

ATF2 Status from last TB meeting

T. Okugi, KEK

2014/10/08

LCWS14

Belgrade (SERBIA)

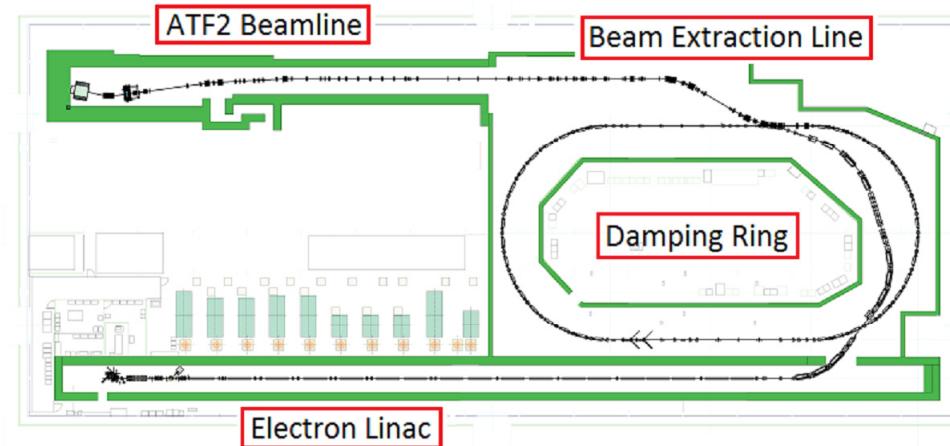
Introduction

Beam Tuning Status

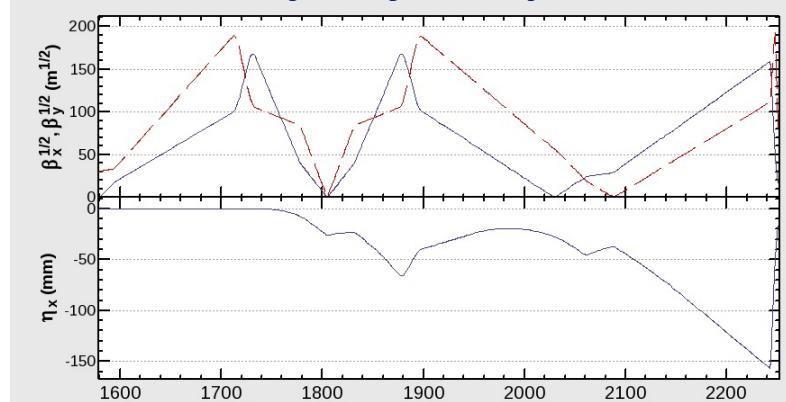
Wake field Issues

Beam Jitter Issues

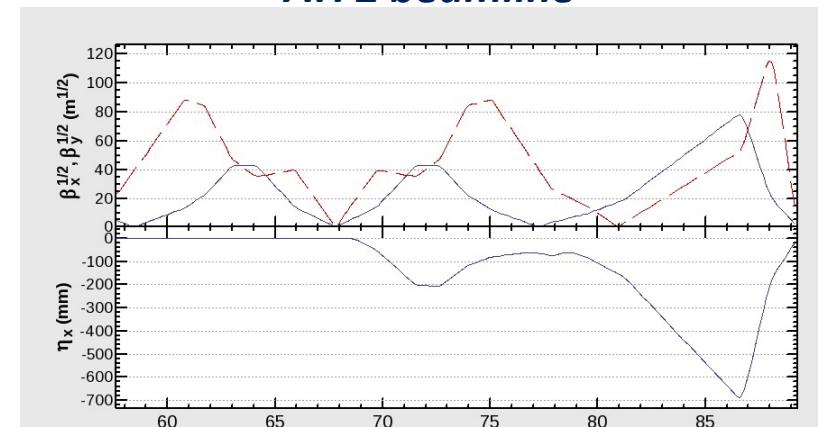
Accelerator Test Facility at KEK



ILC final focus system



ATF2 beamline



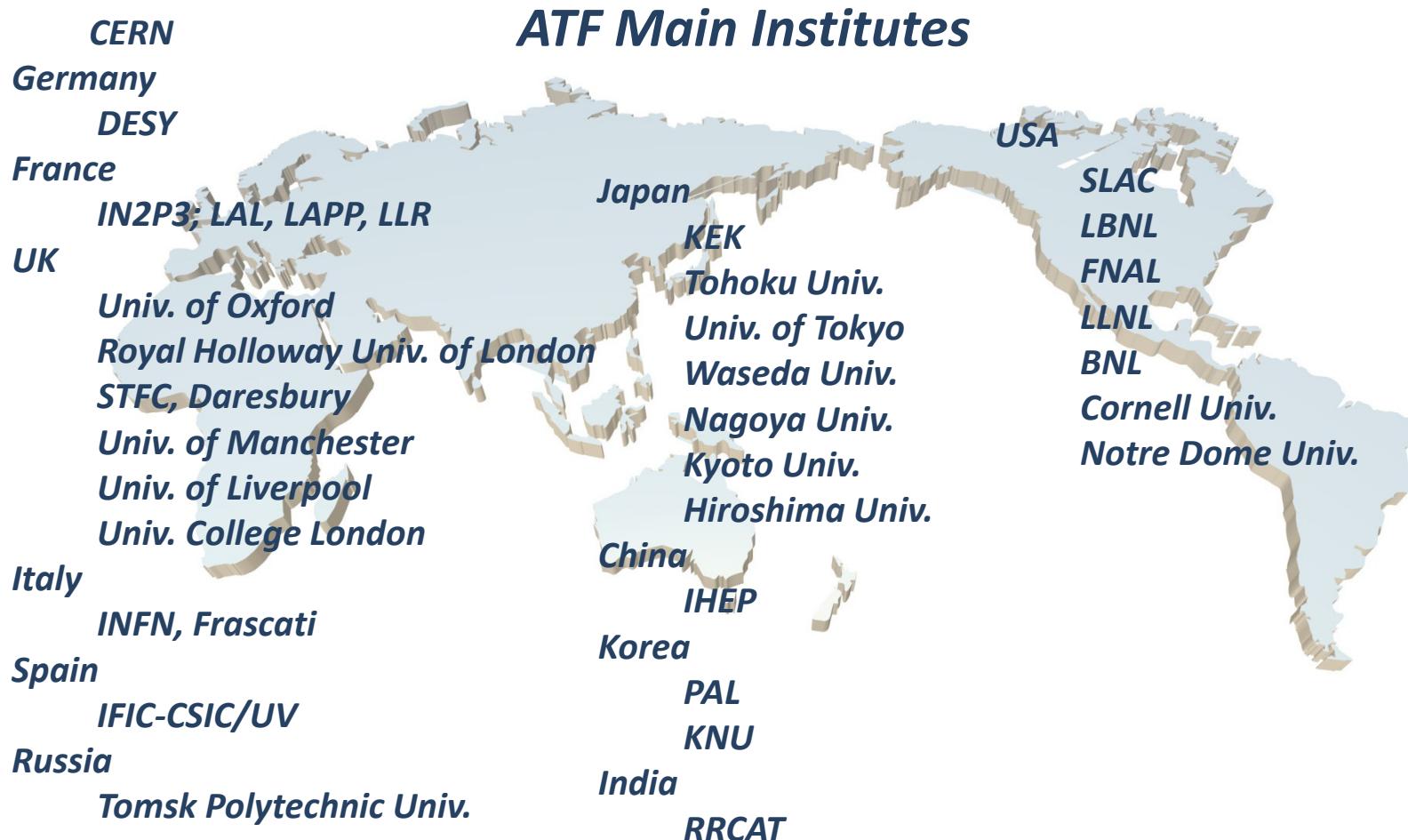
ATF2 is test beamline for ILC final focus system.
Beam optics was based on local chromaticity correction as ILC FFS.

ATF2 International Collaboration

ATF2 was **designed** by the international collaboration.

ATF2 was **constructed** by the international collaboration.

ATF2 is **operating** by the international collaboration.

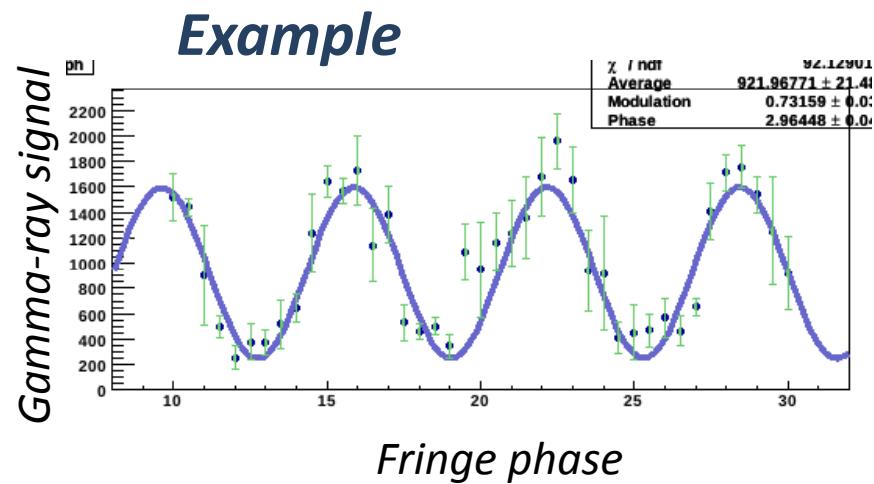
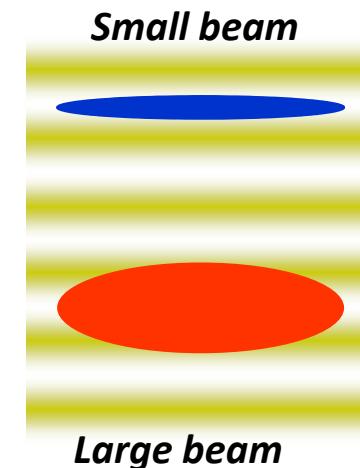
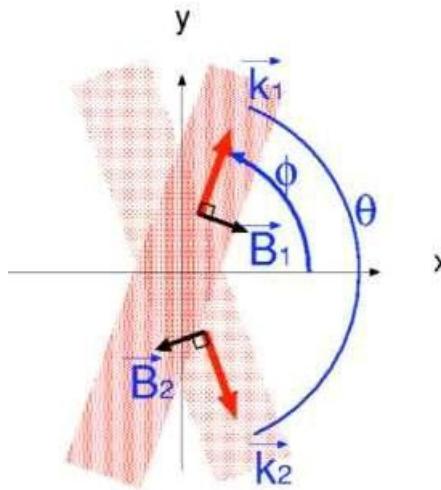


IP Beam Size Monitor (Shintake Monitor)

Laser is split into 2 paths.

The both laser paths
are collided at IP.

The interference pattern
is generated at IP.



