Analysis of low frequency motion in Tevatron

V. H. Ranjbar

Using SVD to calculate location of Orbit Corrections.

- Using betas and phases of correctors and BPMS a Corrector to position response Matrix can be constructed:

$$R_{ij} = \frac{\sqrt{\beta_i \beta_{cj}}}{2\sin(\pi\nu)} \cos(|\psi_i - \psi_{cj}| - \pi\nu)$$

$$\Delta X = R \Delta \theta$$

- This matrix can be inverted using SVD to find the position to corrector matrix

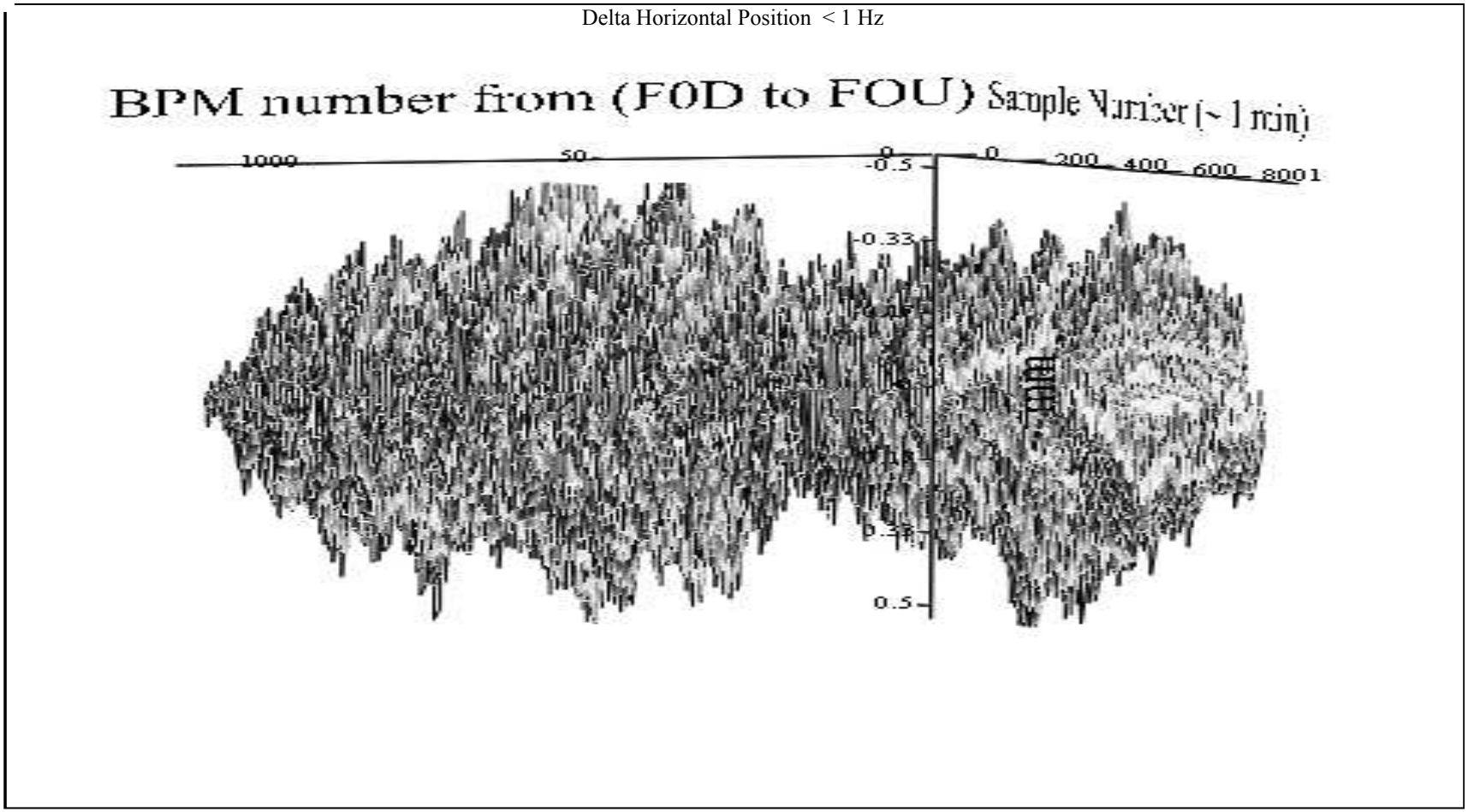
$$\Delta \theta = R_{inv} \Delta X$$

$$where \quad ,$$

$$R_{inv} = VW_{inv} U^T$$

Applying SVD to LB orbit corrections at < 1 Hz over 17 hours

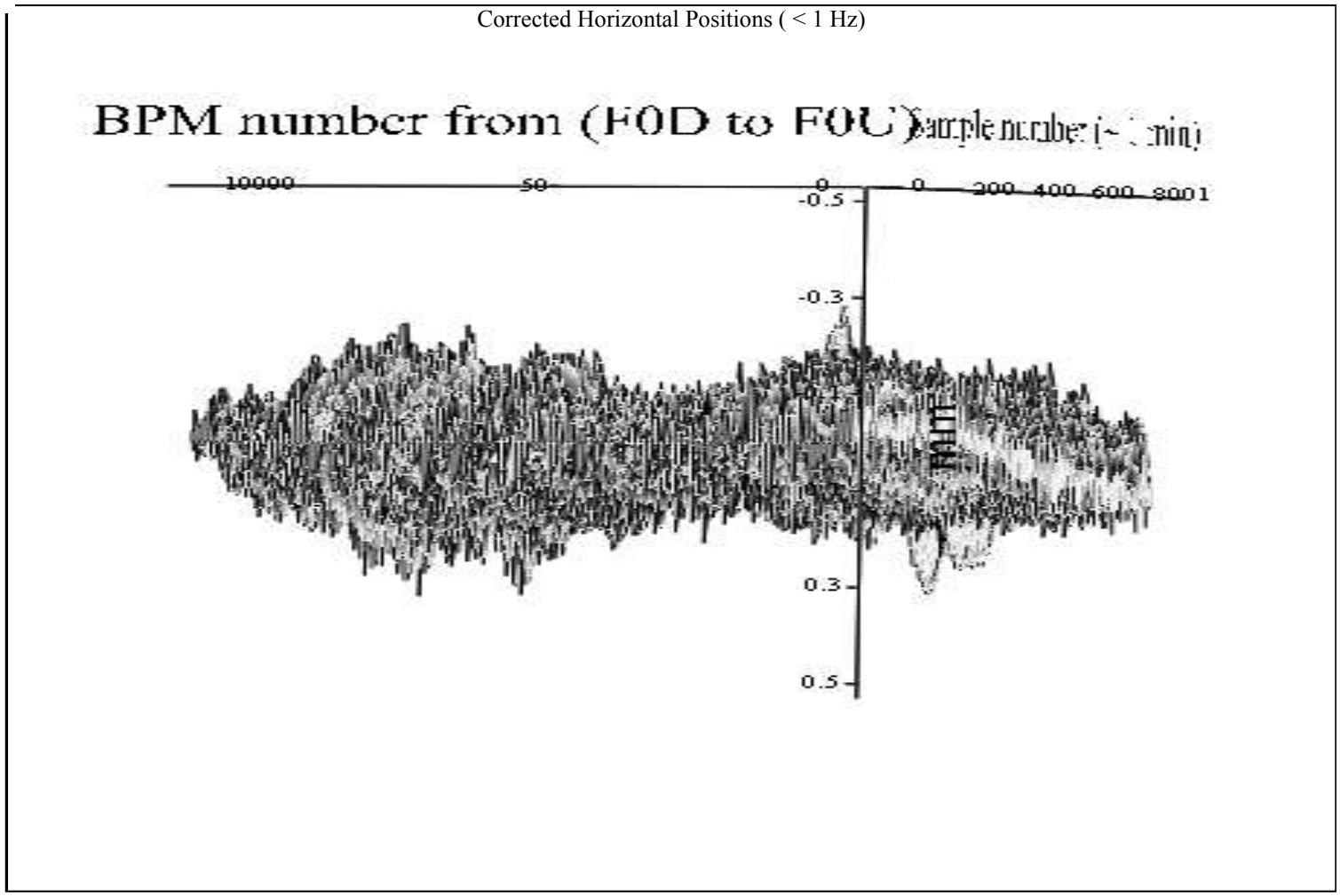
- Max Horizontal orbit deviation of ~ .7 mm, stdev ~ .134 mm



