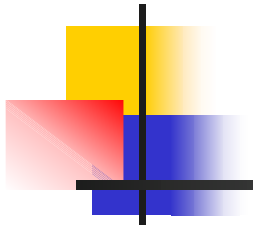
Slow Orbit Correction in the SPring-8 Storage Ring

K.Soutome

on behalf of

"Beam Orbit Stabilization Project Team"

SPring-8



Brief History

Beam Commissioning Started in March, 1997.

Suppression of Main Harmonics of COD around Tune

Calibration of BPMs with Beam:

Imbalance of Voltage from Four Button-Pickups

M.Masaki, et.al. Proc.11th Symp. on Acc. Sci. and Tech. 1997, p.83

Offset by Using High-Harmonic Components

K.Soutome, et.al. NIM A459 (2001) 66

Direct COD Correction w/o Main Harmonics

Minimum Distortion of Dispersion Function

Compensation of Energy Drift (Tidal Effect)

Averaging of BPM Data on VME

"High-Precision" STs

(first installed in January, 2001 and added in August, 2002)

Number and Position of BPMs and STs

BPM

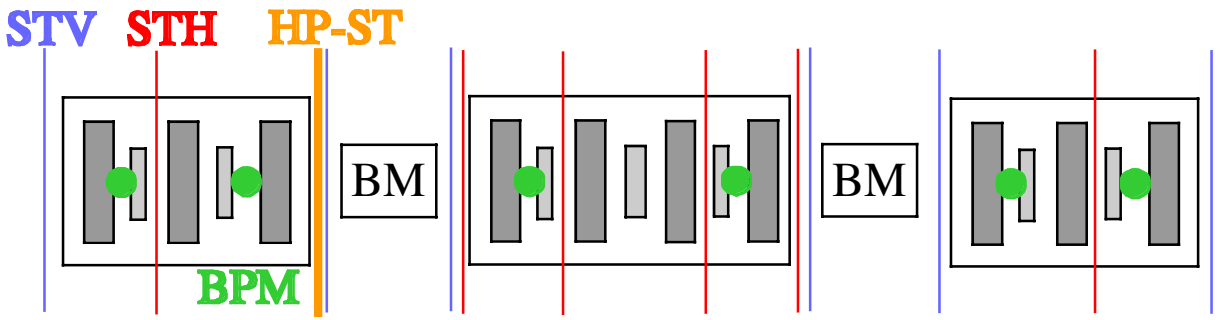
Total Number: 280 **6 BPMs / Cell**

ST ("Normal" Type)

Total Number: 282(H) ; 268(V) **6 STHs & 6 STVs / Cell**

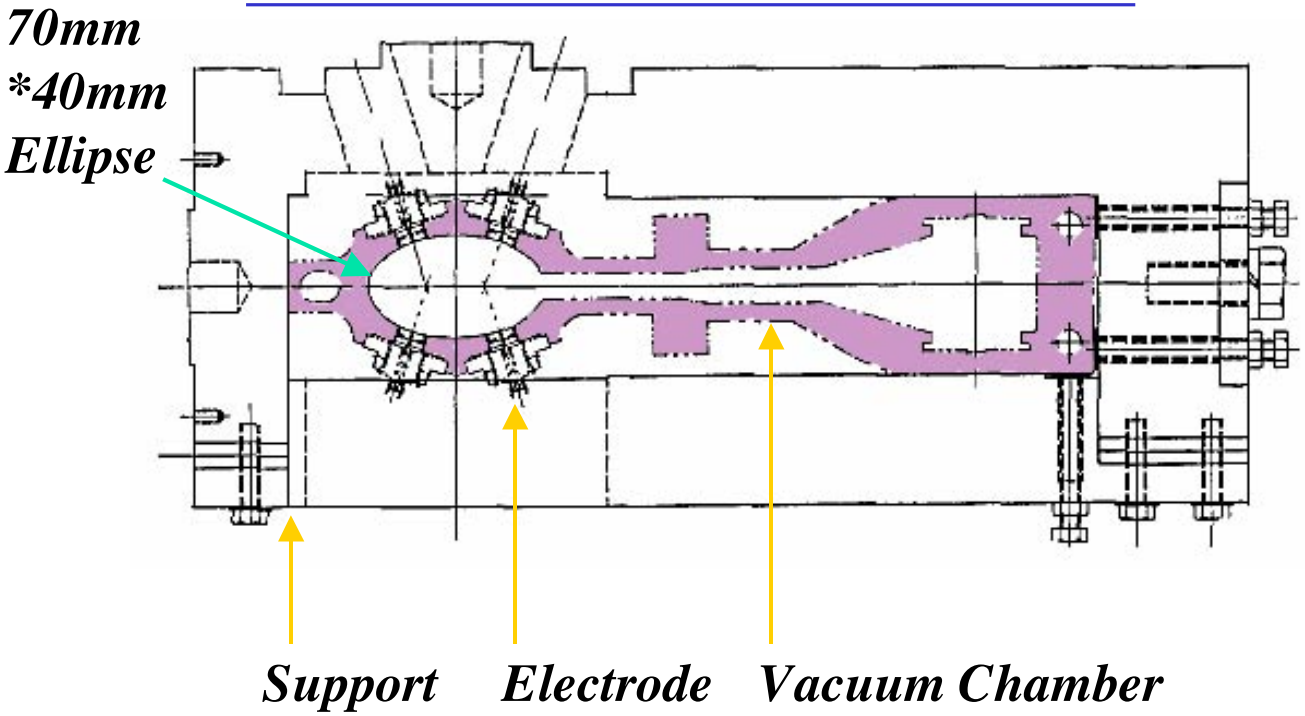
ST ("High-Precision" Type)