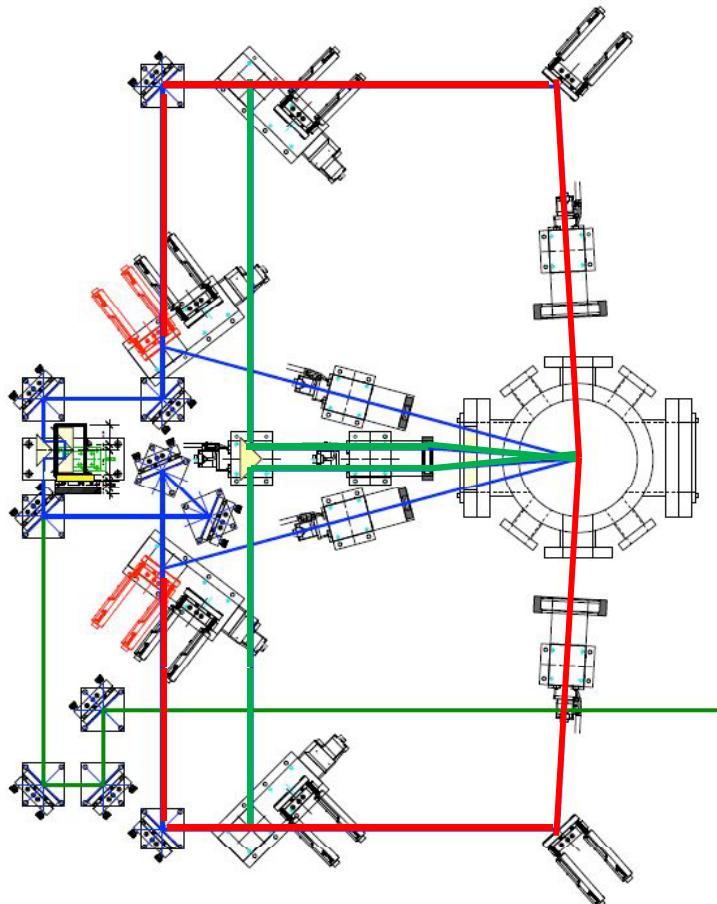
Modulation

$$M = \frac{N_{\max} - N_{\min}}{N_{\max} + N_{\min}}$$

For Gaussian beam profile

$$M = |\cos \theta| \exp\left(-\frac{2\pi^2 \sigma^2}{h^2}\right)$$

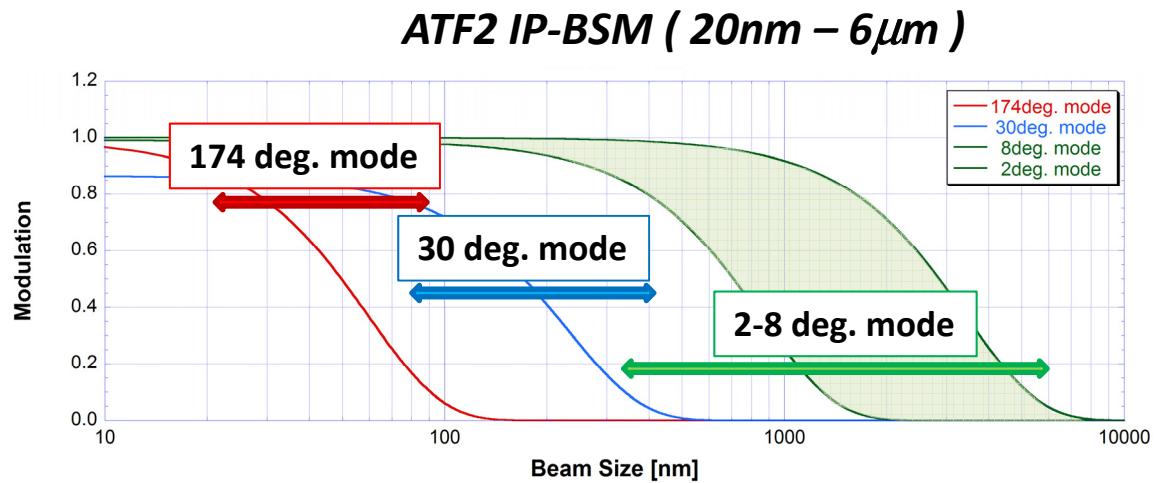
Drawing was made by N.Terunuma



*174deg mode
30 deg mode
2-8deg mode*

with Nd:YAG harmonic doubler (532nm)

IP-BSM for ATF2

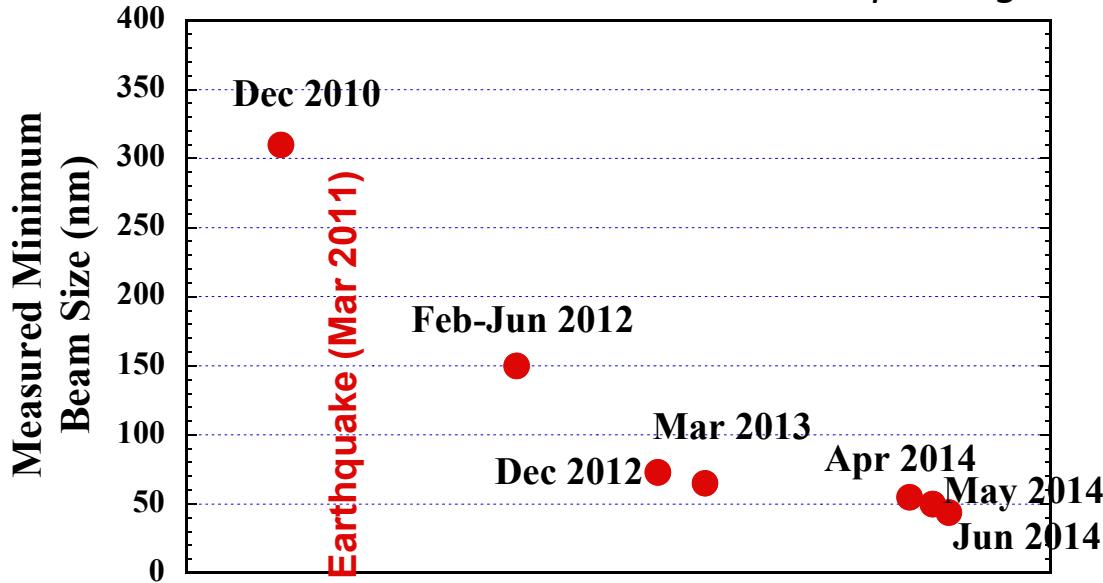


IP-BSM for ATF2 can measure the beam size from 6um to 20nm continuously, by changing 3 collision mode.

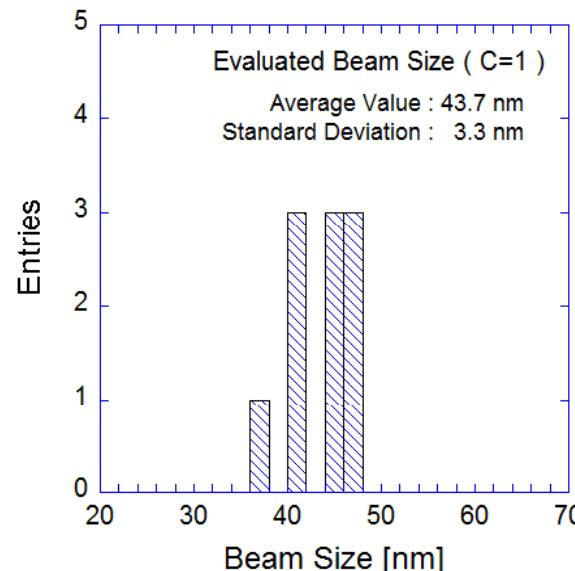
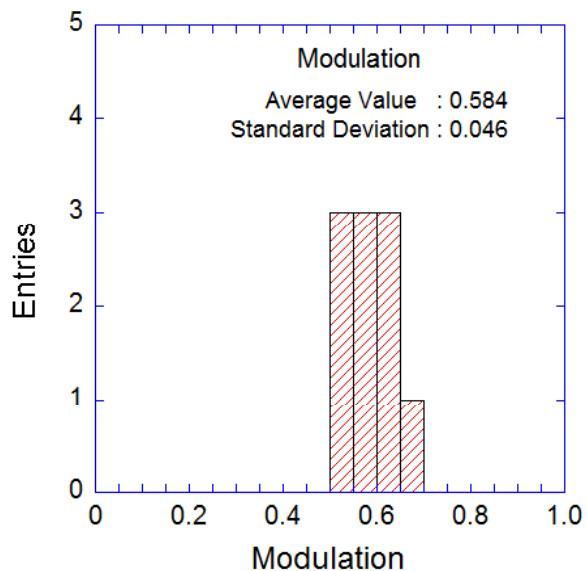
Beam Tuning Status

History of measured minimum beam size

Measured beam size at ATF2 is improving.



Presented by K.Kubo at IPAC2014

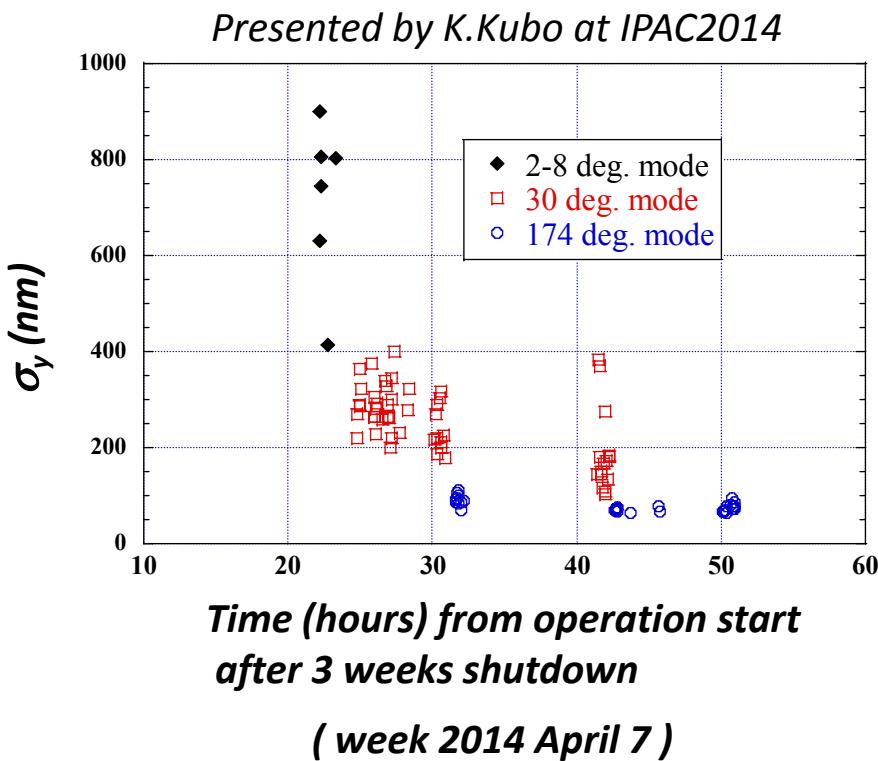


Minimum beam size at ATF2
is 44nm or less.

The minimum beam size
was measured at 6/12/2014.