Δ X

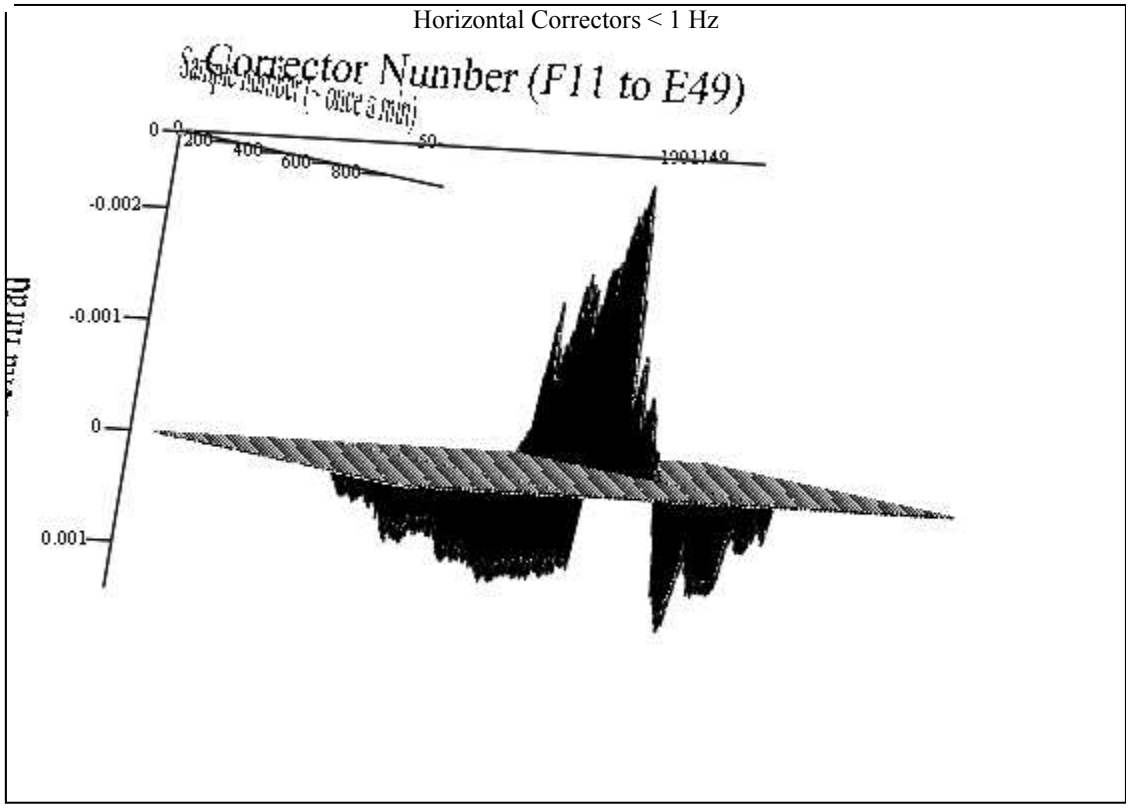
After correction:

- Max orbit Horizontal deviation ~ .3 mm and stdev ~ 0.06 mm using Only 4 singular values.

