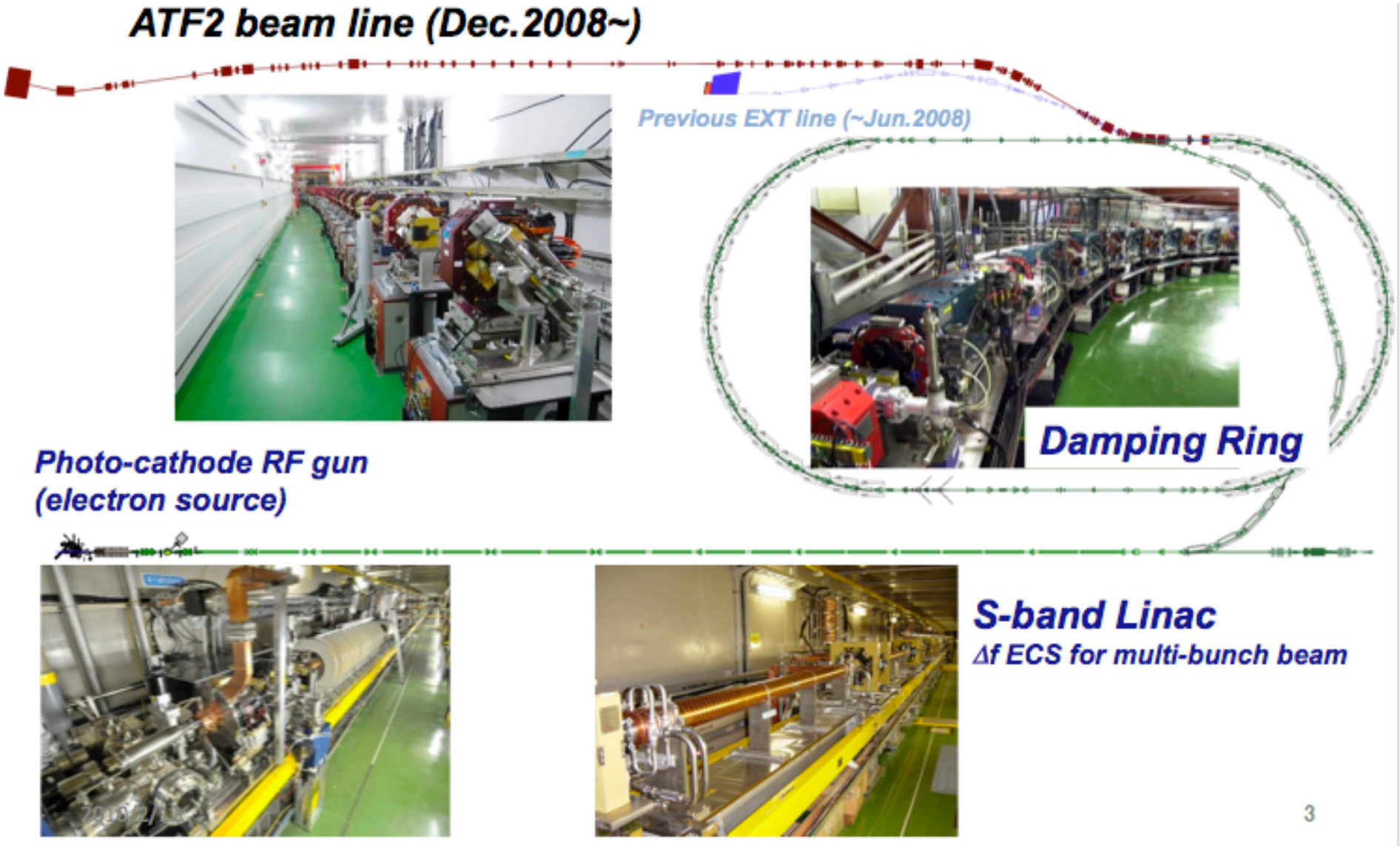
ATF/ATF2 Status

S.Kuroda(KEK)

- Introduction
- Studies in ATF/ATF2
  - DR emittance tuning
  - Fast kicker
  - ATF2 IP beam size tuning
  - Others
- Summary and Future Plan