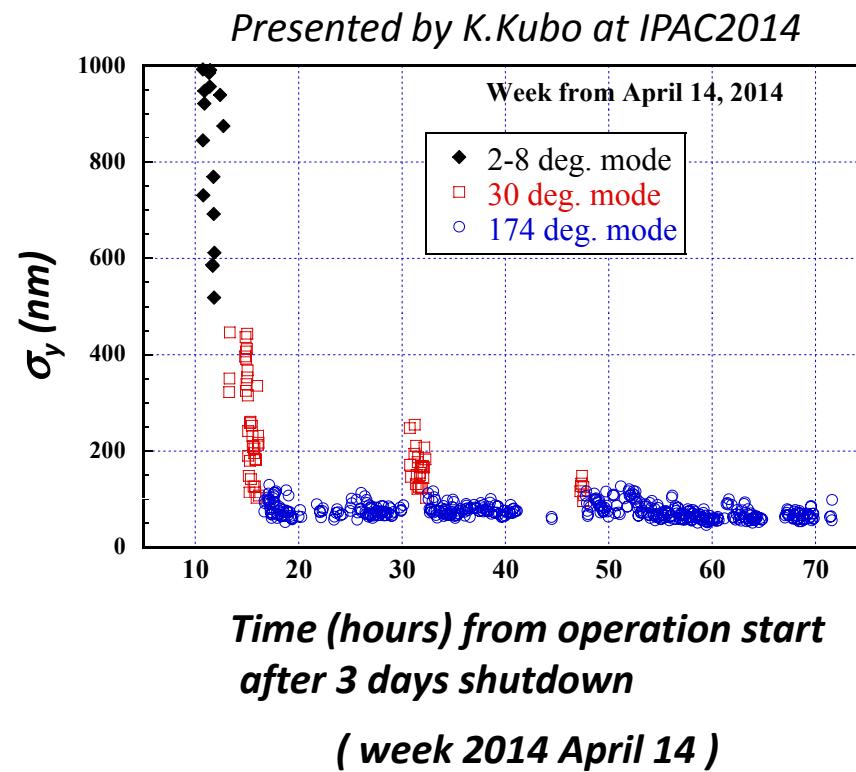
Beam Size Tuning after 3 weeks shutdown

*Small beam (~60 nm) observed
~32 hours from operation start*



Beam Size Tuning after 3 days shutdown

*Small beam (~60 nm) observed
~16 hours from operation start*



Emittance evaluation at IP

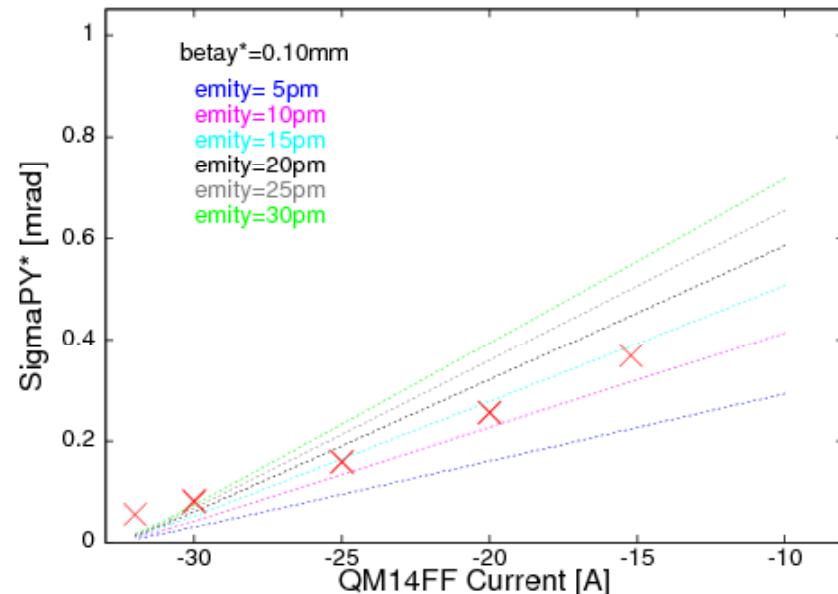
The data was taken at 6/05/2014

BetaY* can be changed when QM14FF strength is changed.

Beam emittance at IP was evaluated by comparing

- beam divergence measured with QD0 scan by IP carbon wire scanner.
- measured IP beam size by IP-BSM, especially for large beam size

Beam Divergence from QD0FF Scan

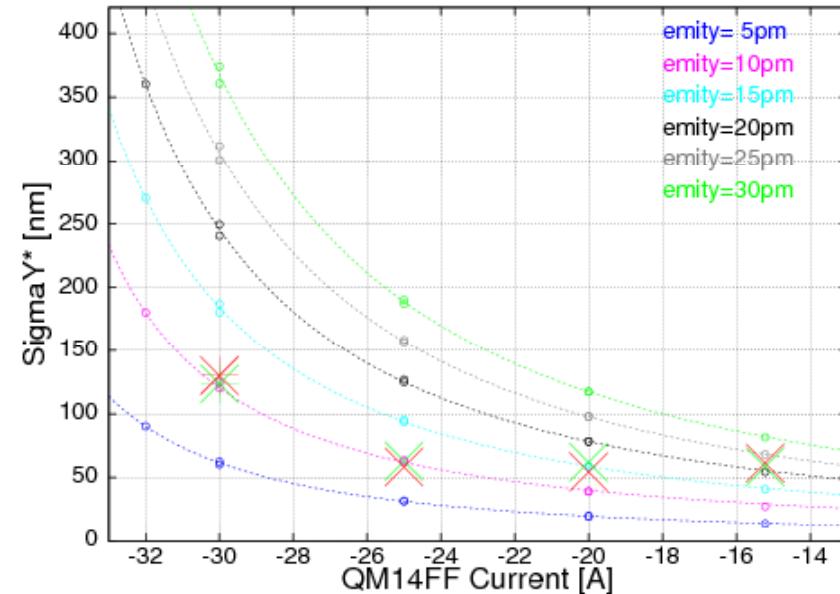


Red cross ; measurement

Dashed line ; model expectation

Good agreement with model

IP Beam Size Measurement



Green cross ; measurement of last week

Red cross ; measurement of this week

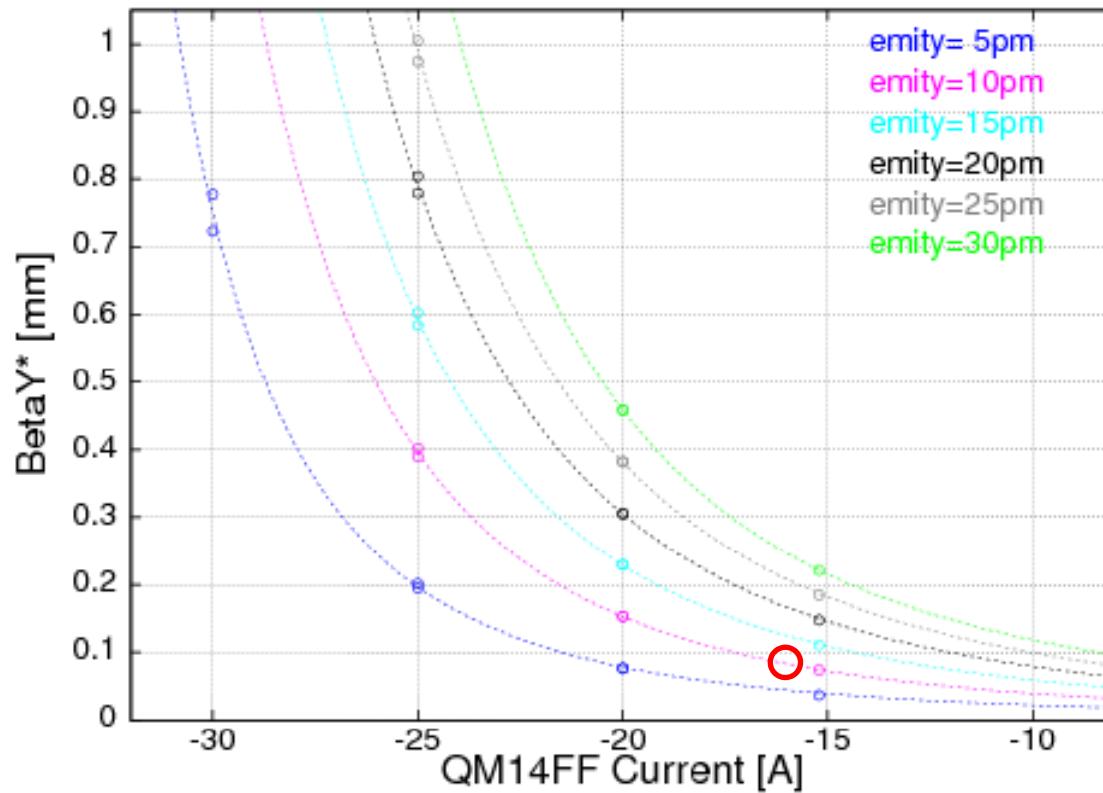
Dashed line ; expectation from QD0FF scan

Intrinsic emittance should be 10pm or less !

Betay expectation from QD0FF Scan*

The data of 6/05/2014 was analyzed.

BetaY evaluation from IP beam divergence measurement*

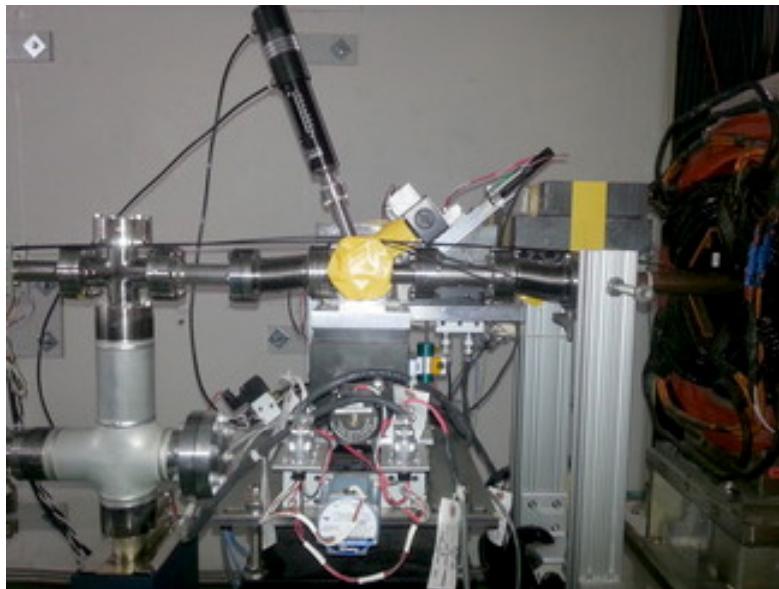


*If we assumed the vertical emittance was 10pm,
the IP vertical beta function was evaluated to 0.08mm
for the nominal QM14FF = -15.215A.*