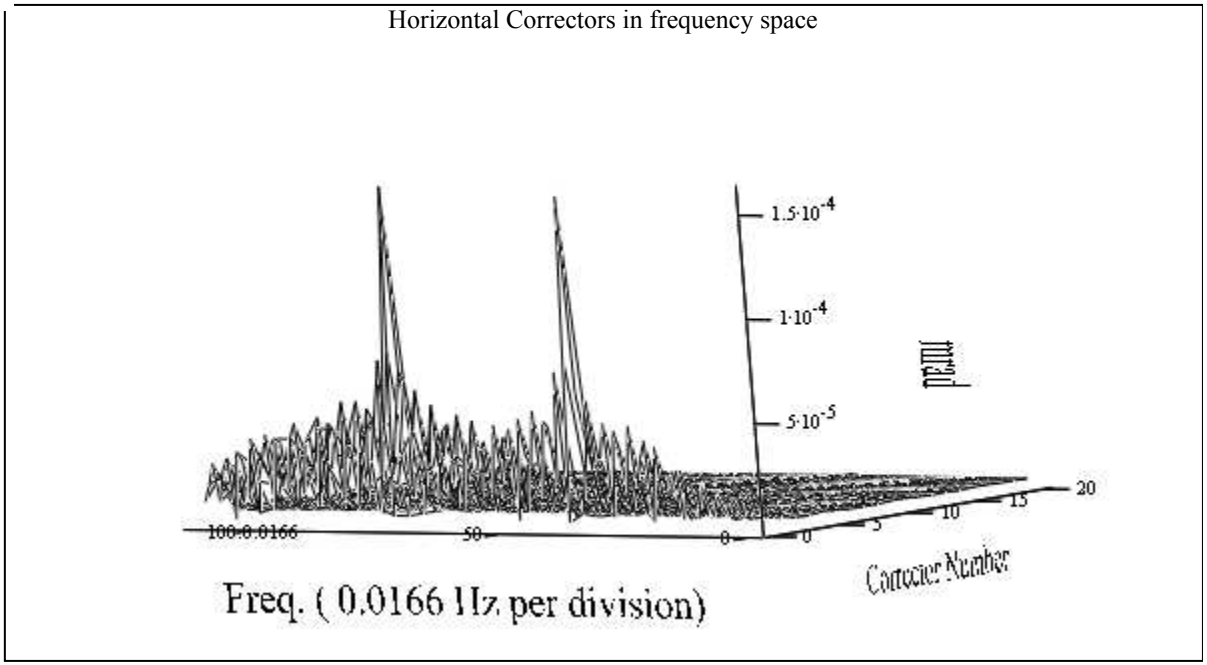


X p

Max change in Horizontal corrector strength is ~ .0006 mrad



Θ1

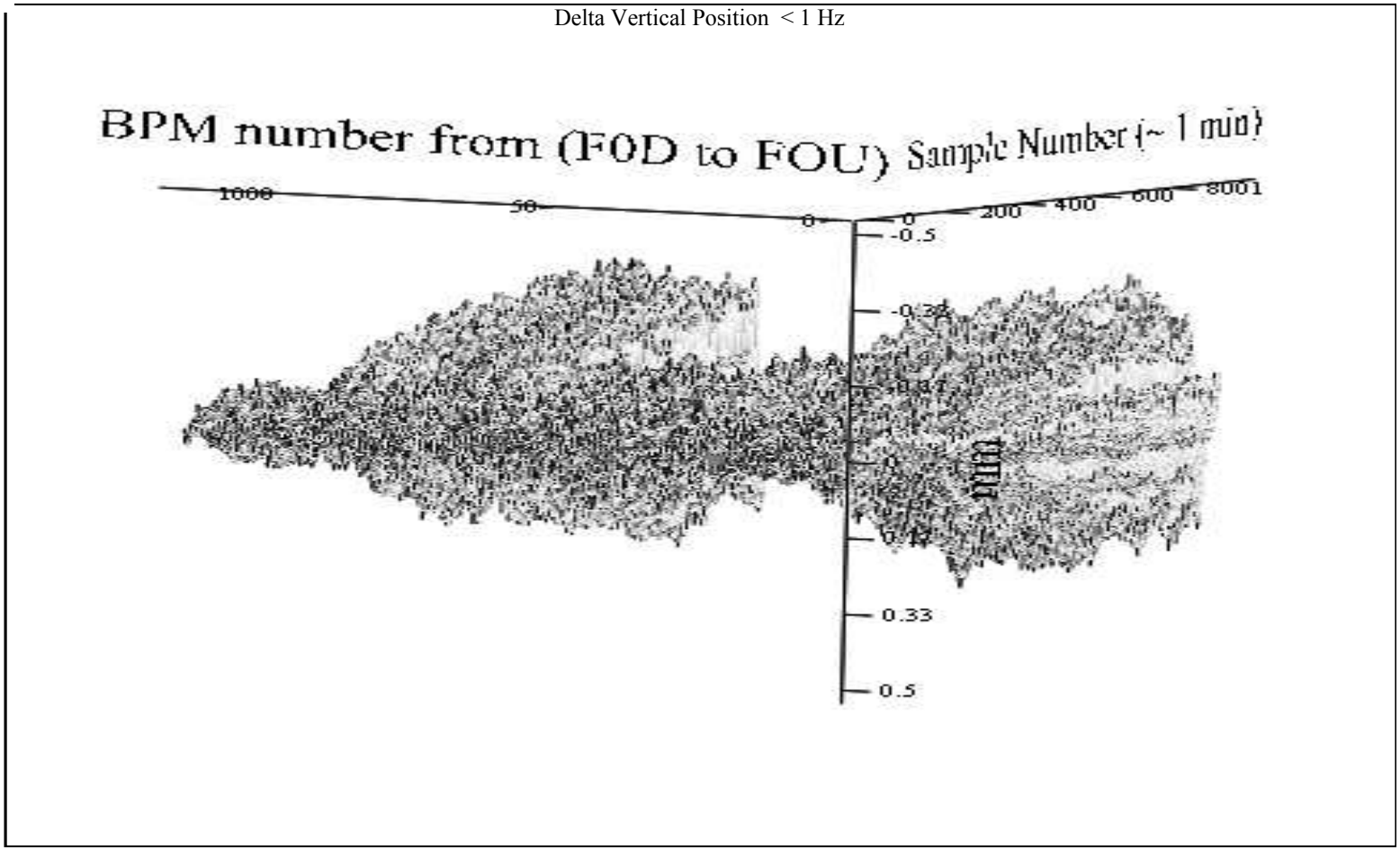


T

- Most correction occurred at HA49 and HC49

Applying SVD to LB orbit corrections at < 1 Hz over 17 hours

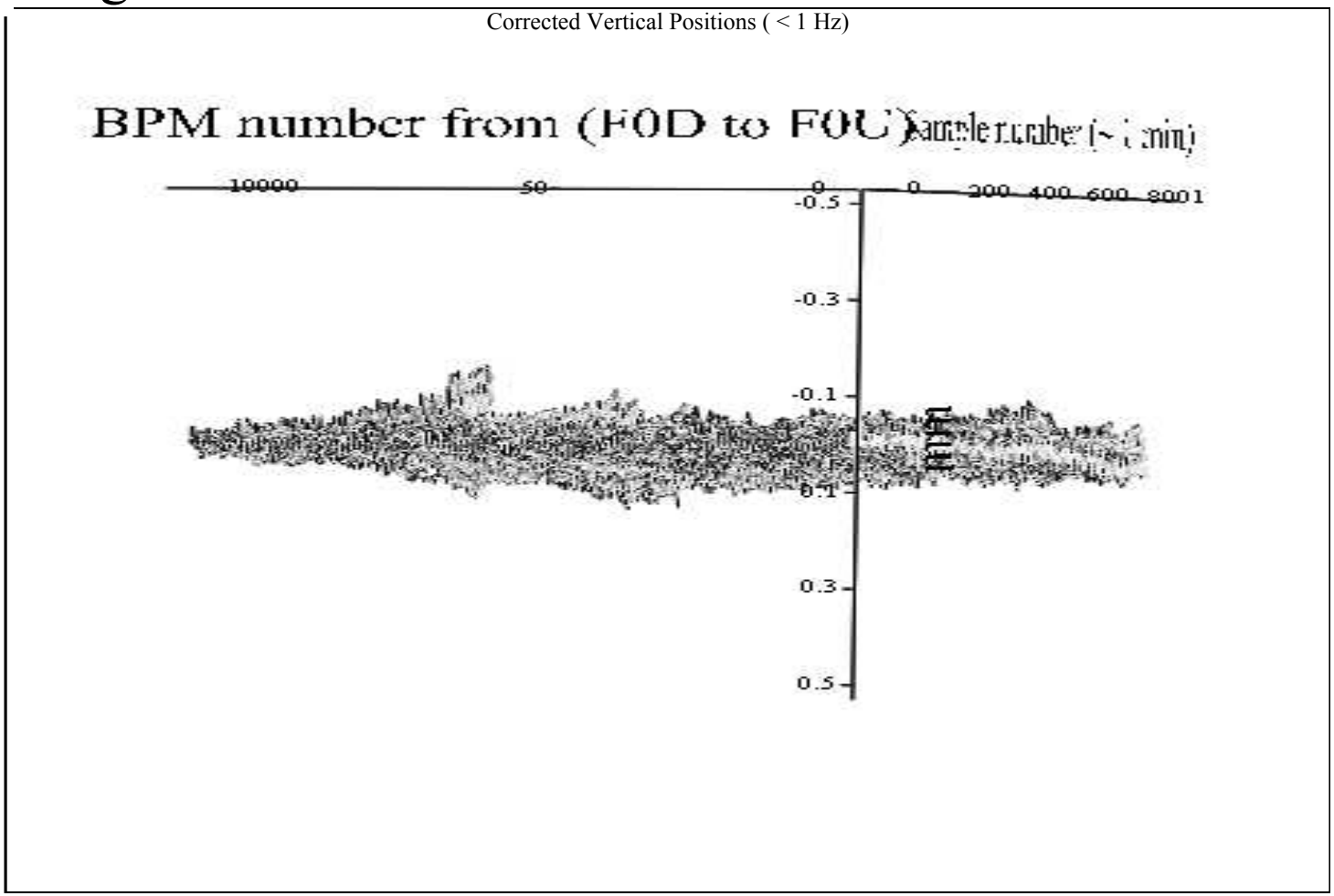
- Max Vertical orbit deviation of ~ .35 mm, stdev ~ .098 mm



