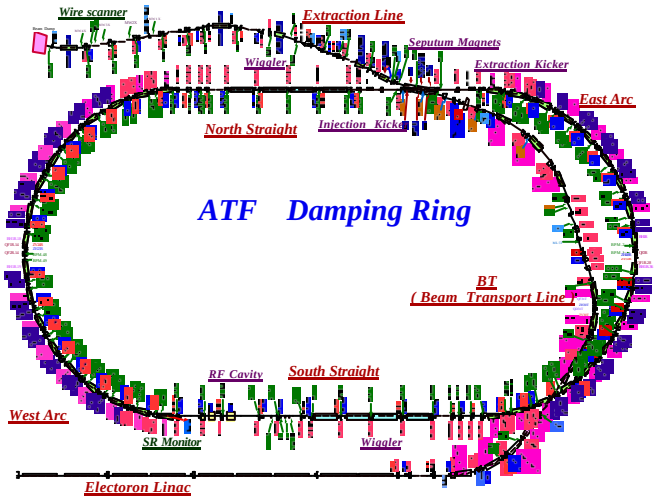
1st Experimetal Results on ATF Wigglers

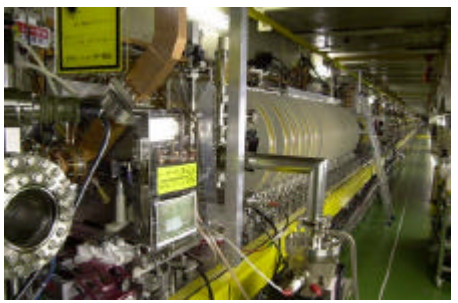
J.Urakawa

Contributors: **T.Naito**, S.Kuroda, Y.Honda, T.Muto, N.Terunuma, M.Kuriki, H.Hayano, J.Urakawa (KEK), **A.Wolski** (LBL), M.Ross, M.Woodley, J.Nelson(SLAC), M.Korostelev, F.Zimmermann (CERN), K.Takezawa (Kyoto Univ.)

Introduction to ATF,
ATF Wiggler,
Damping time measurements,
Energy spread,
Emittance measurements,
Lifetime measurement,
Beam tuning with wigglers,
Future plan.