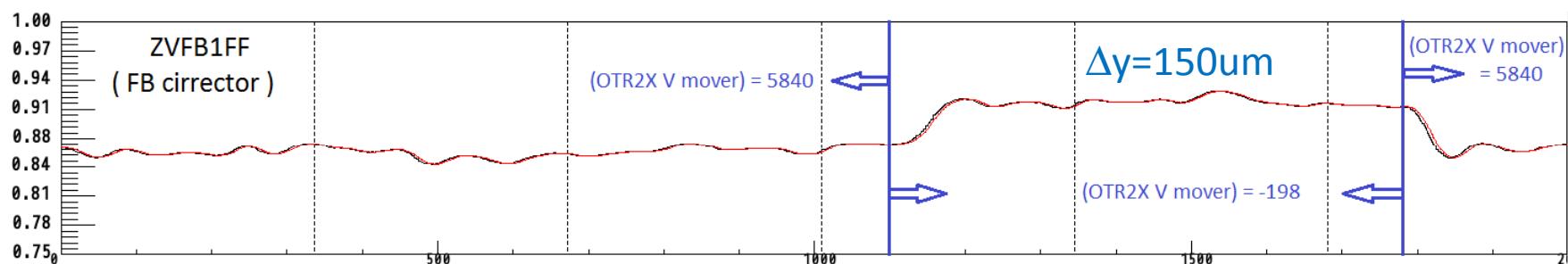
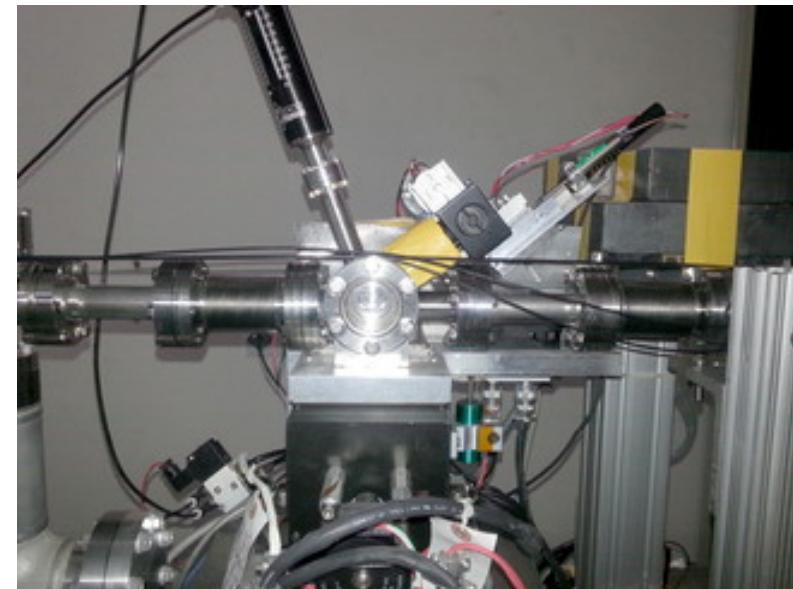
Wake field Issues

OTR2X Vertical Position Effect to Beam Orbit

(OTR2X V mover) = 5840



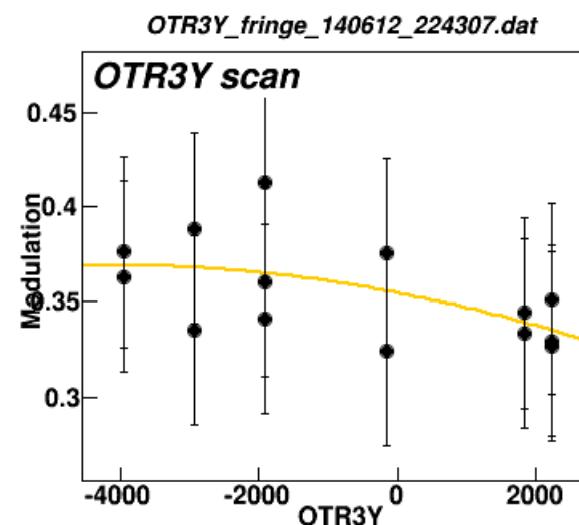
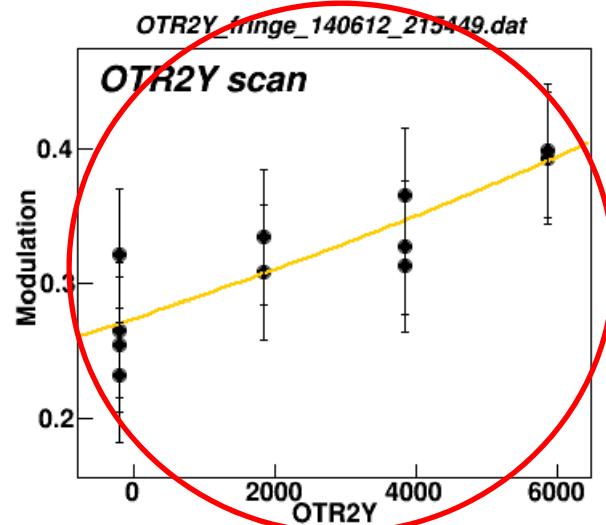
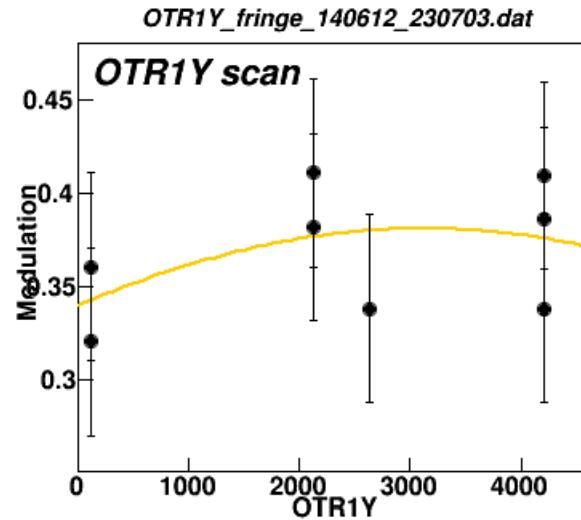
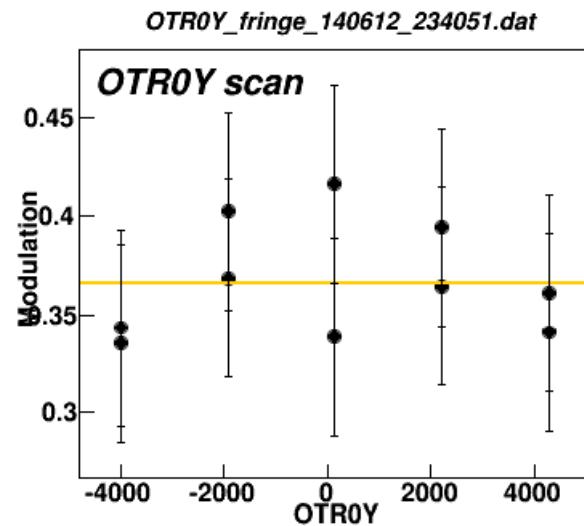
(OTR2X V mover) = - 198



We observed the FF orbit changed, when we changed the OTR2X vertical position.

Effect of other OTRs

Modulation Measurement by IPBSM 174degree mode (N=3e9)



OTR2X only has a clear dependence of vertical mover position.

IP beam size simulation by assuming OTR impedance

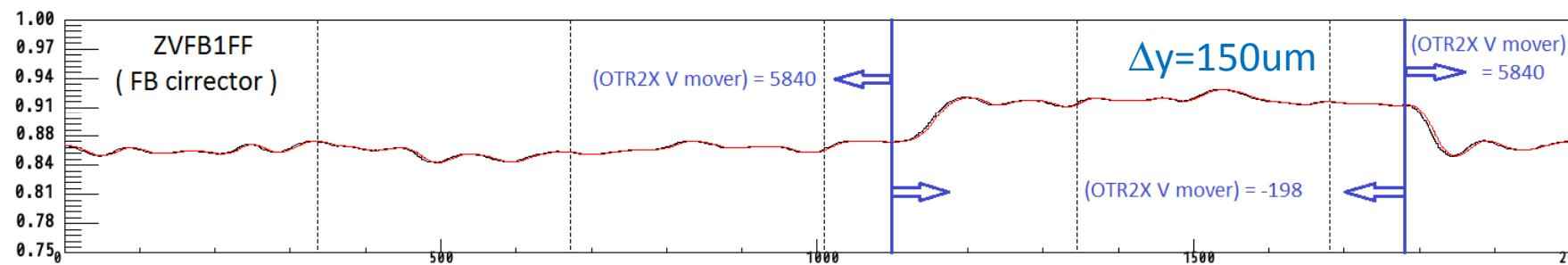
Beam optics was used

- *the magnet current was loaded from Vsystem database.*

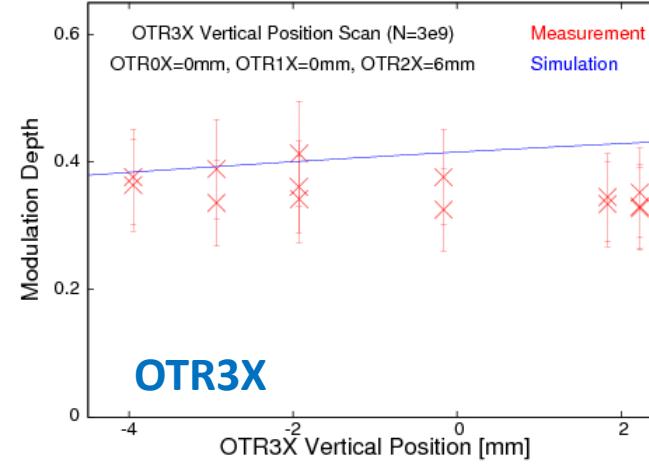
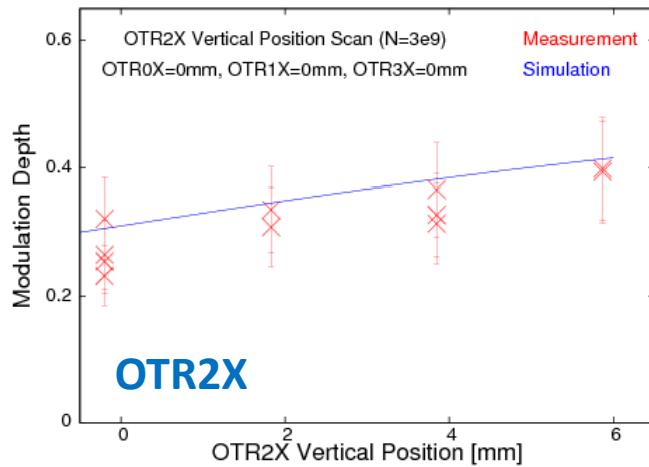
Parameters of Simulation

OTR0X – OTR3X <i>(pure capacitive impedance)</i>	Peak Strength	-0.3V/pC/mm
	Electrical offset	-5mm
Additional Intensity Dependence		10nm/1e9
Modulation Reduction Factor		0.9

