

Orbit Stability in PLS Storage Ring

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2.5 GeV storage ring operational modes to reduce orbit drift

Injection energy	Operation period	Beam current in storage ring	modes
2.0 GeV	Jan.2000–Apr.2001	0 mA–170 mA	ramping + degaussing
2.0 GeV	May.2001–Oct.2002	100mA –180mA	ramping + deramping
2.5 GeV	Since Oct. 2002	100mA–180mA	full energy injection

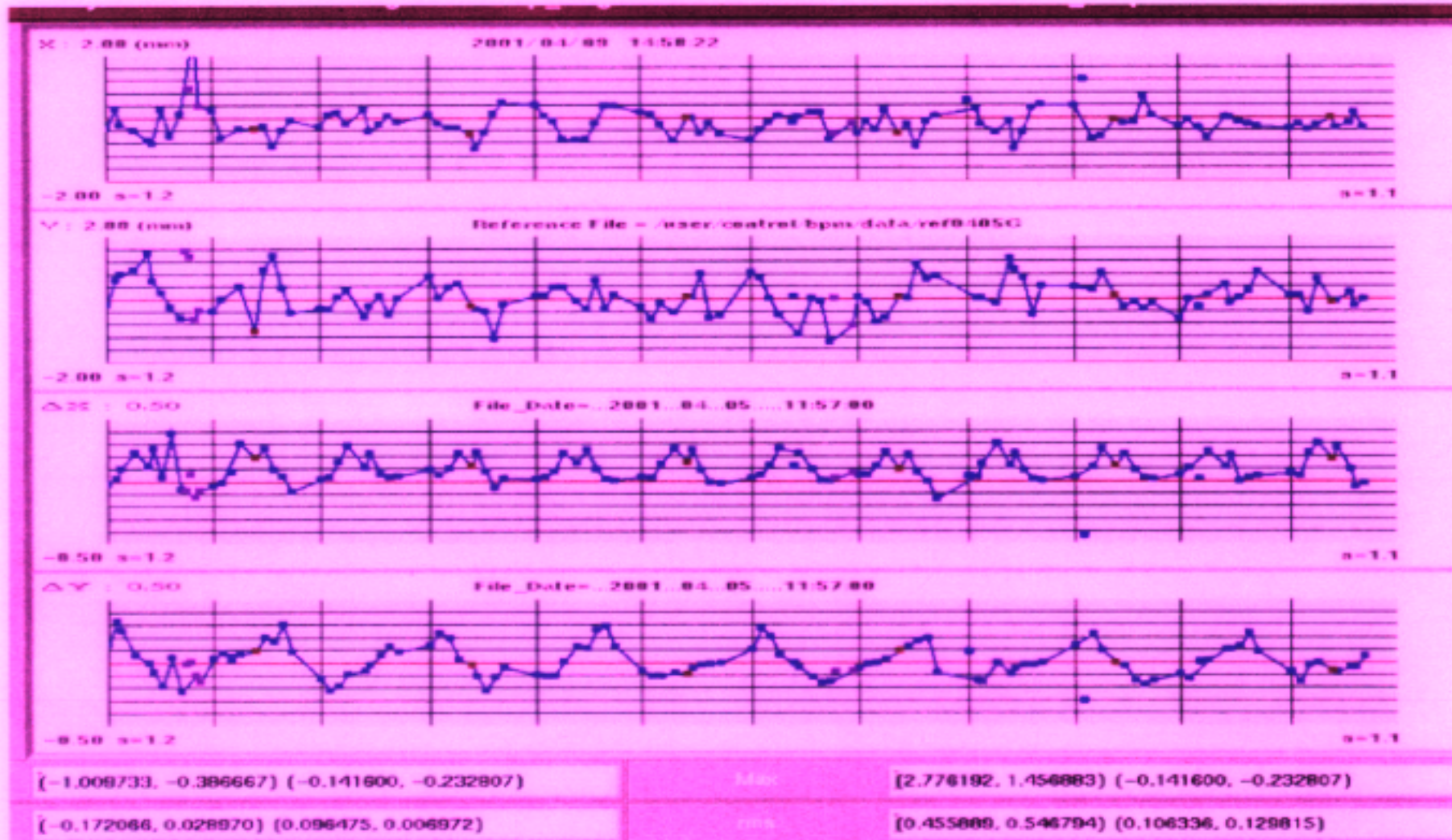
larger

Orbit drift

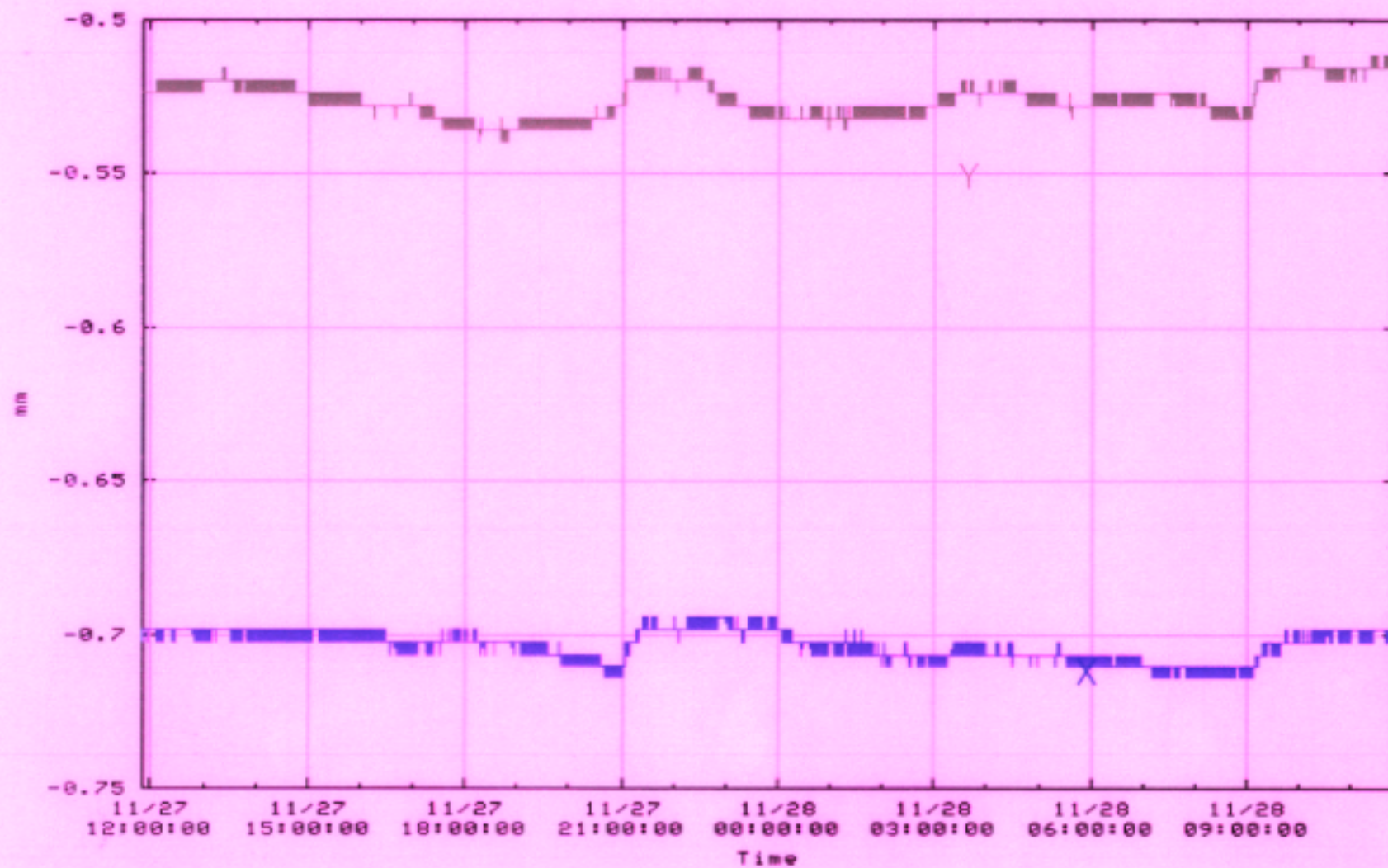
smaller

Orbit drift

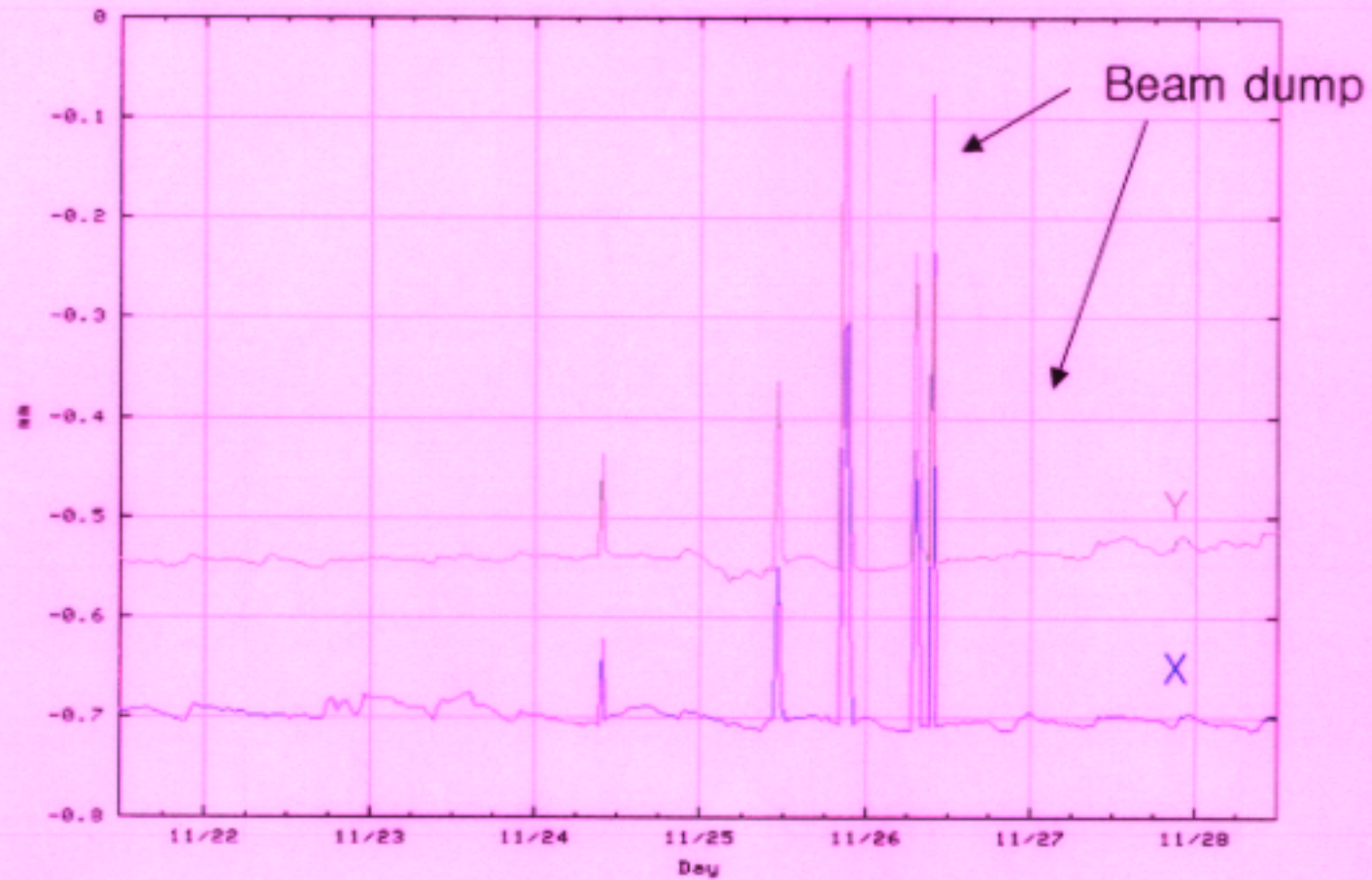
- Orbit drift has been estimated since 23th March 2001.