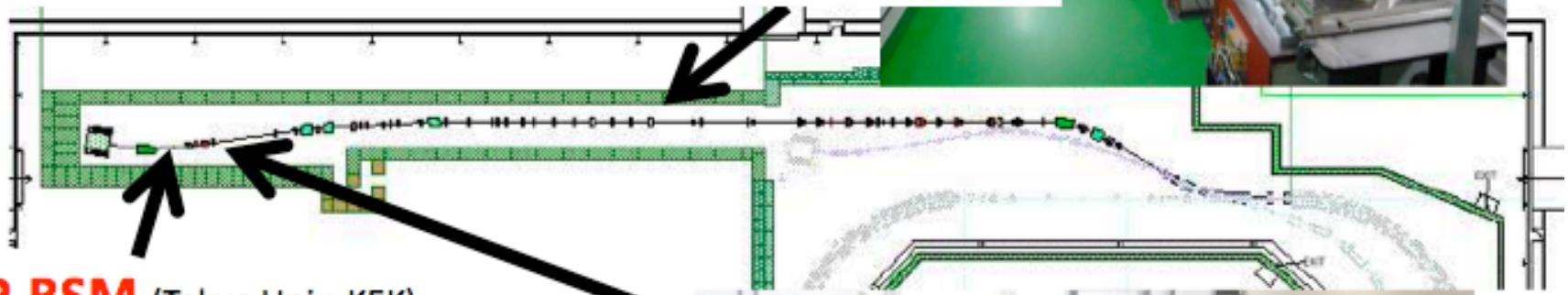
ATF accelerator complex



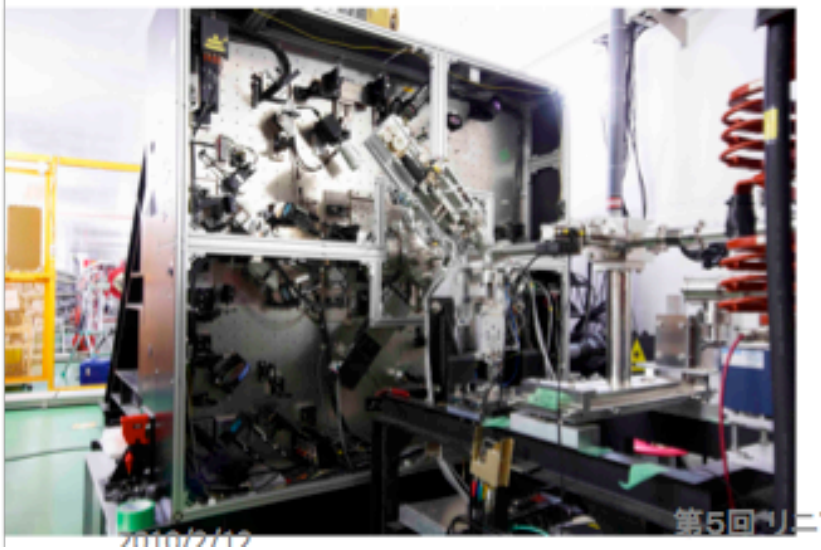
ATF2 Beamline

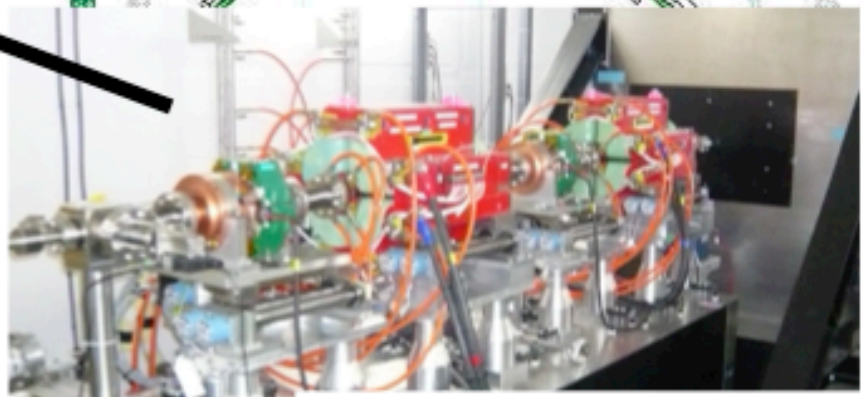
Final Focus beamline

Magnets and Movers (IHEP, SLAC, KEK)
C-band BPM (PAL, SLAC, KEK)
Support Table (KEK)



IP-BSM (Tokyo Univ, KEK)





Final Doublet system

Magnets and Movers (SLAC)
S-band BPM (KNU)
Supports and Table (LAPP)

ATF International Collaboration

CERN
DESY
IN2P3
- LAL
- LAPP
- LLR

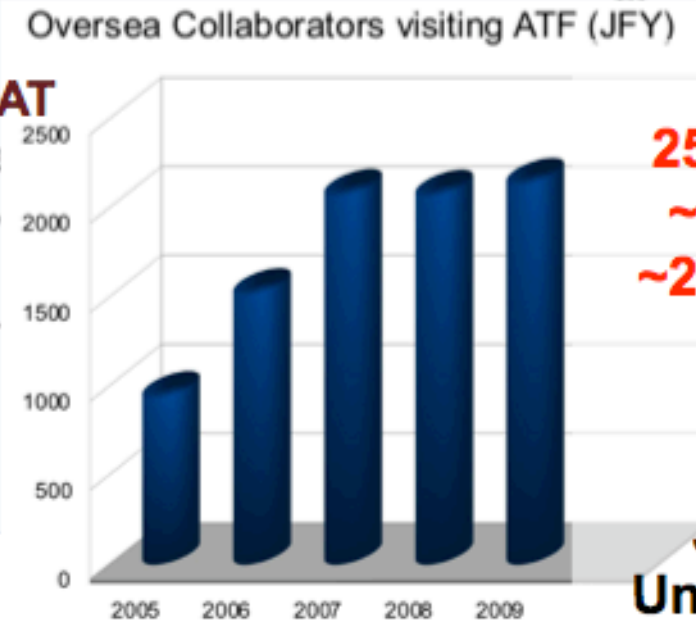
John Adams Inst.
- Oxford Univ.
- Royal Holloway Univ.

Cockcroft Inst.
- STFC, Daresbury
- Univ. of Manchester
- Univ. of Liverpool

University College London
INFN, Frascati
IFIC-CSIC/UV
Tomsk Polytechnic Univ.

KEK
Waseda U.
Nagoya U.
Tokyo U.
Kyoto U.
Tohoku Univ.
Hiroshima U.
IHEP
PAL
KNU
RRCAT

SLAC
LBNL
FNAL
Cornell Univ.
LLNL
BNL
Notre Dome Univ.



Oversea
25 Institutes,
~70 people,
~2000 people-days
+
KEK and Japanese Universities(6)

Recent efforts for low emittance

ε_y ~ 5pm確認後、低エミッタンスの追及はATFの主要な課題でなくなり、2007-2008年には通常の補正では20 pm程度のエミッタンスにしかならない状態であった。

Main motivation:

ATF2 needs low emittance beam (12 pm at N~1E10 in design)
Study of Fast Ion Instability

- Re-alignment of magnets
- Restart with ‘design’ optics
- BBA (Beam Based Alignment) measurement
- Optics correction (Beta-beat correction)
- Improvement of BPM
- Improvement of beam size monitors

（各項目がどの程度有効であったか、定量的評価はできていない。）

K.Kubo

DR Emittance Tuning

- β beat correction
  - Using QM trim, new QM7, IHEP Q trim and QF1&2(for tune adjustment)
- Orbit correction
  - Using correctors for several settings of the Bend trim and electric load
- Dispersion correction
  - η_x in straight section is corrected by QM trim
  - η_y is corrected by correctors
- Coupling correction
  - ONLINE correction: Correction of vertical leakage of the horizontal kicks by a couple of horizontal correctors.
  - OFFLINE correction: The same as ONLINE correction but using data by all the horizontal corrector in the arc.
  - Correction is done by Skew Q winding trim coil of SX.

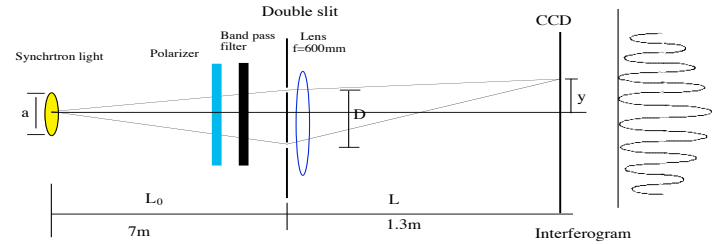
DR Emittance Measurement

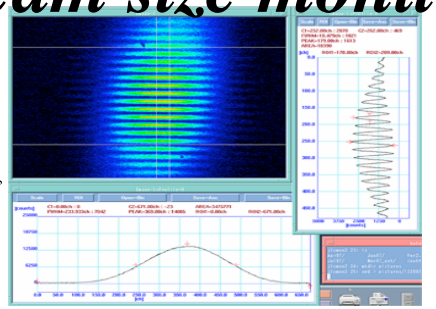
- Beam size measurement
  - SR Interferometer
    - Quick measurement, 5ms
    - Minimum beam size can be measured is ~5-6um
    - Suffering from mechanical vibration
  - XSR monitor
    - Quick measurement, 20ms→50Hz oscillation?
    - Minimum beam size can be measured is ~5-6um
    - Less mechanical vibration but still.
  - Laser wire
    - A few ten minutes requires for measurement
    - ‘design’ laser waist size is 6.5um→going to higher mode, beam size of 1um can be measured.
- Beta function measurement
  - Fitting β of Qs nearby which were obtained from tune slope.

