Position jitters and Emittances of ATF extracted beam

2005.01.05. K.Kubo

Position jitters in Damping Ring

Position jitters of extracted beam

Emittances in Damping ring.

Emittances of extrqacted beam

Single bunch and multibunch

Transverse orbit stability in DR

Fast jitter

Smaller than BPM resolution in DR (5~10 micron).

Slow orbit change

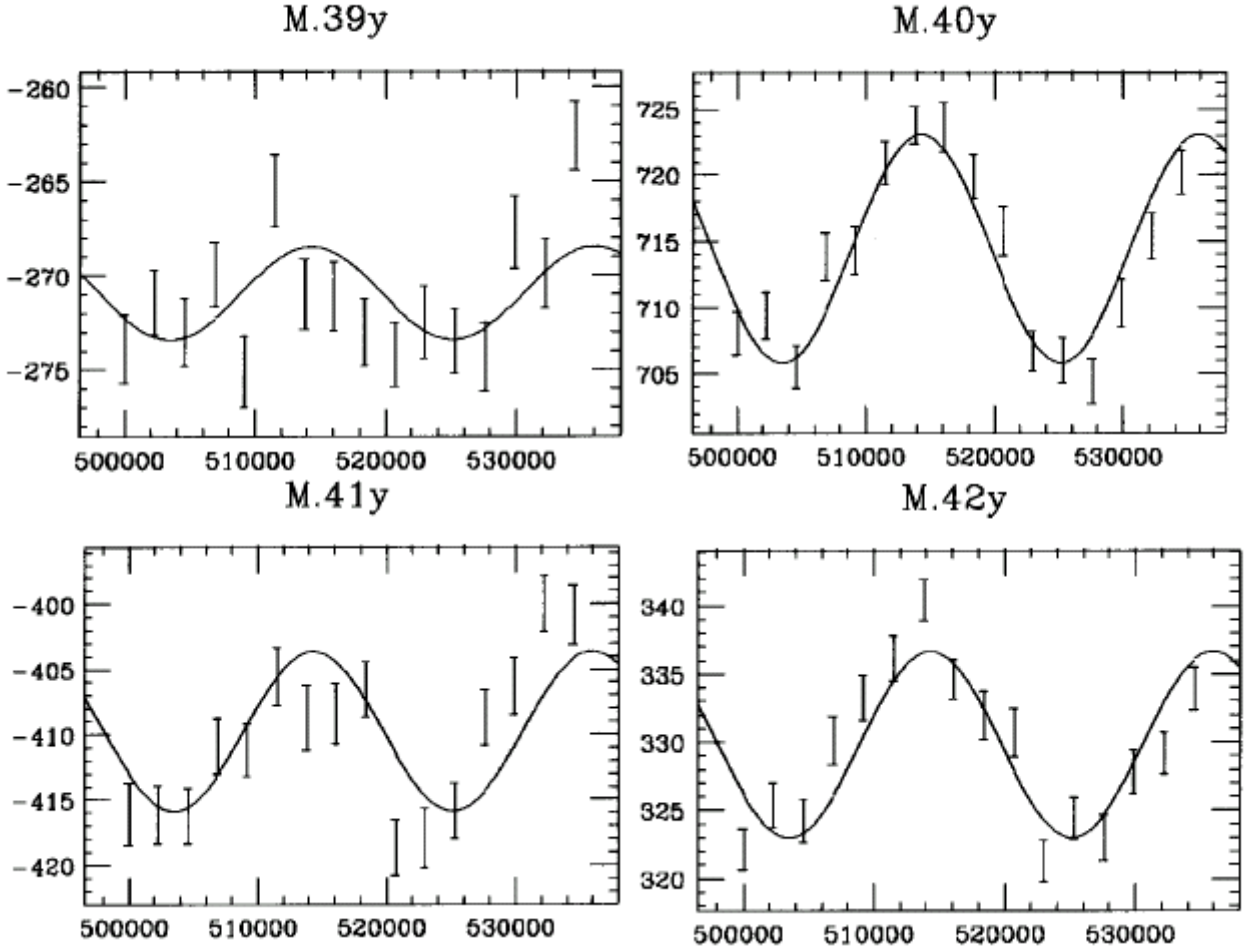
50 and 100 Hz orbit change, amplitude ~ 10 micron, x and y
(related to AC line → No effect to extracted beam.)