Δ X

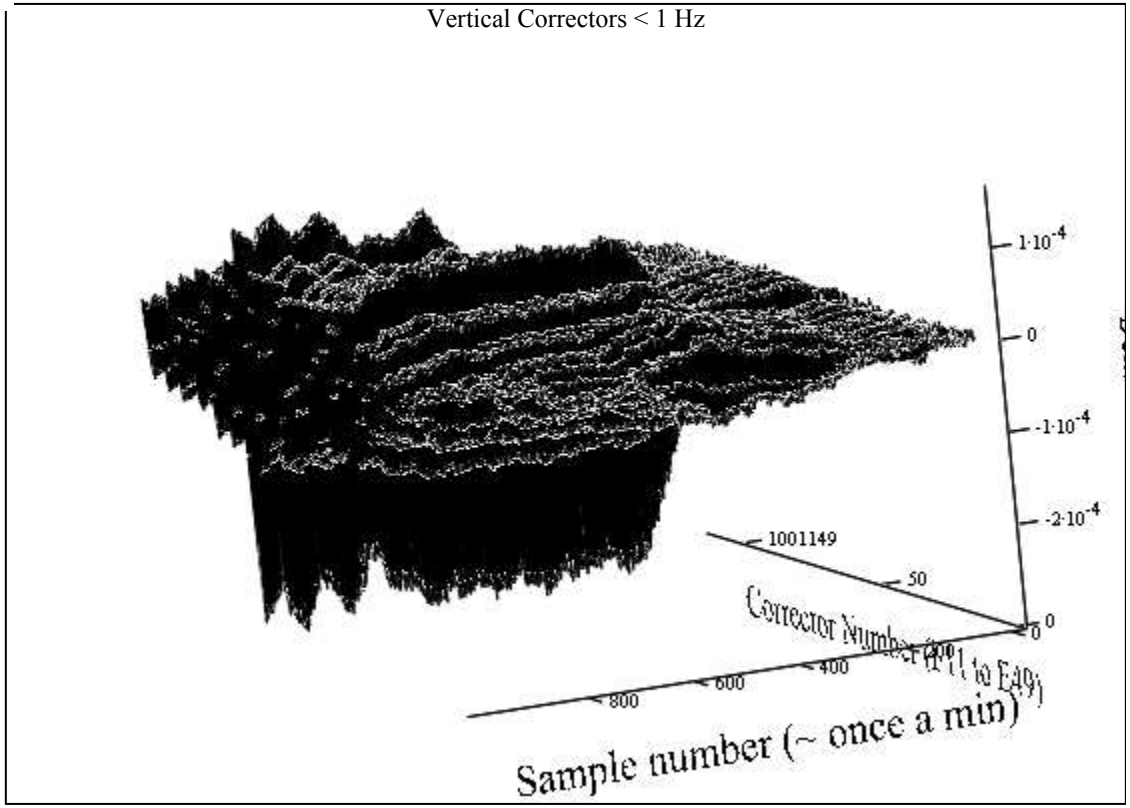
After correction:

- Max orbit Vertical deviation ~ .19 mm and stdev ~ 0.025 mm using Only 4 singular values.