Total Number: 24(H) ; 24(V) **1 STH & 1 STV / 2 Cells**

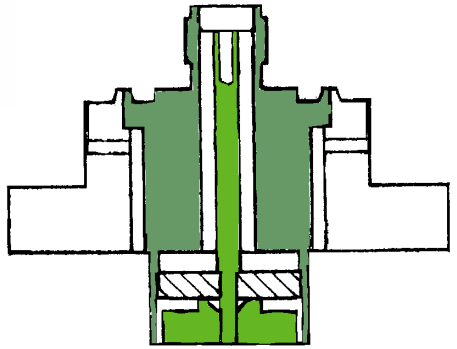


BPMs for COD Measurements

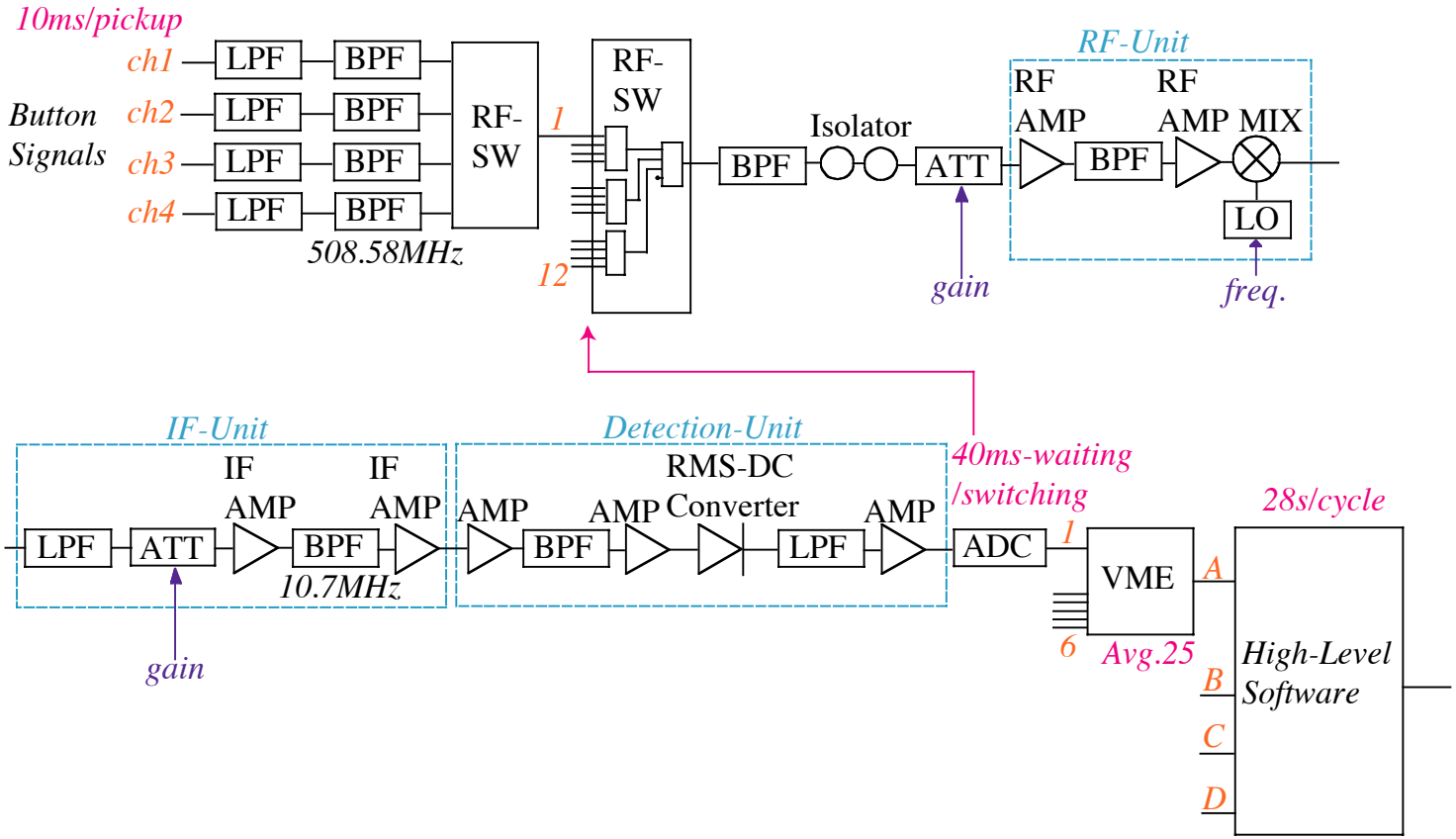
Cross Sectional View of a BPM Section



Electrode



BPMs for COD Measurements (cont.)