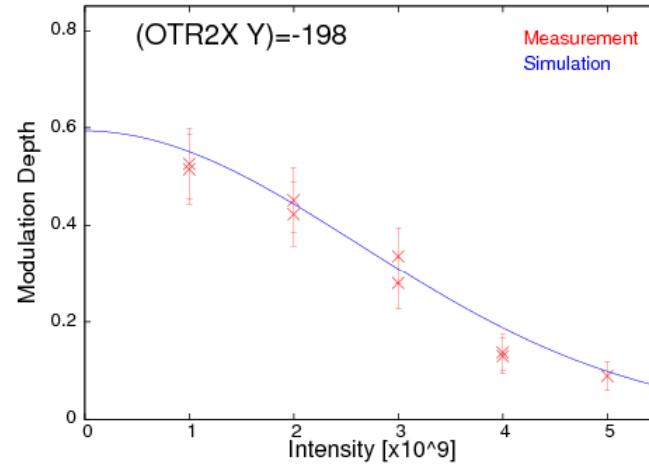
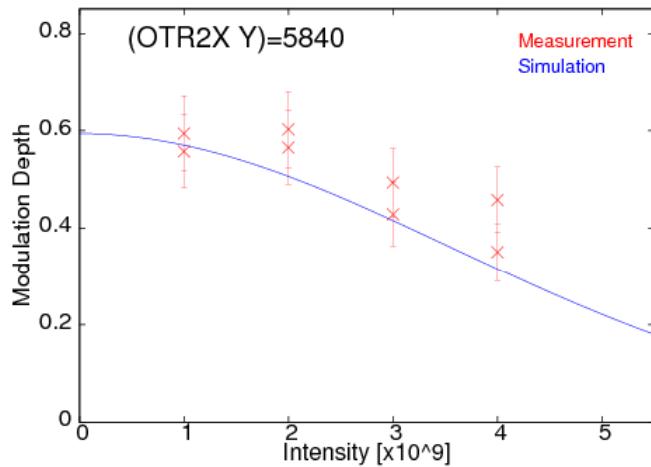
The simulation said the vertical orbit at QD10A moved by 170um, when we moved OTR2X by 6mm.



Mover Position Dependence



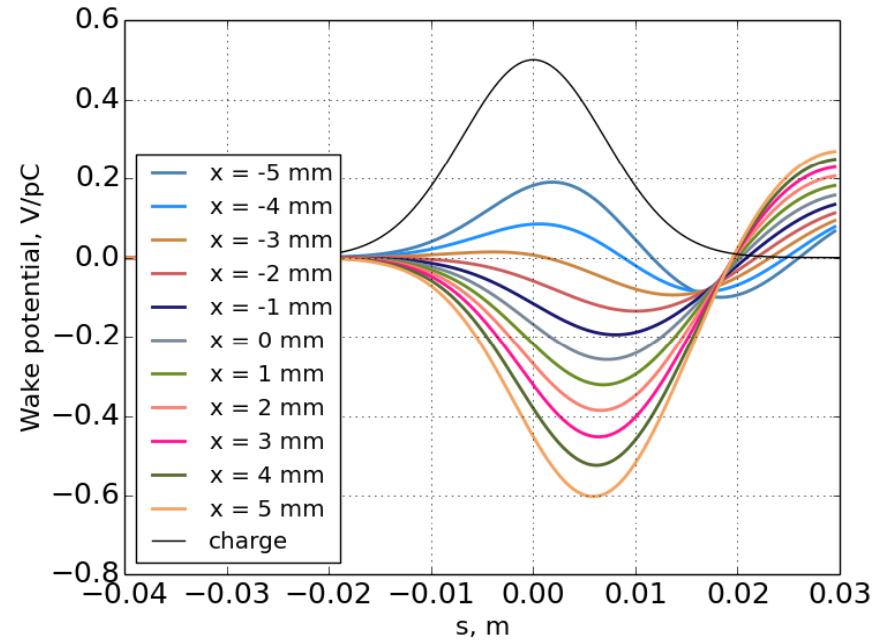
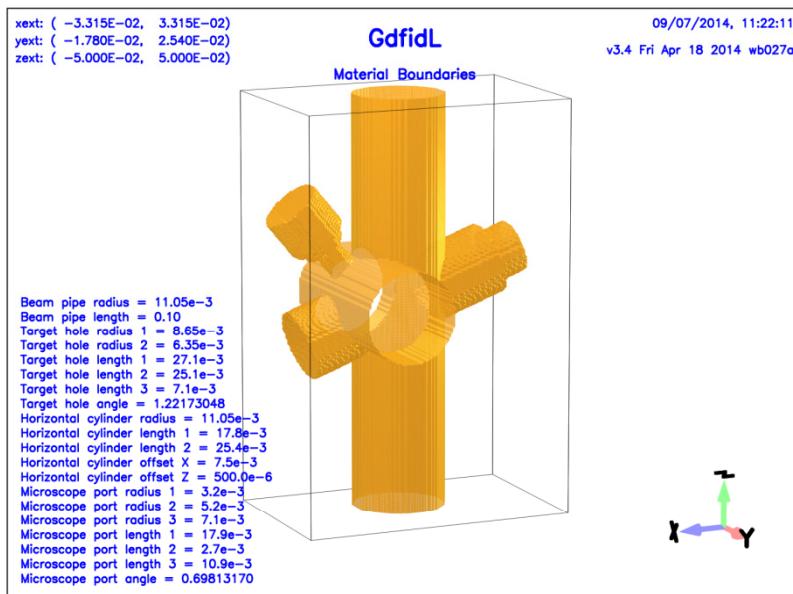
Intensity Dependence



Simulation result is good agreement with the measurement.

Wake field of OTR chamber

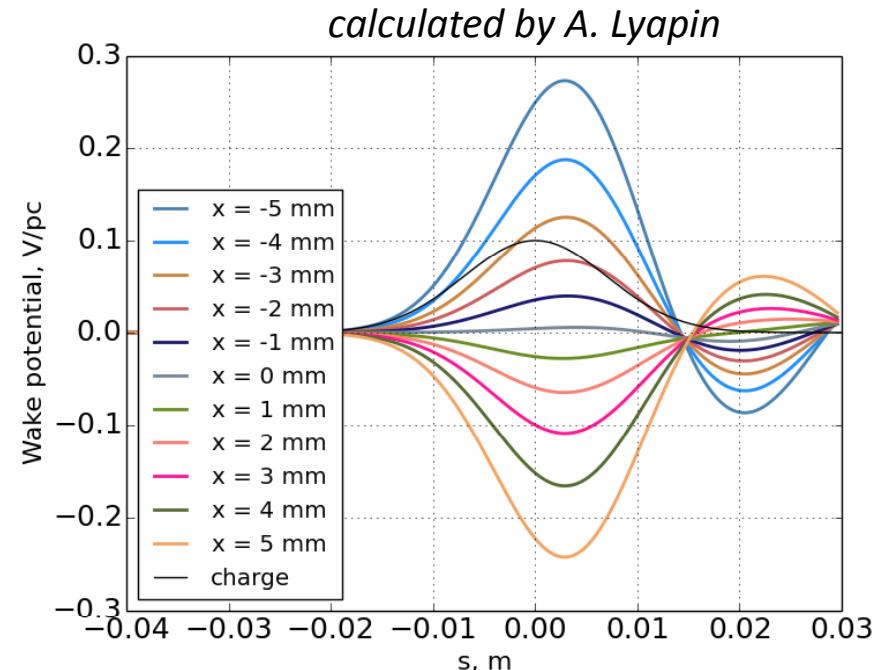
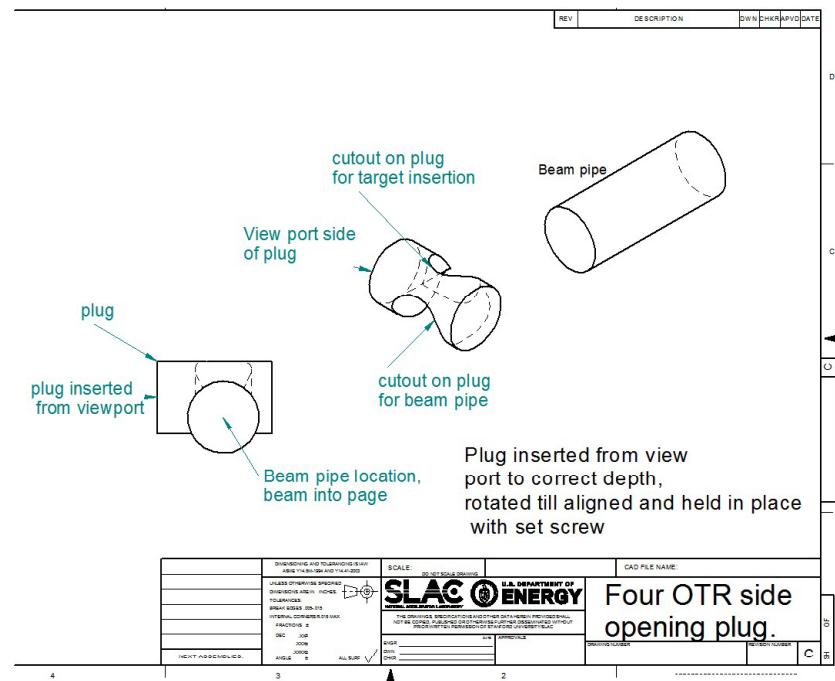
*Wake field of OTR chamber was calculated by A. Lyapin,
which was presented in ATF operation meeting.*



The wake field of OTR chamber has large electrical offset for vertical direction.

