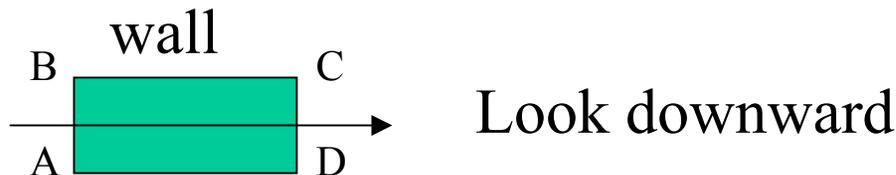


Misalignments in MAD model

1. Survey data \rightarrow dx, dy, dpsi as needed in MAD
(See TM-2223)



$$dy_0 = \text{average}[Z(A), Z(B), Z(C), Z(D)] - 221.4325\text{m}$$

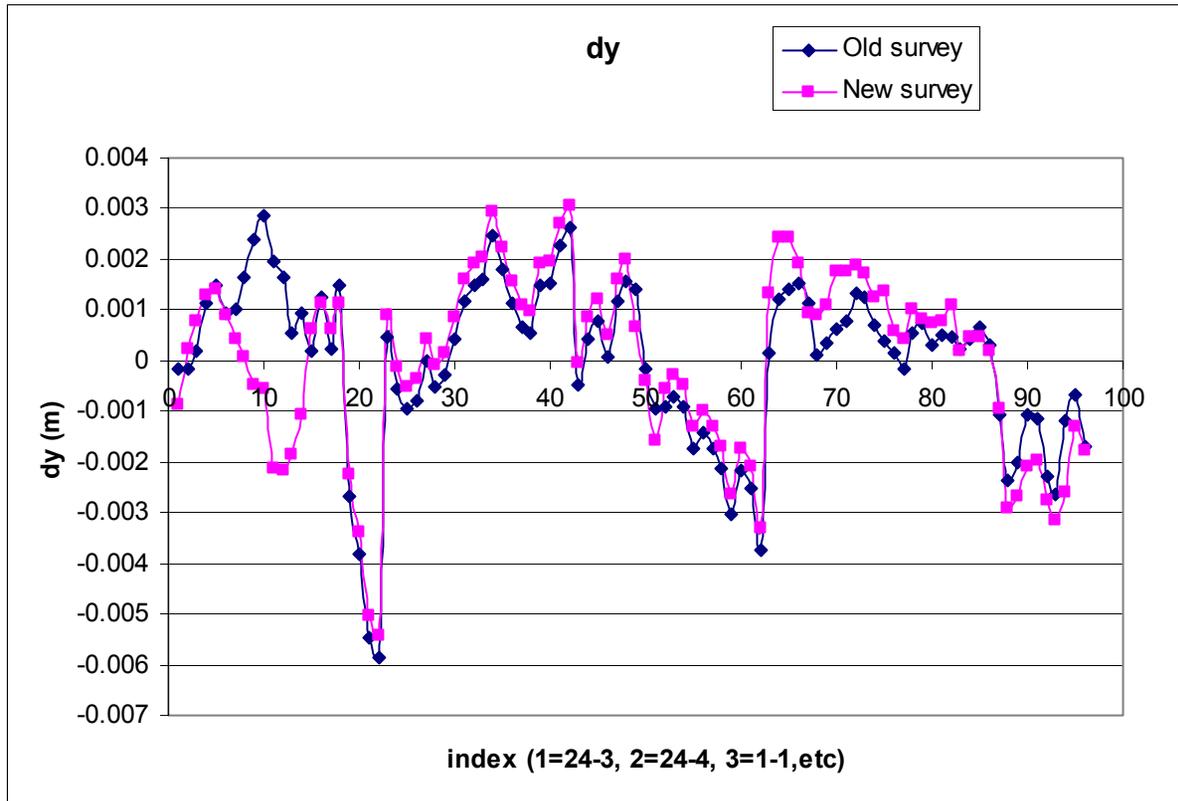
$$dy = -(dy_0 - \text{average}(dy_0))$$

$$dpsi = -(Z(A) + Z(D) - Z(B) - Z(C))/2/L, \text{ with } L=0.38144\text{m}$$

Note: '-' is put in for dy and dpsi because the surveyor's coordinate system doesn't agree with that of MAD program