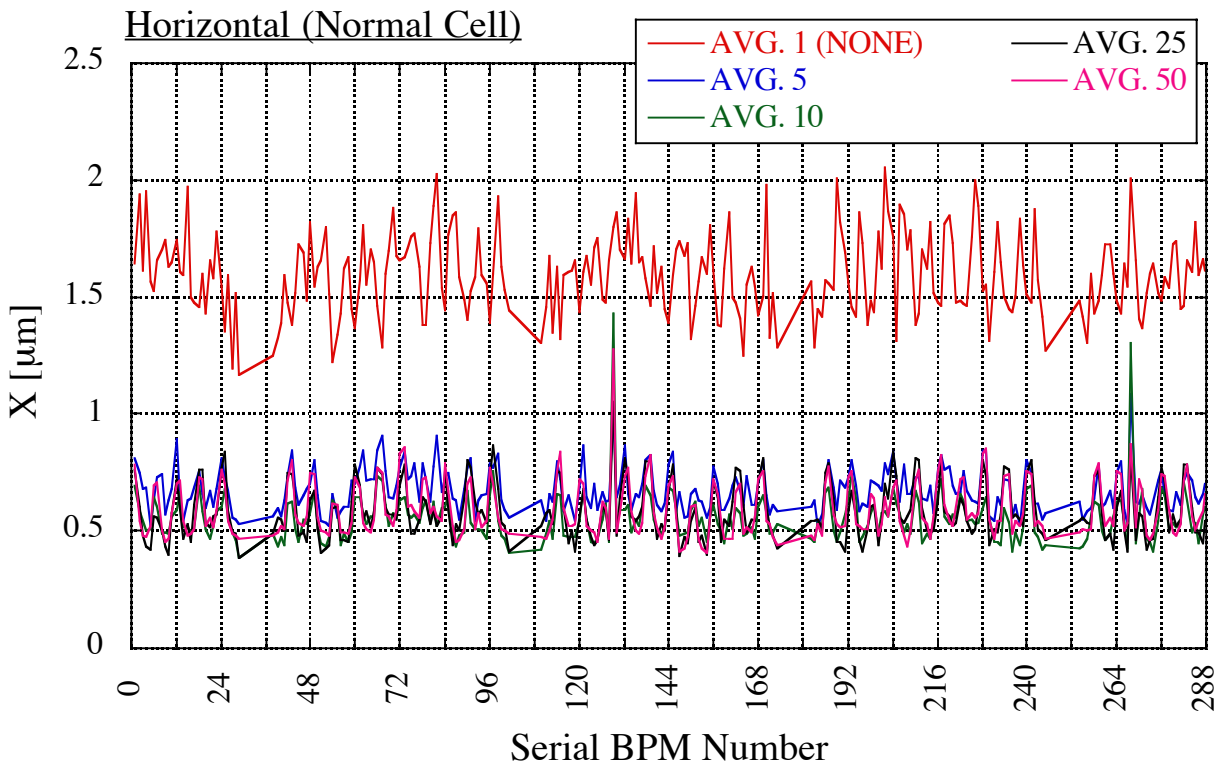
28sec for a Sequence of COD Measurement (Avg. 25)

Reproducibility of BPMs

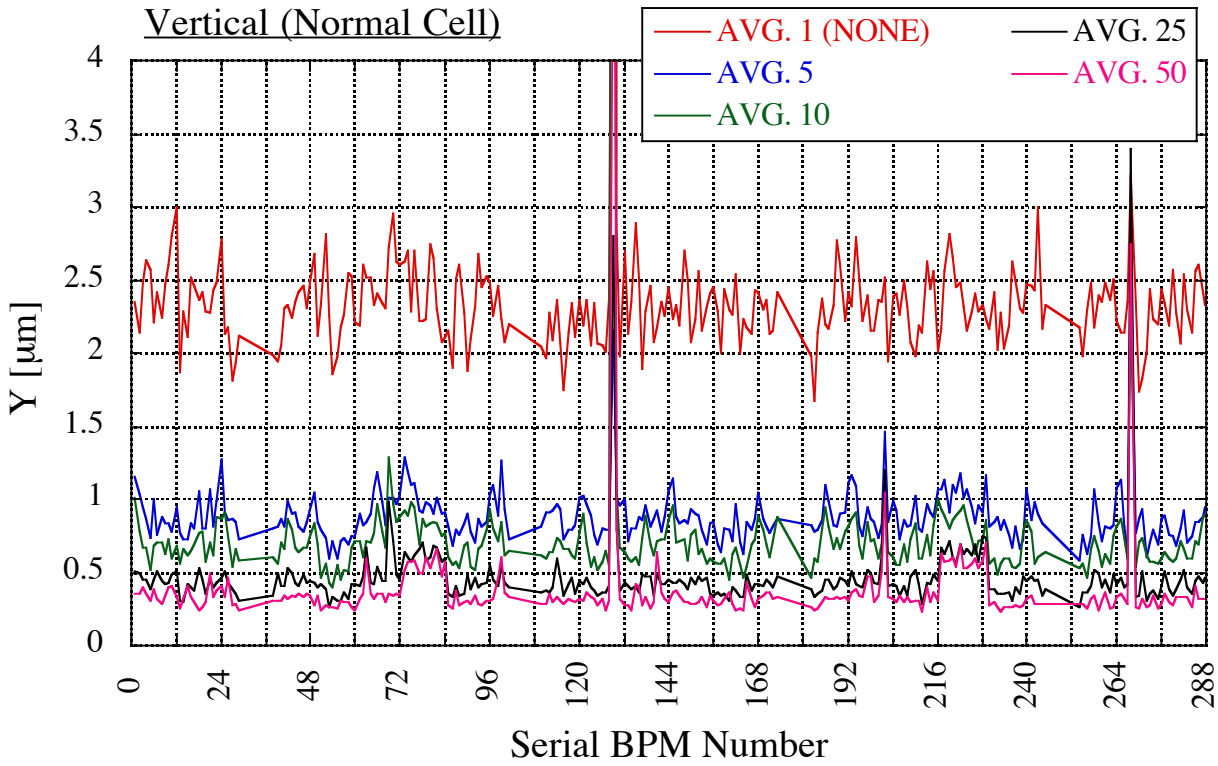
Measure COD repeatedly about 100 times.