Beam Size Measurement in DR

SR interference beam size monitor

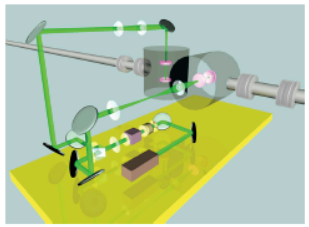
Layout of the SR-interferometer

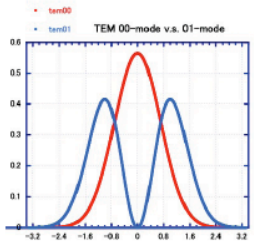


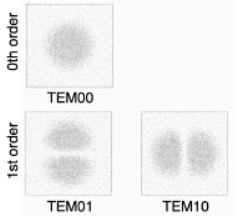


$$I = \pi a J_0\{1+\exp[-(\frac{2\pi Da}{\lambda L_0})^2]\cdot\cos(\frac{2\pi Dy}{\lambda L})\}$$

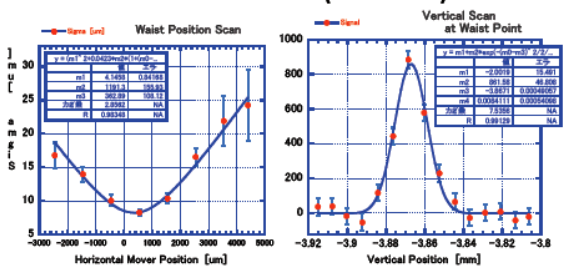
Laser wire beam size monitor in DR





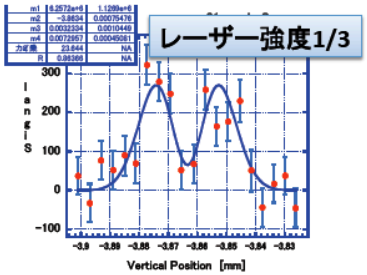


Fundamental mode(00 mode)



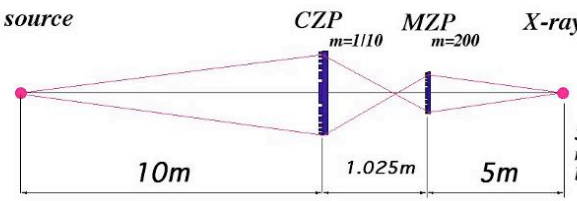
σ_e=4.1±0.8um

Higher order mode(01 mode)

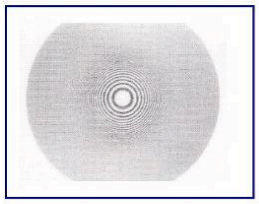


σ_e=3.2±1.0um

X-ray SR monitor using zone plate (Tokyo Univ.)



3.23KeV(0.384nm) SR
magnification 20
beam size resolution 1.87μm



microscope image of zone plate

CZP : 3mm dia.
6497 zone rings
minimum zone width 108nm

MZP : 75μm dia.
584 zone rings
minimum zone width 127nm

Beam image (x:46.2, y:10.2μm)

ビームサイズモニターの性能向上(2009年)

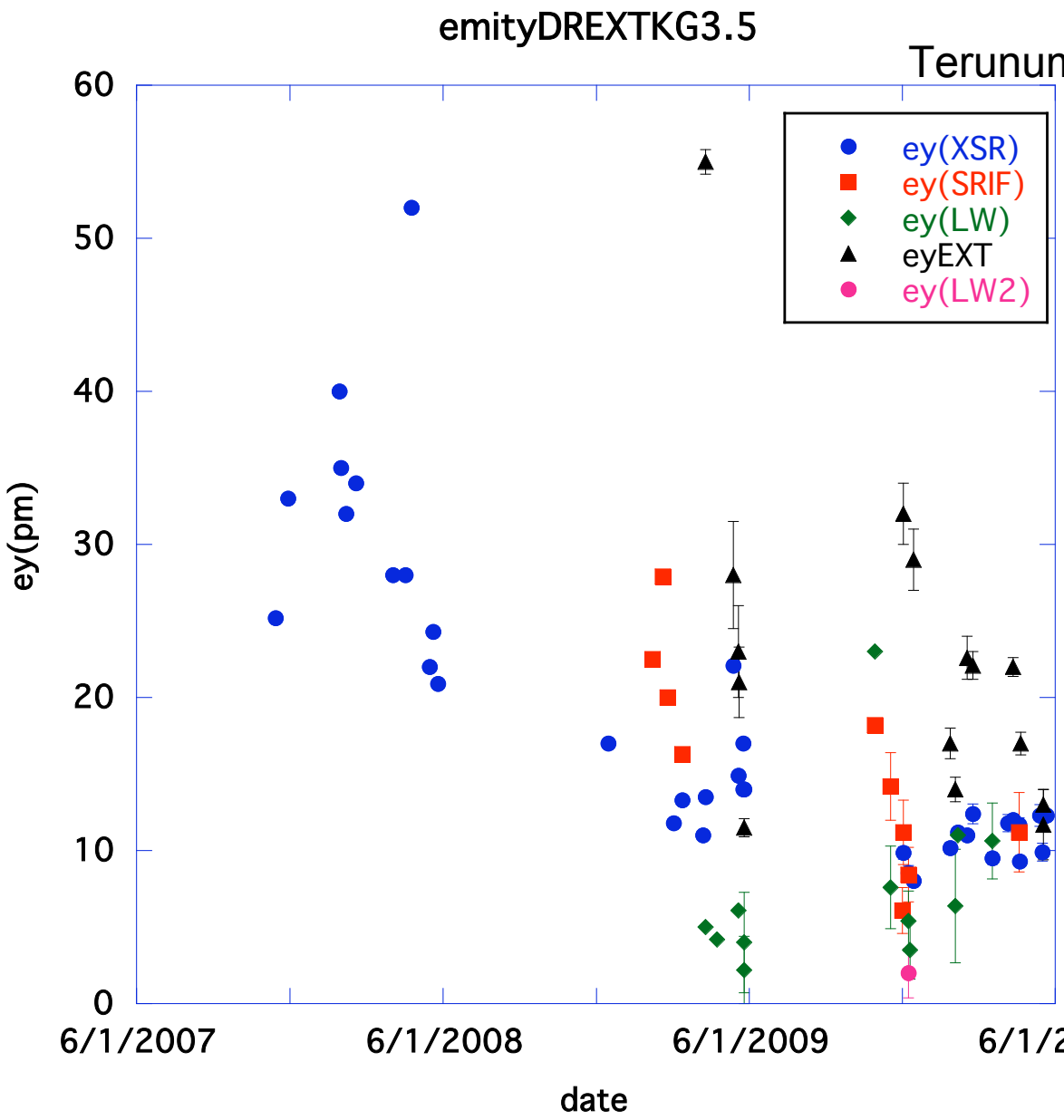
- SR interferometer
  - 光路の再アラインメント
  - スリット間隔 40 mm → 60 mm
    → ~4 micron vertical beam size
- X-ray SR profile monitor
  - 機械的振動の低減
    → ~4 micron vertical beam size
- Laser Wire
  - Storage mode だけでなく通常の運転(ビーム取り出し)モードでも測定できるように変更
    - ビームタイムを占有することなく測定可能 (測定に要する時間は長い)