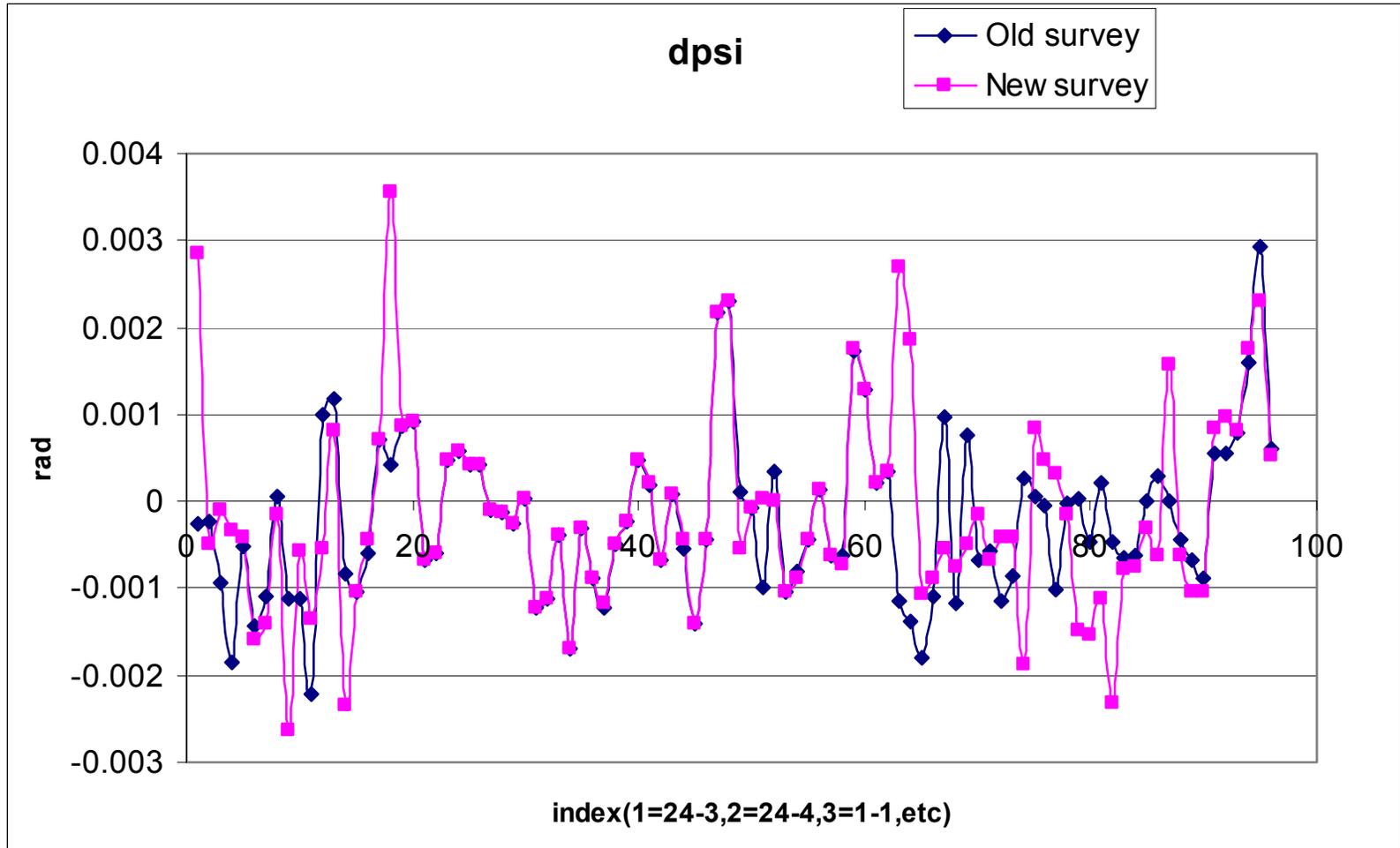
average(dy0) = -0.6872 mm for OLD SURVEY (1994)

average(dy0) = -1.1189 mm for NEW SURVEY (2004)



