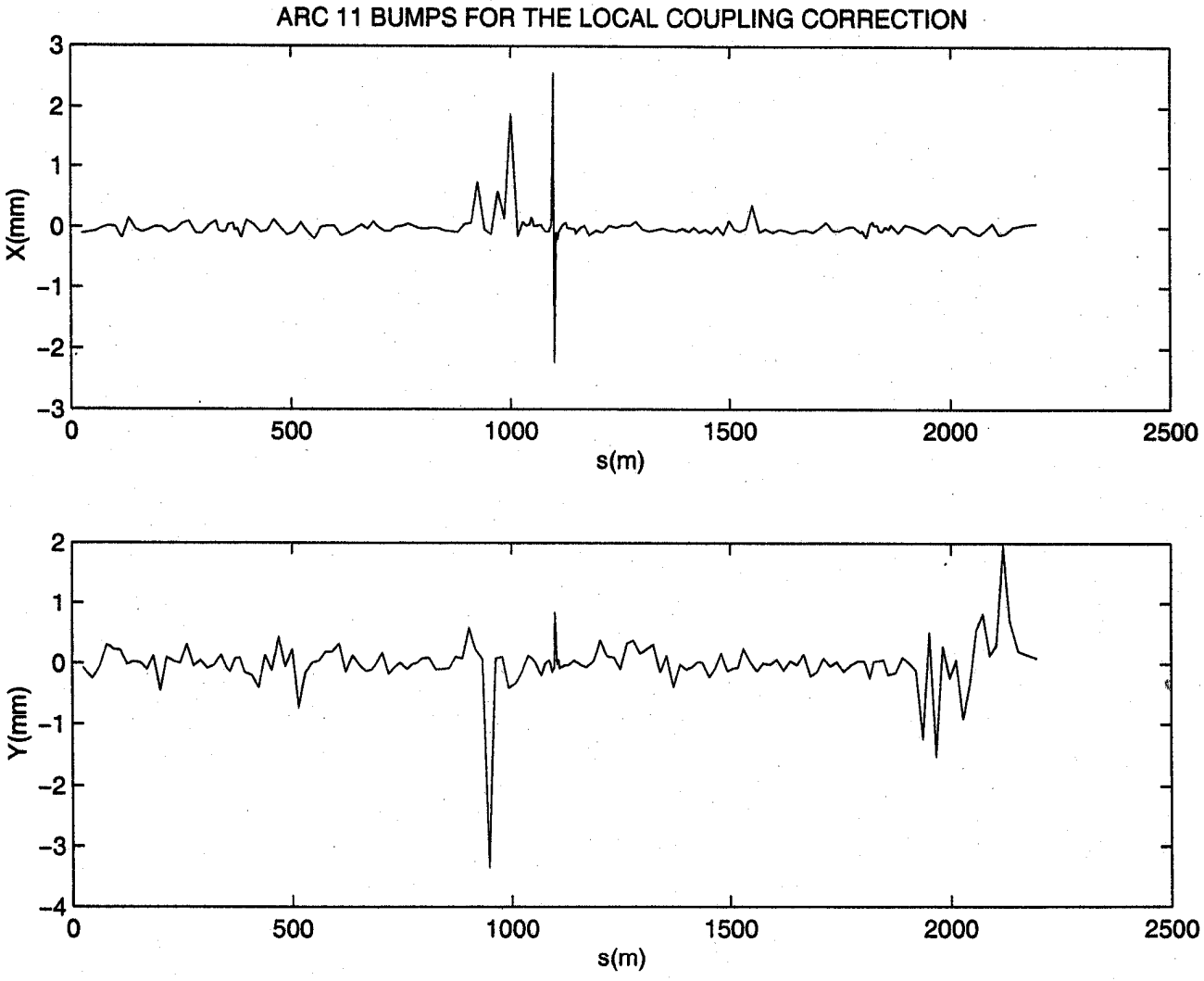

y(mm)
s−coordinate(m)
1.5
1
0.5
0
−0.5
−1
0
500
1000
1500
2000
2500

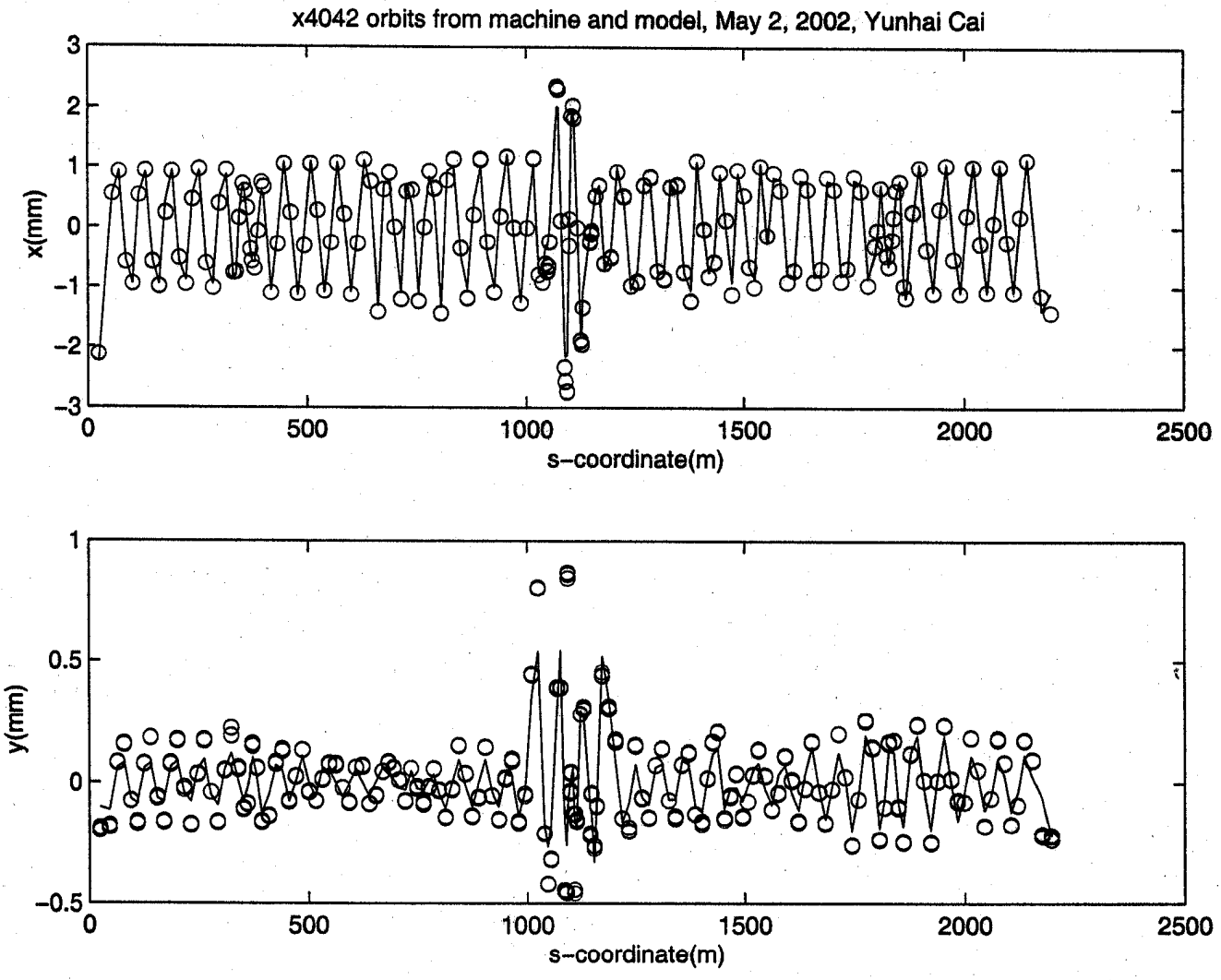

Three y4052 orbits, May 23, 2002, Yunhai Cai
x(mm)
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
0
500
1000
1500
2000
2500
s−coordinate(m)
y(mm)
3
2
1
0
−1
−2
0
500
1000
1500
2000
2500
s−coordinate(m)