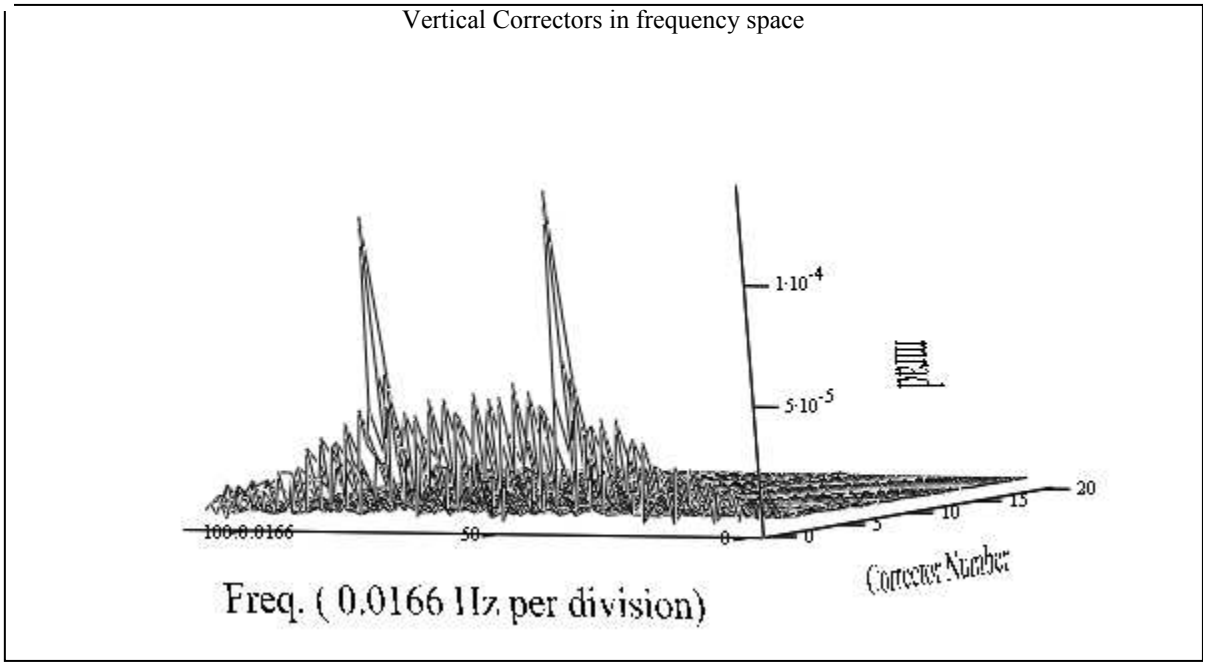


X_p

Max change in Vertical corrector strength is ~ .0003 mrad



Θ

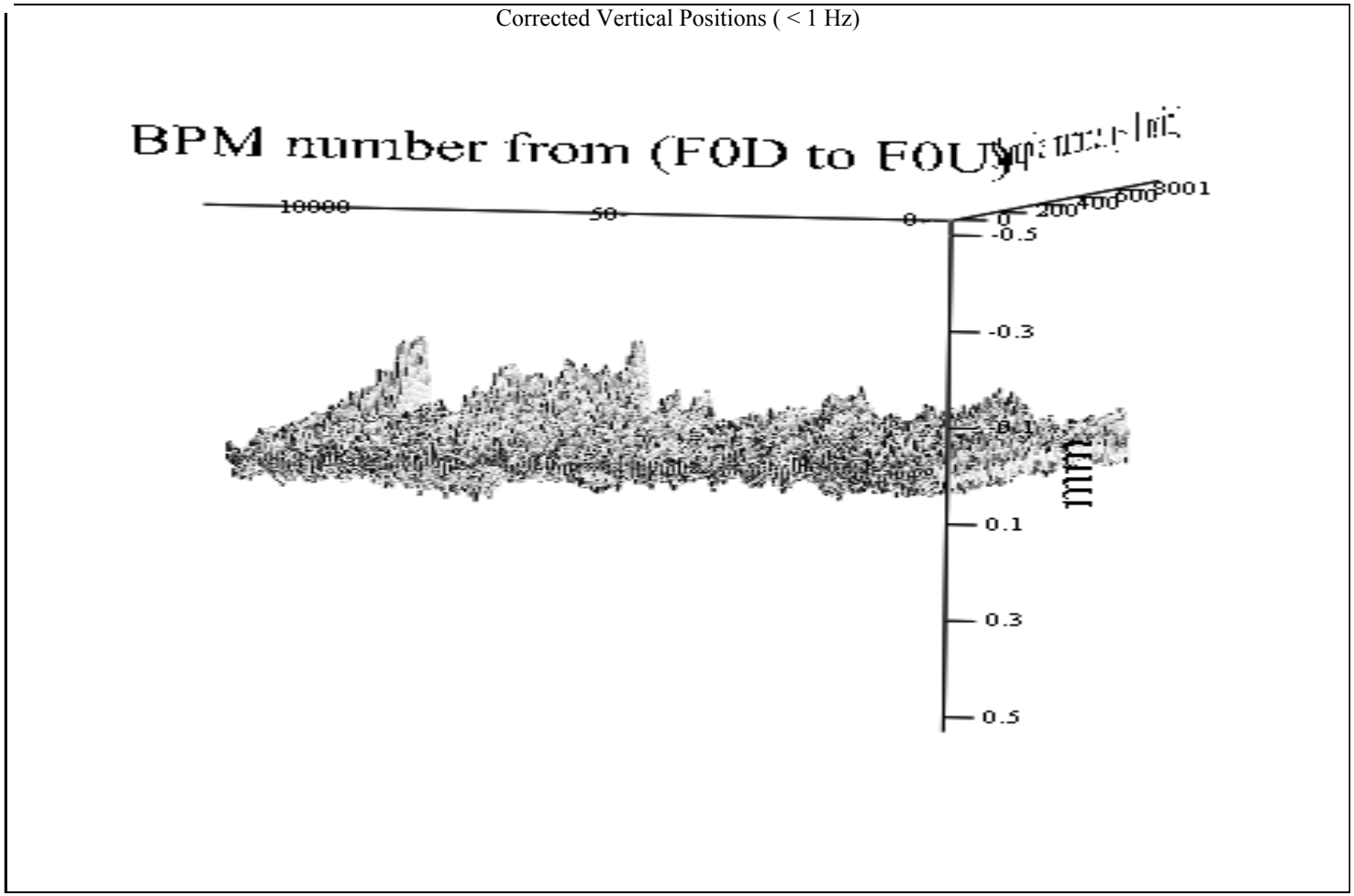


T

• Most correction occurred at VB11 and VD11. So let's perform SVD again with only these two correctors and see how we do?

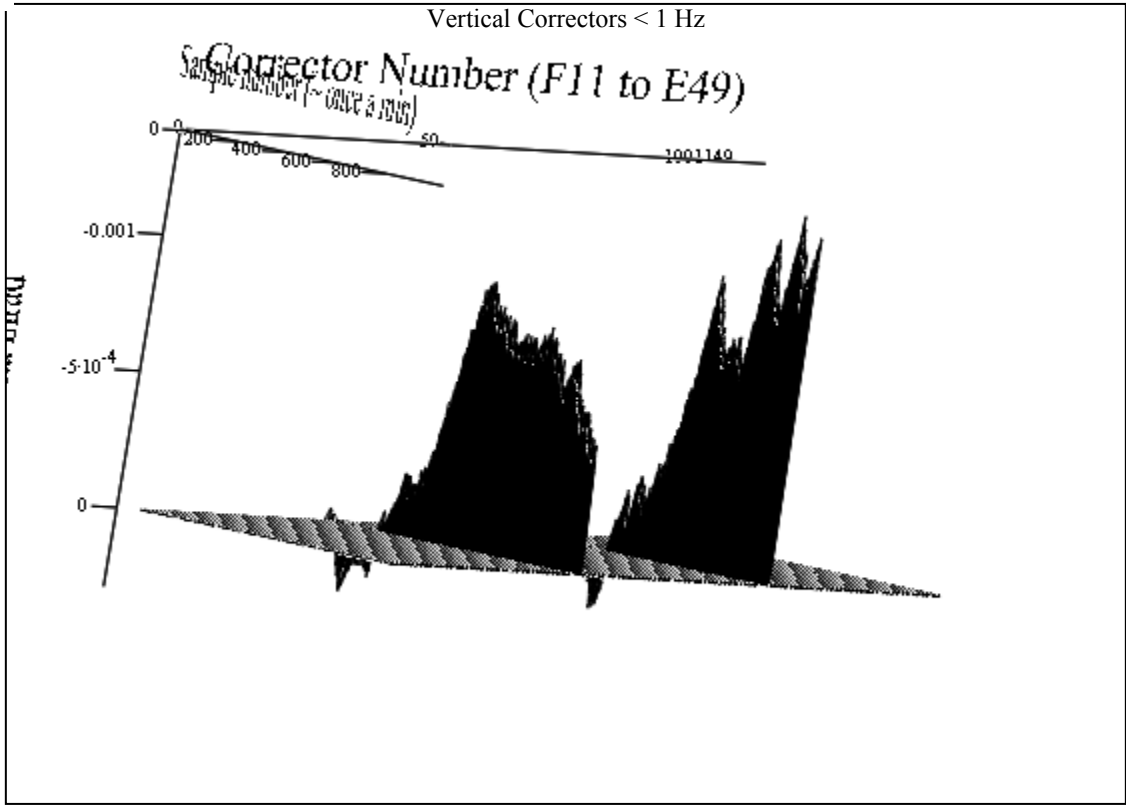
After correction:

- Max orbit Vertical deviation ~ .19 mm and stdev ~ 0.028 mm using Just two correctors.