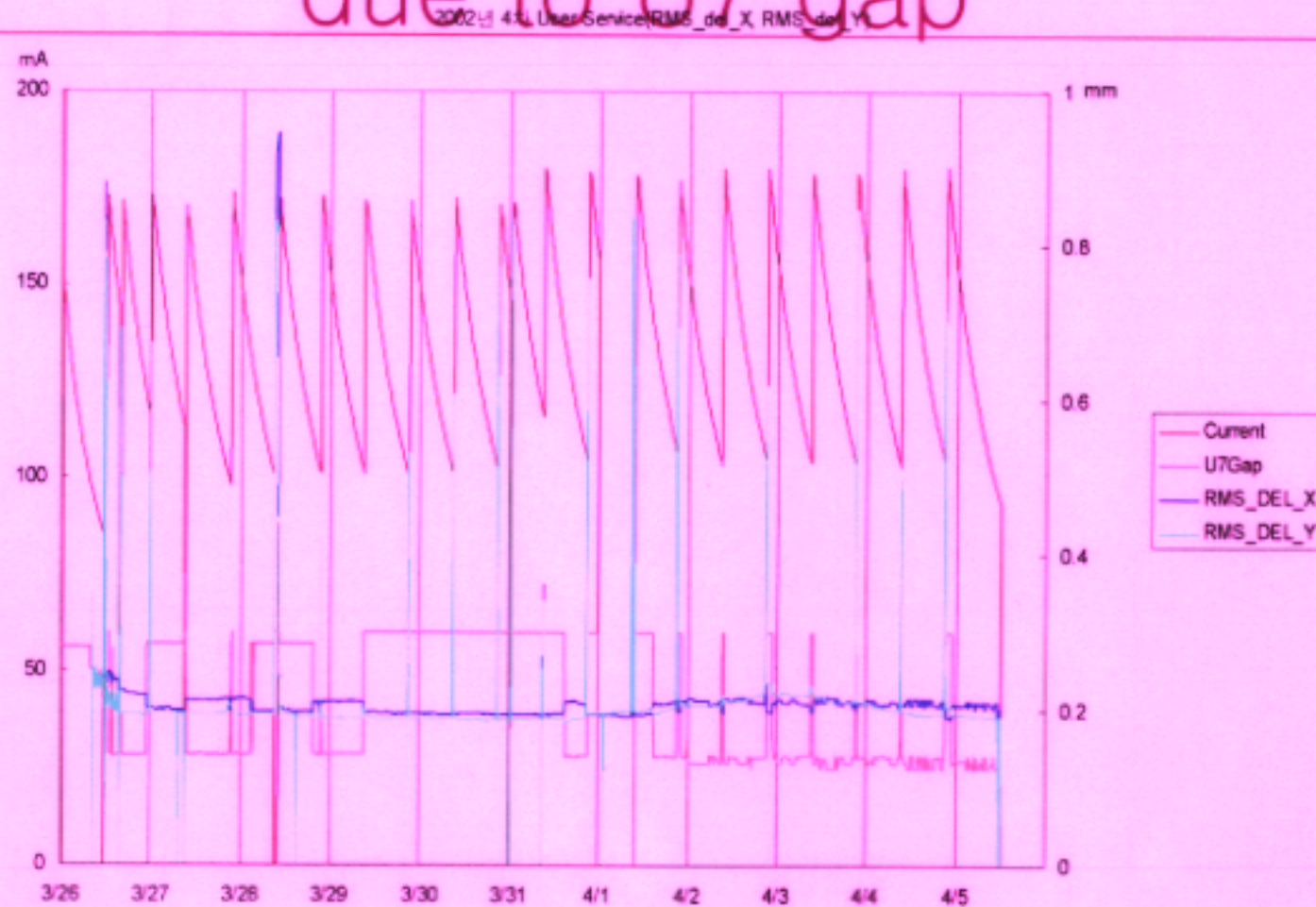
Daily Orbit drift (~ 20 micron)
Nov. 27 2002