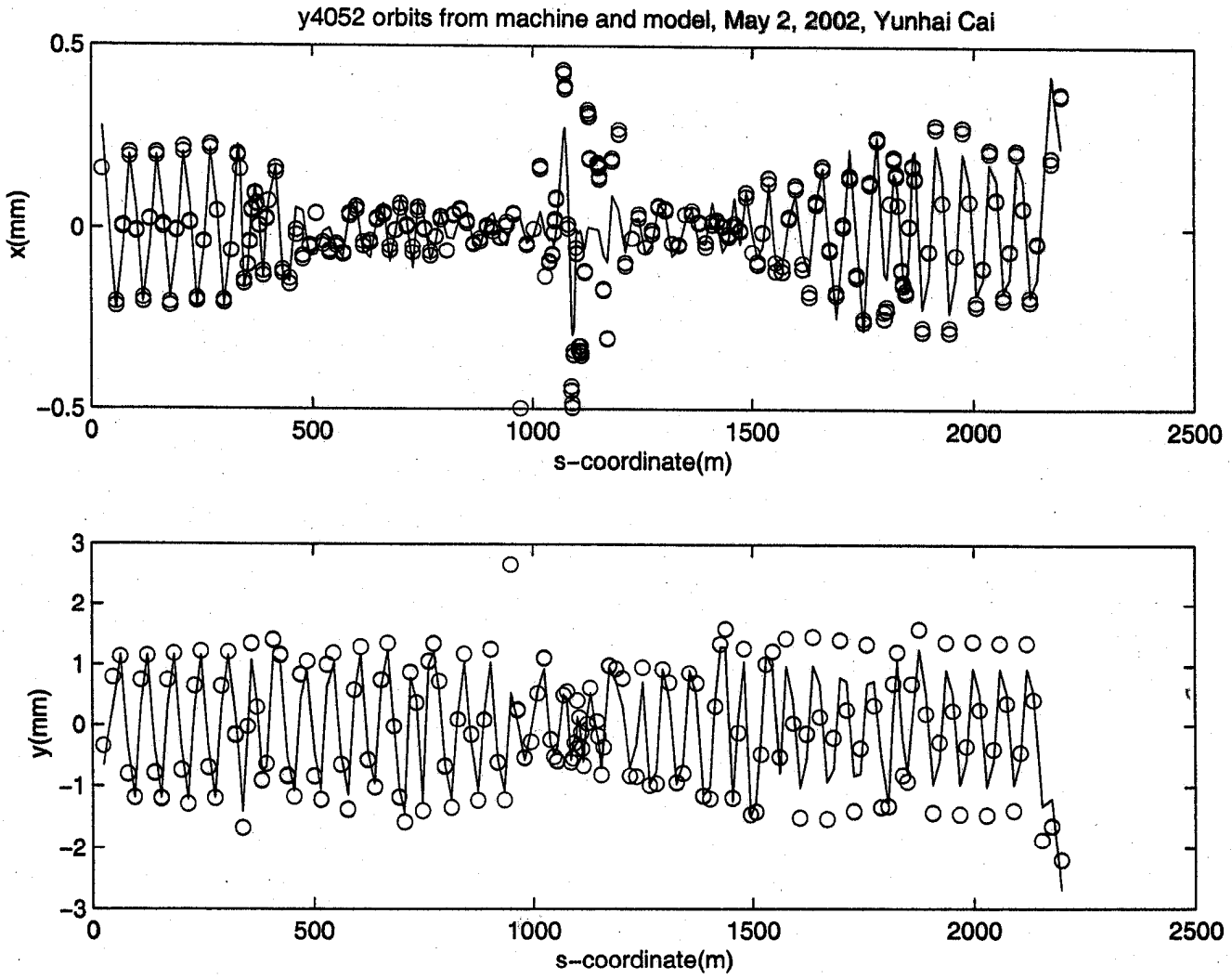
Setting of Global Skew Quadrupoles

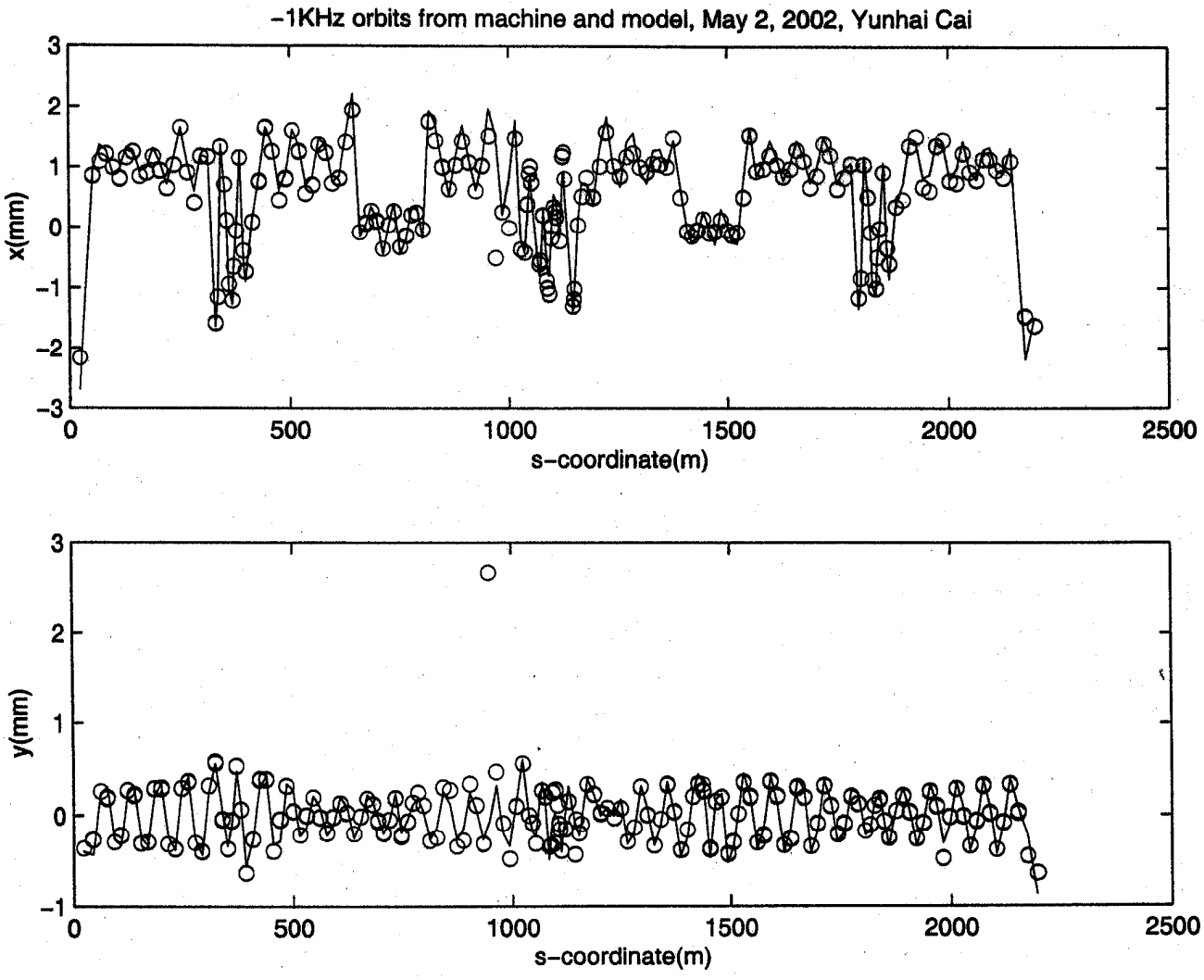
- Normal #398 (before the correction):
  - SKG1: 0.51341
  - SKG2: -1.6362
  - SKG3: 1.2025
  - SKG4: 1.5656
- Normal #419 (after the correction):
  - SKG1: 0.12493
  - SKG2: -0.81686
  - SKG3: 1.0381
  - SKG4: 0.33785


ARC 5 BUMPS FOR THE LOCAL COUPLING CORRECTION
X(mm)
s(m)
Y(mm)
s(m)