In surveyor's
coordinate
system

1 = 24-3, 2 = 24-4, 3 = 1-1, 4=1-2, etc



No new horizontal survey data

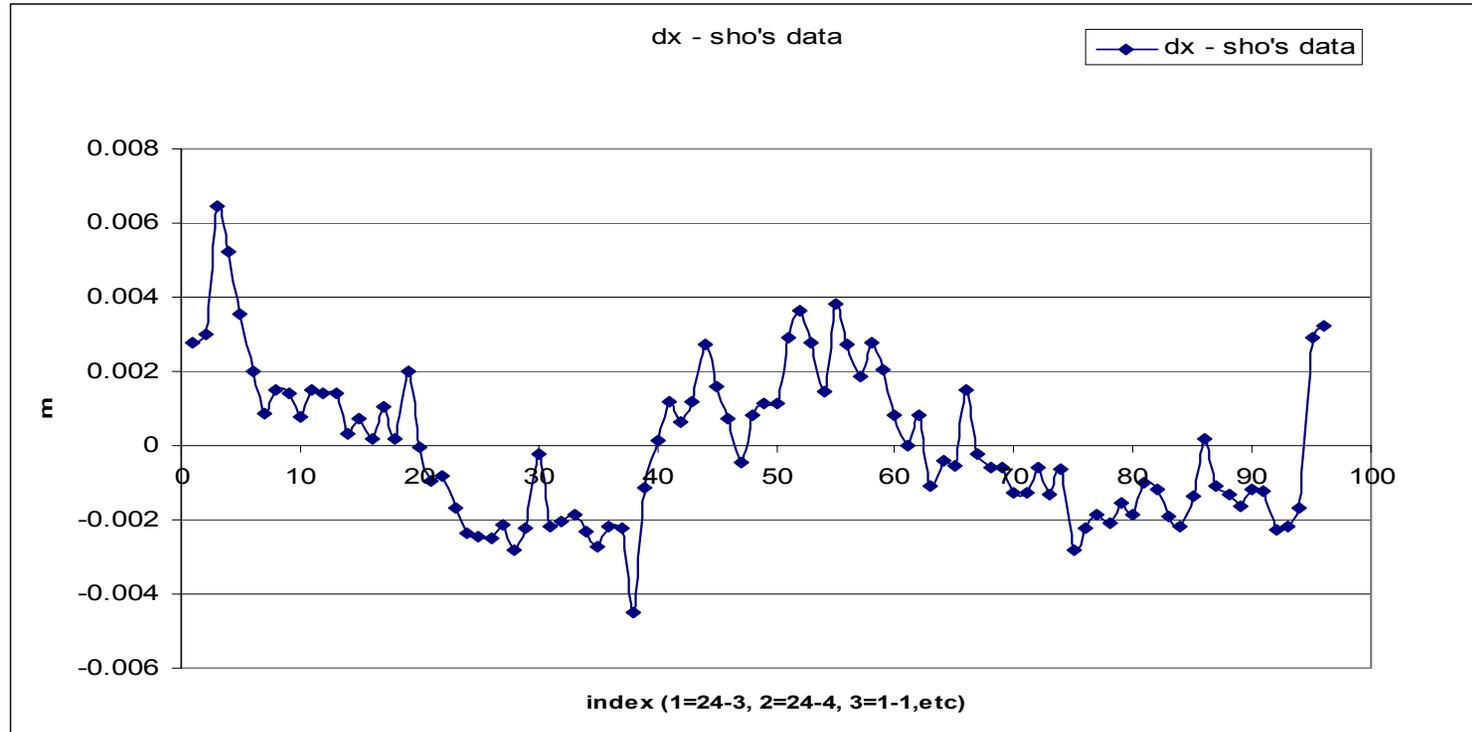
Data from TM2223

$$r(F) = 75.501645 \text{ m}$$

$$dx(F) = r - r(F)$$

$$r(D) = 75.434875 \text{ m}$$

$$dx(D) = r - r(D)$$

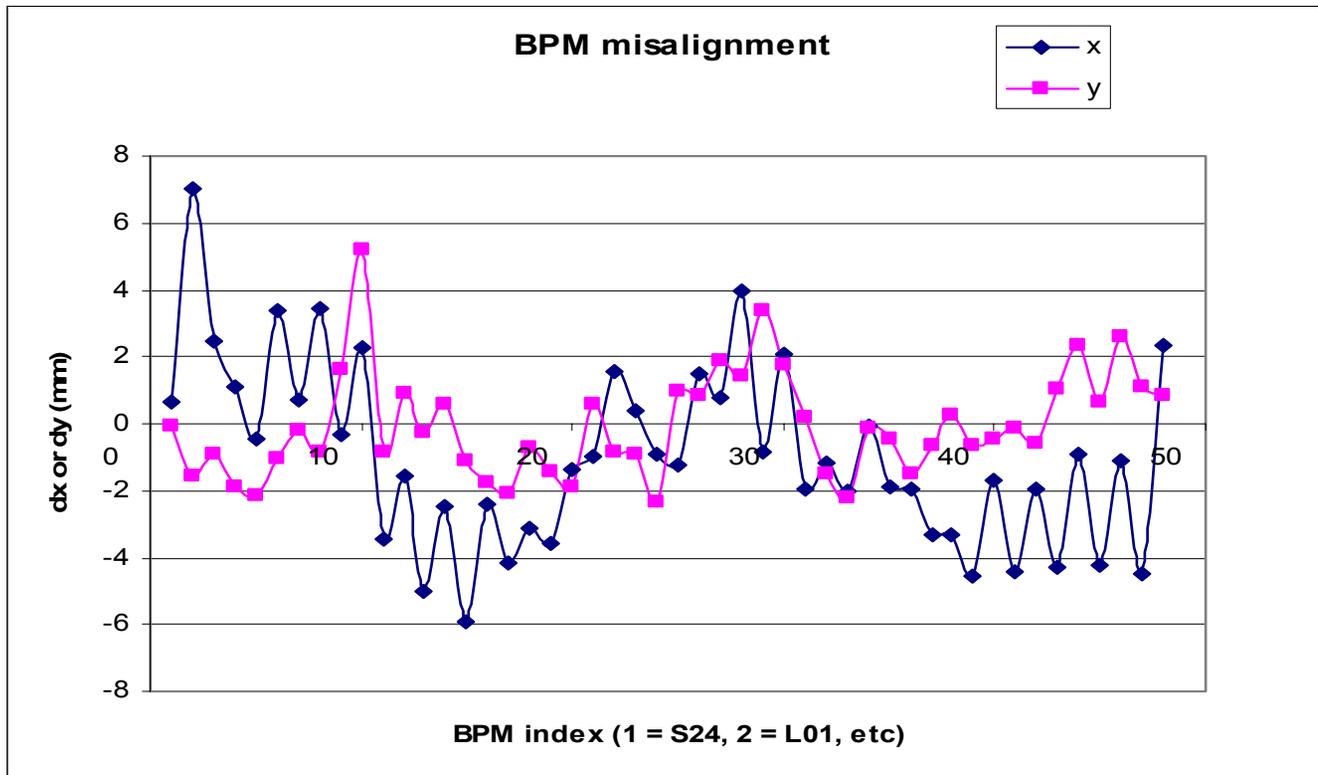


Radius r is computed with center (X_c, Y_c) that minimizes $[r(F) - \text{avg}(r(F))]^2 + [r(D) - \text{avg}(r(D))]^2$