今後、レーザーの交換(大出力)の計画あり

- **測定時間の短縮**

K.Kubo

DR Emittance Summary



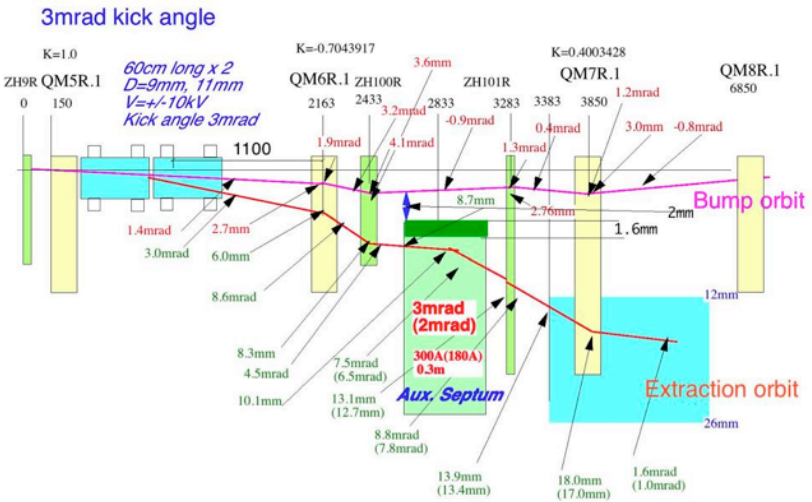
Measured $\varepsilon_y \cong 10$pm by XSR/ EXT WS.
Study for the discrepancy in other meas. is still on going.

For smaller emittance (~2 pm)

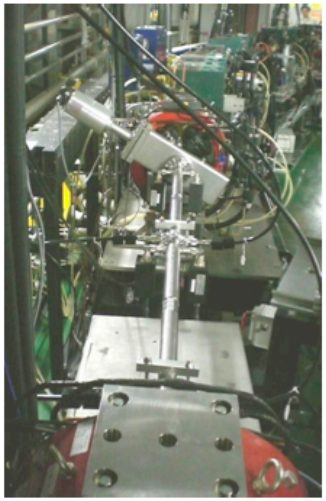
- BPM electronics upgrade
  - Done in June, but the emittance tuning not yet. → Autumn run
- Beam size monitor improvement
  - At LW, beta-y is about 5m. Beam size of 3um must be measured for 2pm emittance. →higher order mode

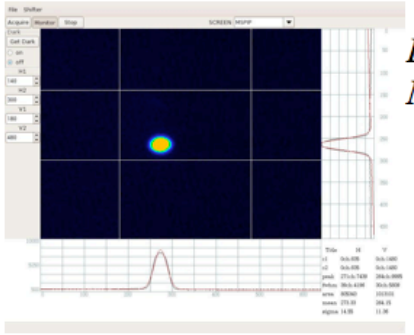
Fast Kicker

Beam Extraction Orbit using Strip-line Kicker, Aux. septum & Pulse bump



Beam Extraction succeeded from DR to ATF2 2009.Oct. 22.





Beam profile at MS1X

Firs Beam extraction was confirmed 2009/Oct/22. However, the kick angle jitter was not so good(2x10-3) and the extracted multi-bunch was only 17 bunches not 30 bunches.

T.Naito

Fast kicker is needed for ILC DR

5.6ns bunch spacing in DR→300ns in EXT

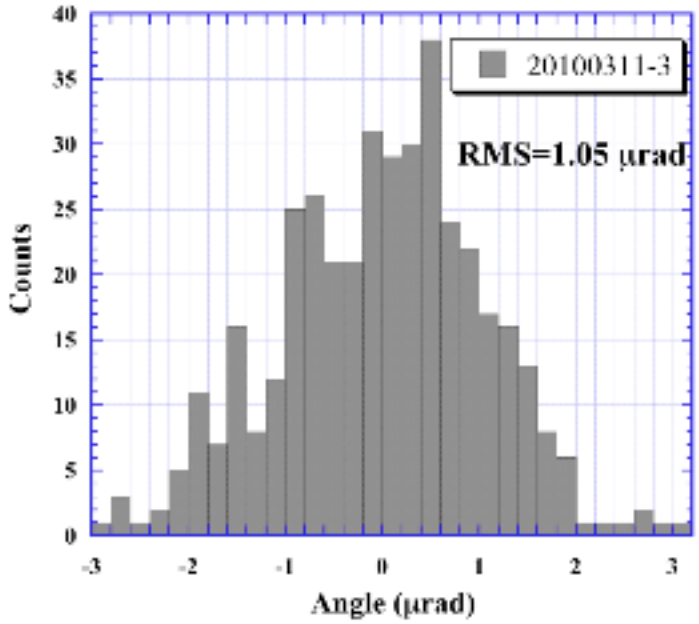
Issues:

1. Jitter measurement(single bunch operation)
2. 30 bunch extraction(multi-bunch operation)

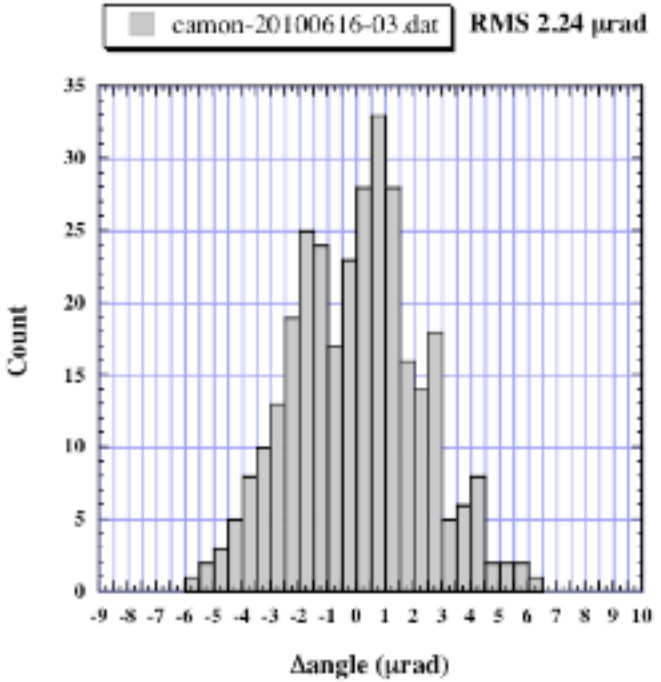
Distribution of fitted angle at EXT entrance