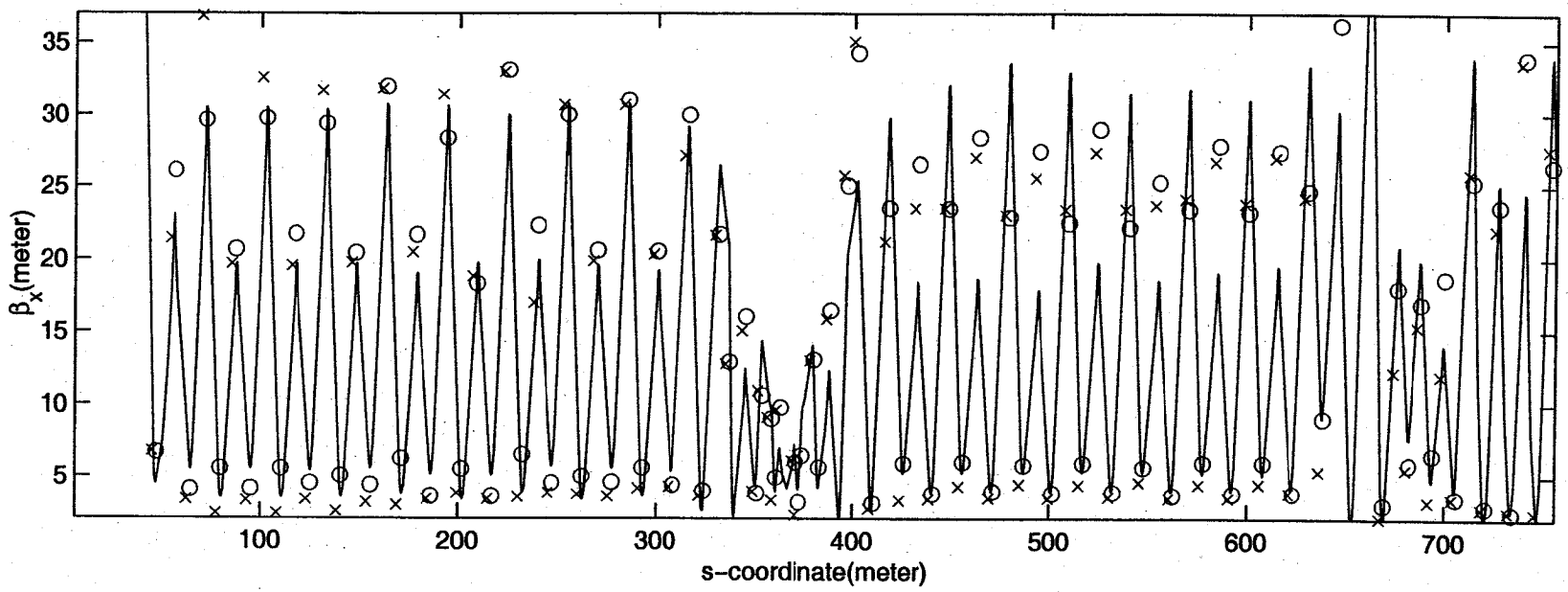

ARC 11 BUMPS FOR THE LOCAL COUPLING CORRECTION
X(mm)
3
2
1
0
−1
−2
−3
0
500
1000
1500
2000
2500
s(m)
Y(mm)
2
1
0
−1
−2
−3
−4
0
500
1000
1500
2000
2500
s(m)