X p

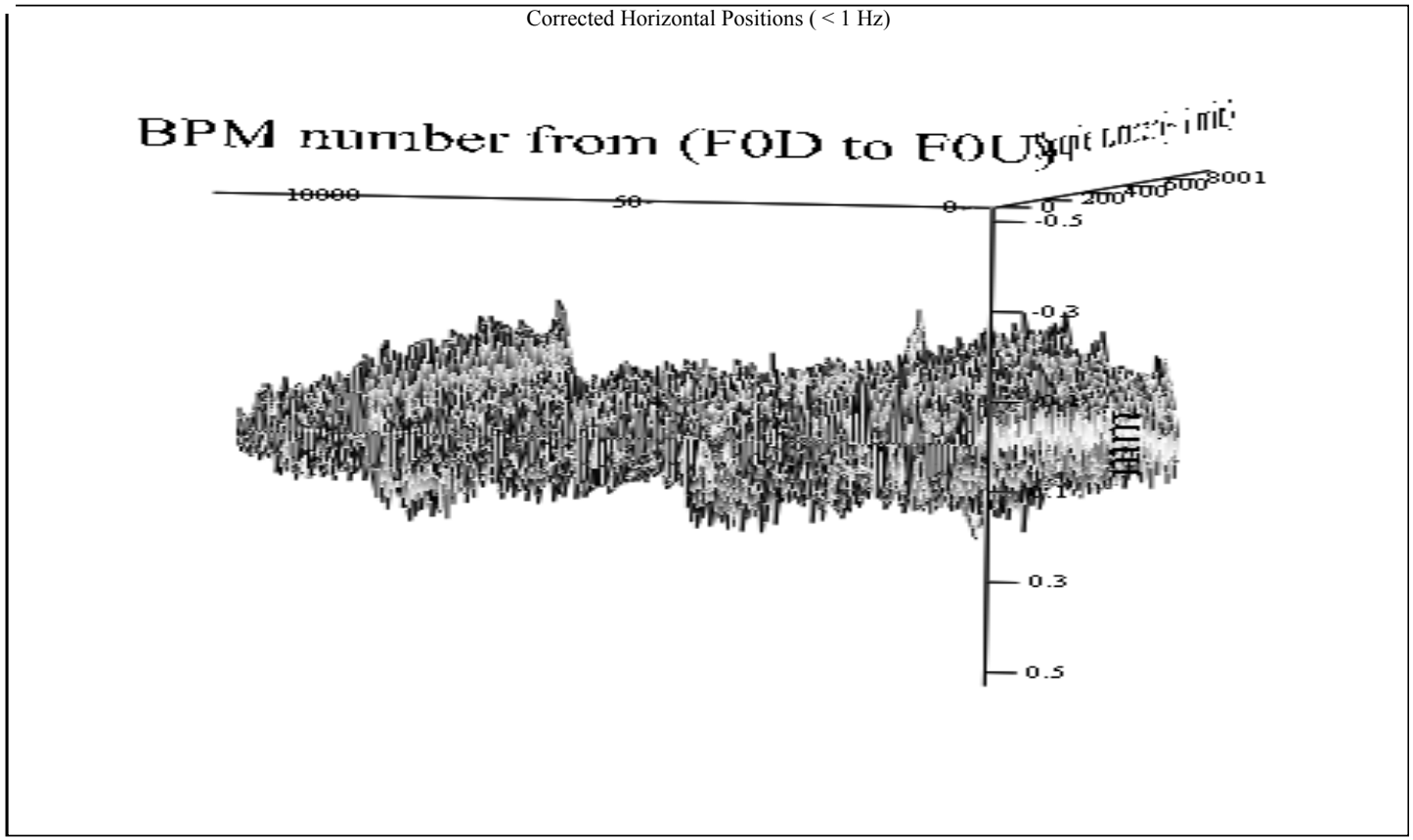
Max change in Vertical corrector strength is ~ .0014 mrad



Θ1

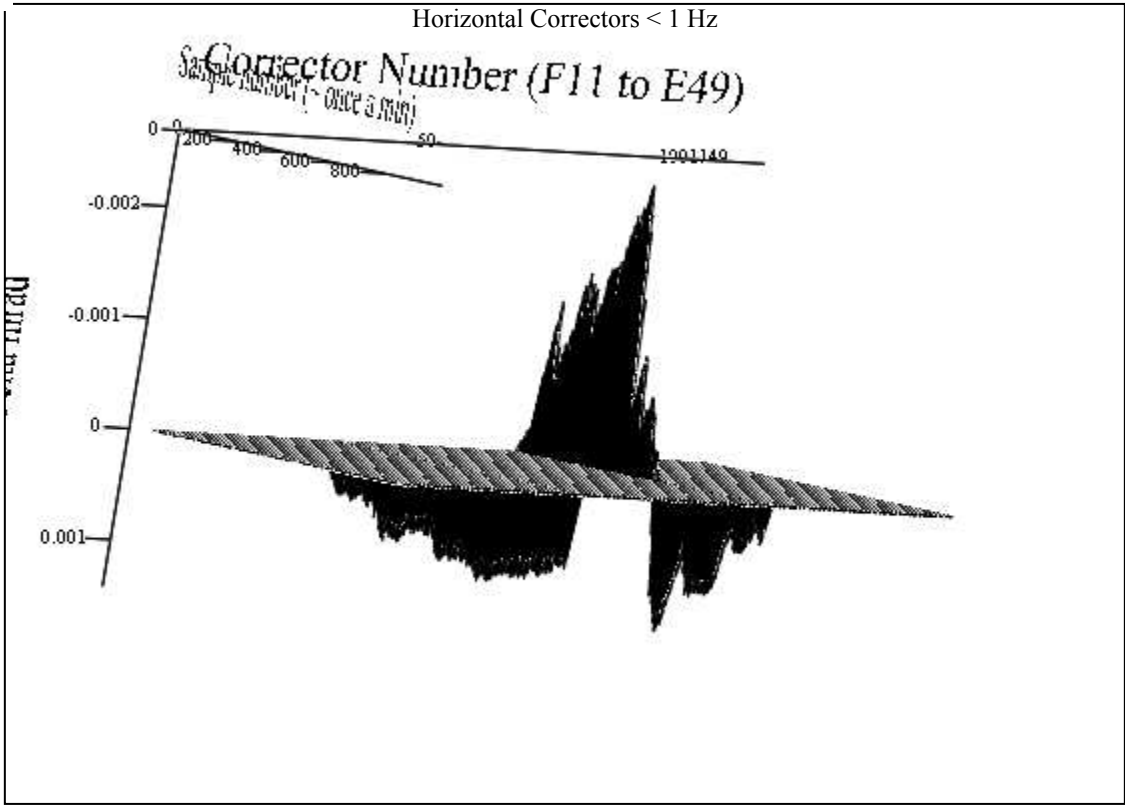
Now looking at the Horizontal plane again:

- Max orbit Horizontal deviation ~ .26 mm and stdev ~ 0.053 mm using Only two correctors