(single bunch)

Jitter 1.05e-6/3e-3=3.5e-4

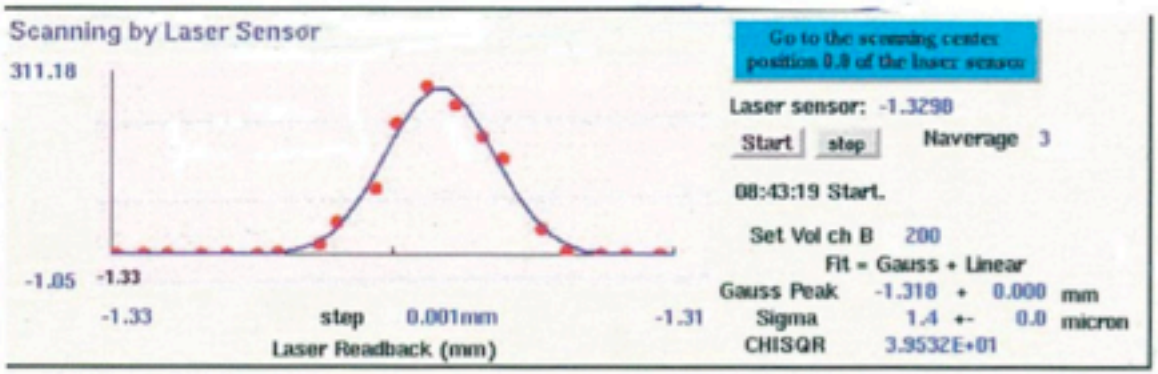


Jitter 2.24e-6/3e-3=7.4e-4



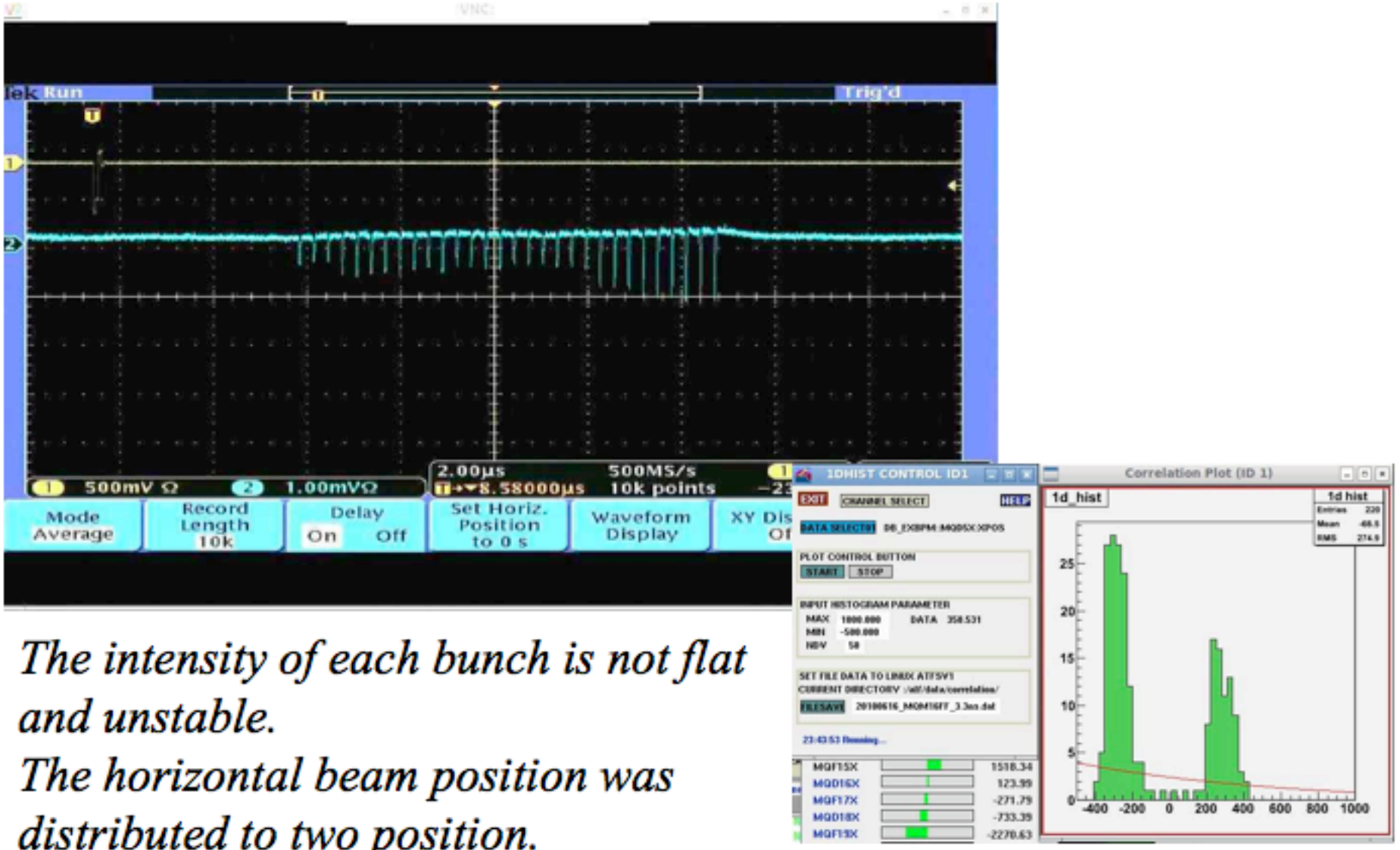
K.Kubo

Use for ATF2 beam



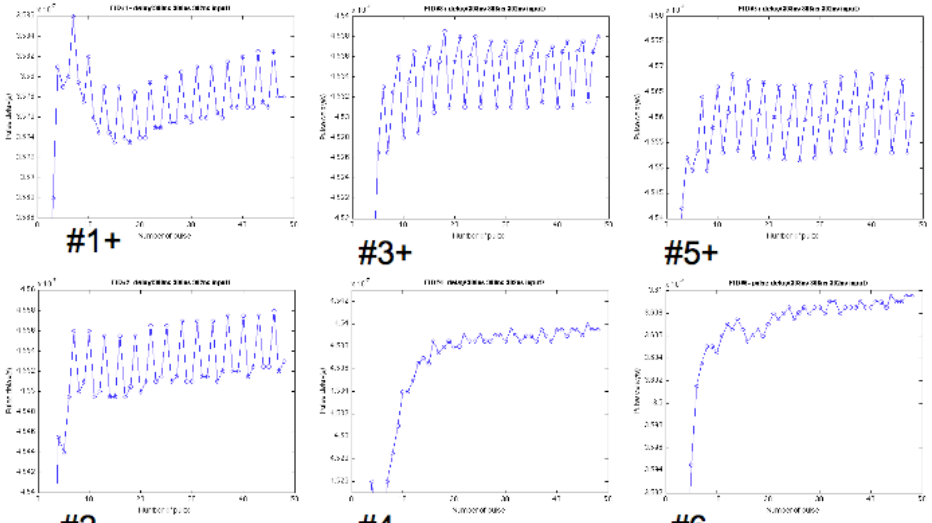
The beam tuning at the focus point was done at the ATF2 beam line including the dispersion correction by looking the beam profile change of the MS1IP wire scanner. The measured size was limited to 1.4um due to the wire size.