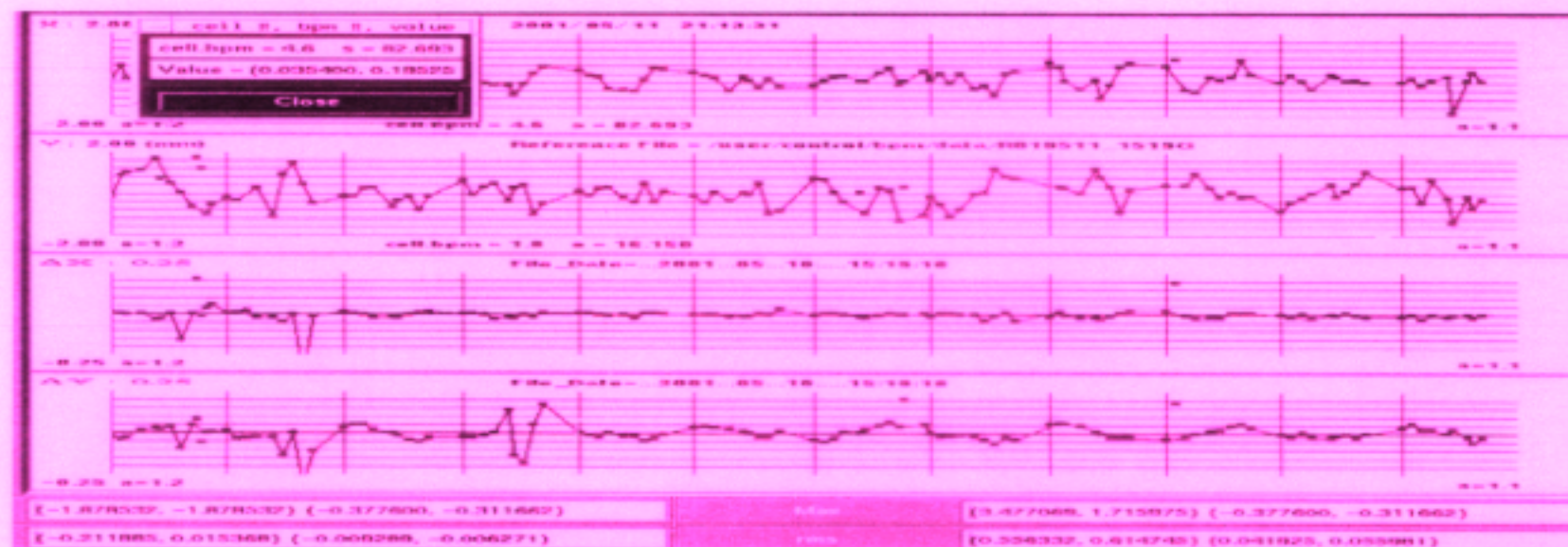


Weekly Orbit drift (~ 40 micron)
Nov. 21 - Nov. 27 2002



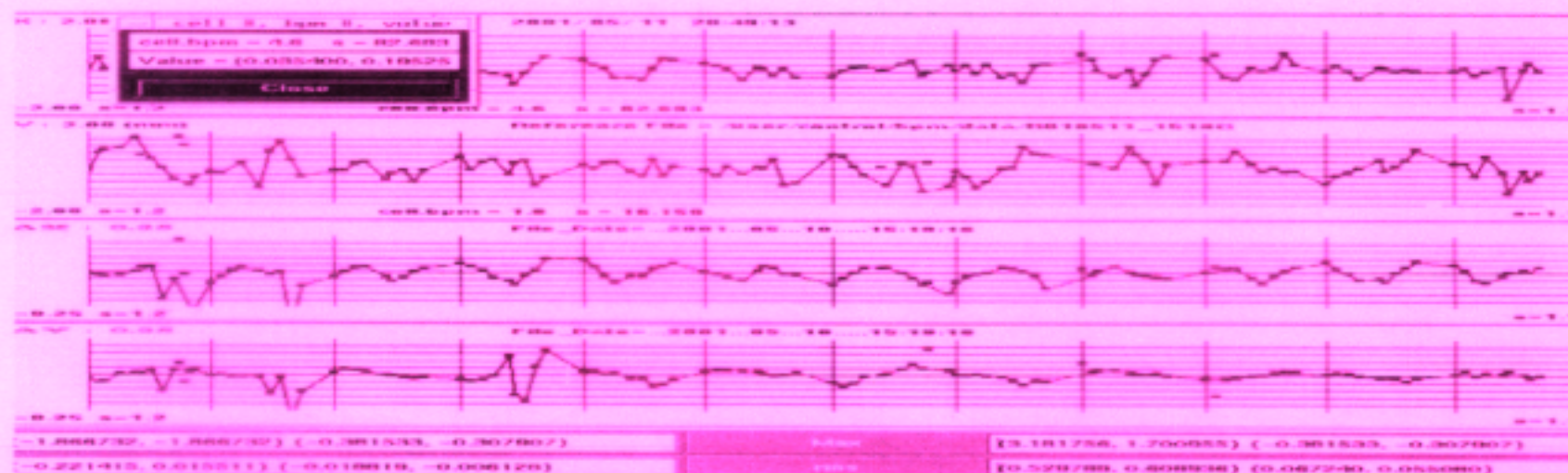
Horizontal orbit variation due to U7 gap





U7 Gap= 60 mm

rms x = 41 um, rms y = 55 um, fy=209.2 kHz fx=301.7 kHz



U7 Gap= 29 mm

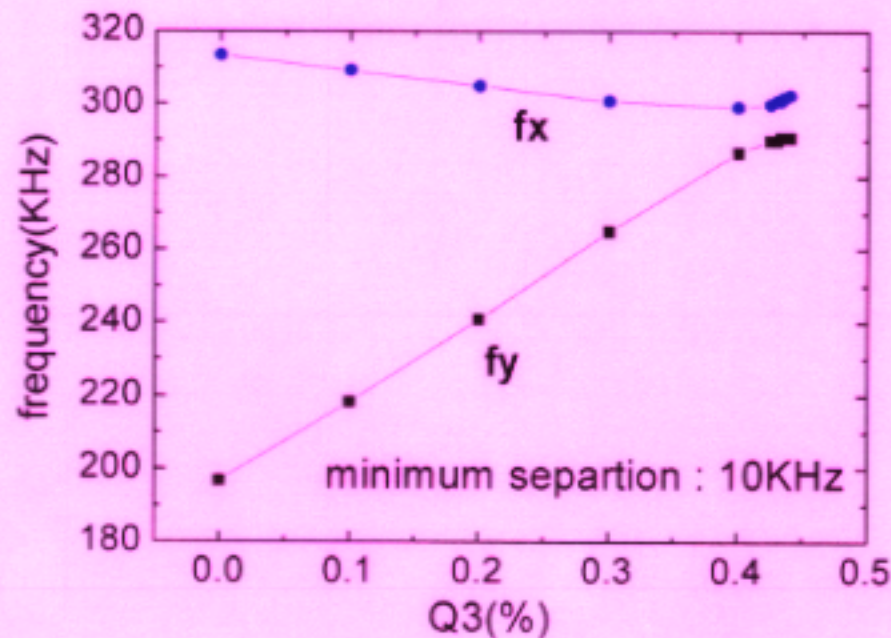
rms x = 67 um, rms y = 55 um, fy=211.7 kHz fx=302.5 kHz

Beam intensity with coupling constant

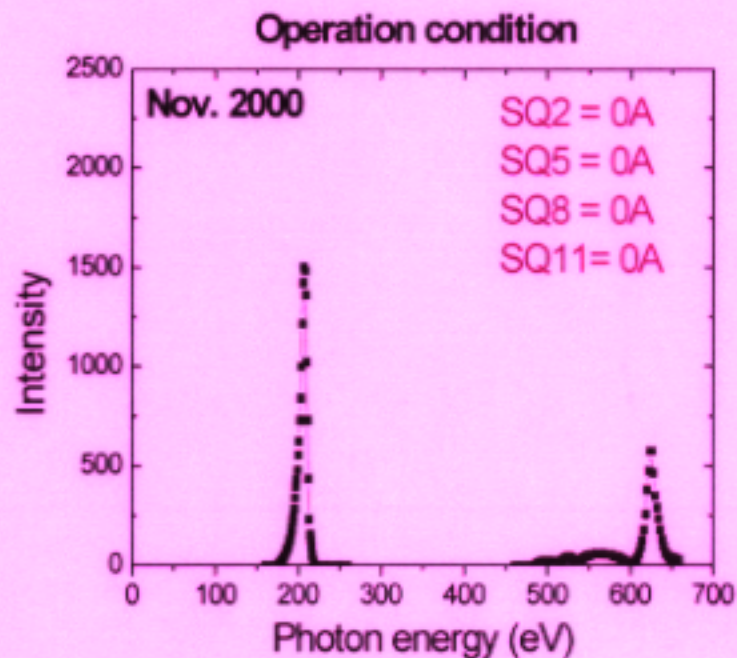
- Closest tune approach is used as a measure of the coupling constant of the beam.
- To raise the beam brightness, 4 skew quadrupoles are used to minimize the tune split. Then normal quadrupoles are returned to their original values to bring the machine back to its normal operating point.