Slower drift

Vertical 1~2 micron at Laser wire region (beta 5m)
period ~ a few minutes [Y.Honda, 8th ATF co.lab. mtg.]

100 Hz oscillation in DR (from AC line)

Vertical position vs. Turn number in DR



K.Kubo, ATFinternal-99-12

Energy jitter in DR (synchrotron oscillation)

Rms ~ 7.5E-5 (1/8 σE/E)

Amplitude ~ 2E-4

Pulse to pulse energy jitter at 500,000th turn in DR, evaluated from horizontal measured dispersion and measured positions at arc BPMs

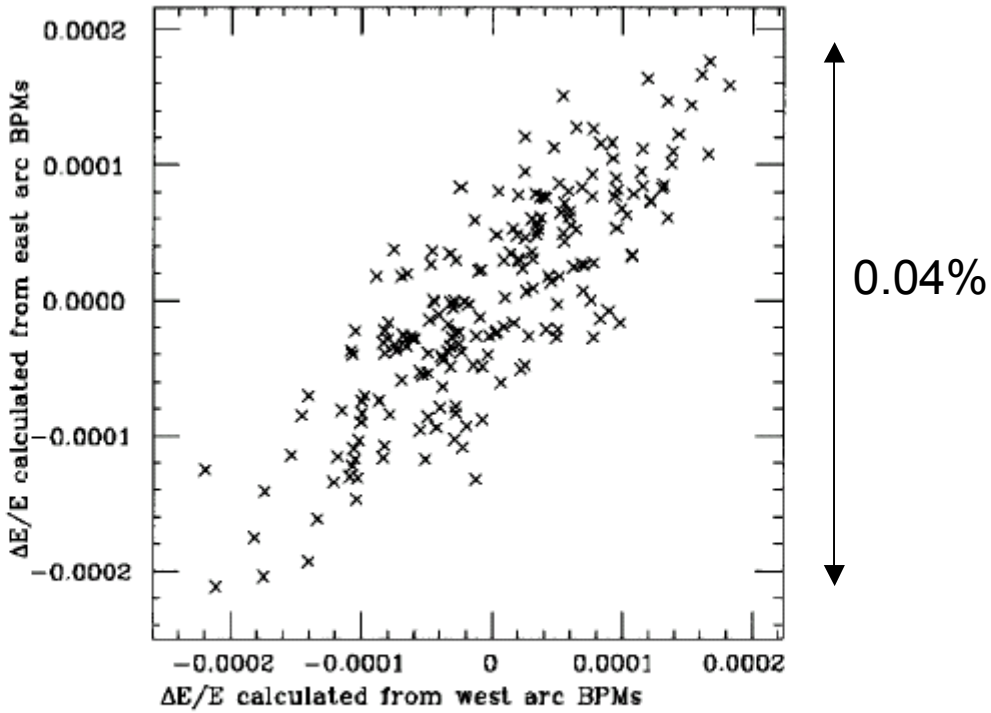
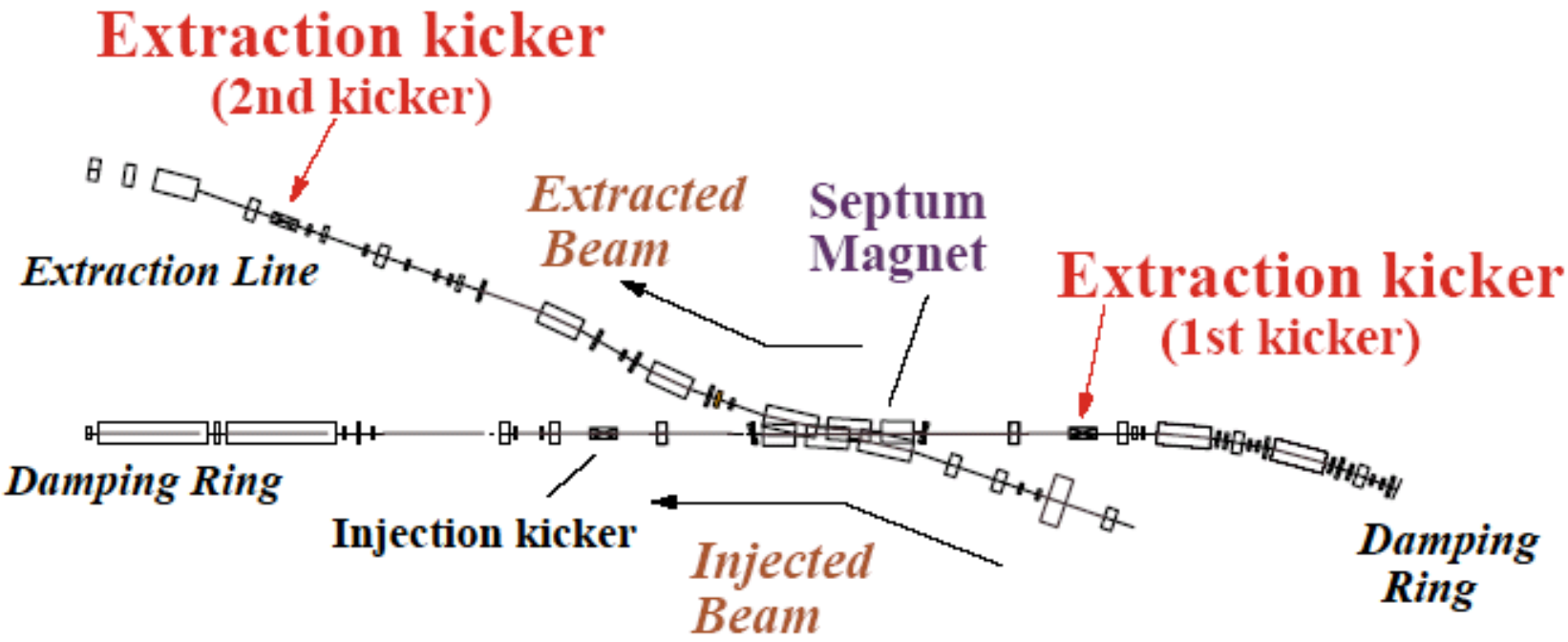