ATF Introduction





E=1.28GeV

Ne=1x10^{10} e^{-}/bunch

1 ~ 20 bunches

Rep=1.5Hz

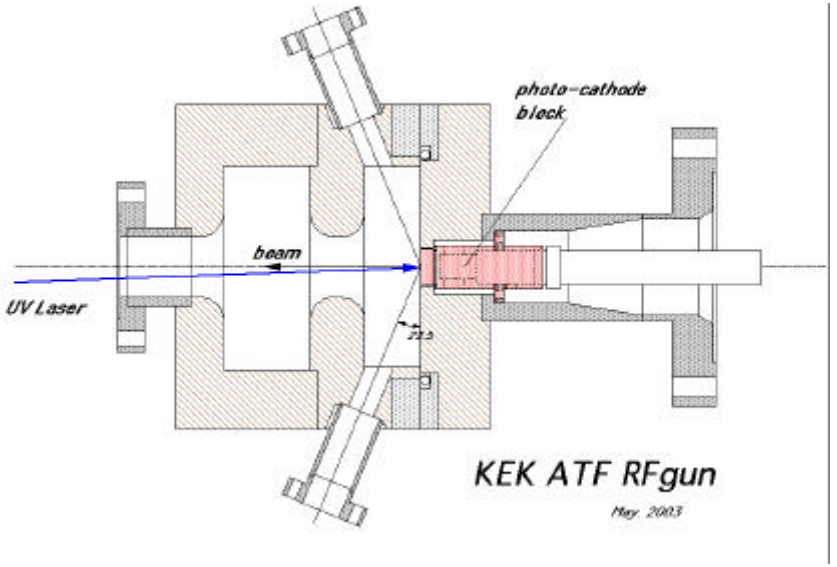
Normalized

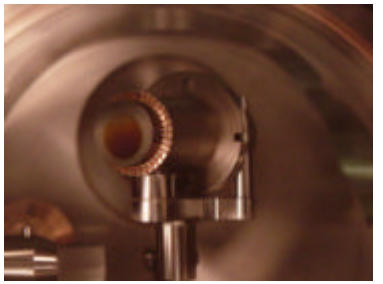
X emit=2.5E-6 **(at 0 intensity)**

Y emit=1.25E-8 **(at 0 intensity)**

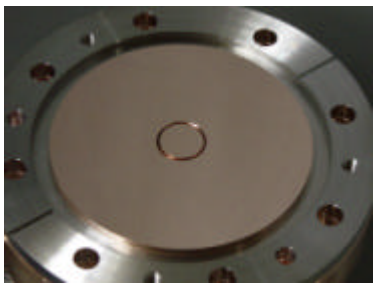
Photo-cathode RF-gun

2.5 years operation experience from Oct.2002





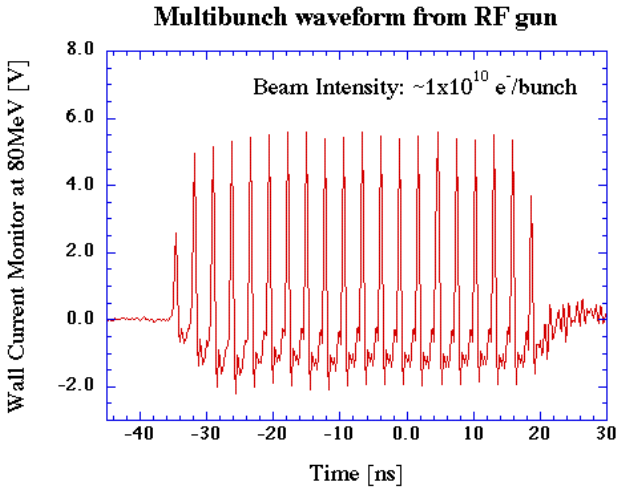
Cathode block with CsTe coating



End plate with cathode block

Cathode block

Multibunch e^- beam at 80 MeV point



- Beam Intensity

  ~ 2×10^{10}/bunch
- Normalized Emittance

  $\varepsilon_y = 5 \times 10^{-6}$ rad.m
- Bunch length

  $\sigma_z = 6 \sim 8$ ps
- Energy spread

  dE/E = ~ 1.0% full-width
- Q.E. of CsTe cathode

  16% initial, 1 ~ 2% with RF ON & is kept over 1-2 months

Multibunch emittance study

- ***Scrubbing of DR was started (automatic storage).***

  DR pressure should be < 7 x10^{-7} Pa for 1% emittance ratio

  for 1.0 x10^{10} e^{-}, 20 bunches, (=67mA) 0.78Hz repetition

  so far, >1 x10^{-6} Pa

- ***Monitors of MB emittance***

  MB (or projected) Laser-wire

  Projected SR interference monitor, X-ray SR monitor

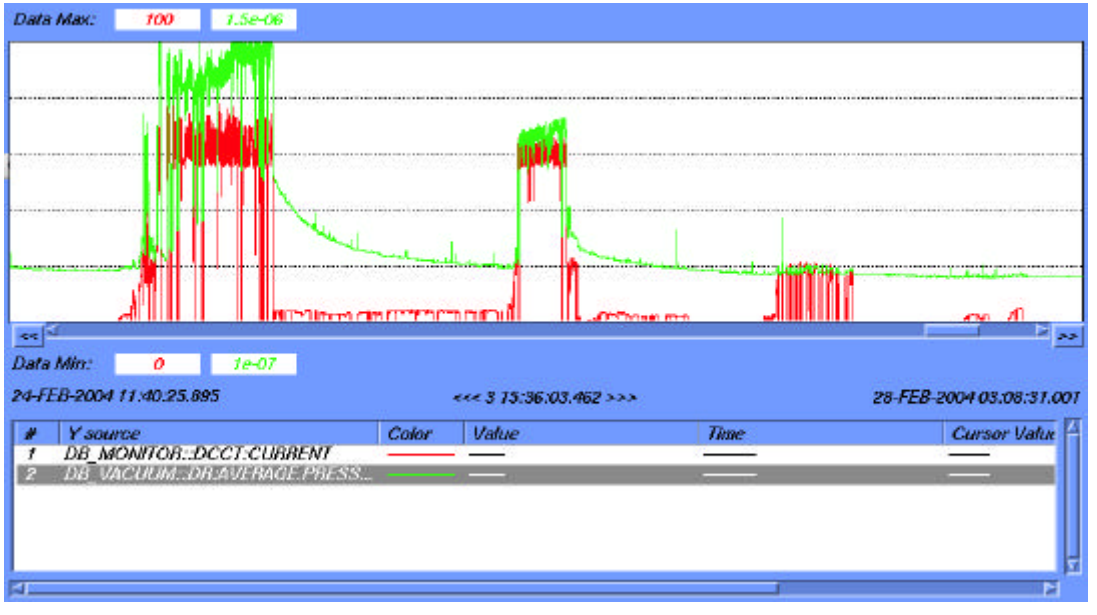
  MB (or projected) wire scanner: (EXT-line coupling problem?)

- ***Problem of MB emittance***

  Fast Ion Instability ?

  Energy fluctuation (coupled bunch longitudinal oscillation ?)