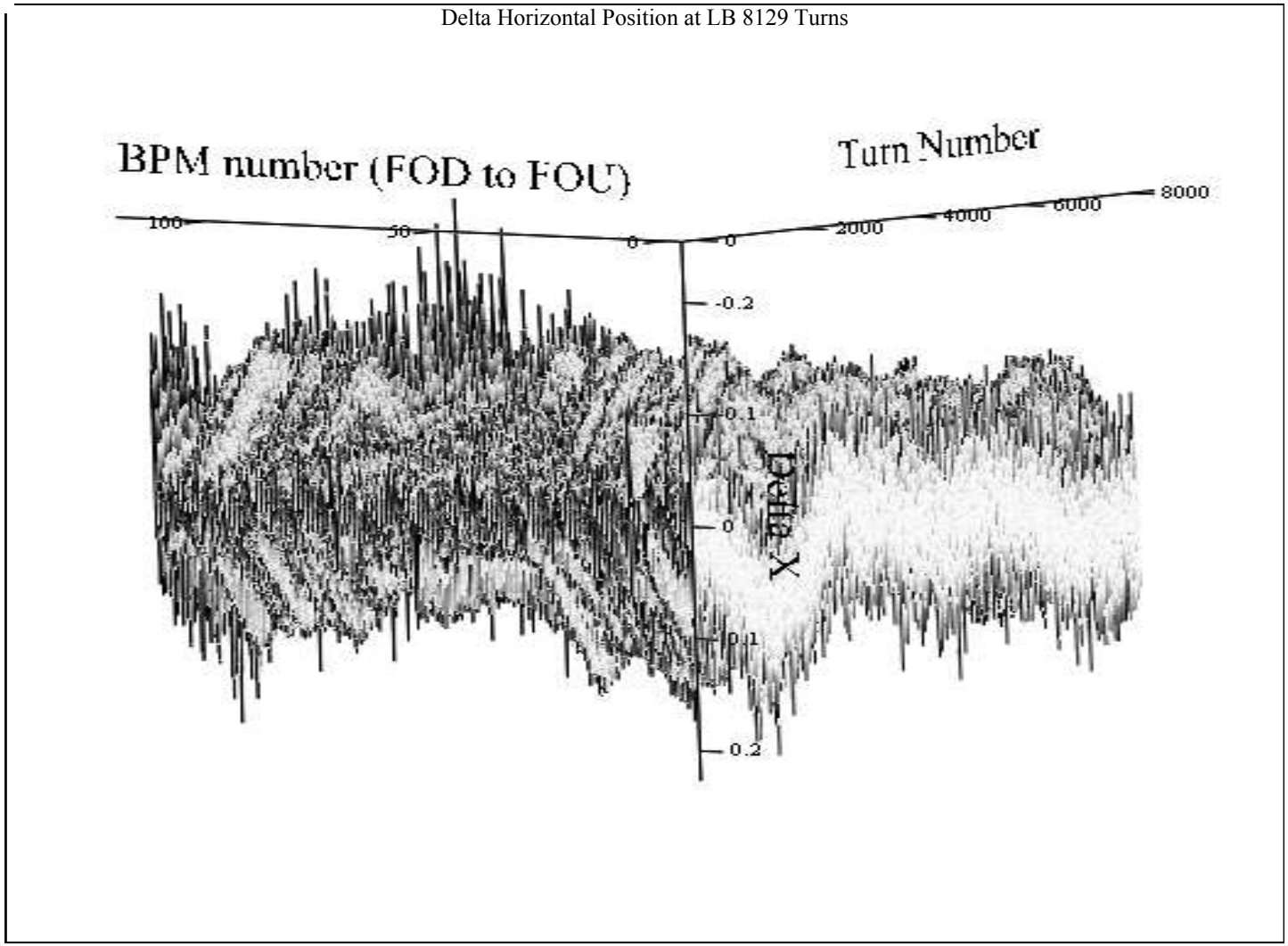
X p

Max change in Horizontal corrector strength is ~ .0025 mrad



Θ1

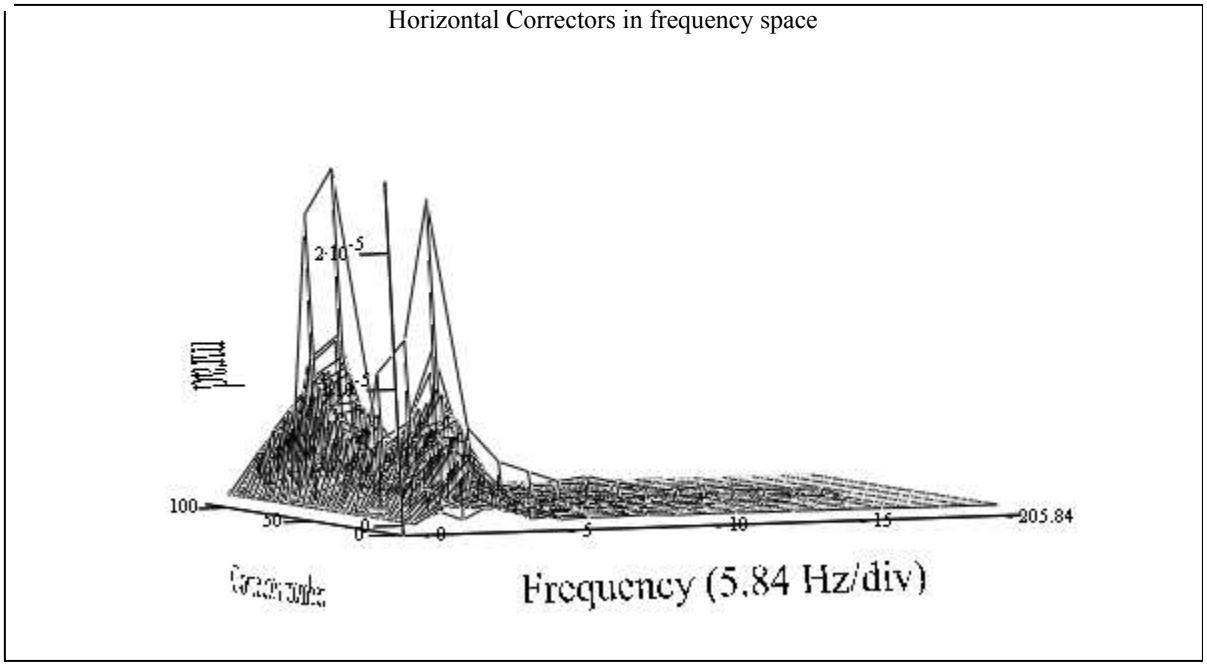
Applying SVD to orbit motion 6 Hz – 100 Hz
Initial stdev Horizontal orbit deviation is .04 mm



Δ X

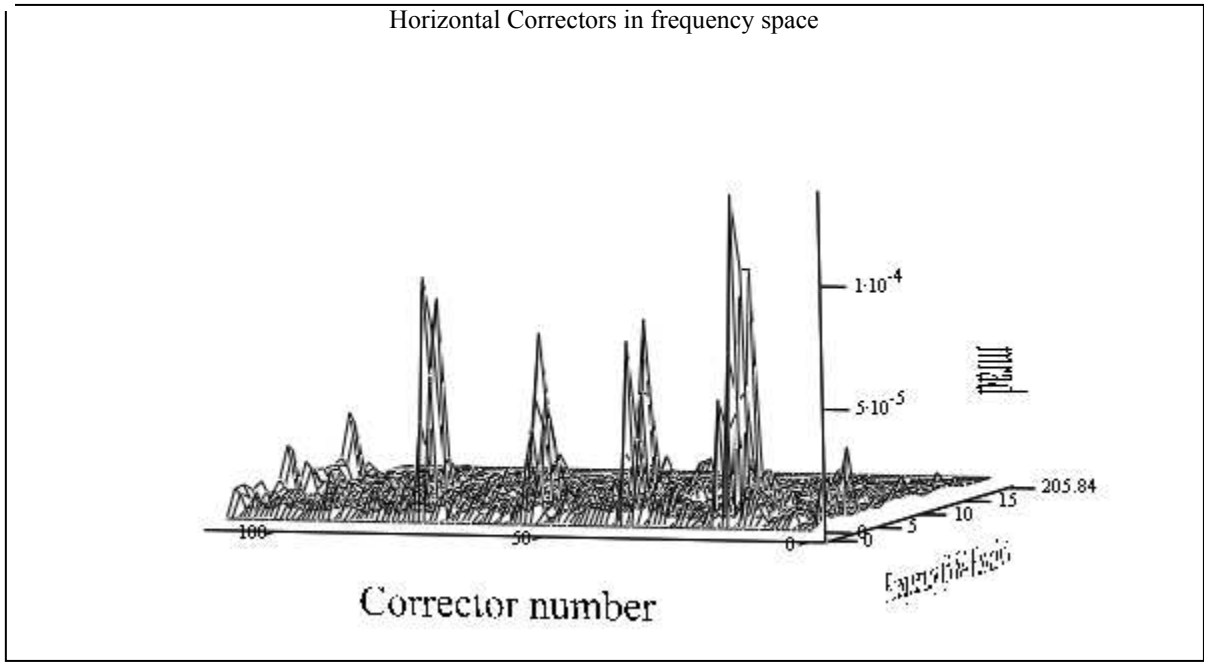
Frequency of motion excluding < 6 Hz with only 4 Singular Values
Reduced stdev to 0.02 mm