BPM misalignment (As described in TM2223)

Short section: average of two neighboring magnet (F) ends

Long section: the upstream end of the nearest magnet (D)



2. Run MAD to compute closed orbit

1. Without trim dipoles

--- all correctors off

2. With trim dipoles

---all correctors set to operation values as on
3:30pm 2/4/2004

3. Measured closed orbit vs. model calculation

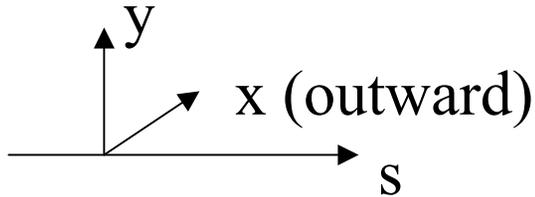
--- closed orbit was taken at 3:30pm 2/4/2004
for $t = 3.1$ ms (injection at 2.0 ms)

--- BPM misalignments subtracted

Coordinate and kickers

MAD convention:

Positive kick angle increases P_x or P_y

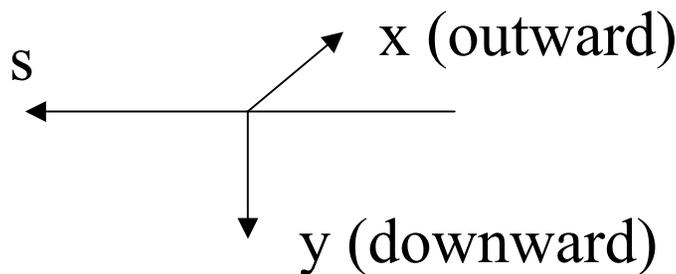


Horizontal:

Positive kick current \rightarrow

beam **outward** $\rightarrow dx > 0 \rightarrow$ increase P_x

\rightarrow Kick angle > 0



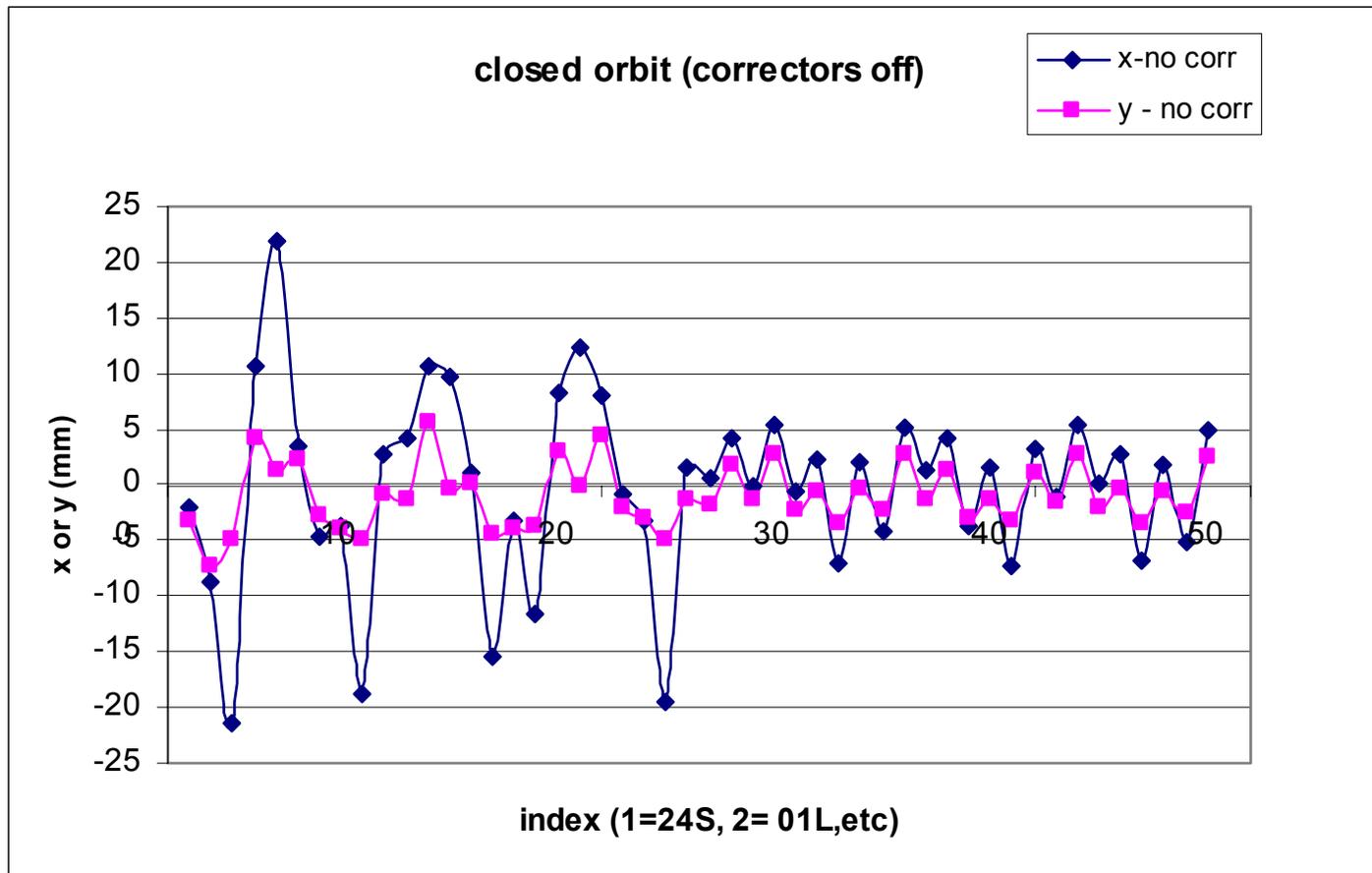
Vertical:

Positive kick current \rightarrow

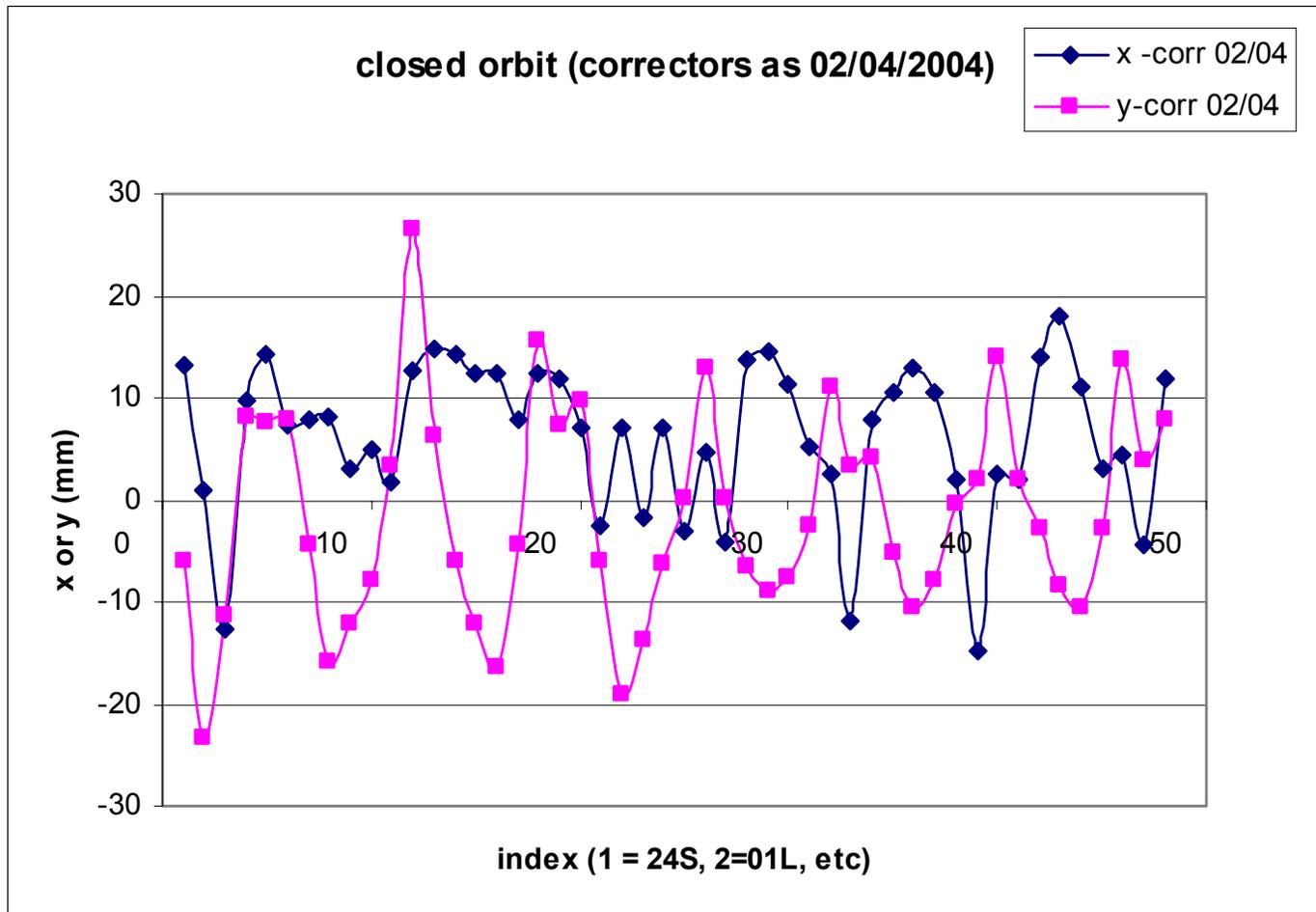
beam **downward** $\rightarrow dy > 0 \rightarrow$ increase P_y