Scrubbing of DR example

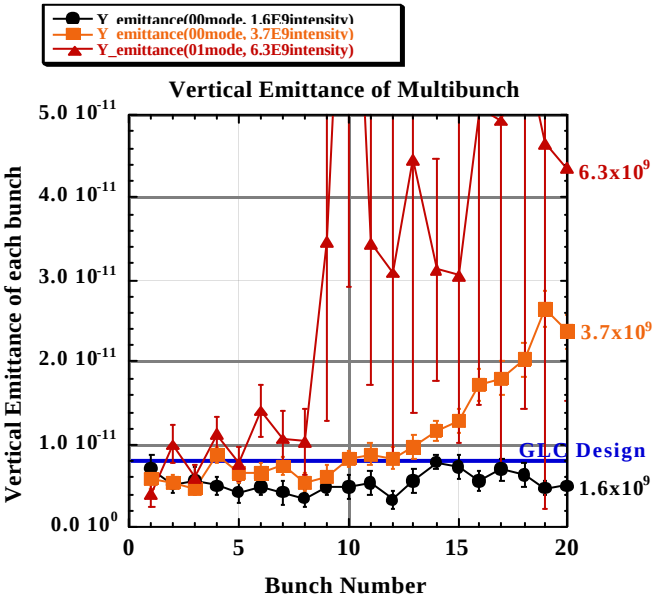


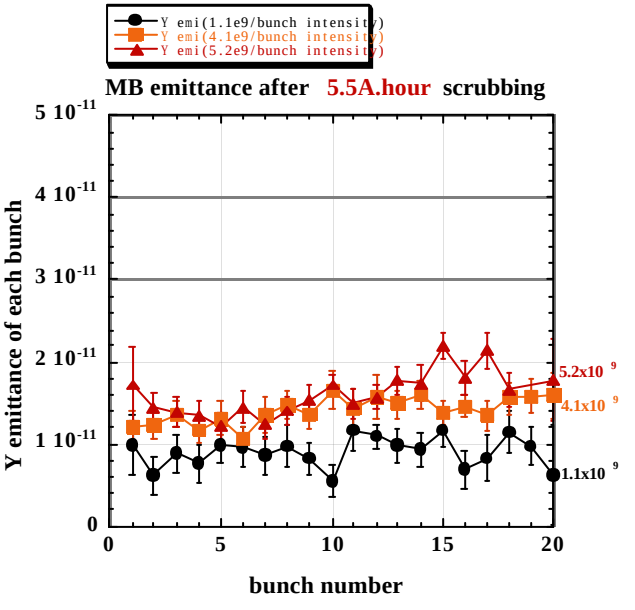
60~70mA (20bunch, 3train) (to 210mA in the future)

1.3~1.5x10^{-6} Pa → 1.0~1.1x10^{-6} Pa→(5x10^{-7}Pa)

Fast Ion Instability: Experimental Results at ATF

Required vertical emittance : 2pm· rad for ILC

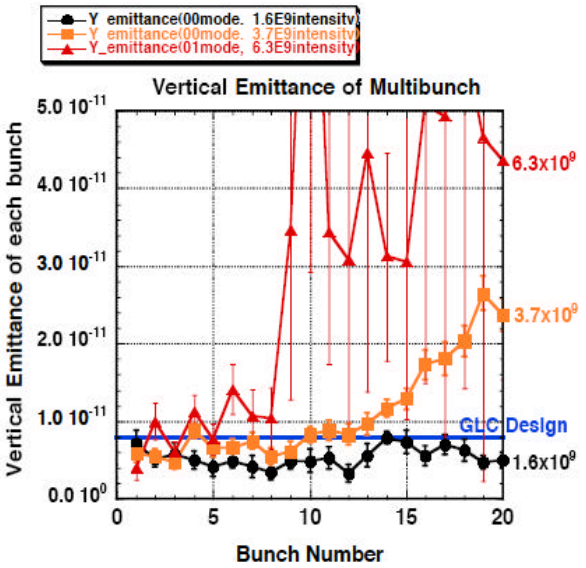




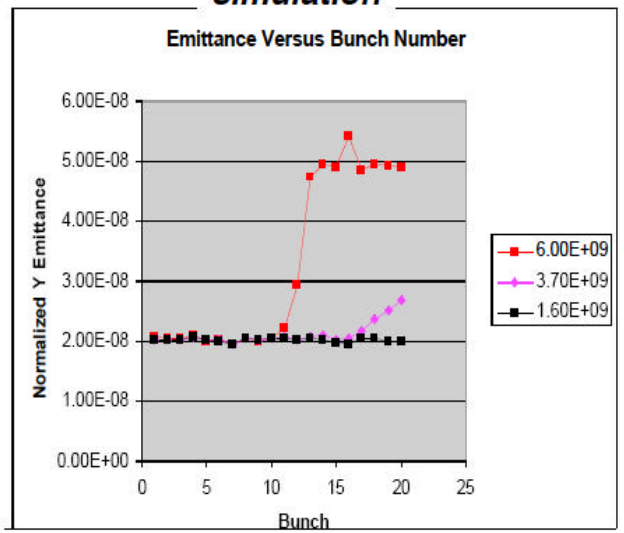
Vacuum Pressure<10^{-8} Pa

Preliminary result of Fast Ion Instability simulation

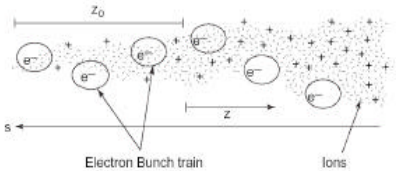
By Tor (2004)



simulation



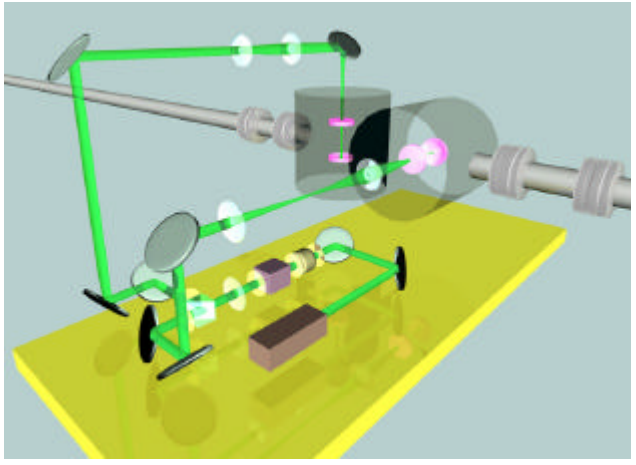
Behavior of Y emittance is very similar.



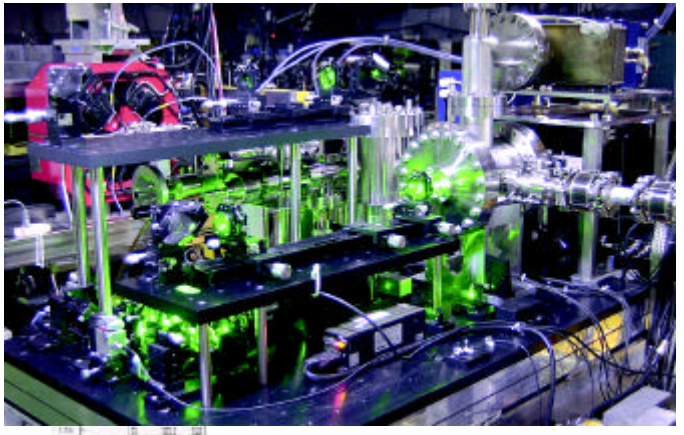
Schematic of the Fast-Beam Ion Instability

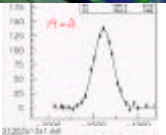
Precise beam profile monitor in the ring : Laser wire
CW laser measures transverse beam profile and pulsed laser wire measures bunch length in the optical cavity.