- At HA49 is 17.472 Hz @ 2.3*10^-5 mrad
- At HC49 is 11.648 Hz @ 1.23*10^-5 mrad



G

If we add all the Singular values back then we can see
An additional frequencies A0 @ 12 Hz. C0 @ 17 Hz
And our stdev Drops to .0086 mm

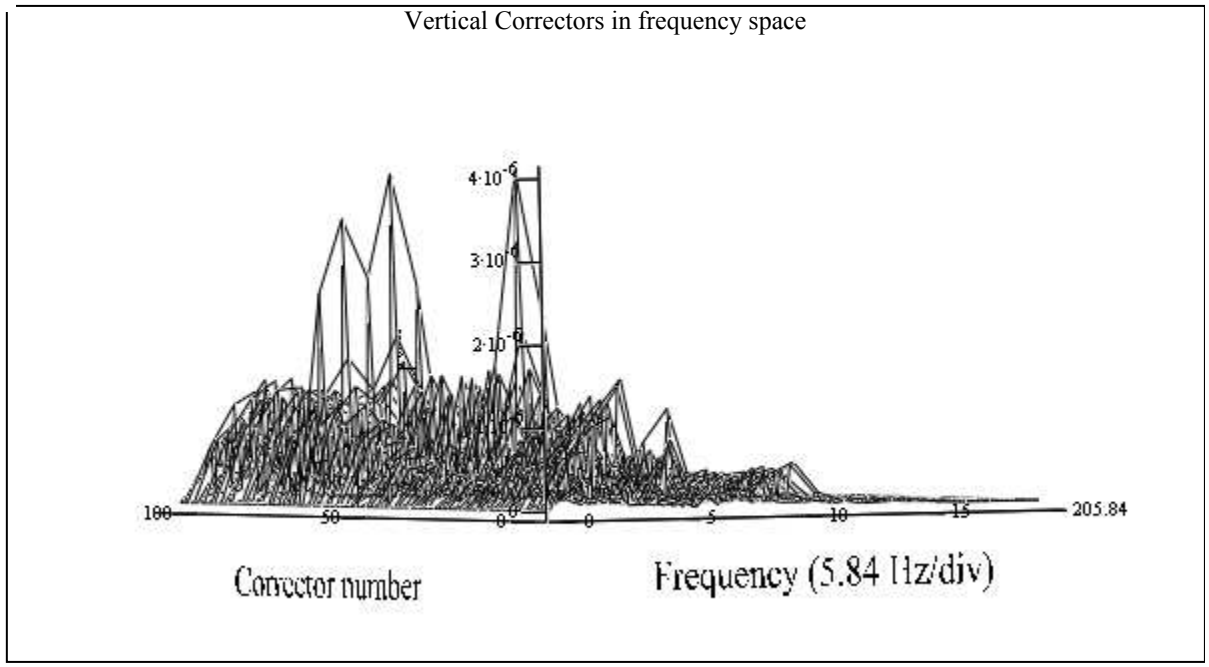


G

In the Vertical plane excluding < 6 Hz:

- At VB11 23.296 Hz @ 4*10^-6 mrad
- At VD11 11.648 and 23.296 Hz @ 3.4*10^-6 mrad

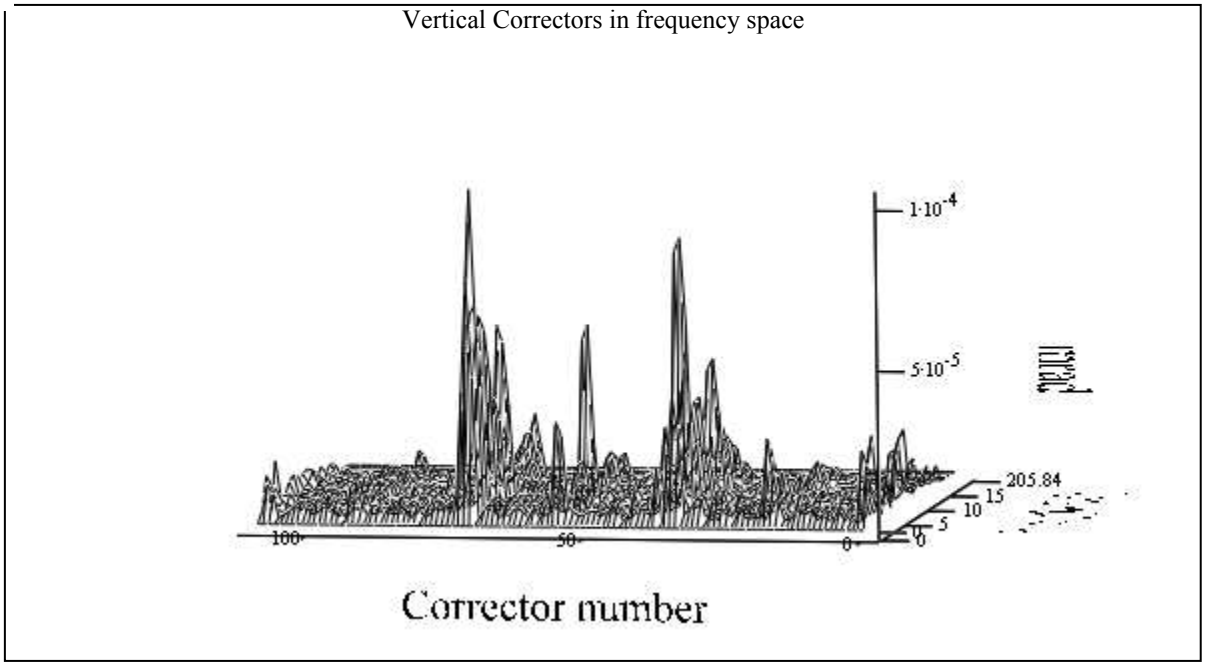
Stdev went from .02 mm to .019 mm



G

These are most likely really the same frequencies as the Horizontal
Since at 8129 turns we can only resolve down to +/-5.8 Hz.

If we add all the Singular values back then we can see
An additional frequency around C0 @ 40 Hz. And stdev
Drops to .01 mm



G