\rightarrow Kick angle > 0

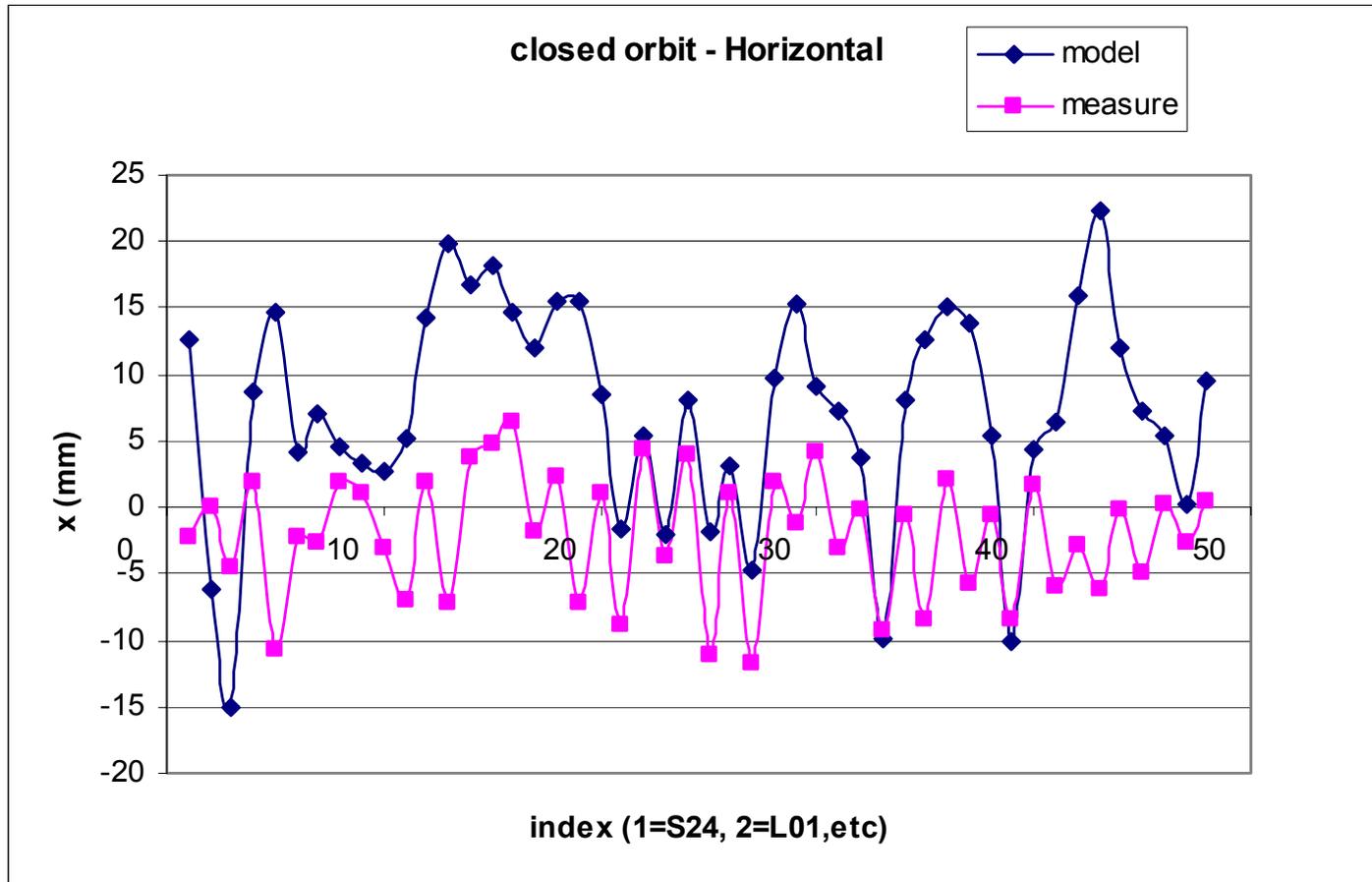
1. Correctors off



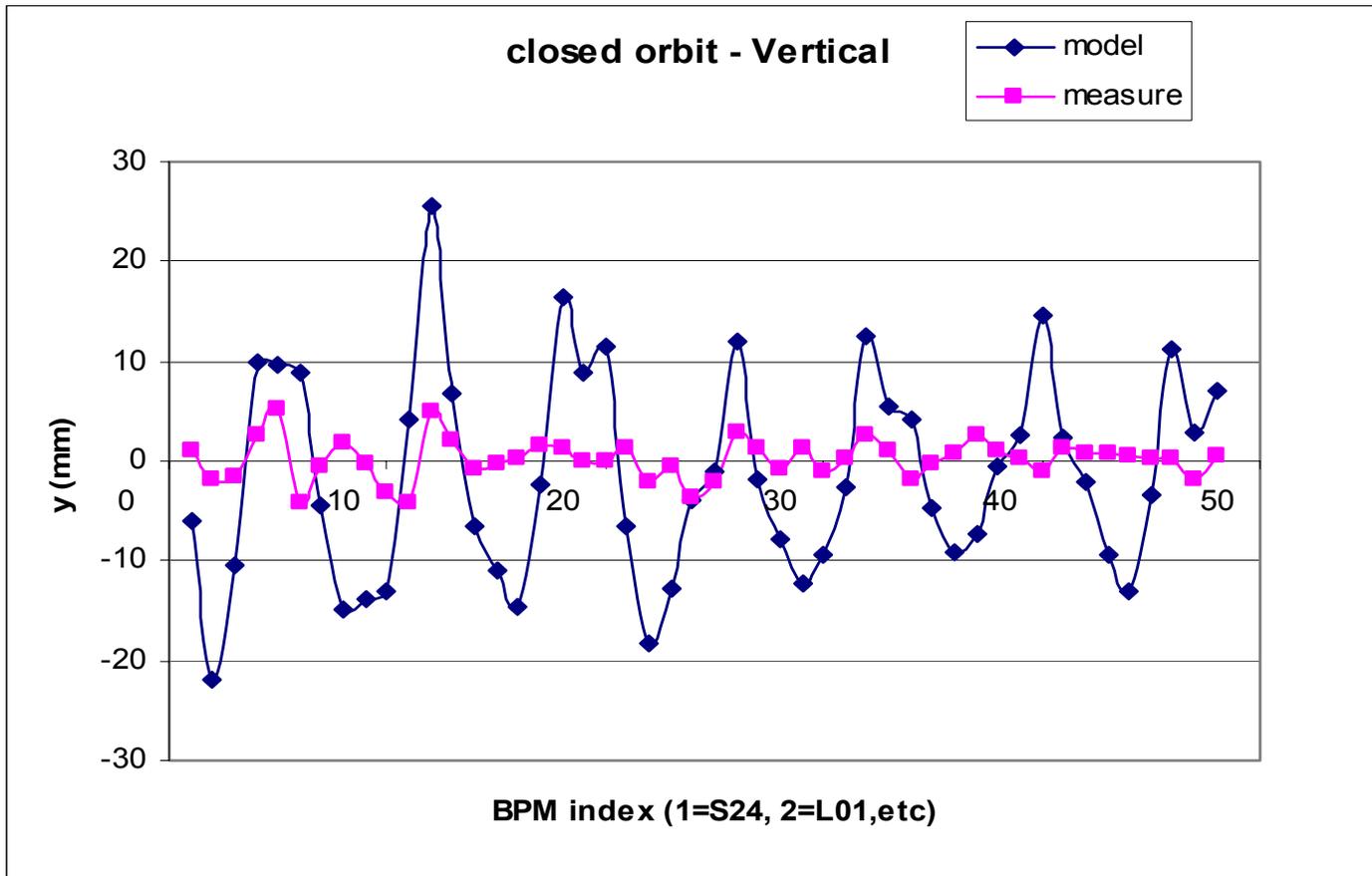
2. Correctors on



3. Expr. Vs. model -- Horizontal



3. Expr. Vs. model –Vertical



Why model disagree with measurement?

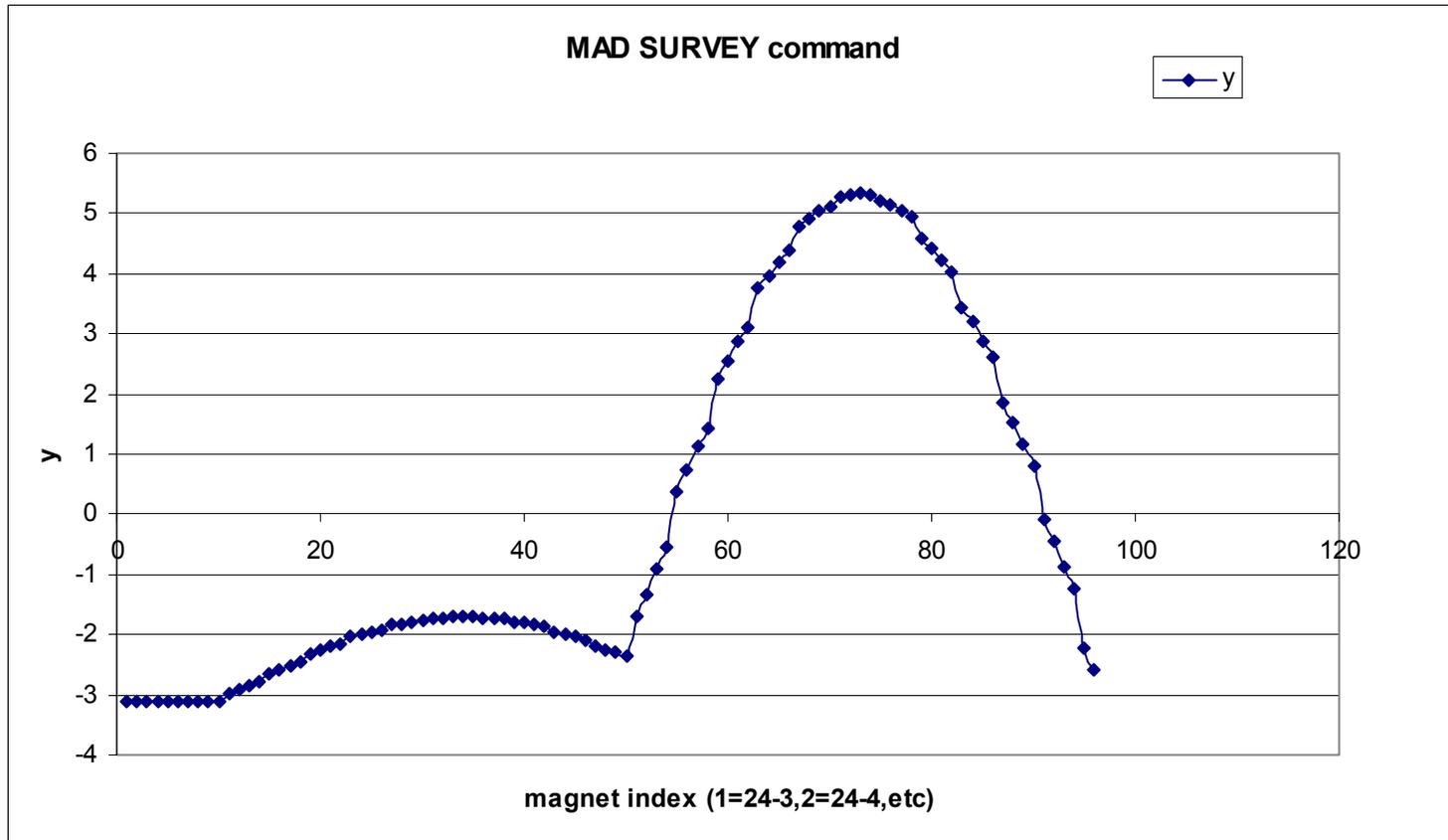
1. The MAD model assumes a different 'ideal orbit' than the one used for misalignment calculation (for horizontal plane)
2. The BPM misalignments are not accurate.
3. The BPM electrical centers don't agree to the geometrical centers.
4. Orbit deviation in trim quads, as a dipolar effect, causes orbit distortion, which is not taken into account in MAD.
5. More...