Tune change vs Q3 strength

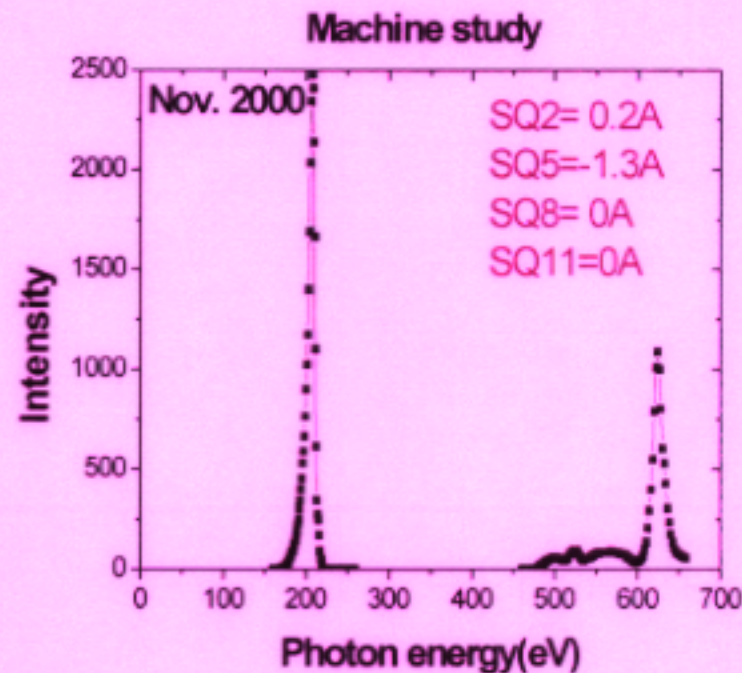
- Coupling constant on operation : $\sim 0.7\%$



Intensity variations in U7 vs. coupling constants



Closet tune separation : 10 kHz
0.7 %



Closet tune separation : 1.5 kHz
0.2 %

Beam distribution studies

- Distribution of particles in a beam:

core region : beam brightness

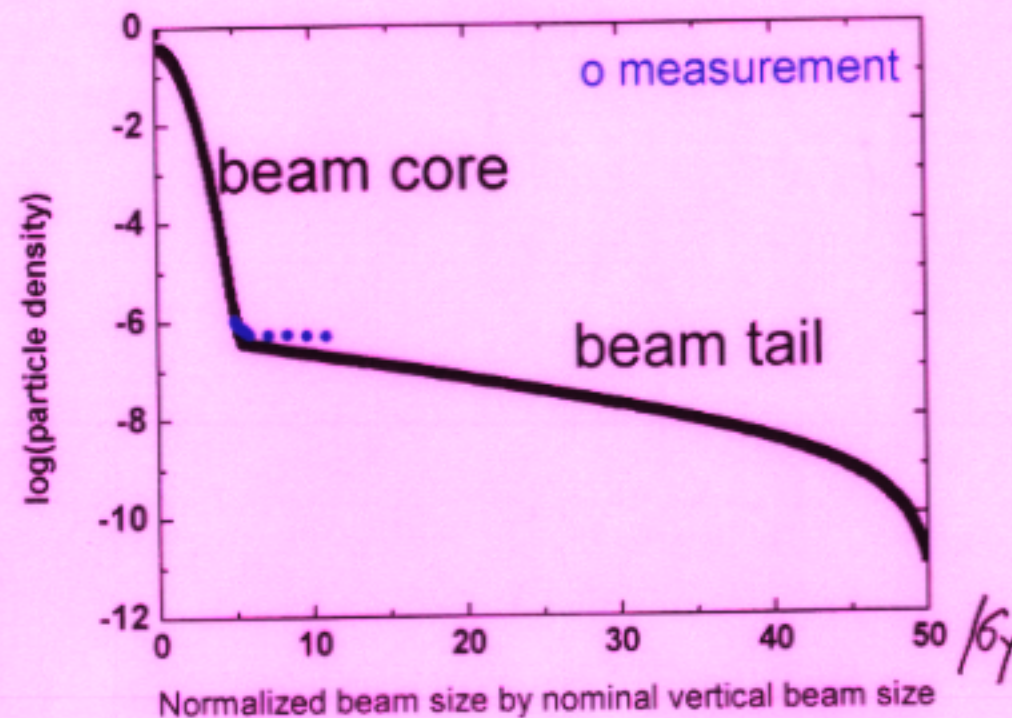
tail region : beam lifetime

1) Simulation method.

- Beam-residual scattering
- Intra-beam scattering
- Beam-residual gas bremsstrahlung

2) Measurement by using scraper.