Laser wire X & Y scan, Higher Mode wire

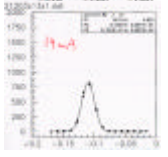


Two wire chamber



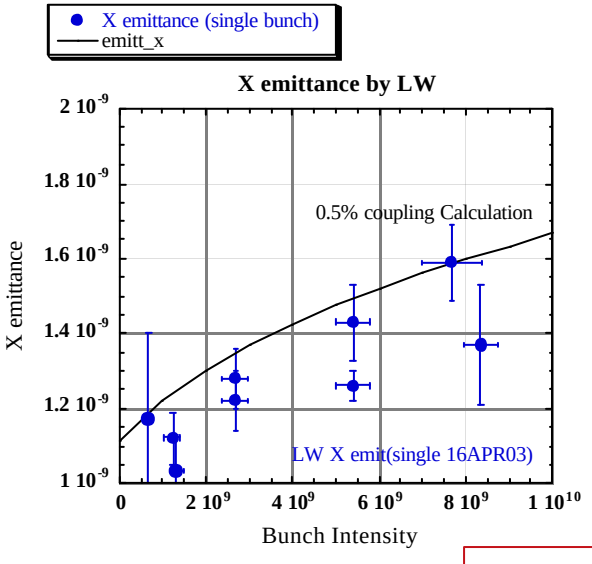


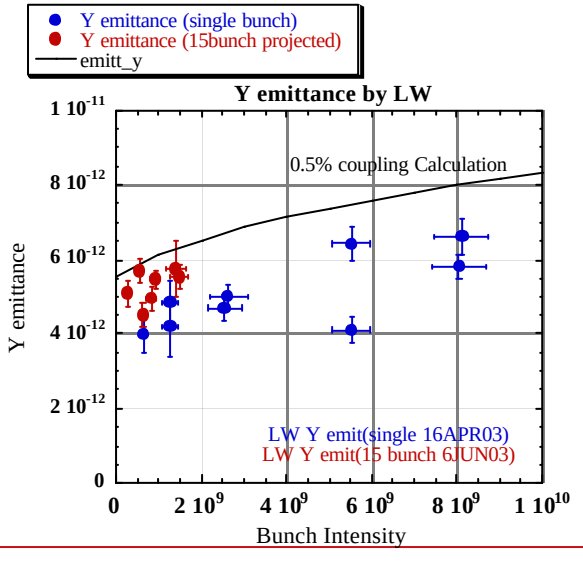
X profile



Y profile

Emittance by Laser wire





< 0.5% y/x emittance ratio

Y emittance =4pm at small intensity

VOLUME 92, NUMBER 5 PHYSICAL REVIEW LETTERS week ending 6 FEBRUARY 2004

Achievement of Ultralow Emittance Beam in the Accelerator Test Facility Damping Ring

Y. Honda,[1] K. Kubo,[2] S. Anderson,[3] S. Araki,[2] K. Bane,[3] A. Brachmann,[3] J. Frisch,[3] M. Fukuda,[8] K. Hasegawa,[14] H. Hayano,[2] L. Hendrickson,[3] Y. Higashi,[2] T. Higo,[2] K. Hirano,[13] T. Hirose,[15] K. Iida,[12] T. Imai,[9] Y. Inoue,[1] P. Karataev,[6] M. Kuriki,[2] R. Kuroda,[8] S. Kuroda,[2] X. Luo,[11] D. McCormick,[3] M. Matsuda,[10] T. Muto,[2] K. Nakajima,[2] Takashi Naito,[2] J. Nelson,[3] M. Nomura,[15] A. Ohashi,[8] T. Omori,[2] T. Okugi,[2] M. Ross,[3] H. Sakai,[12] I. Sakai,[15] N. Sasao,[1] S. Smith,[3] Toshikazu Suzuki,[2] M. Takano,[13] T. Taniguchi,[2] N. Terunuma,[2] J. Turner,[3] N. Toge,[2] J. Urakawa,[2] V. Vogel,[2] M. Woodley,[3] A. Wolski,[4] I. Yamazaki,[3] Yoshio Yamazaki,[2] G. Yocky,[3] A. Young,[3] and F. Zimmermann[3]

ATF Wiggler(see ATF-report-09 by Andy)