→ RMS difference of nearest two CODs

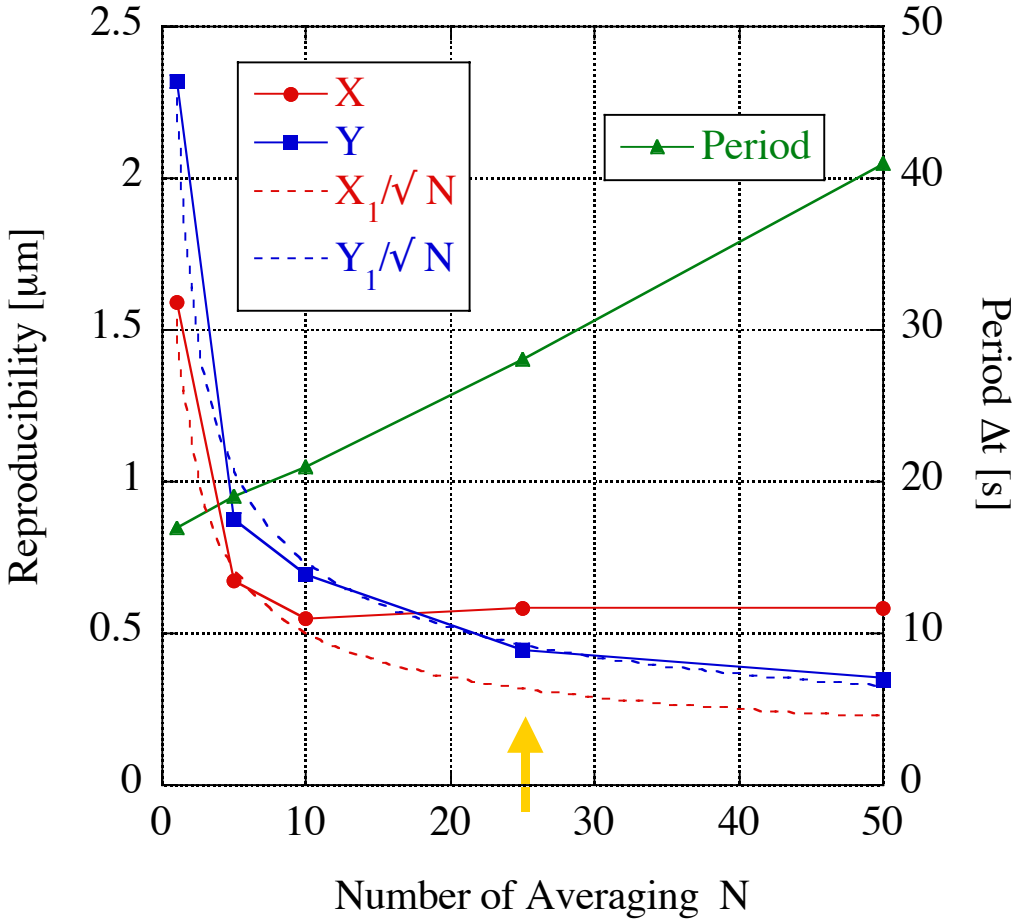
→ Reproducibility: $[\mathrm{COD}(t+\Delta t) - \mathrm{COD}(t)]_{\mathrm{RMS}} / \sqrt{2}$



Reproducibility of BPMs (cont.)



Resolution of BPMs



Resolution Estimated from Reproducibility:

better than

0.6μm(H); 0.5μm(V)

for N = 25

Note: The effect of real orbit drift within Δt is included.

Two Kinds of Steering Magnets

"Normal" Type with Iron-Yoke

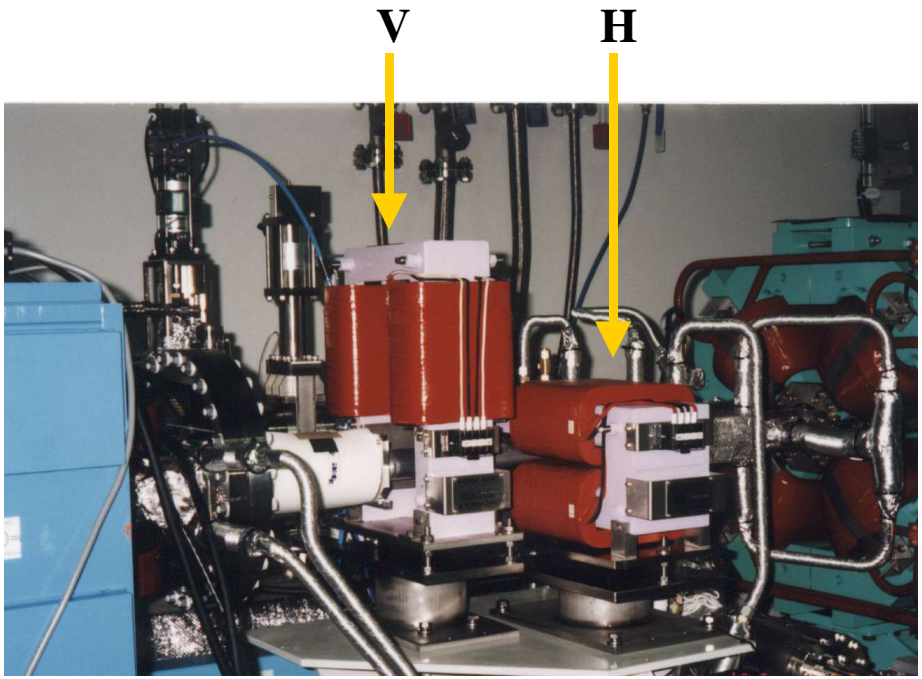
Total Number: 282(H) ; 268(V)
Max. Kick Angle: ±1mrad (H) ; ±0.5mrad (V)
Power Supply: ±5A, 16bit
Min. Step: 0.03μrad (H) ; 0.015μrad (V)
... used in manual correction for e.g. beam tuning