Beam distribution by simulation and measurement

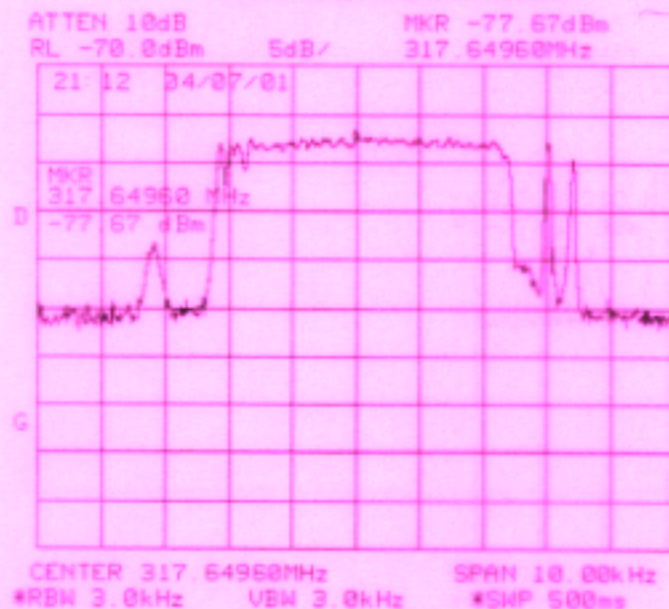


$$I_{\text{beam}} = 0.4 \text{ nA}$$

$$P_{\text{vac}} = 0.6 \text{ nT}$$

Accumulated tune variations for 5 minutes due to MPS ripples

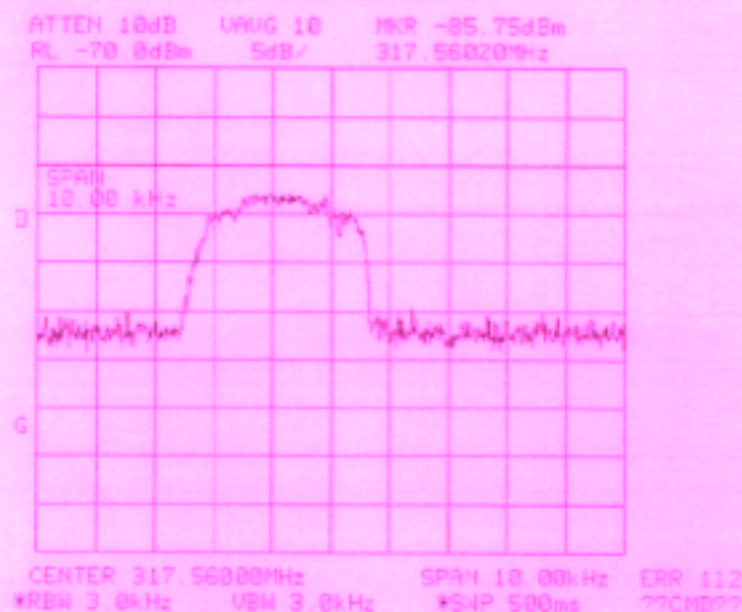
100 ppm ripple



~ 7 kHz variation

April 2001

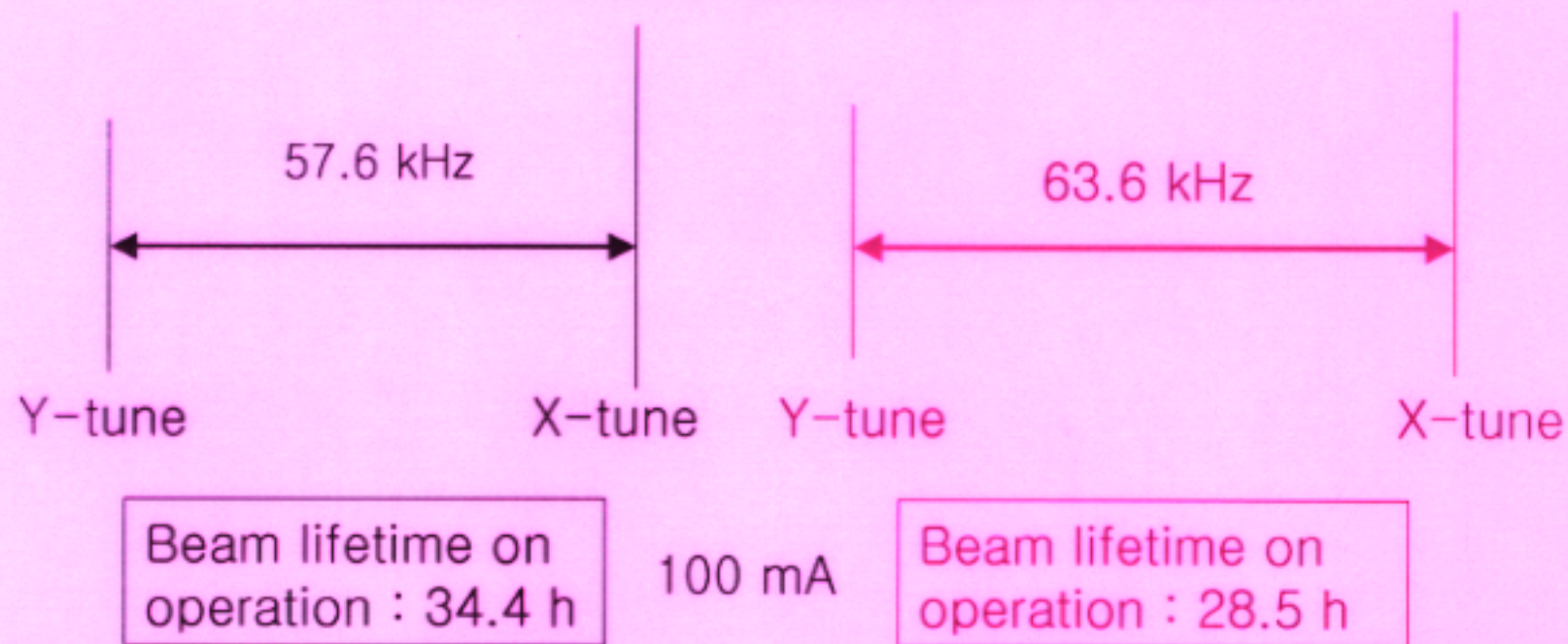