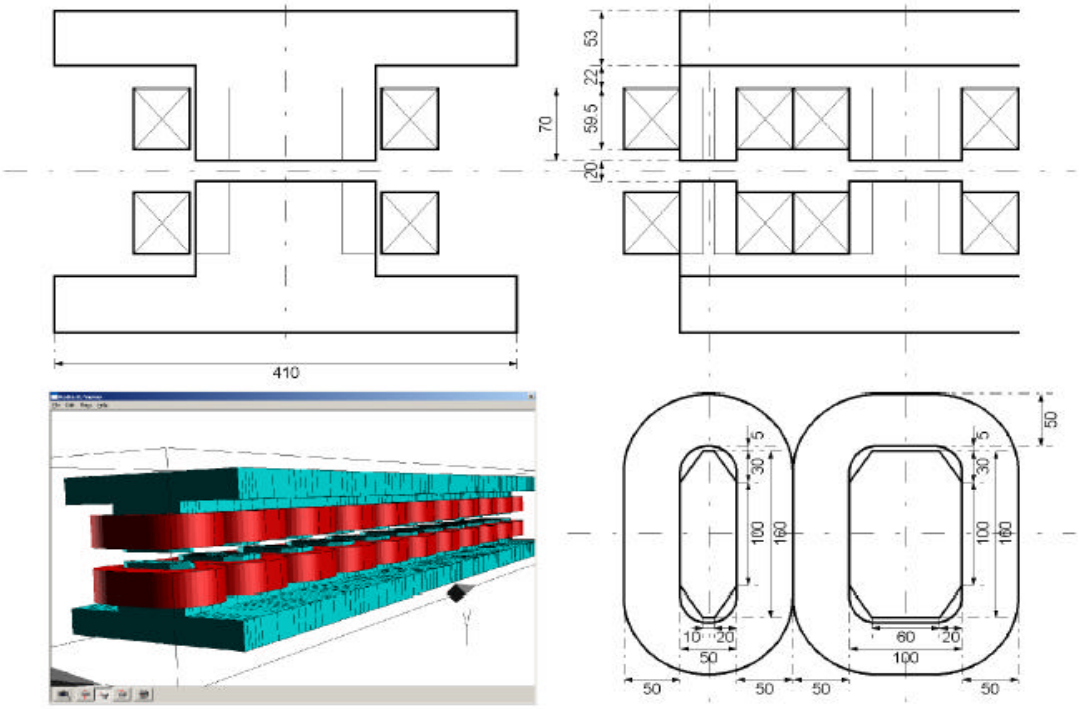
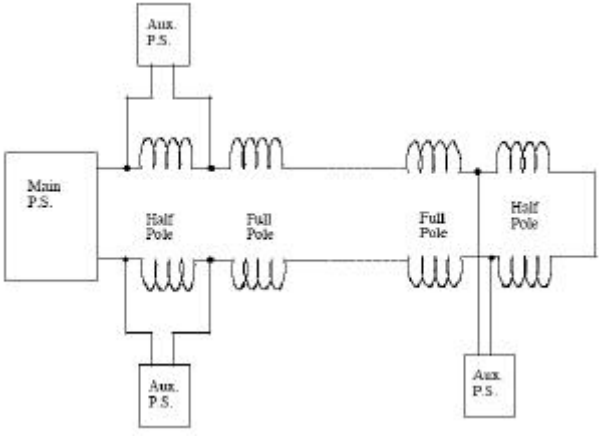
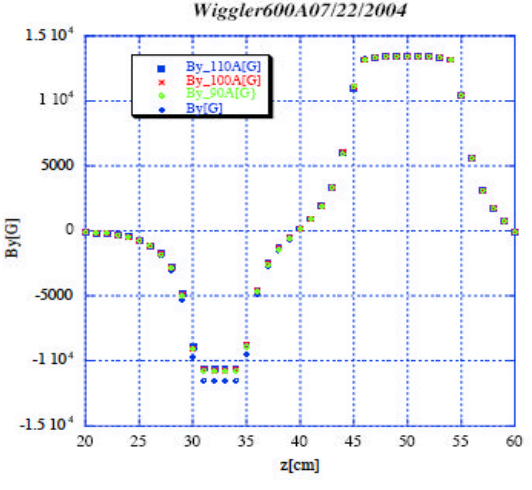
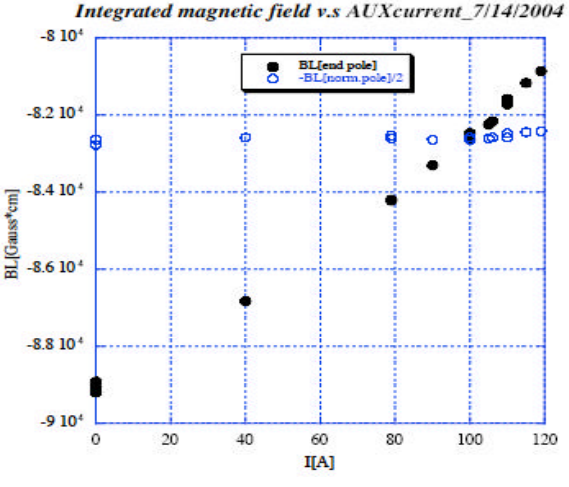


FIG. 1: Geometry of the KEK-ATF wigglers. Clockwise from top left: front elevation; side elevation, showing an end-pole and the adjacent full-length pole; cross-sections of an end-pole and the adjacent full-length pole; full wiggler model in RADIA. All dimensions are in mm.