Insertion piece to put OTR chamber

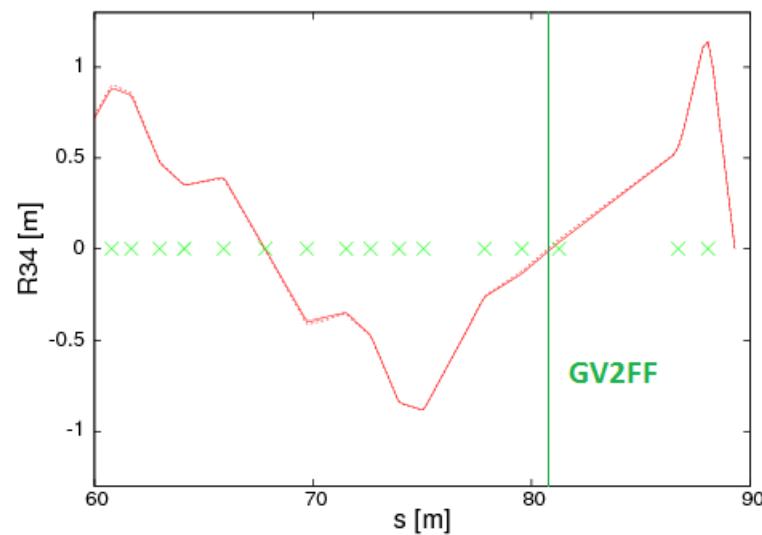
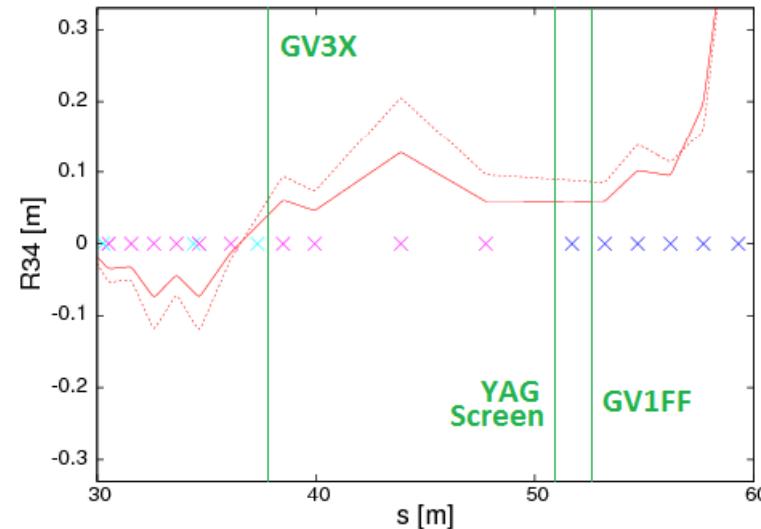
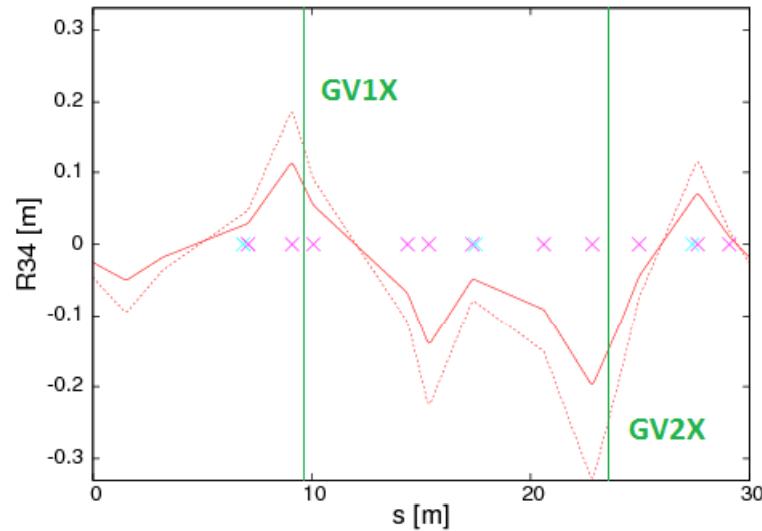
The device have been prepared by SLAC (presented in ATF operation meeting by D. McCormick)



After the insertion pieces will be inserted to OTR chambers, we expected to the wake field of OTR chamber will be symmetric for vertical direction.

Asymmetric structure in ATF2 beam line

Response function to IP



*The gate valve is set by 45degree rotated.
Therefore, it is also asymmetric for vertical direction,
and have a gap larger than bunch length.*

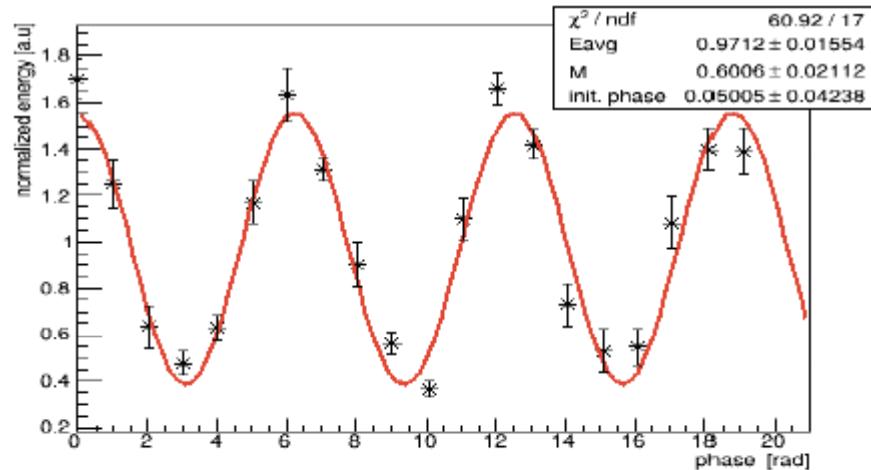
*Therefore, we set the gate valve to be parallel
to horizontal plan.*

*The inner structure of gate valve will be symmetric
for vertical direction from autumn beam operation.*

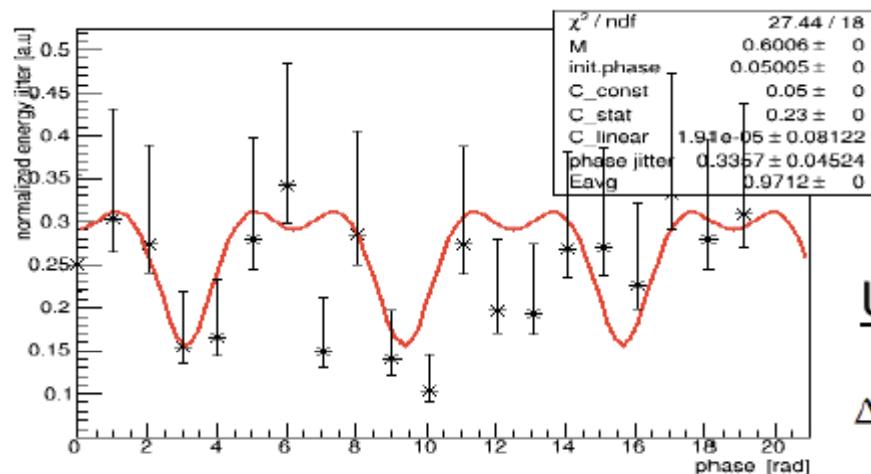
IP beam jitter Issue

IP position jitter analysis from IP-BSM signal

see the presentation of J. Yan



IP beam size is evaluated
from the modulation depth of IP-BSM signal.



Phase jitter (IP position jitter)
was evaluated from the phase dependence
of IP-BSM signal fluctuation.

Uncertainty of error evaluation

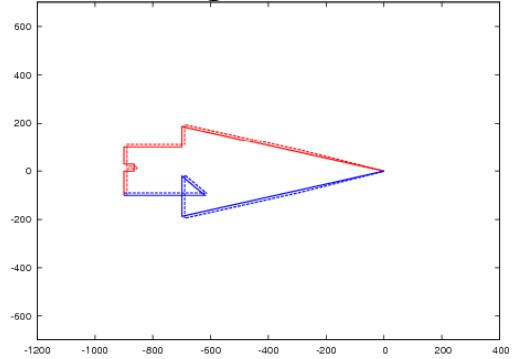
$$\Delta M_{corr} = \frac{M_{meas}}{C_{tot}^2} \Delta C_{tot} = M_{corr} \frac{\Delta C_{tot}}{C_{tot}} = M_{corr} \sqrt{\sum_i \left(\frac{\Delta C_i}{C_i} \right)^2}$$

Some data were analyzed by J. Yan for the data, which were taken in May-June 2014.

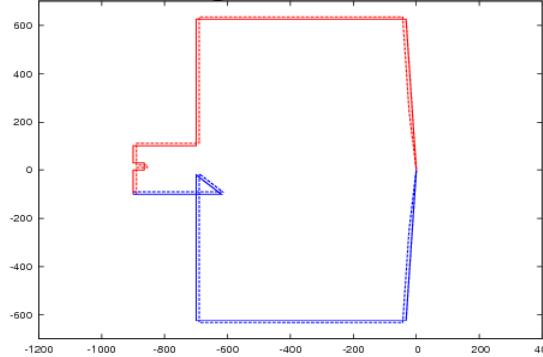
Phase jitter from Laser Path

presented by T.Okugi at ATF operation meeting (5/30/2014)

30degree mode



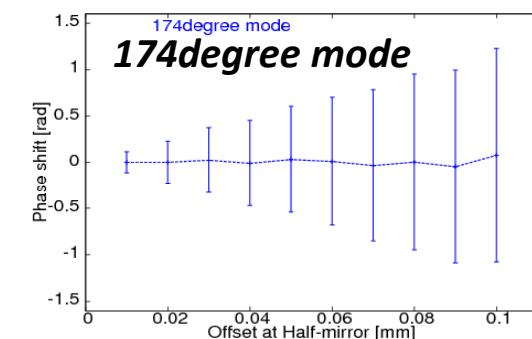
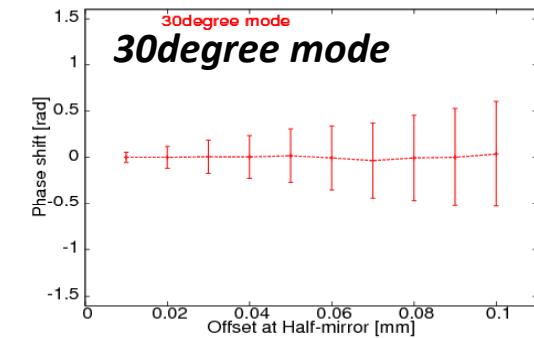
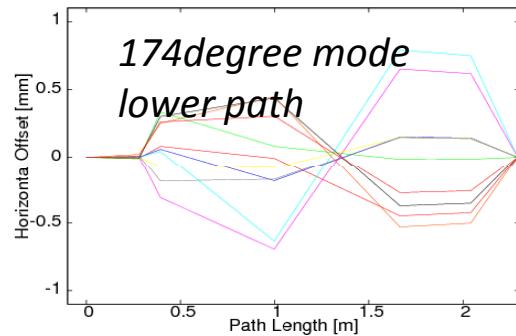
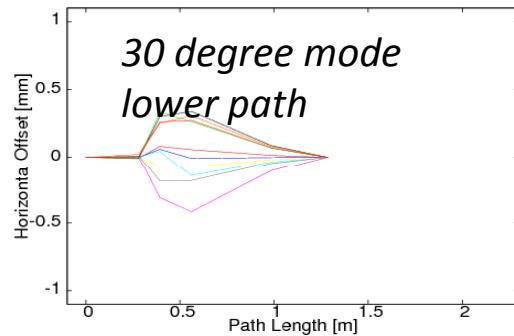
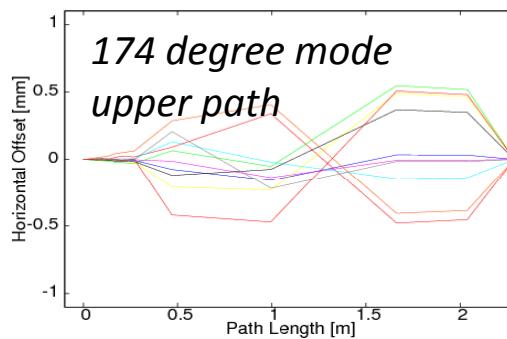
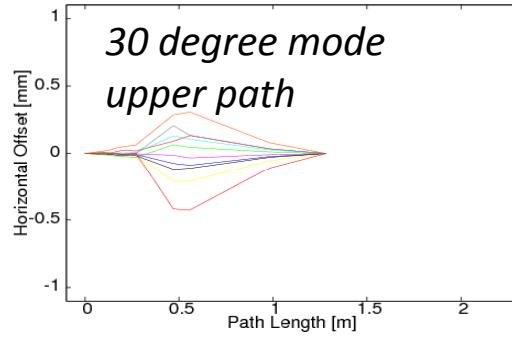
174degree mode