Fig. 3(b), Energy deviation calculated from the west arc BPMs vs. calculated from the east arc BPMs. Data on June 9.

K.Kubo, ATFinternal-99-11


Extraction kicker
(2nd kicker)
Extracted
Beam
Septum
Magnet
Extraction kicker
(1st kicker)
Extraction Line
Damping Ring
Injection kicker
Injected
Beam
Damping
Ring

Horizontal orbit jitter in Extraction line.

Table 4: The comparison of the measured position jitter with the estimated position jitter came from each source in the double kicker mode

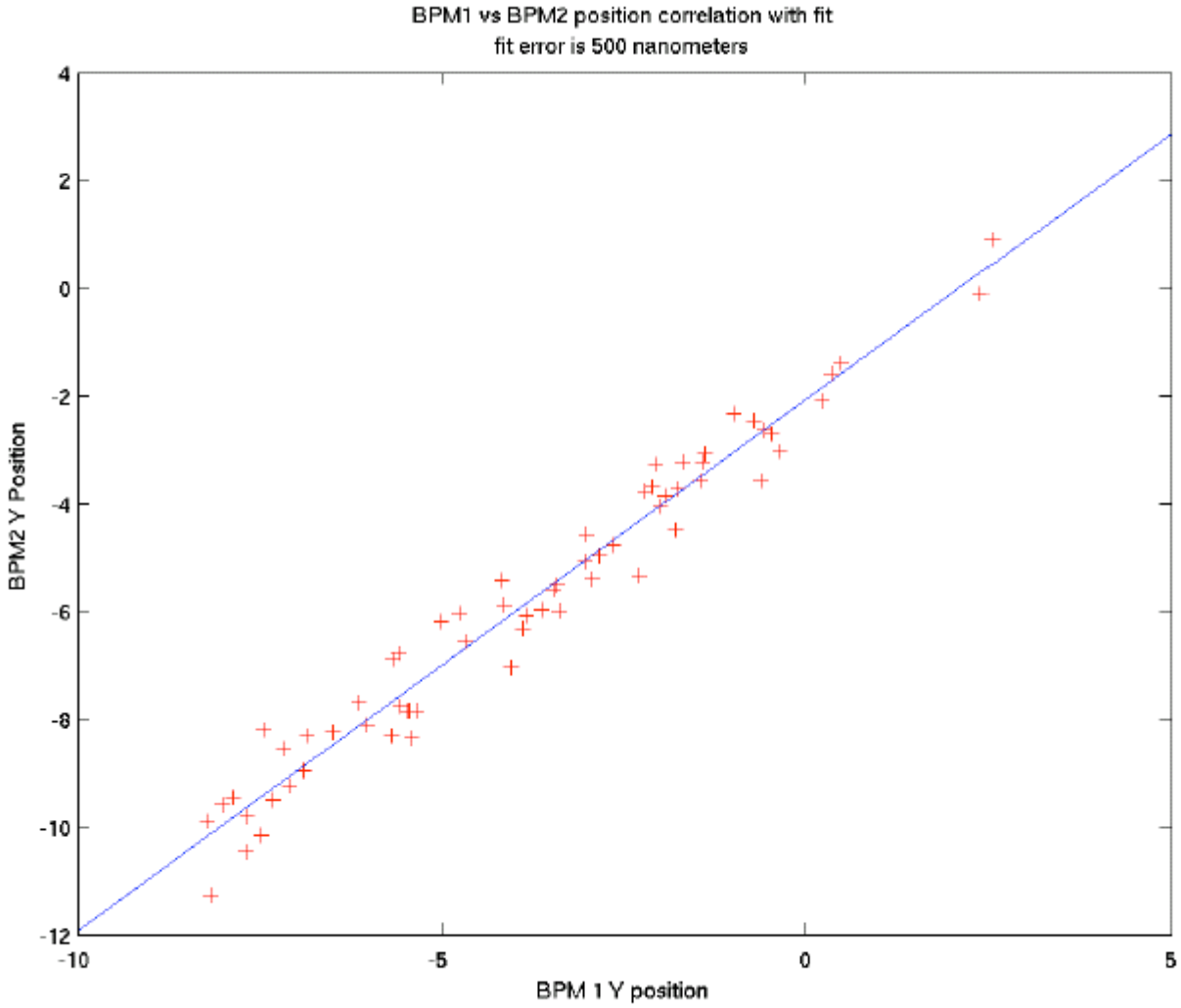
	Double kicker mode			
	Measured jitter	Estimated jitter		
BPM Name	$\sigma_{\Delta x^i}$	$\sigma_{\Delta x^i_{\text{kicker}}}$	$\sigma_{\Delta x^i_{\text{inj}}}$	$\sigma_{\Delta x^i_p}$
MM1X	12.0 μm	4.0 μm	11.9 μm	0.6 μm
MM2X	9.2 μm	2.5 μm	8.2 μm	0.6 μm
MM3X	3.4 μm	2.0 μm	3.6 μm	0.3 μm
MM4X	17.5 μm	7.2 μm	16.6 μm	0.2 μm
MM5X	18.4 μm	6.5 μm	15.9 μm	0.3 μm

beam size: 50 – 100 micron

T.Imai et.al.

Horizontal jitter 1/10 – 1/5 of beam size.
Main jitter source is not the kicker. (Double-kicker works.)

Vertical position by cavity BPM. ~10 micron p-p.



J.Frisch et.al., ATF-03-04

Vertical orbit jitter in Extraction line

Slow drift + fast jitter. Fast jitter ~ 2 micron (rms)