Multi-bunch extraction (30 bunches) with 308ns bunch spacing
2010/06/17



The intensity of each bunch is not flat and unstable.
The horizontal beam position was distributed to two position.

FID10-3000G timing delay from the input to the output

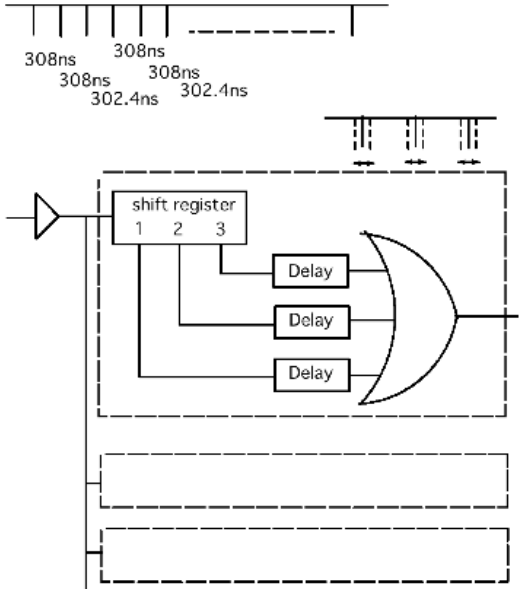


Hor: number of pulse, Ver: timing delay(200ps/tic)
measured by a oscilloscope with 50ps/sample resolution

Next Step

- Difference in timing delay in pulses
- Stabilization of DR muti-bunch beam

pulse train delay adjustment circuit



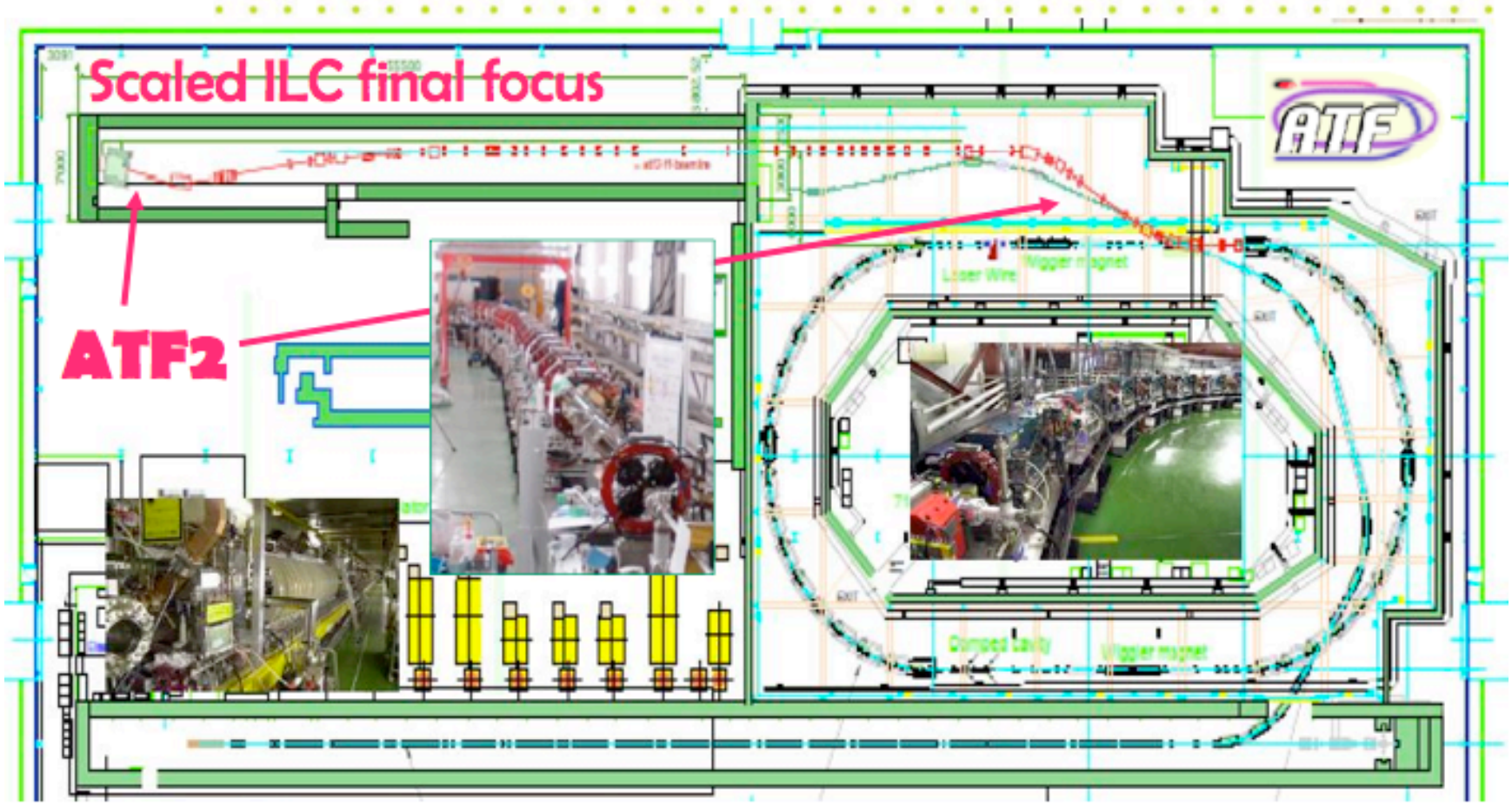
The pulse train of the input signal is separated every three pulses and delayed independently for compensate the output pulse timing of FID pulsers.
The different timing delay of FID pulsers will be compensated by using this circuit.