"High-Precision" Type with Air-Core

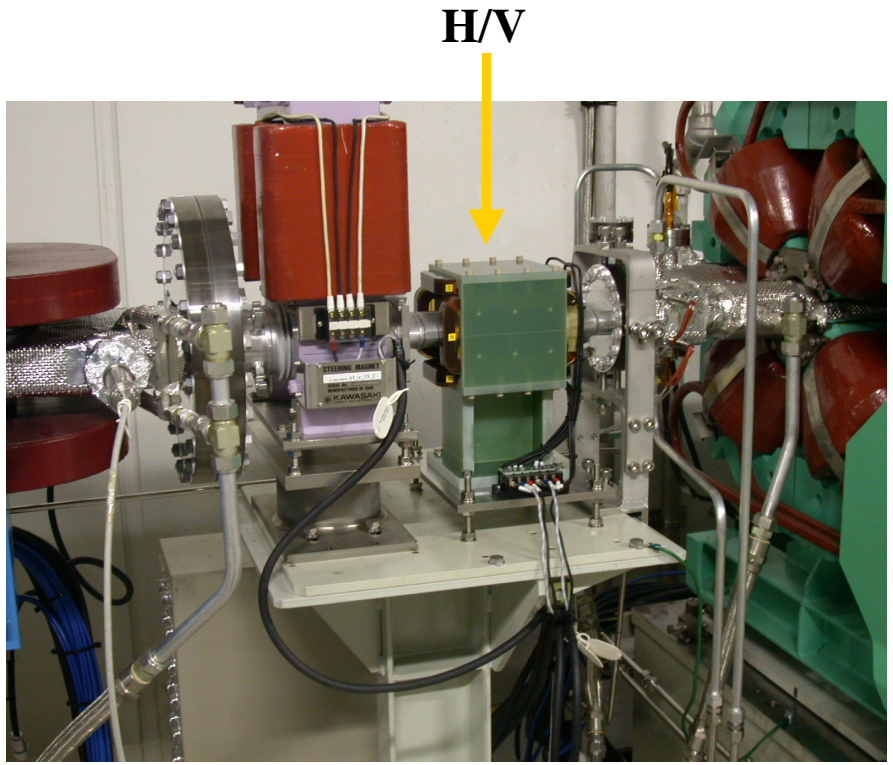
Total Number: 24 (H); 24(V)
Max. Kick Angle: ±13μrad
Power Supply: ±5A, 16bit
Min. Step: 0.0004μrad
... used in auto-correction for user time
Hysteresis-Free

Two Kinds of Steering Magnets (cont.)

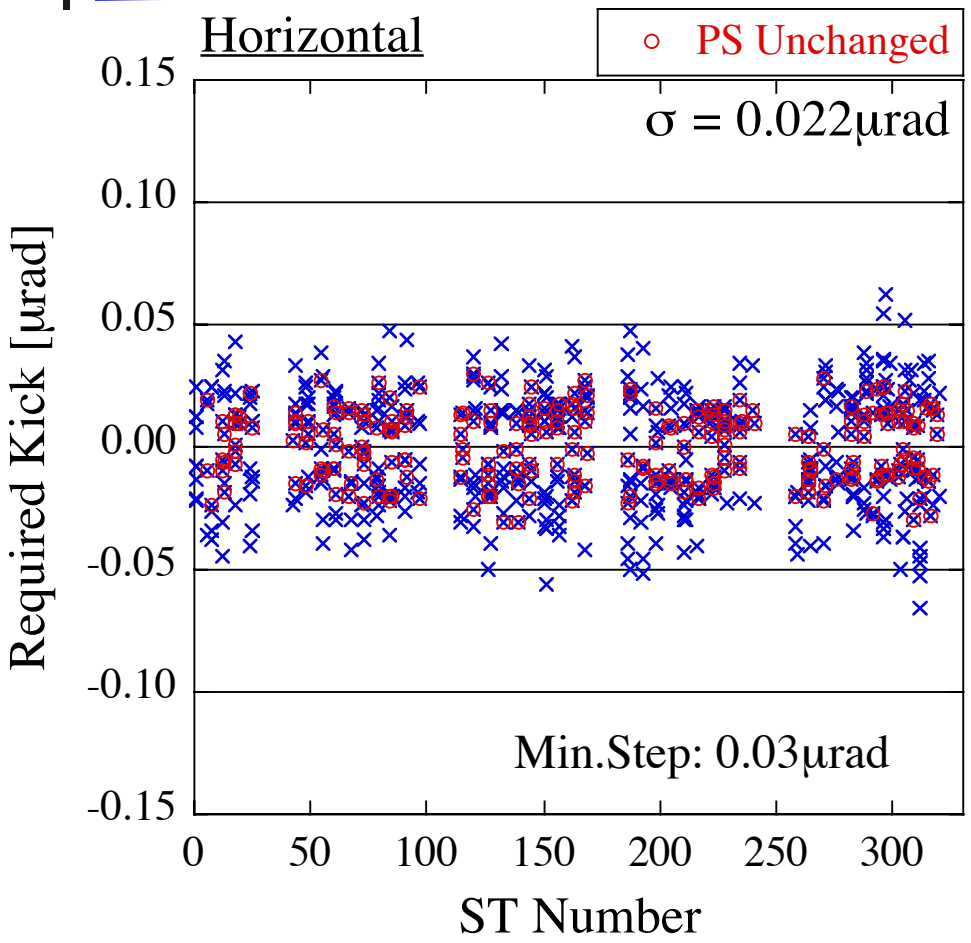
"Normal"