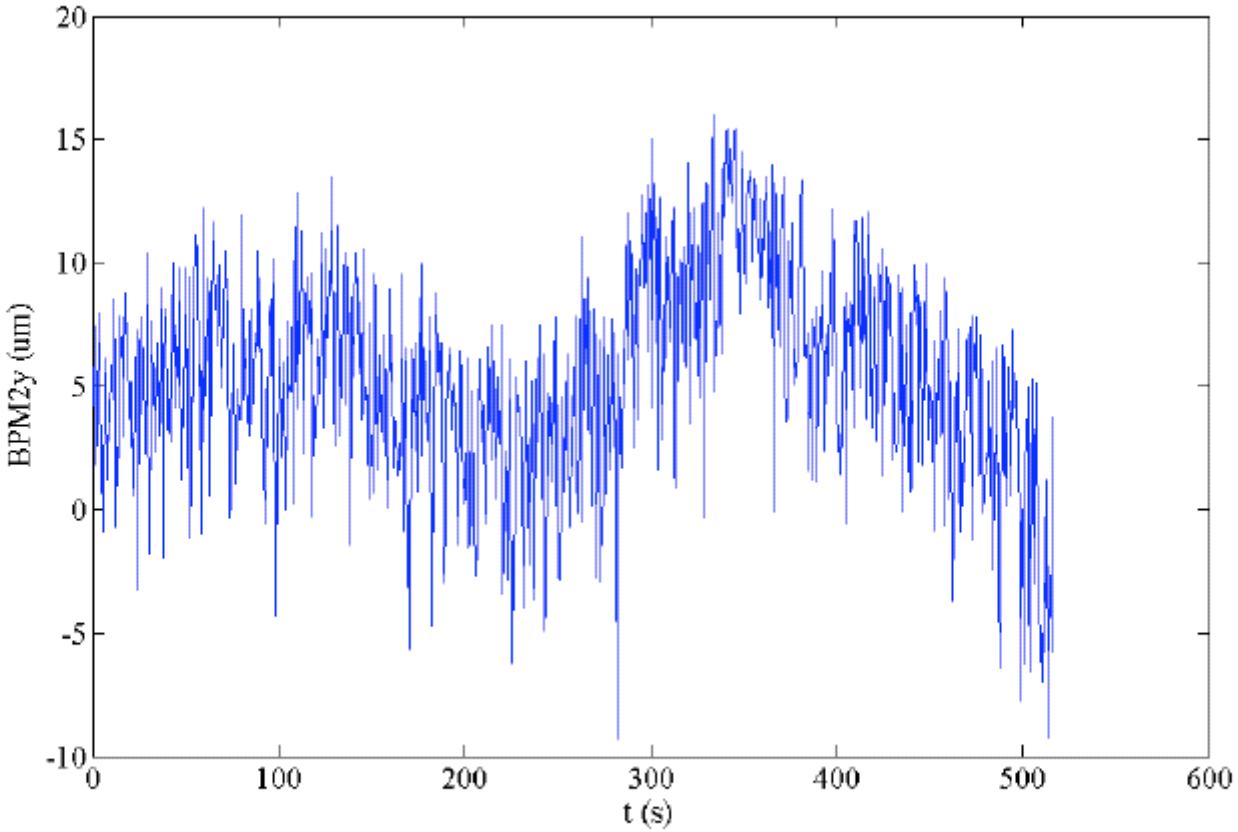


Figure 16: Position stability at BPMy2. The period of the oscillation is about 4 minutes.