T.Naito

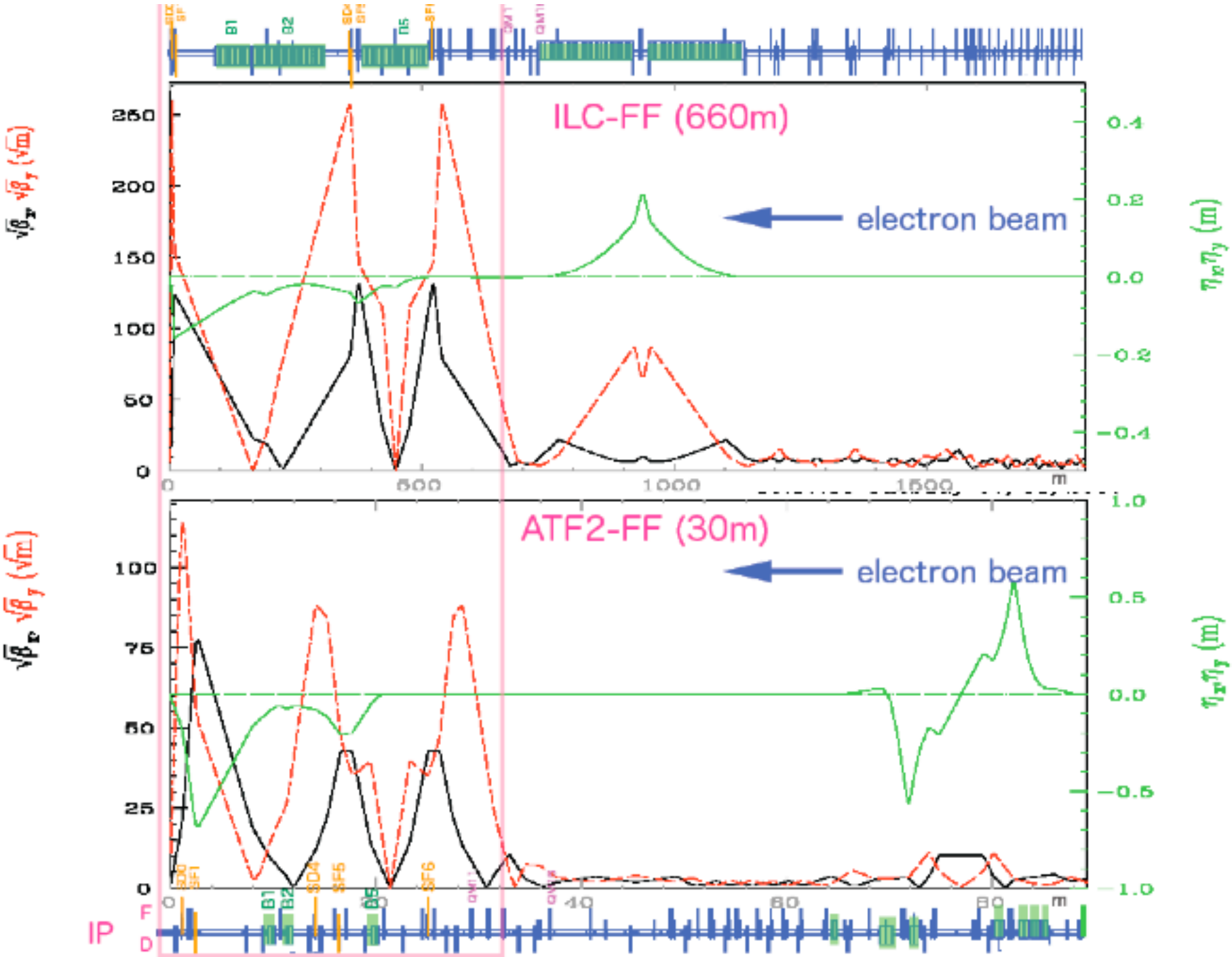
ATF2

ATF2: model of ILC beam delivery

goals: ~37nm beam size; nm level beam stability



- Dec 2008: first pilot run; Jan 2009: hardware commissioning
- Feb-Apr 2009: large β; BSM laser wire mode; tuning tools commissioning
- Oct-Dec 2009: commission interferometer mode of BSM & other hardware


ILC-FF (660m)
electron beam
ATF2-FF (30m)
electron beam
IP
F
D
m

ATF2 parameters & Goals A/B

ATF2 proposed IP parameters compared with ILC

Parameters	ATF2	ILC
Beam Energy [GeV]	1.3	250
L^* [m]	1	3.5 – 4.2
$\gamma\,\epsilon_x$ [m-rad]	3×10^{-6}	1×10^{-5}
$\gamma\,\epsilon_y$ [m-rad]	3×10^{-8}	4×10^{-8}
β_x^* [mm]	4.0	21
β_y^* [mm]	0.1	0.4
η' (DDX) [rad]	0.14	0.094
σ_E [%]	~0.1	~0.1
Chromaticity W_y	$\sim 10^4$	$\sim 10^4$

- Scaled design of ILC local-chromaticity correction style optics.
- Same chromaticity as ILC optics.

- ATF2 goal for beam size is ~37nm
- ATF2 goal of 37nm, scaled to 250 GeV, would correspond to 2.7nm (~twice smaller than ILC design value of 5.7nm)
- The intermediate "ILC-scaled" milestone of ATF2 is ~80nm

Tuning Procedure (week May 17 – 21)

- DR tuning
  - COD, dispersion, coupling, E match ...
- EXT + FFS steering, setup
  - Cav. BPM cal, BBA, steering, background reduction
- EXT tuning
  - Dispersion, coupling correction.
  - Matching into FFS
- FFS tuning
  - Check match conditions at IP
  - "Coarse" IP matching (beta, alpha, dispersion)
    - e.g. "Irwin Knobs", MAD/SAD rematching
  - Fine tuning of IP aberrations with "multiknobs" and IPBSM "Shintake Monitor".
    - Waist, dispersion, coupling, sensitive second-order terms.
    - Sextupole mover-based multiknobs, FD roll scans, EXT skew-quad scans...