"High-Precision"



Why "High-Precision" STs in User Time?

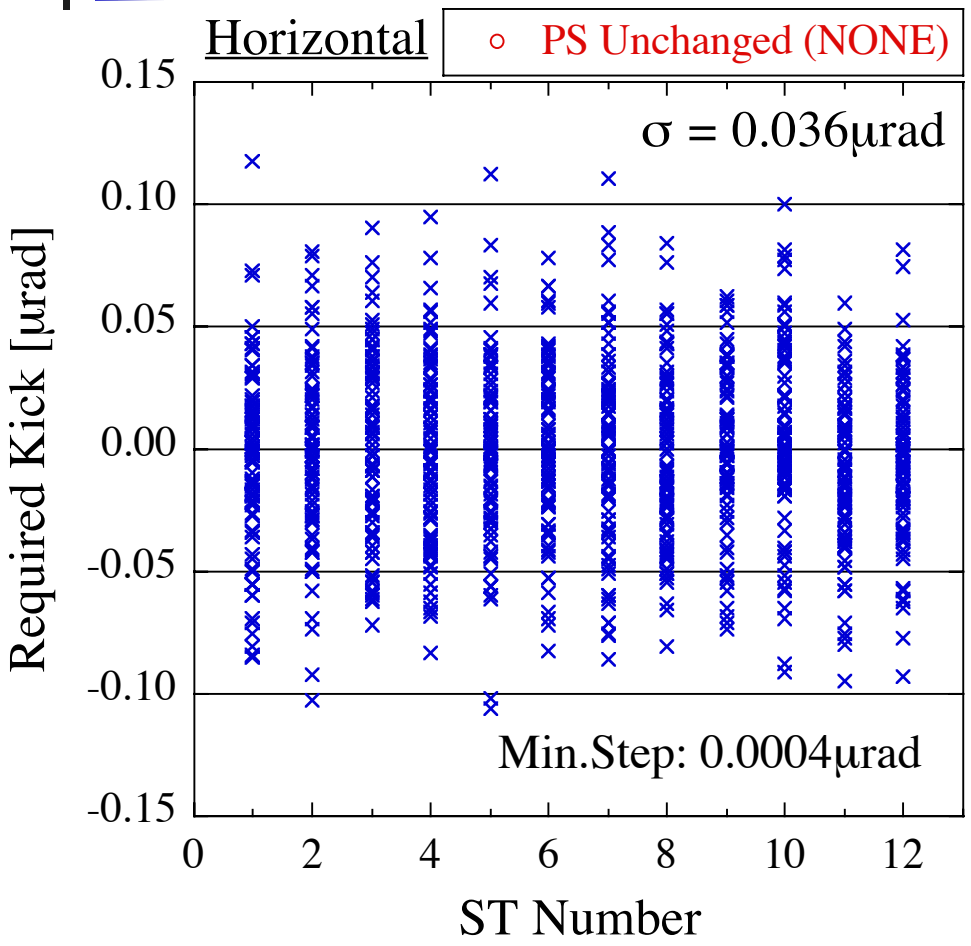


COD Correction with "Normal" ST

"Best-Corrector" Method
- **12 STs Used**
- **Interval: 40s**
- **50 Corrections**