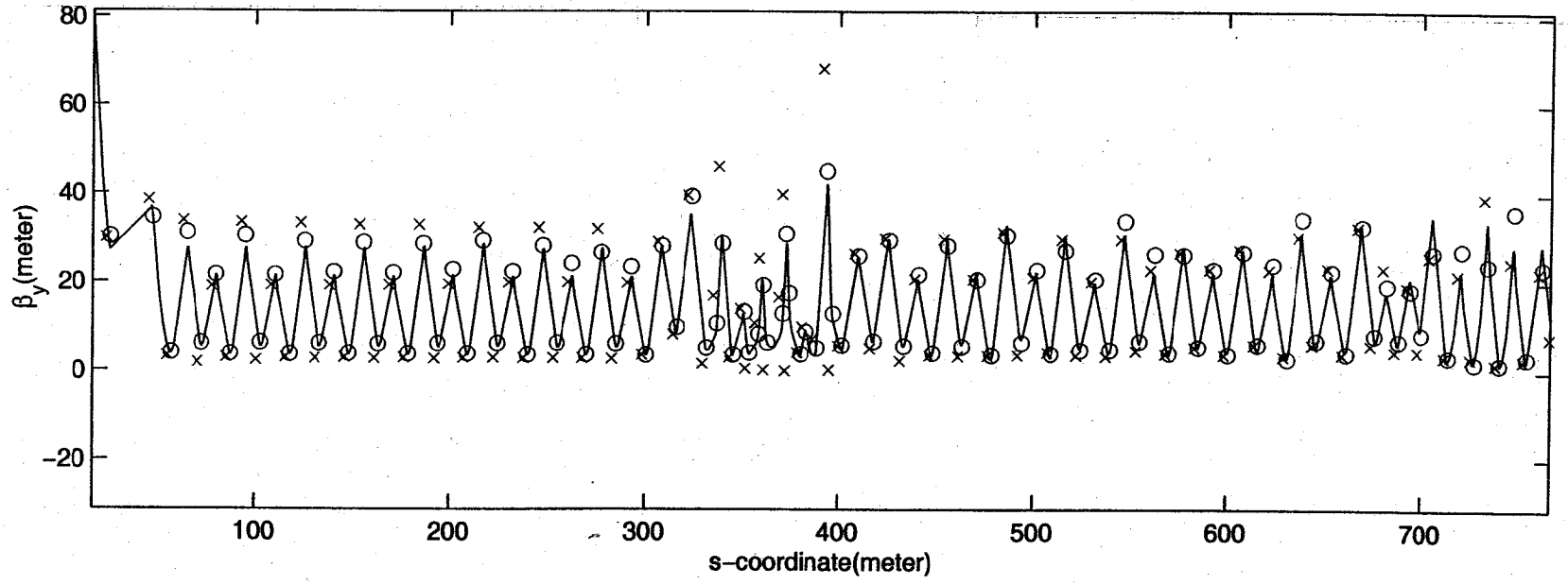

x4042 orbits from machine and model, May 2, 2002, Yunhai Cai
x(mm)
s–coordinate(m)
y(mm)
s–coordinate(m)


y4052 orbits from machine and model, May 2, 2002, Yunhai Cai
x(mm)
0.5
0
−0.5
0
500
1000
1500
2000
2500
s−coordinate(m)
y(mm)
3
2
1
0
−1
−2
−3
0
500
1000
1500
2000
2500
s−coordinate(m)


-1KHz orbits from machine and model, May 2, 2002, Yunhai Cai
x(mm)
s-coordinate(m)
y(mm)
s-coordinate(m)

Beta Fuantions in the Machine and Model, May, 2, 2002, Martin Donald, Uli Wienands, and Yunhai Cai





Parameters Based on the Model Near Half Integer Including Lattice Functions, Coupling, and Dispersions (May 2, 2002)

- Lattice parameters:
  - $\beta_x^* = 43.56\text{cm}$ ($\beta_x^* = 50\text{cm}$)
  - $\alpha_x^* = 0.3329$ ($\alpha_x^* = 0$)
  - $\beta_y^* = 11.1\text{mm}$ ($\beta_y^* = 12.5\text{mm}$)
  - $\alpha_y^* = 0.1643$ ($\alpha_y^* = 0$)
  - $\eta_x^* = -17.7\text{mm}$ ($\eta_x^* = 0$)
  - $\eta_y^* = 2.8\text{mm}$ ($\eta_y^* = 0$)
- Beam parameters:
  - $\sigma_x^* = 113.6\mu\text{m}$ ($\sigma_x^* = 116\mu\text{m}$)
  - $\sigma_y^* = 7.05\mu\text{m}$ ($\sigma_y^* = 2.8\mu\text{m}$)
  - $\theta^* = 18.7\text{mrad}$ ($\theta^* = 0$)
- Ring parameters:
  - $\nu_x = 38.6045$ ($\nu_x = 38.535$)
  - $\nu_y = 36.7203$ ($\nu_y = 36.610$)

Conclusion

- Alignments of sextupoles in arcs of the Low Energy Ring (LER) have been analyzed using the oscillation data. The most misalignment obtained from the analysis are at the order of millimeter and consistent with the readings of beam position monitor (BPM). However, we have found a few BPM that have large offsets.
- Beam-based alignment has been applied in the LER with a mixed result. We need to further improve the implementation procedure, for example to eliminate the leakage to the outside of the bump or to steer a new reference orbit that goes through the center of sextupoles.
- Analysis of the oscillation data has been extended to include dispersions. Based on the analysis result, we can conclude that almost all optics errors including beta beating, coupling, and dispersion in the LER can be explained by the misalignment of strong and non-interlaced sextupoles.