M.Ross et.al., ATF-03-05

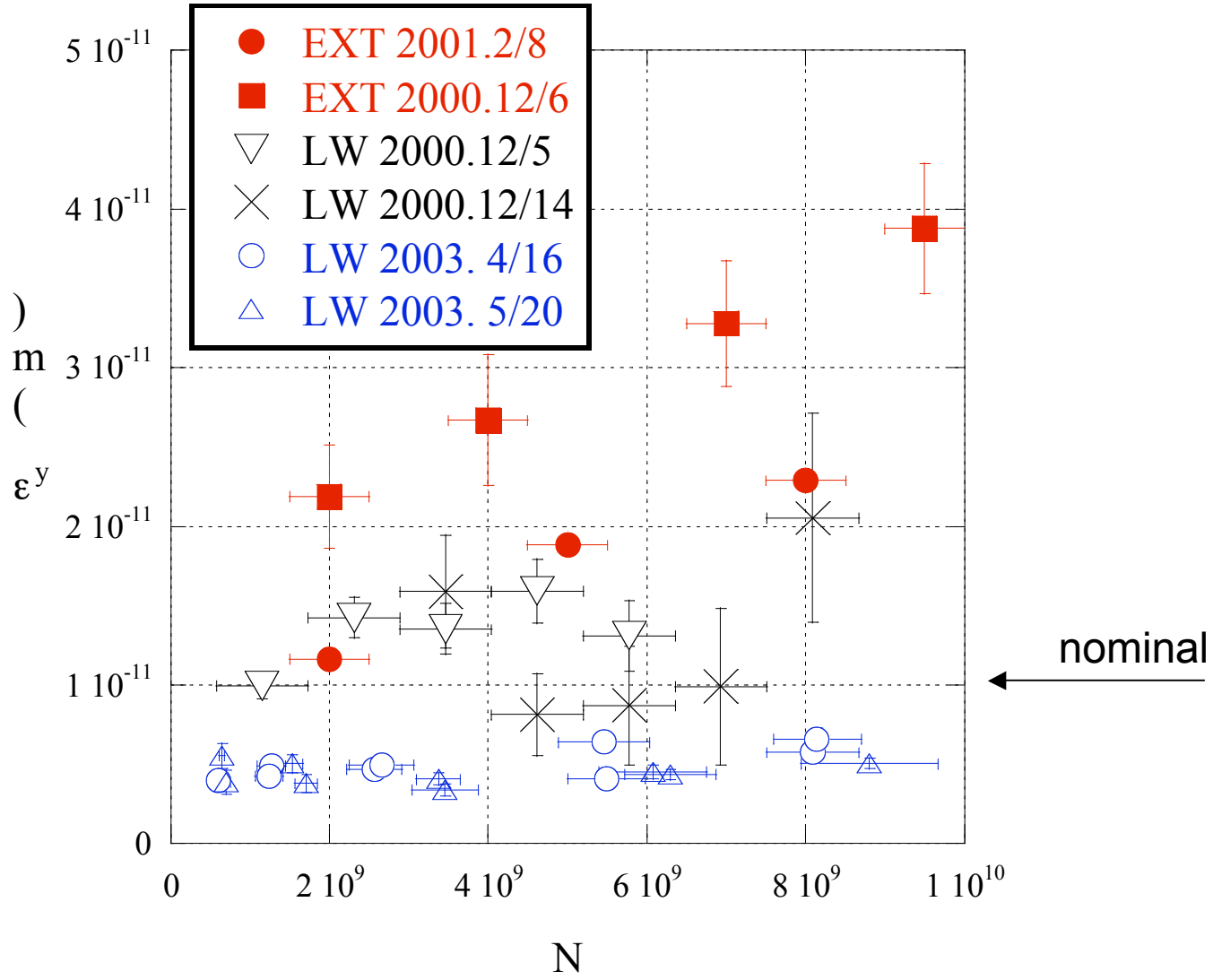
New result from nano-BPM study in Dec. 2004

x jitter	20 um
y jitter	3.5 um
x' jitter	1.0 mrad
y' jitter	2 urad

(x jitter) x (x' jitter) = 2E-8 εx=1E-9

(y jitter) x (y' jitter) = 7E-12 εy=1E-11

Vertical emittance in DR and EXT



Multibunch longitudinal oscillation in DR.

Large oscillations of tail bunch.