No misalignment

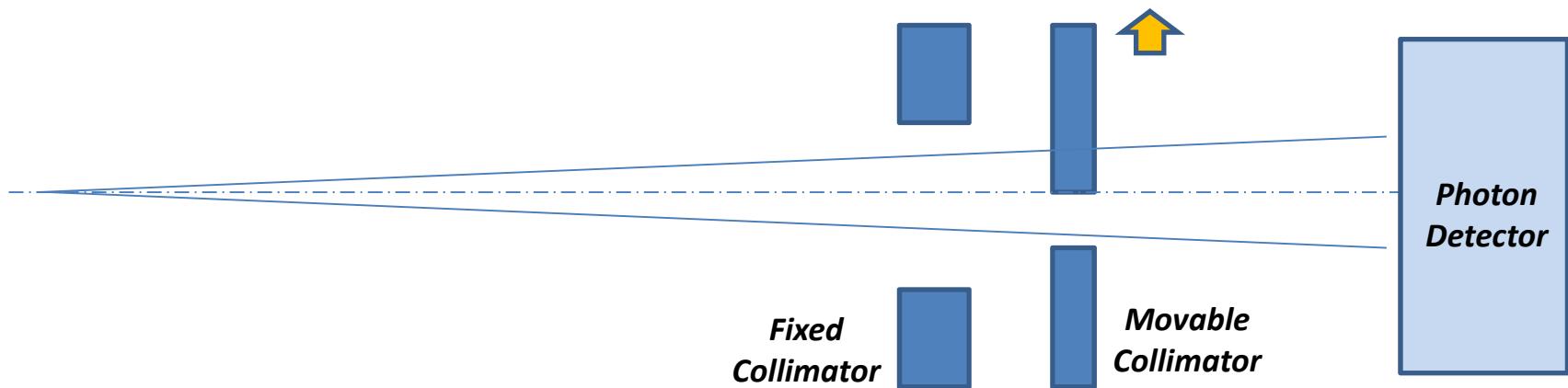
There are no path length difference for upper and lower paths even when there is injection jitter.

However, when there is misalignment (rotation errors) to mirrors, the path length difference was generated with small injection jitter .

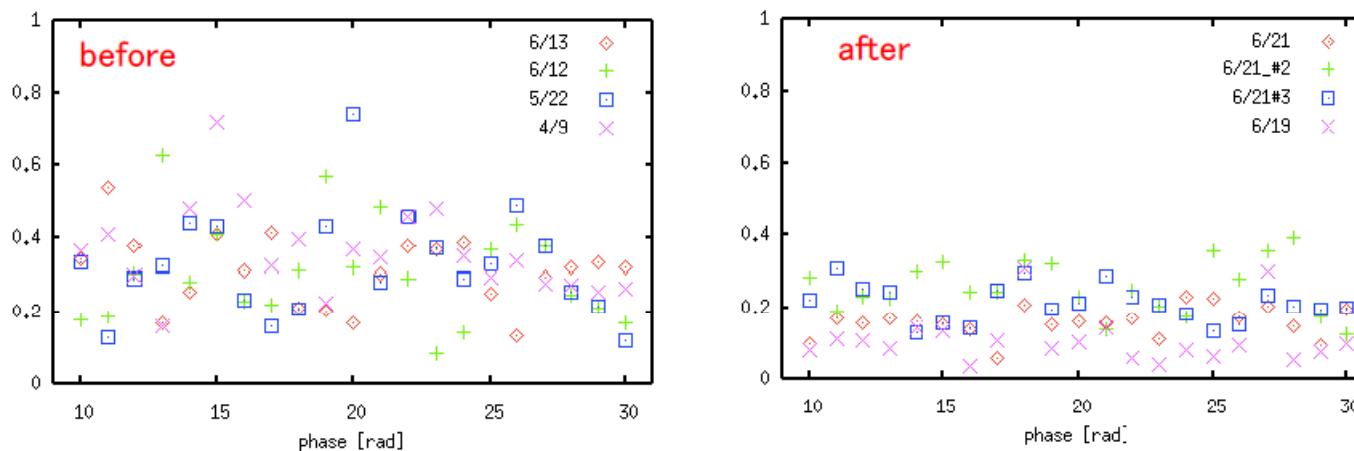


Phase jitter , which generated by laser injection jitter for 174deg. mode is expected to be larger than 30 deg. mode.

Effect of the collimator alignment



Since it was found that the photon was not go to the center of movable collimator, we adjusted the position of the movable collimator at the last week of June 2014.

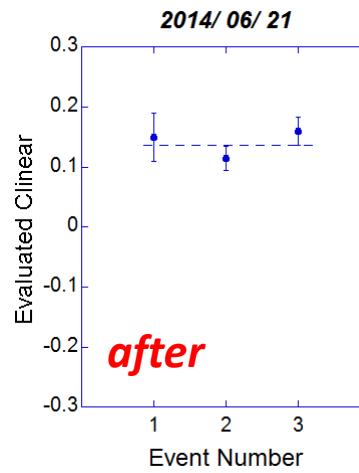
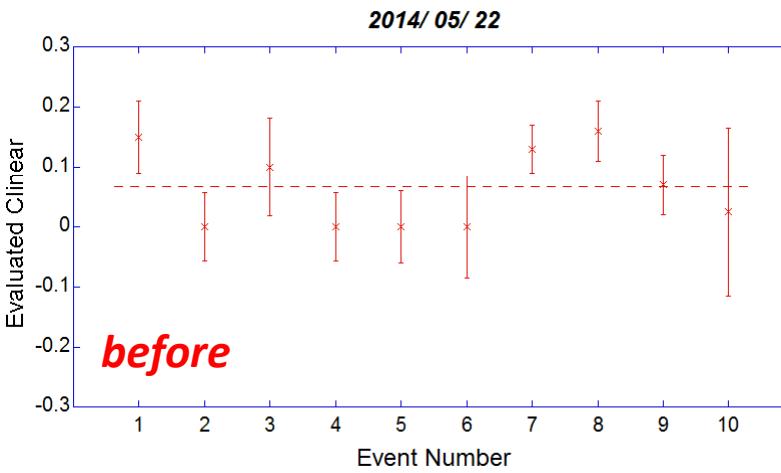
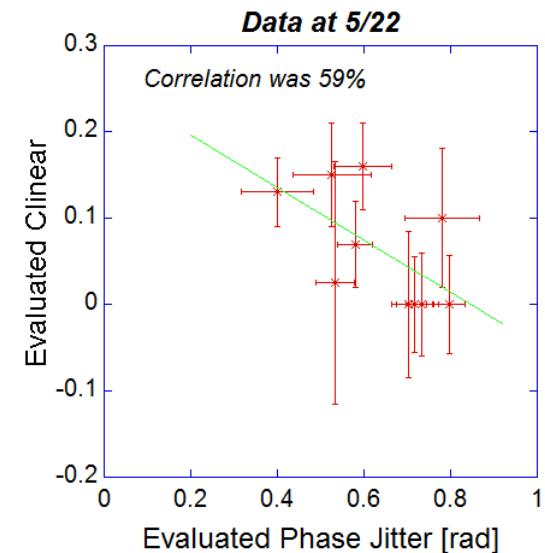
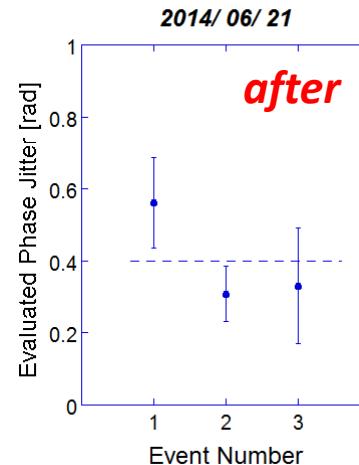
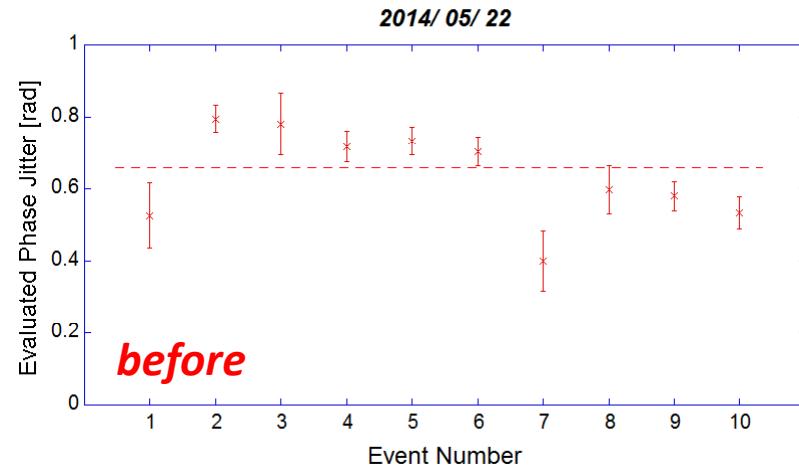


Presented by J.Yan at ATF operation meeting(2014/06/27).

After the collimator adjustment, the signal jitter was reduced.

Relationship between signal jitter and evaluation

Graph was plotted by T.Okugi with the data, which was analyzed by J.Yan.



The phase jitters were evaluated before collimator adjustment.

The Clinear also fluctuated before collimator adjustment.