50 ppm ripple



~ 3 kHz variation

Sep. 2002

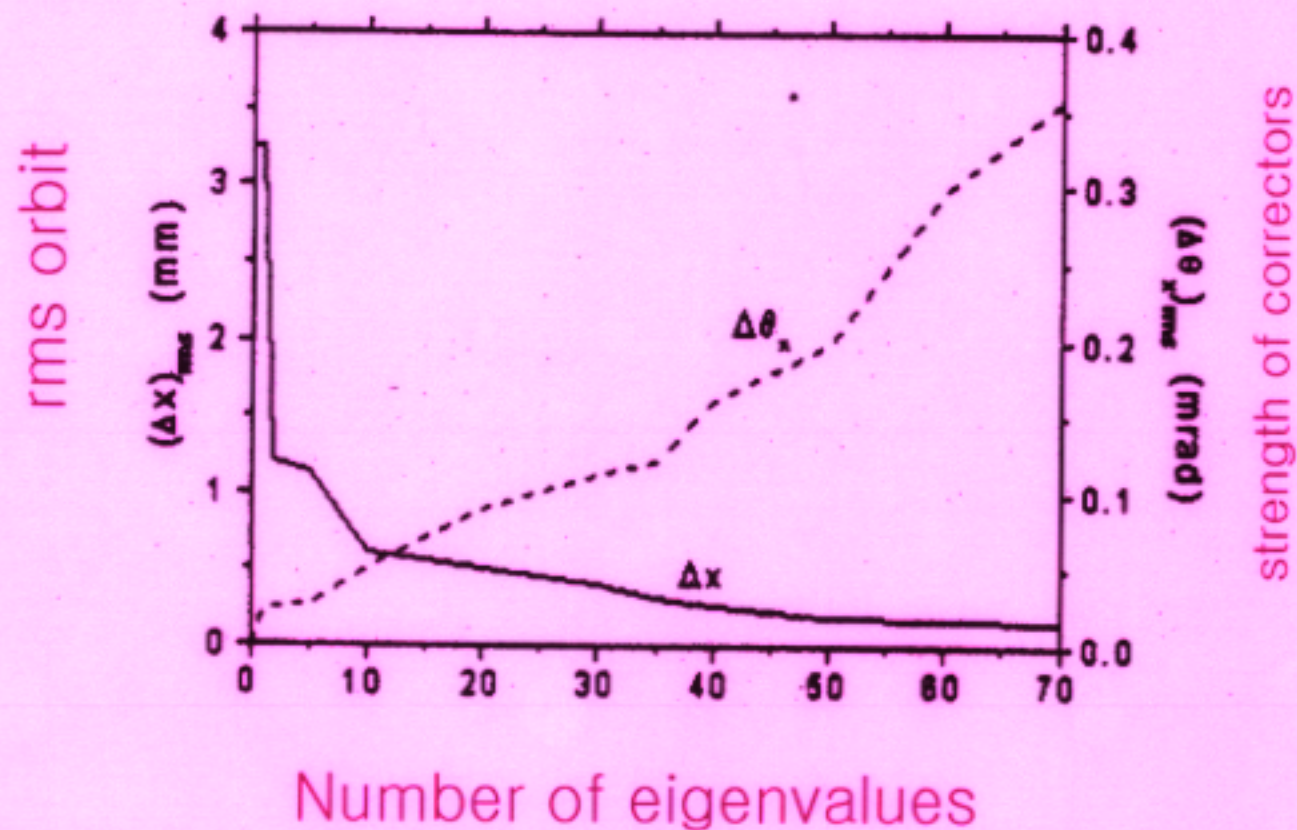
Betatron Tune stability



6 h in beam lifetime was varied due to 6 kHz tune change.

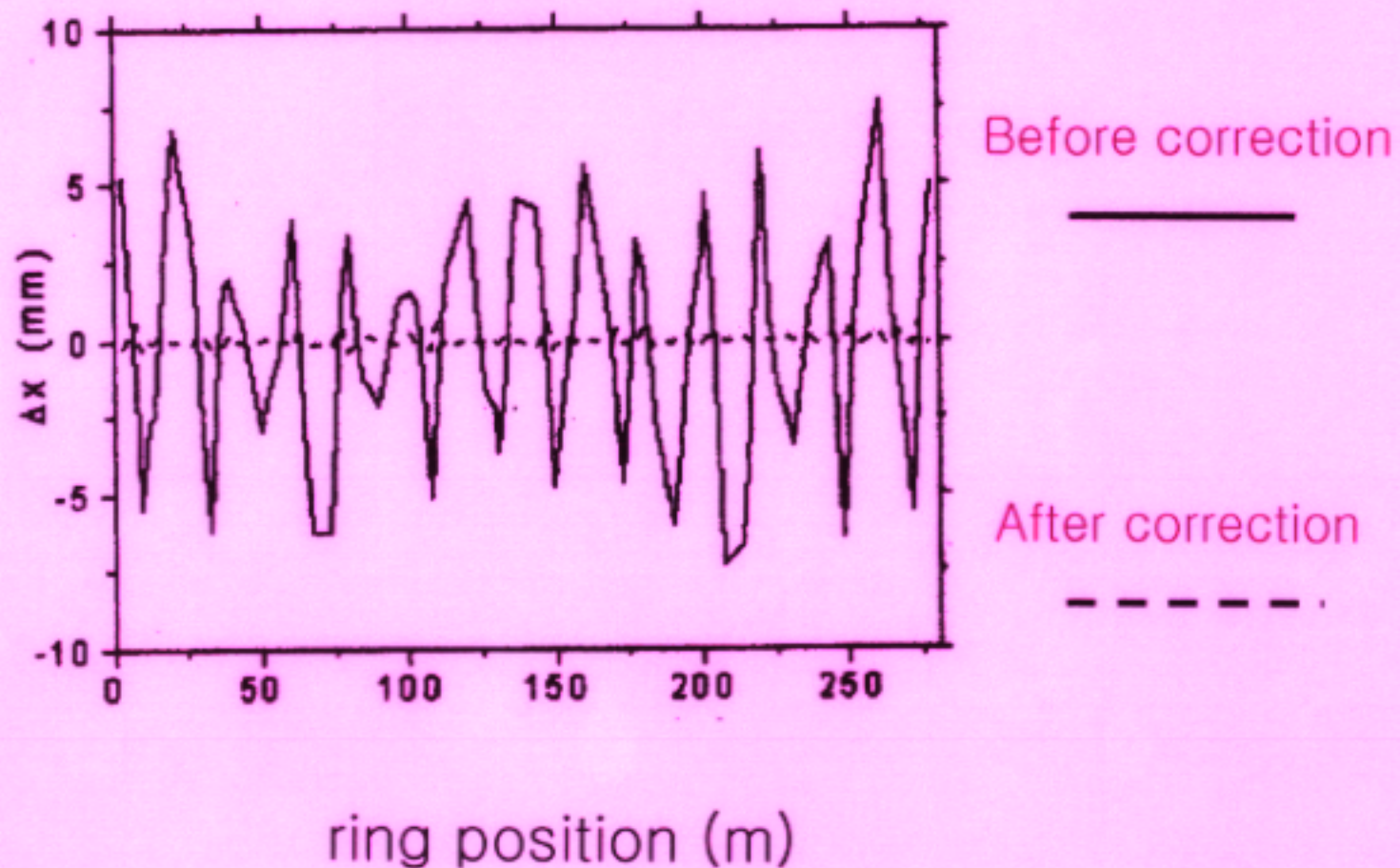
Tune variation of 1.5 kHz variation due to MPS ripple corresponds to variation of 1 h in beam lifetime.