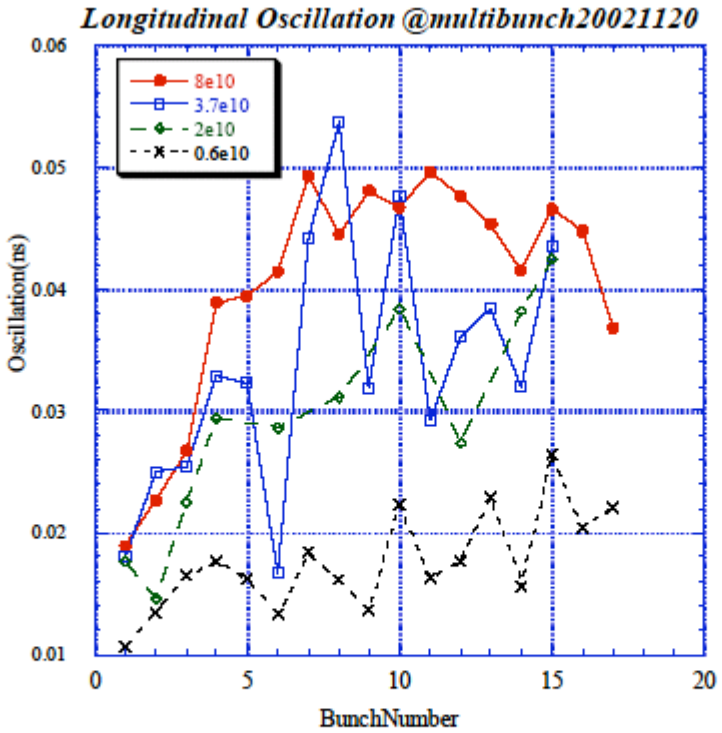
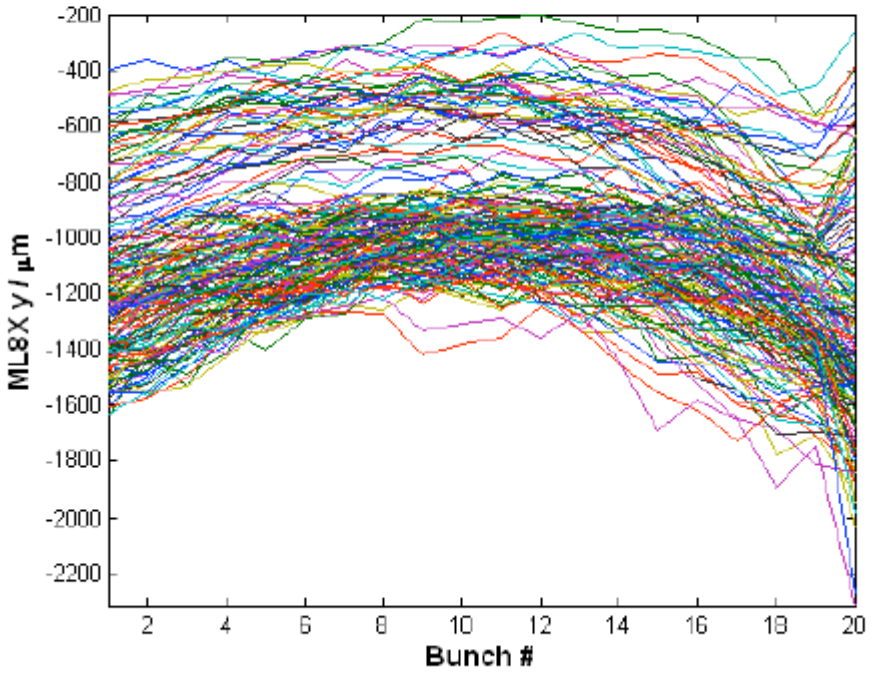


Fig. 3 The amplitude of the longitudinal oscillation at each bunch

T.Naito et.al., SAST03

Multibunch (very unstable condition)