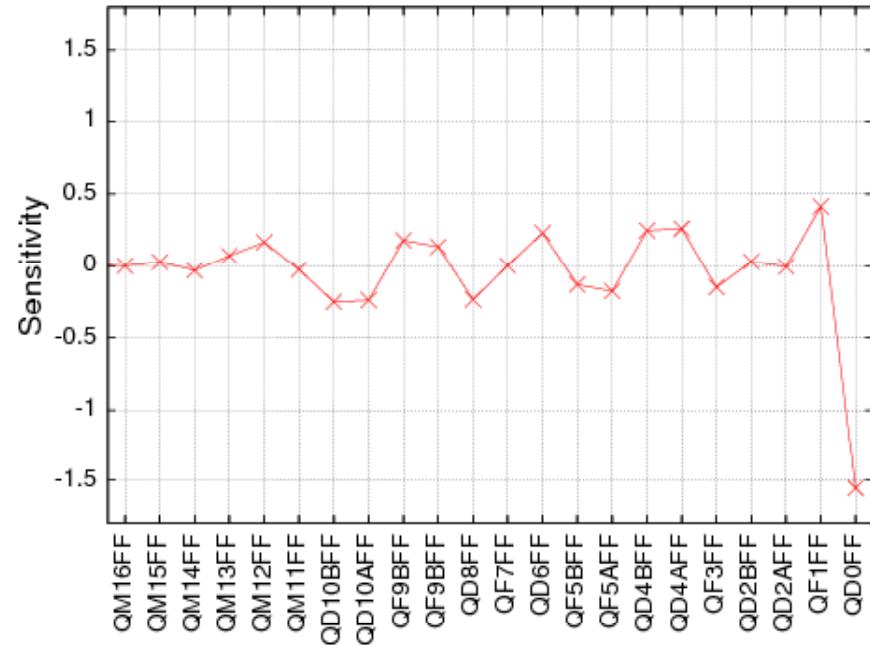
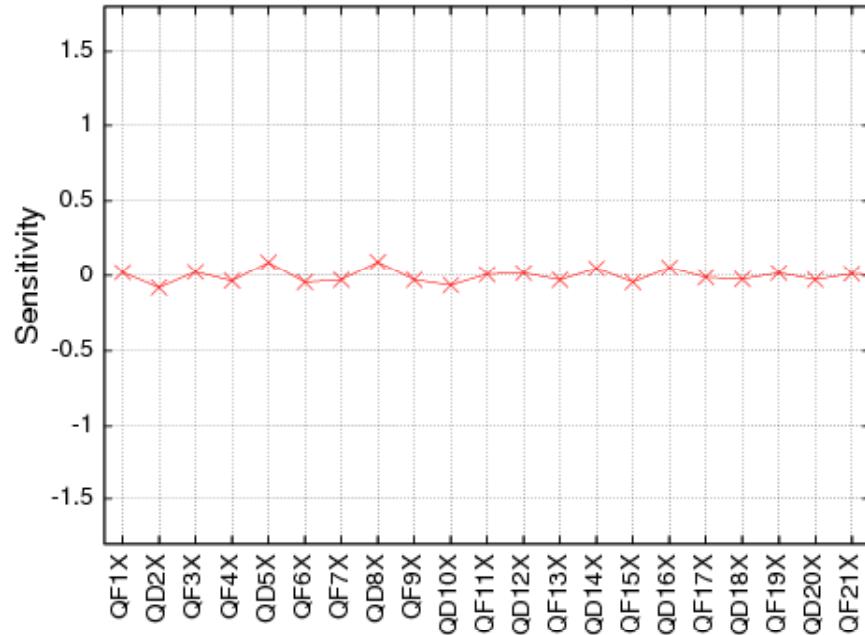
The phase jitter and Clinear has correlation (59%).

Since the evaluated phase jitter was strongly correlated to the signal jitter, it is difficult to evaluate the phase jitter quantitatively in this method (at least large jitter case).

We still have a lot of systematics to be solved in order to evaluate the IP position jitter from IP-BSM signal.

IP position jitter expectation from vibration measurement

Jitter sensitivities to IP position



The definition of the sensitivity is
 $(IP \text{ position jitter}) = (\text{sensitivity}) * (\text{magnet vibration})$

Most sensitive magnet in ATF2 beamline is QD0.

Next is QF1, and some of QEA magnets also comparable sensitivity to QF1.

IP position jitter evaluation from vibration measurement

Andrea presented the FD magnet position jitter at ATF2 meeting on 8/30/2013

2013 by Andrea JEREMIE (same analysis)	Tolerance	Measurement (between QD0)	Measurement (between new QF1)
Vertical	7 nm (for QD0) 20 nm (for QF1)	4.8 nm	30 nm
Parallel to the beam	~ 10,000 nm	25 nm	290 nm



A.Jeremie

ATF2 Meeti

11

Outside tolerance for
2% effect on beam!

The magnet position jitter was converted to the IP vertical beam size contribution

	QD0	QF1
Vertical	7.3 nm	12.6 nm
Parallel	0.4 nm	0.8 nm

Total IP vertical beam size contribution of magnet position jitter is **14.6 nm at least** from FD.
40.4 nm -> 43.7 nm (8.2% of IP vertical beam size growth) for 6/12 data.

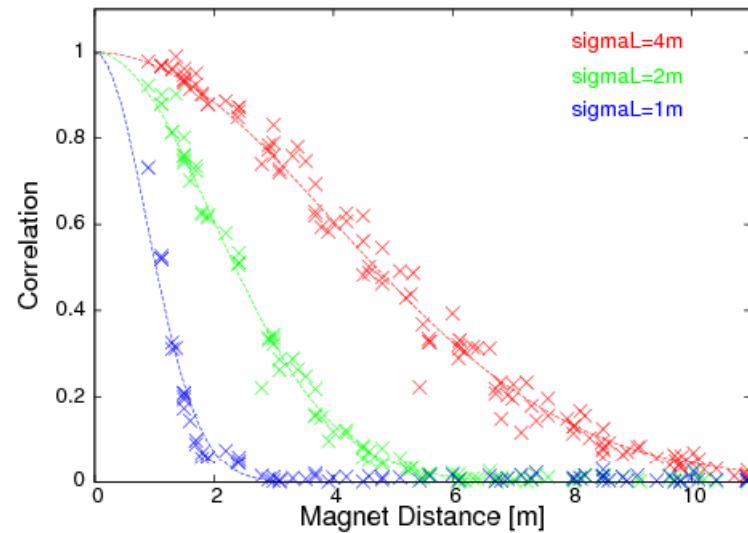
Effect of the vibration of QEA magnet

Furthermore, the vibration from QEA magnets also affected to IP position jitter

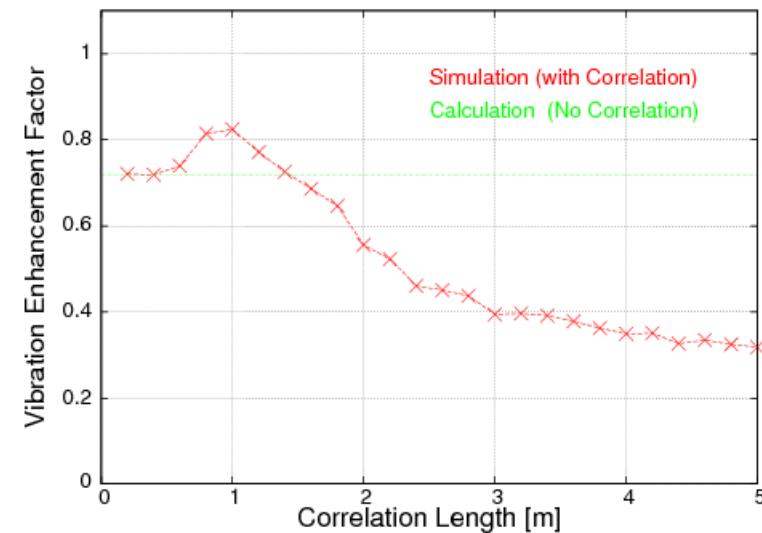
The sensitivity of QEA magnet vibration is evaluated by simulation.

- 1) We assumed same amplitude of vibration for QM16FF-QD2A.
- 2) We assumed the correlation depth for each QEA magnets.

***Correlation of magnet vibration
in the simulation***

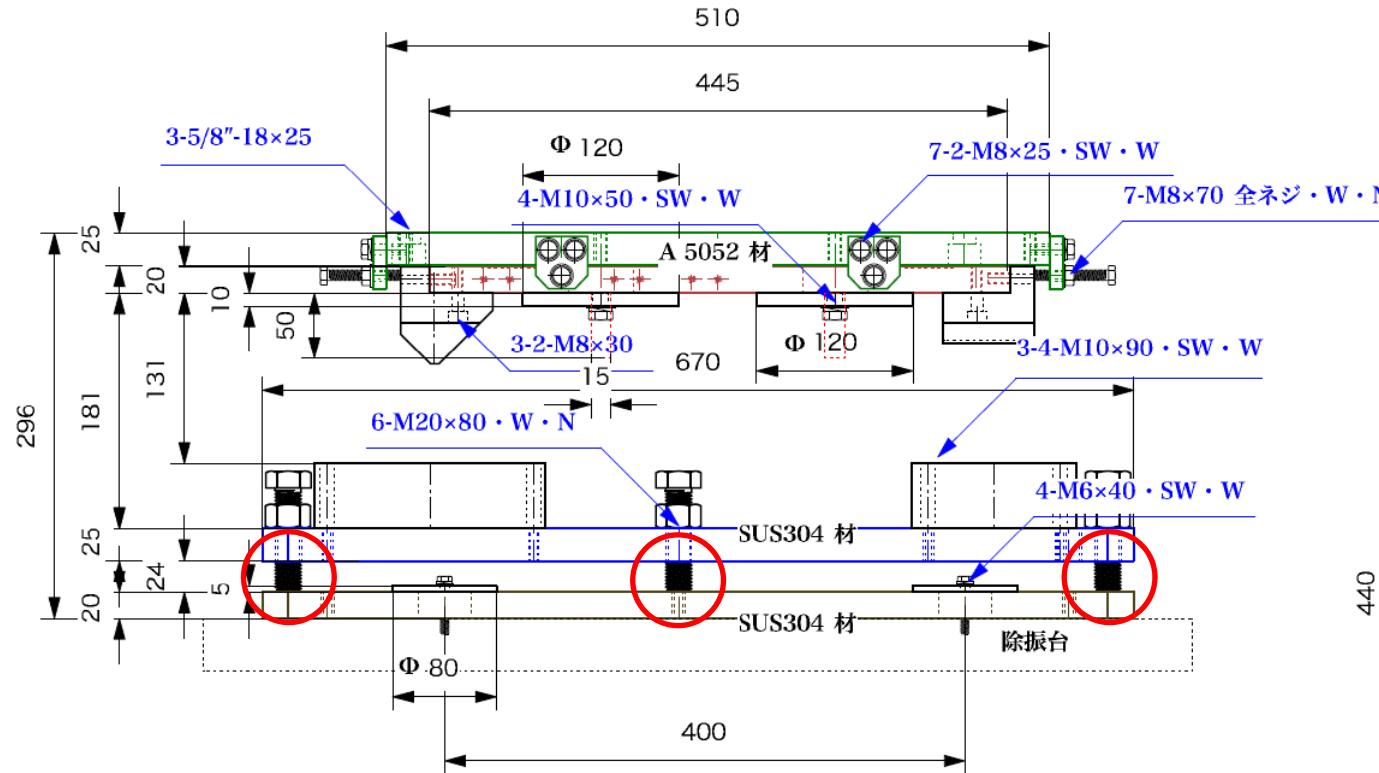


***Total sensitivity of QEA vibration
as a function of correlation length***



Sensitivity of QEA magnet is strongly depends on the correlation length.

Jitter reduction of QF1 magnet



The base plate of QF1 is supported by some screws.

There are a possibility to generate the vibration by this support.

Therefore, Andrea Jeremie (LAPP) and Marcin Patecki (CERN) measured the vibration with and without shims in between QF1 plates (see the presentation of M. Patecki).

They also plan to measure the vibrations and correlations of QEA magnets.

Summary

Small beam (~ 60 nm) observed ~32 hours from operation start after 3 weeks shutdown.

Small beam (~ 60 nm) observed ~16 hours from operation start after 3 days shutdown.

The minimum beam size was 44nm in the 2014 spring operation.

The IP betay = 0.08mm and vertical emittance was about 10pm
1 week before the minimum beam size was measured.*

*Since there were huge vertical electrical offset for OTR wake,
we will put the insertion pieces to OTR chambers in next week.*

The gate valve was rotated to make their vertical wakes symmetric .

*Since the evaluated phase jitter was strongly correlated to the signal jitter,
it is difficult to evaluate the signal jitter quantitatively by IP-BSM signal.*

The measurements and reductions of the jitters for QF1 and QEA magnets were done.