The shape of Booster model vs. survey

	Radius (m)	RMS (m)	Survey (m)
F1	75.5087	0.00008	75.5016
D1	75.4147	0.00008	75.4349
D2	75.4981	0.00008	75.4349
F2	75.5327	0.00008	75.5017

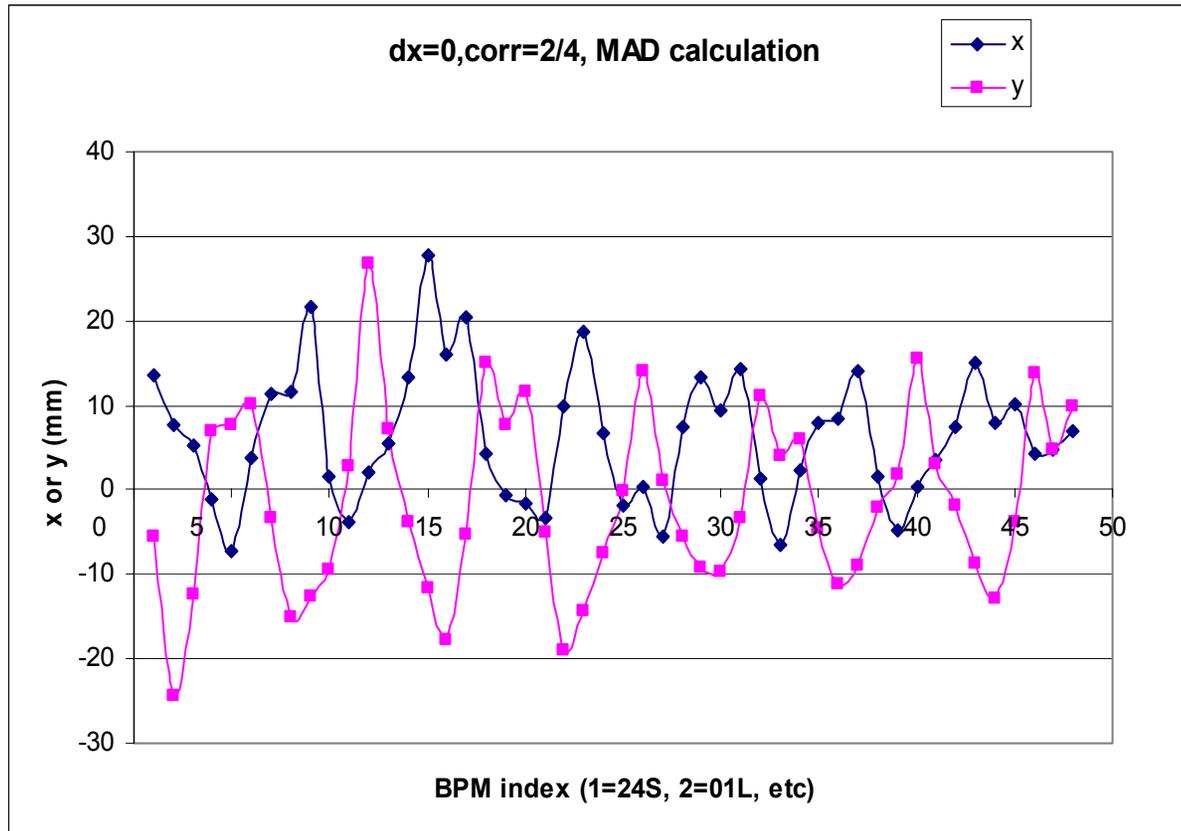
1. RMS for physical survey is typically 2 mm
2. Model shape is obtained with MAD SURVEY command

Vertical orbit by MAD SURVEY command



Closed orbit with horizontal misalignments set to zero

Correctors on, settings as 2/4 12:05pm



Conclusion

1. Measured orbit doesn't agree to model calculation
2. MAD model assumes a different "ideal orbit" from the physical one (surveyed)
3. Operational orbit bump settings distort the closed orbit in MAD calculation, why?
4. There is a big gap to fill between BPM readings and MAD calculations with surveyed misalignments.