A.Seryi

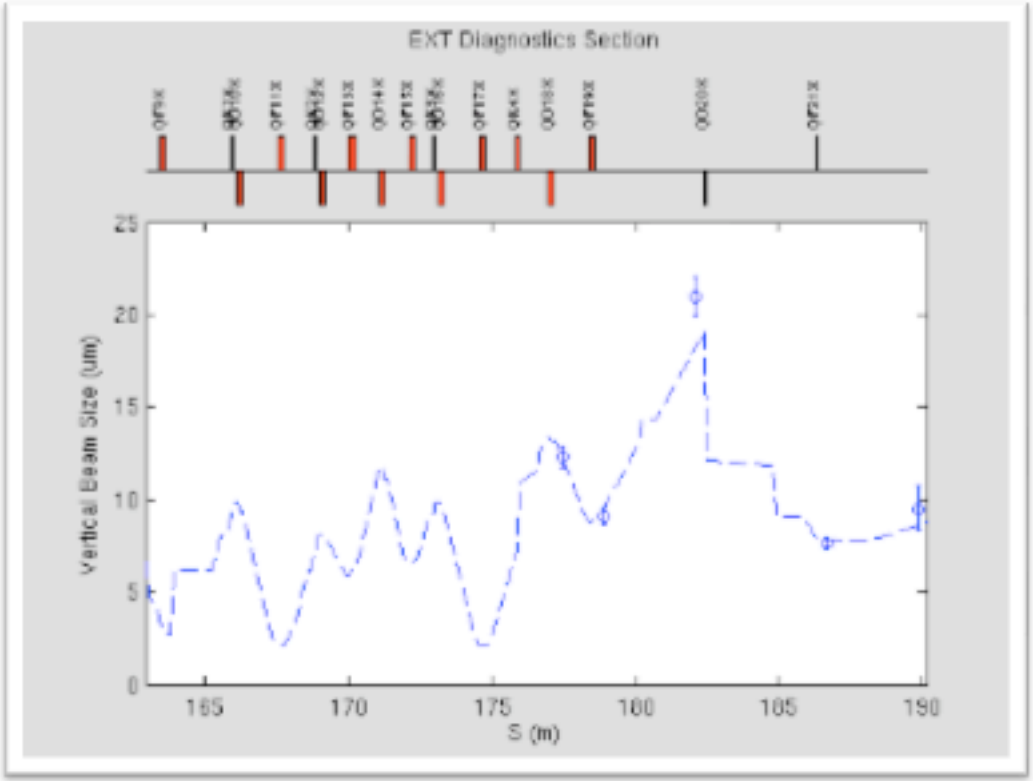
Extracted Emittance

(DR emit_y = 10pm)

sigt	sigd	sigw	sig
13.63	5.31	2.50	12.30
10.47	4.57	2.50	9.08
23.07	9.20	2.50	21.00
8.97	3.89	2.50	7.68
10.30	3.00	2.50	9.53

Vertical emittance parameters at MW0X

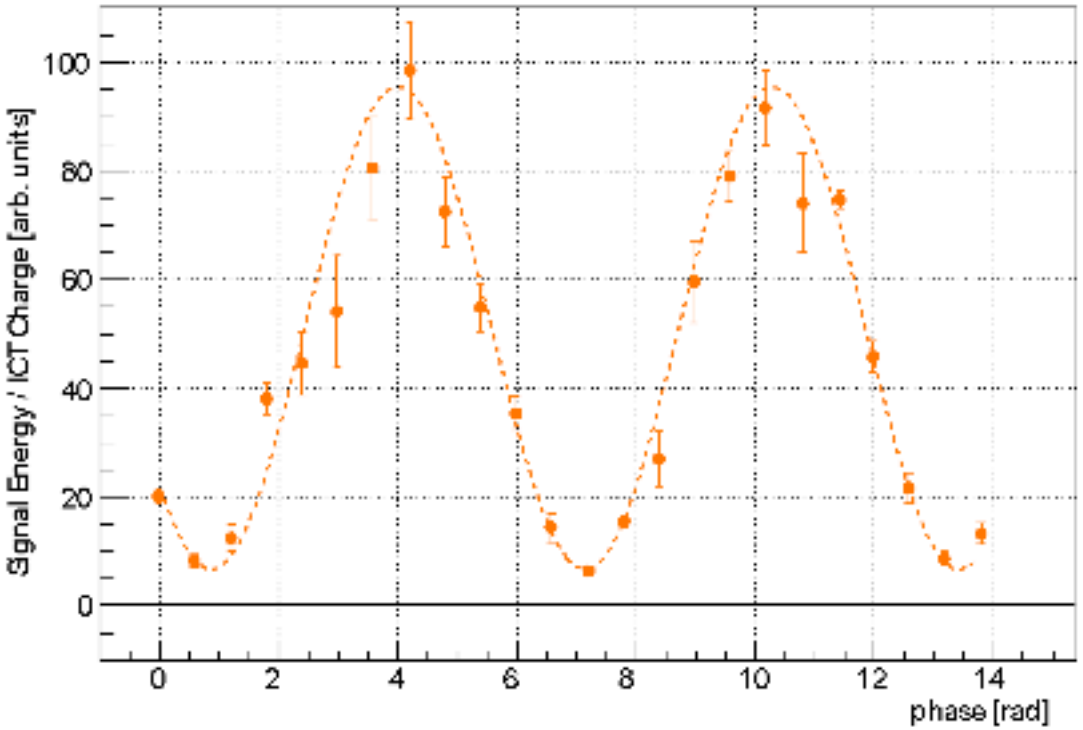
energy	= 1.2817	GeV	
emit	= 11.7381 +-	2.2922 pm	
emitn	= 29.4427 +-	5.7495 nm	
emitn*bmag	= 42.2019 +-	1.9205 nm	
bmag	= 1.4334 +-	0.2490	(1.0000)
bmag_cos	= 0.0448 +-	0.0000	(0.0000)
bmag_sin	= -0.7150 +-	0.0000	(0.0000)
beta	= 12.6951 +-	2.0753 m	(8.4774)
alpha	= 3.5809 +-	0.4296	(3.0756)
chisq/N	= 7.9155		



M.Woodley

Result of continuous run

Oroku@The Univ. of Tokyo
Shintake Monitor



Beam condition
- $_x^*$ ~ 4 cm (setting)
- $_y^*$~ 1 mm (setting)

•BG 6.5GeV
•S/N 30

Measurement condition
• Crossing angle ~ 7.96 deg
  = fringe pitch ~3.83 m

Modulation ~ 0.85

$$\sigma_y = 313 \pm 31\ (\mathrm{stat.})\ {}^{+0}_{-40}\ (\mathrm{sys.})\ \mathrm{nm}$$

M.Oroku

ATF2 status and plan

- Optics (βx, βy)=(4cm,1mm)(10 times bigger than nominal design)
- Beam size of 300 nm achieved, while expected beam size is 100nm

- For nominal design, background study is needed.
- QF1 roll is beyond mover limit→check fiducialization/alignmet
- Signal of BSM lost in multi-knob scanning← beam position changed/monitor stability
  - Laser position stabilization
  - IPBPM installation

Other Studied

- Cav.BPM study at Linac end
  - Beam study of ILC ML BPM
- Fast Ion instability in DR
- Cavity Compton in DR
  - ILC positron production
- FONT
  - Feedback for ILC BDS
- Laser wire in EXT
- IPBPM
  - High resolition/Low Q for multi-bunch beam
- …

- Some of above need stable multi-bunch operation→ systematic study is planned in autumn run 2010.

Summary

- ATF/ATF2 is successfully operated in international collaboration.
- Many studied are on going now with fruitful results.

ATF long term plan