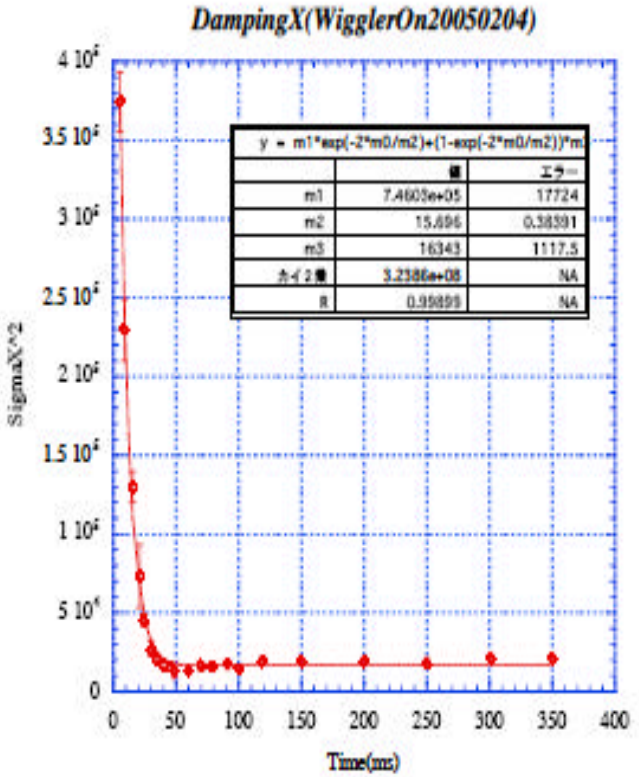


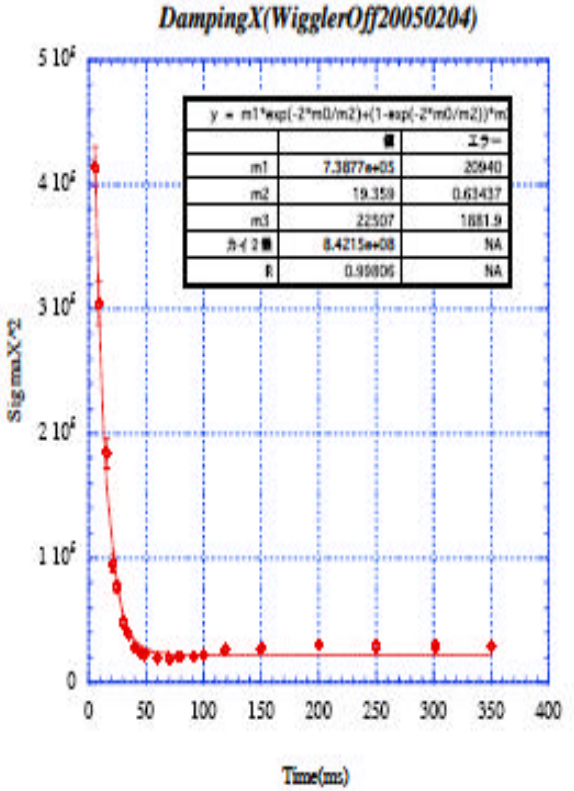


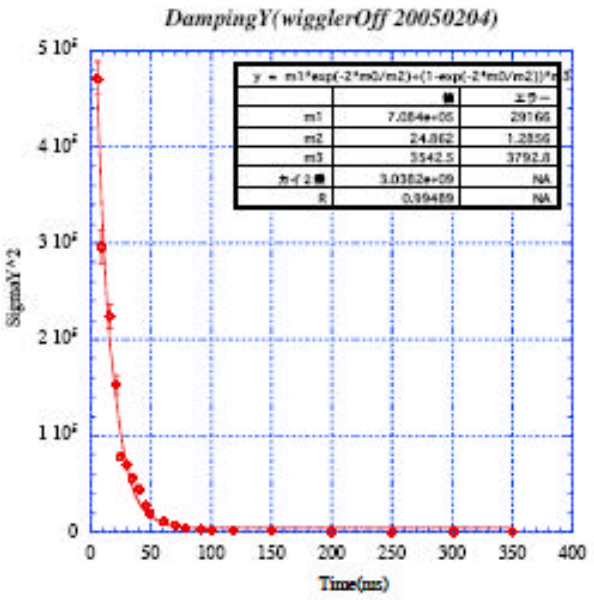


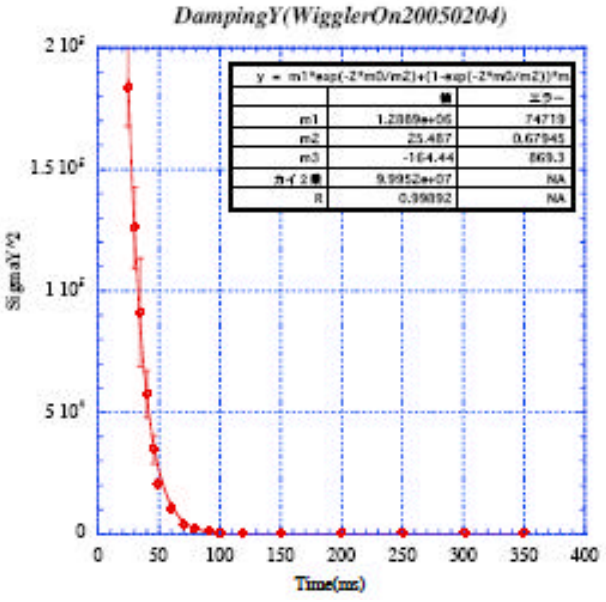
During last summer, electronic DC-Load was connected to control the magnetic field at both end poles.