Horizontal orbit correction by SVD method

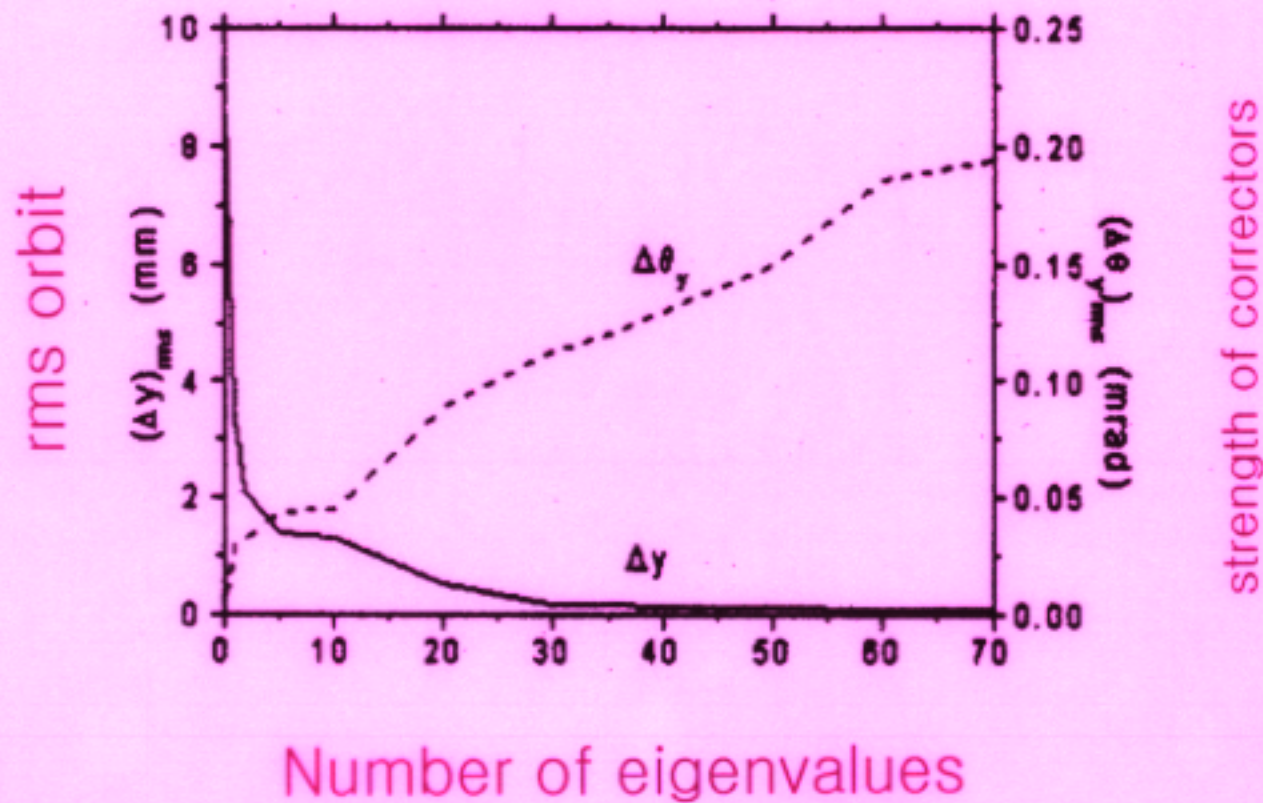


Horizontal orbit correction by SVD method

$$\nu_X = 14.28$$

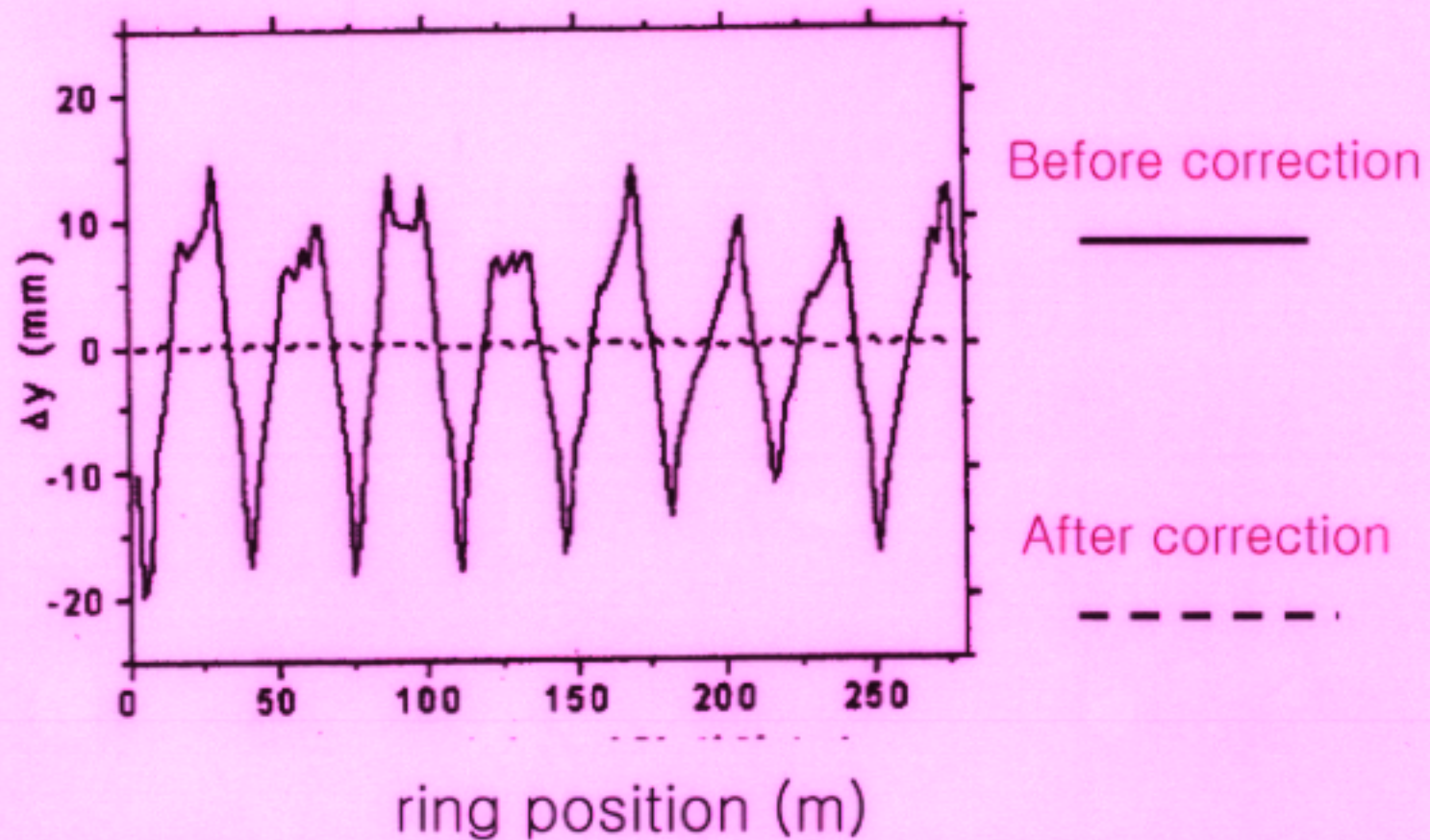


Vertical orbit correction by SVD method



Vertical orbit correction by SVD method

$$\nu_y = 8.18$$



Summary

- Orbit drift at PLS is constantly being improved.
- We also expect that orbit drift can be improved more by orbit feedback systems that are being tested and prepared.