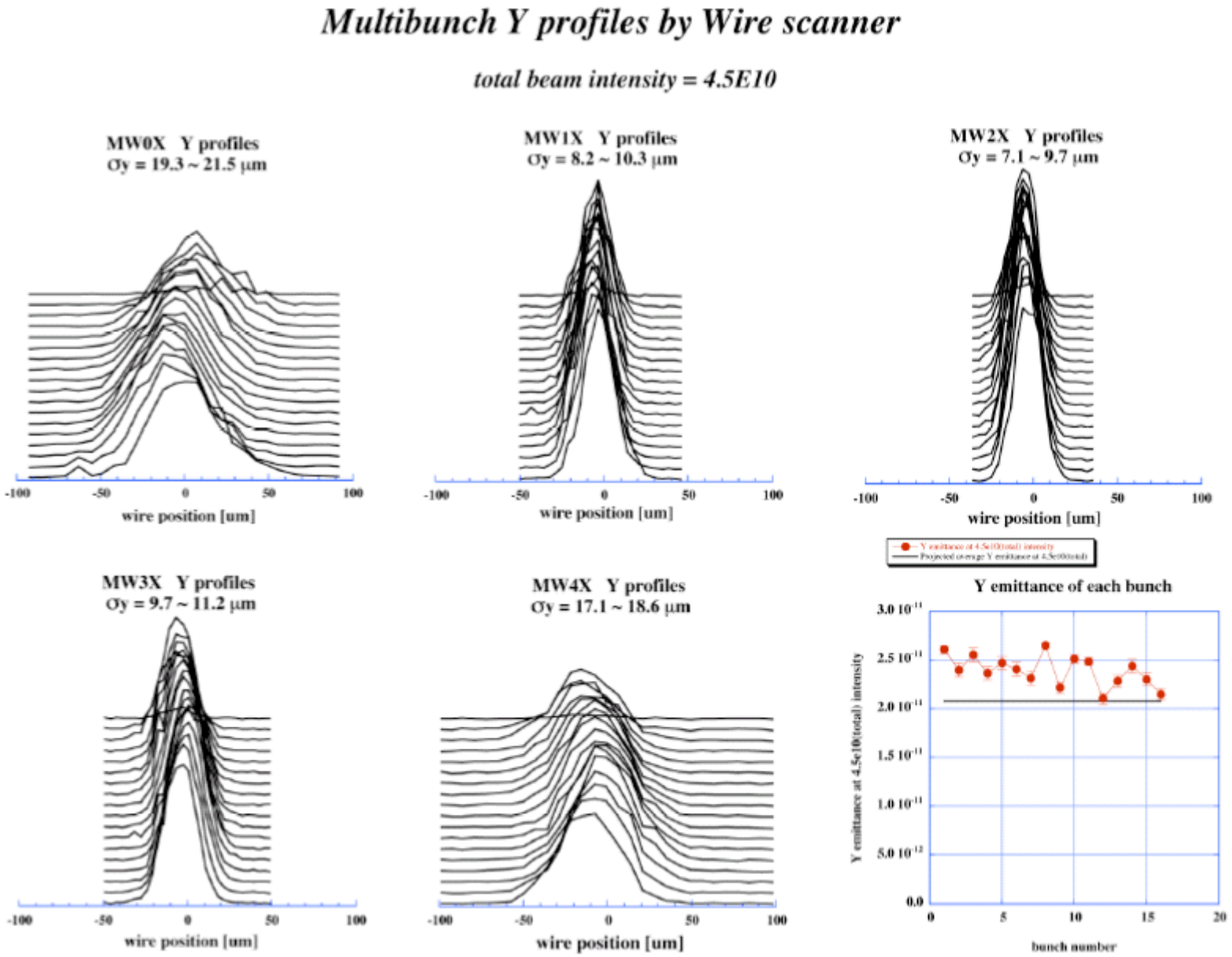
All Bunch Train Position Data



Big bunch to bunch mean position difference ~ 400 micron (p-p)
Intra train jitter ~ 30 micron (rms)
Pulse to pulse average position jitter ~ 245 micron (rms)

Glen White, QMUL
nanoBPM Workshop, June, 2004

Relatively stable condition.



H.Hayano, ATF Colab.mtg. Oct.2002

Summary of Orbit and energy stability in DR

Transverse jitter (randomly excited betatron oscillations)

Smaller than BPM resolution in DR. No accurate data?

Slow orbit change

50 and 100 Hz orbit change, amplitude ~ 10 micron, x and y

(related to AC line → No effect to extracted beam.)

Slower drift

Vertical 1~2 micron at Laser wire region (beta 5m)

period ~ a few minutes [Y.Honda, 8th ATF co.lab. mtg.]

Energy jitter (randomly excited synchrotron oscillations)

Single bunch: $\Delta E/E$ amplitude ~ 2E-4

(due to noise of RF?)

Multibunch high current: larger oscillation of tail bunches

(due to wakefield??)

SUMMARY of Orbit stability in Extraction Line

(All numbers are rough and preliminary.)

Orbit jitter (pulse to pulse)

horizontal (rms) ~10 micron (~0.2σx)

vertical (rms) ~ 3 micron (~0.3σy)