Damping time measurements

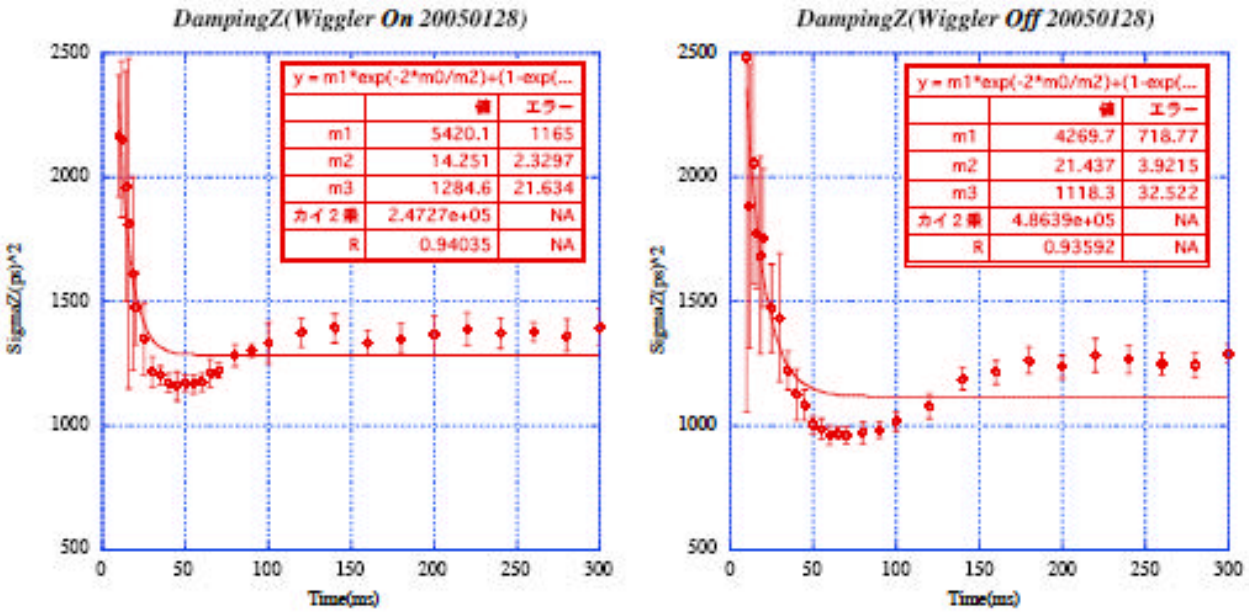








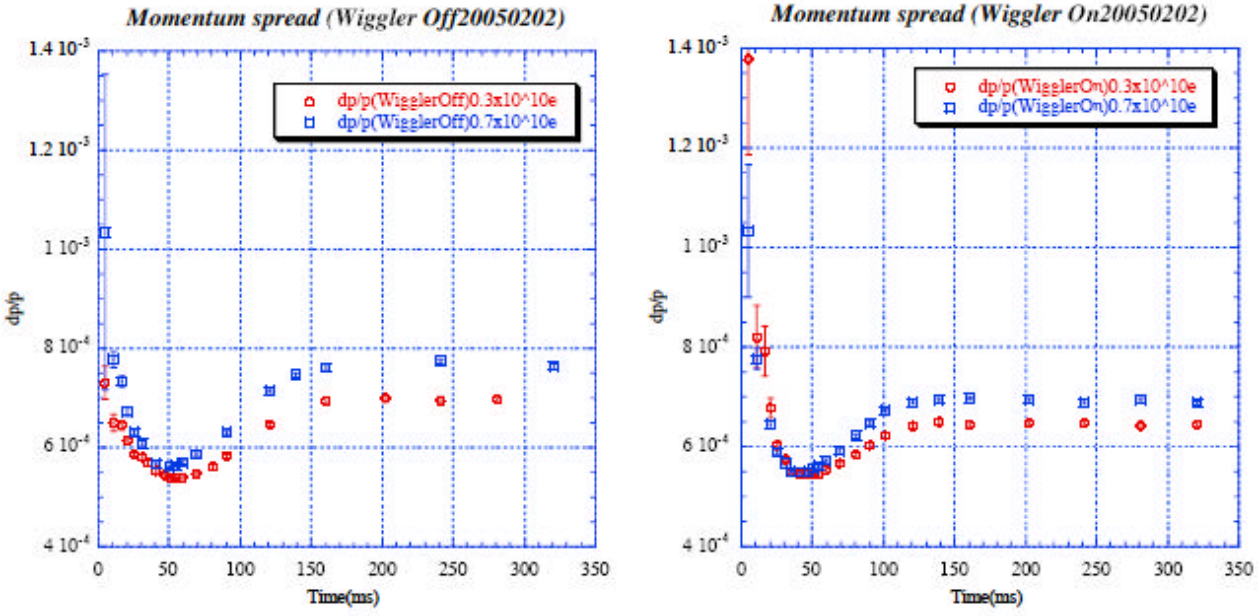
Damping Time	Cal.,wiggler off	Cal.,wiggler on	Meas.wiggler off	Meas.wiggler on
Horizontal damping time τ_x	17.5 ms (17.0 ms)	15.0 ms (13.8 ms)	19.3+/-0.63 ms	15.7+/-0.38 ms
Vertical damping time τ_y	28.5 ms (28.5 ms)	23.0 ms (20.5 ms)	28.8+/-1.5 ms	25.4+/-0.67 ms
Longitudinal damping time τ_z	20.5 ms (21.5 ms)	15.5 ms (13.6 ms)	21.4+/-3.9 ms	14.2+/-2.4 ms



For these fitting, we used simple formula :