← **Jump of a few μm order was observed at each correction!**

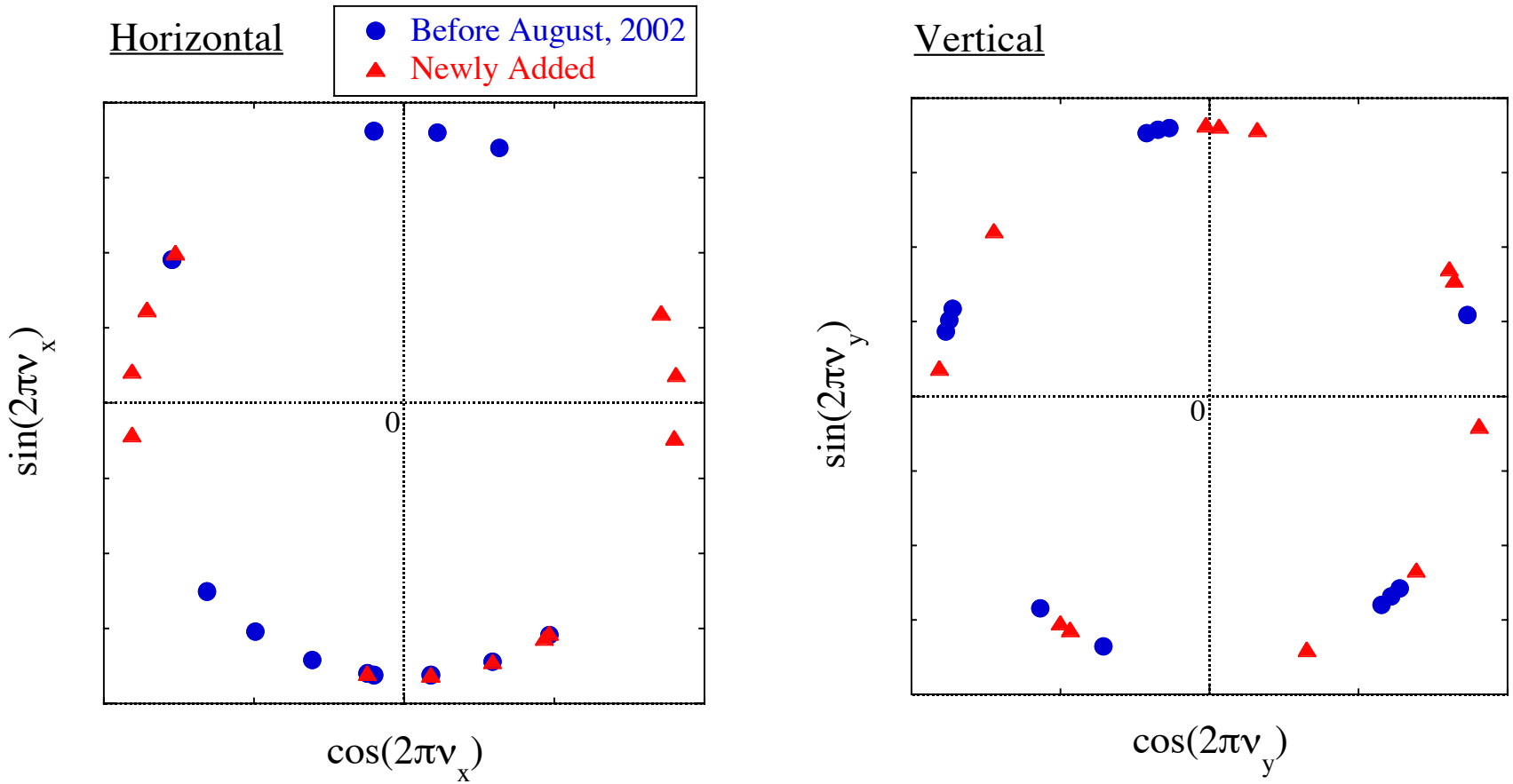
Why "High-Precision" STs in User Time? (cont.)