Slow orbit change (minutes)

horizontal ?

vertical (p–p) ~ 10 micron:

due to temp. of cooling water of ?

Residual dispersion in EXT and energy oscillation in DR.

Single bunch: ΔE/E amplitude ~ 2E-4

(p-p 4 micron, for 10 mm dispersion)

SUMMARY of Orbit stability in Extraction Line (Continued)

Multibunch:

High current:

Larger energy oscillation of tail bunches in DR
→ position jitter with dispersion

Beam profile measured by wire scanners → jitter < 10 micron

Observation in June 2004 by FONT group:

Big bunch to bunch position difference ~ 400 micron (p-p)
Mostly fixed pulse to pulse.
(Caused by kicker non-flatness + x-y coupling??)
Intra train jitter ~ 30 micron (rms)
Pulse to pulse jitter ~ 245 micron (rms)
(Residual dispersion might be large.?)

Vertical Emittance of extracted beam

εy ~ 1E-11 m at low intensity
> 2E-11 m at N~1E10

Larger than εy in DR by factor 2 or more.
Strong intensity dependence.
Stronger than longitudinal and horizontal emittances.
→ should be non linear effects.?
(Not only linear x-y coupling ??)
Problem with field quality of
septum? kicker? .....?

Multibunch: εy ~ 2 – 2.5E-11 m (in stable condition)