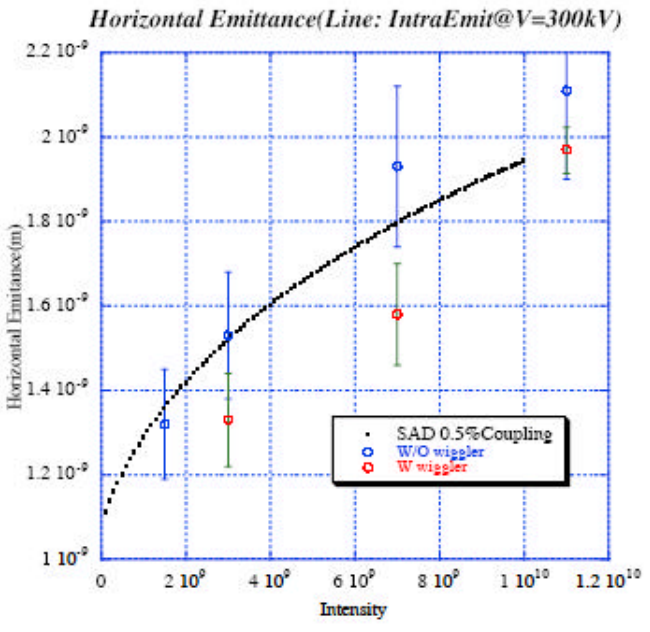
$\sigma^2(t)$ is proportional to $\varepsilon_i e^{-2t/\tau}+\varepsilon_f(1-e^{-2t/\tau})$ without IBS effect.

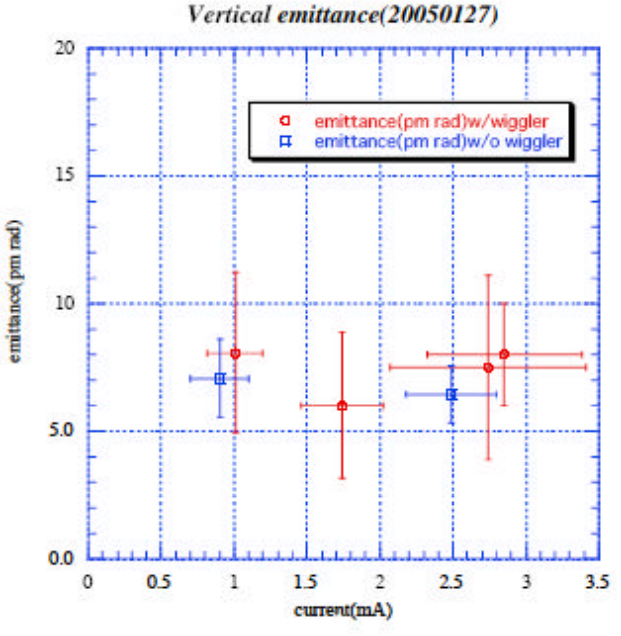
K.Kubo is going to analyse these data with IBS effect.



Measured damping times are agreed well with the calculation by Kuroda and Andy. The IBS growth effects after damping are observed at the horizontal beam size, the bunch length and the energy spread.
We can clearly observe the reduction of the damping time and suppression of the IBS effect with the wiggler operation.

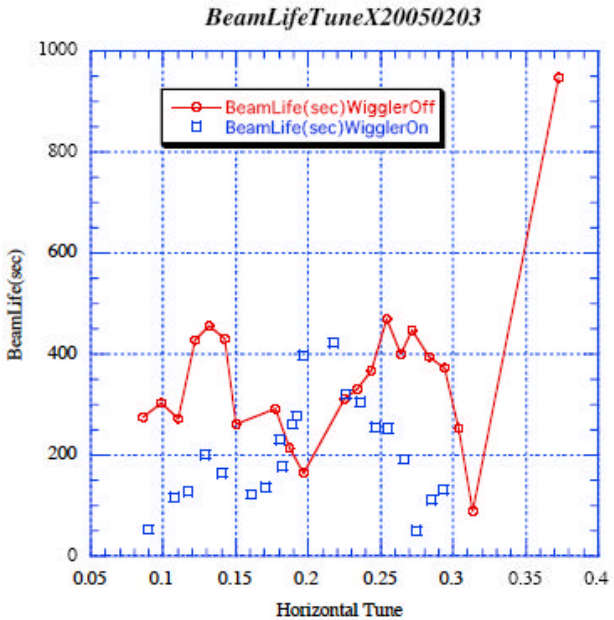
Emittance measurements





Natural emitt.	Cal.wiggler off	Cal.wiggler on	Meas.wiggler off	Meas.wiggler on
ε_0	1.03×10^{-9} m (1.1 nm)	0.87×10^{-9} m (1.0 nm)	$(1.1\pm0.2)\times10^{-9}$ m	$(0.9\pm0.2)\times10^{-9}$ m

Lifetime measurement



Beam tuning with wigglers : *first beam orbit correction, next dispersion correction, next coupling correction and iteration. ORM(orbit response matrix) measurement and correction by Andy. Both tuning achieved 4pm. How do we improve to achieve 2pm?*

Beam dynamics Study with wigglers

- Four wigglers(2m long) are turned on and 600A supplied to main coil.
- The damping times were measured and consistent with calculation values.
- We are going to establish how to make a beam tuning. (from 6pm to 2pm.)
- Try to measure microwave (Instability).

ATF Plans for 2005 and 2006

- ***MB emittance study***
  - ***High current injection is started. (210mA)***
  - ***X, Y emittance will be confirmed by Laser Wire.***
  - ***Longitudinal oscillation is studied now.***
  - ***Fast Ion Instability (Measurement of bunch dipole motion)***
- ***nm resolution BPM test & demonstration***
  - ***Development of new precise mover & new cavity-BPM electronics.***
- ***3nsec fast kicker demonstration***
- ***Fast feedback test & demonstration (with UK,SLAC,LLNL)***
  - ***Basic test of BPM & kicker at first.***
  - ***Feedback test by 1 train & 3 train extraction will be done.***
- ***Instrumentation developments***
  - ***LW, XSR monitor, ODR monitor, etc***
- ***ATF2 design and construction***