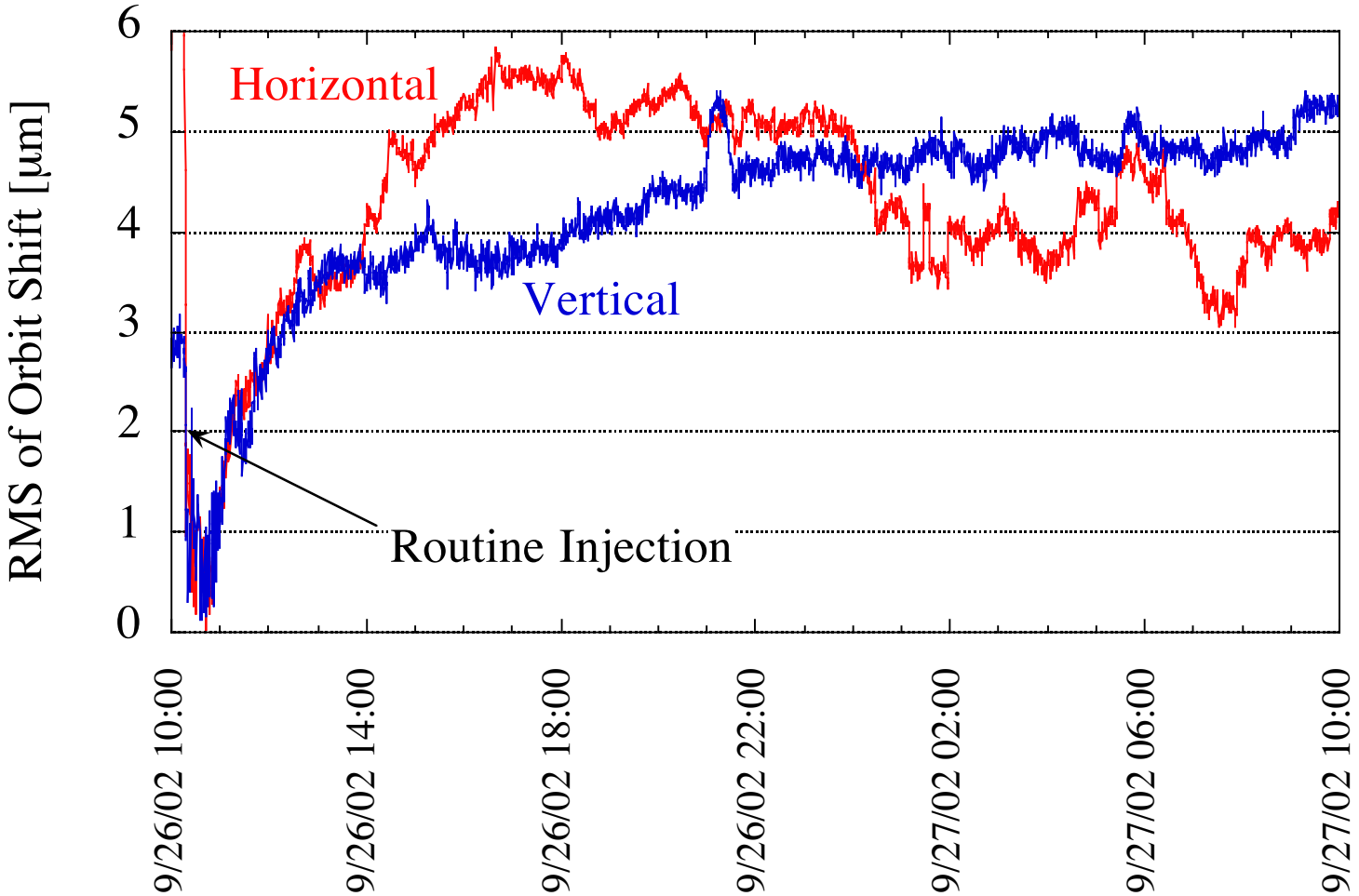
COD Correction with "High-Precision" ST

← **Smooth Correction**

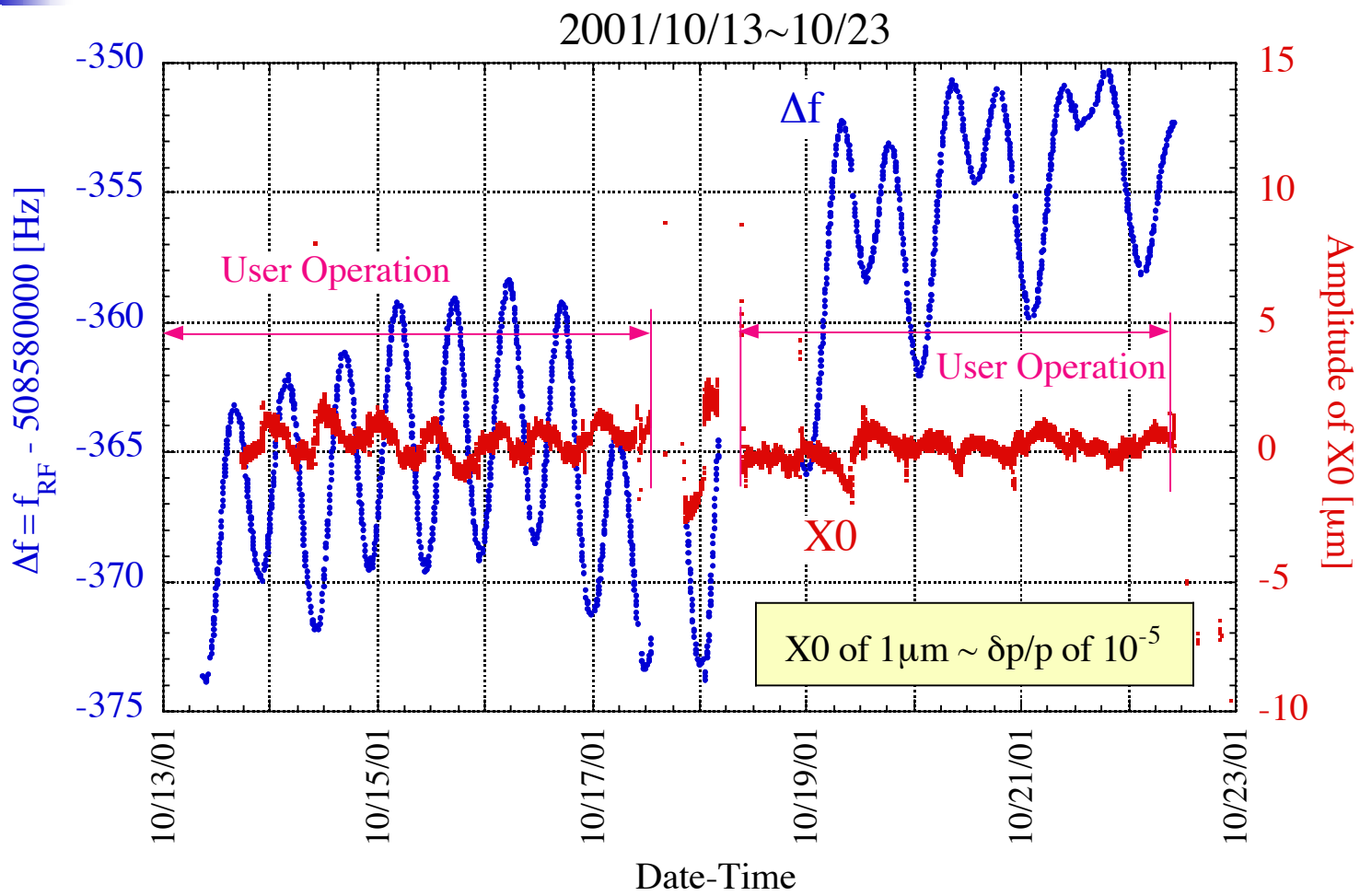
Betatron Phase at High-Precision STs



COD Correction - RMS Deviation/Day -



Compensation of Energy Drift



Summary

BPMs

Averaging on VME: 25 times

Resolution: better than 0.6μm(H); 0.5μm(V)

Steering Magnets

Two Types of Steering Magnets

"High-Precision" Type for Smooth Correction in User Operation

COD Correction

Direct Correction w/o Main Harmonics (Drift < 5 - 6 μm/day)

Compensation of Energy Drift by RF Frequency ($\Delta p/p \approx 10^{-5}$)