ATF2 beam tuning status in 2015 (after the last ATF2 project meeting)

Intensity Dependence

Minimum IP beam size

IP beta evaluation with random jitter source

Beam stabilization

Toshiyuki OKUGI, KEK

2016/01/14

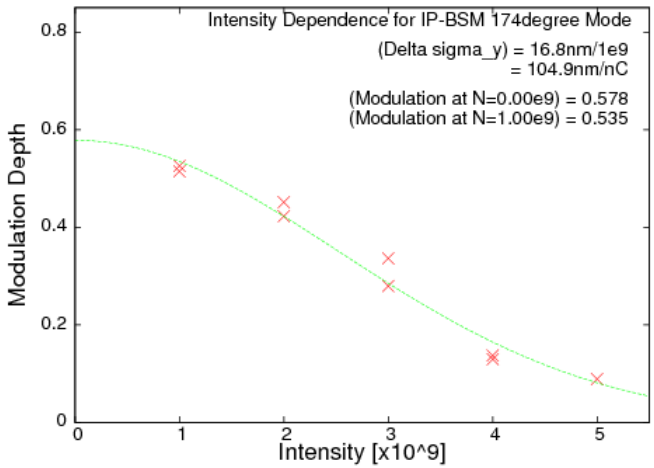
ATF2 Project Meeting.

LAL, France

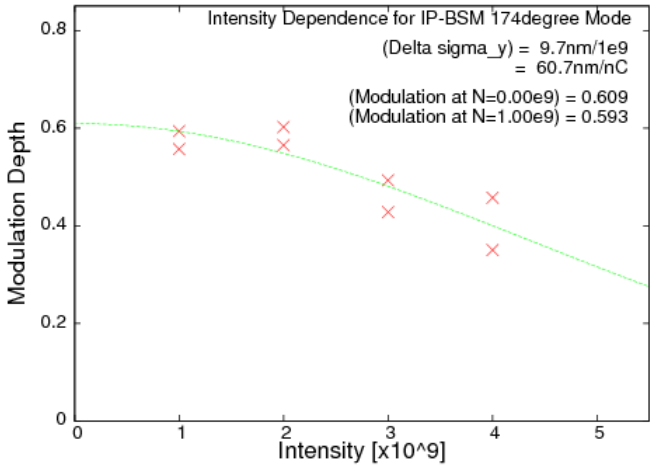
Intensity Dependence

Intensity dependence of 2014 spring operation

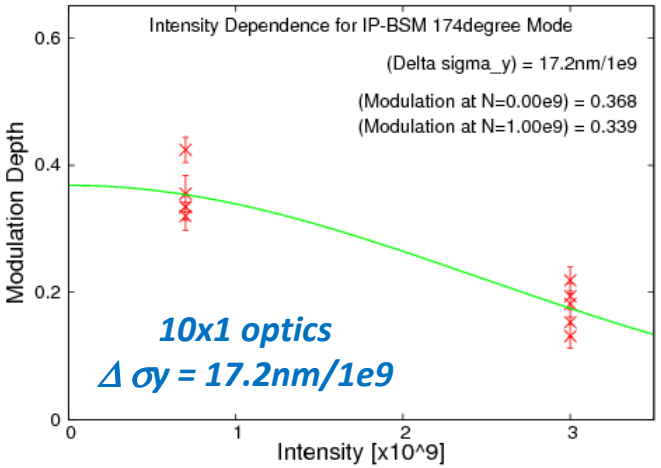
Before OTR2 position optimization
Δ σy = 16.8nm/1e9

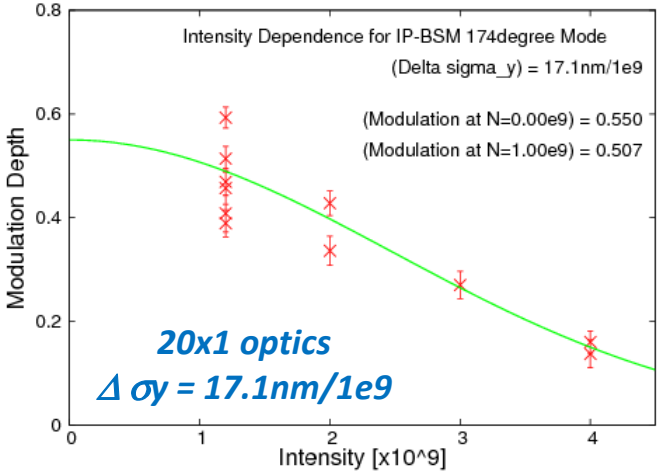


After OTR2 position optimization
Δ σy = 9.7nm/1e9



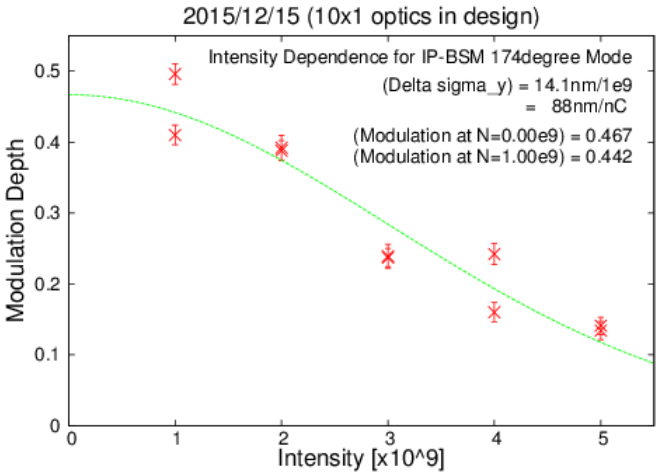
Intensity dependence of 2015 spring operation

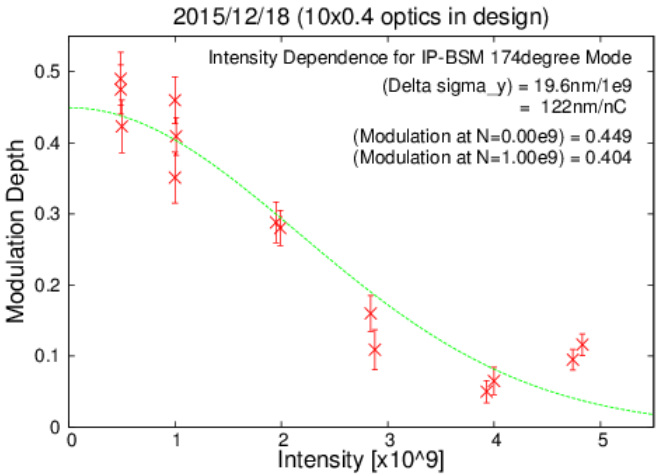




Intensity dependence was large, even after OTR2X-Y position optimization.

Intensity dependence of 2016 autumn operation





Date	Optics	OTR optimization	Peak Modulation	Intensity dependence
2014/06	20 x 1	No	0.578	16.8 nm/1e9
2014/06	**20 x 1**	**Yes**	**0.609**	**9.7 nm/1e9**
2015/06	10 x 1	With shim	0.368	17.2 nm/1e9
2015/06	20 x 1	With shim	0.550	17.1 nm/1e9
2015/12	10 x 1	With shim	0.467	14.1 nm/1e9
2015/12	10 x 0.4	With shim	0.449	16.9 nm/1e9

The smallest intensity dependence was observed at 2014/06 after OTR chamber optimization.

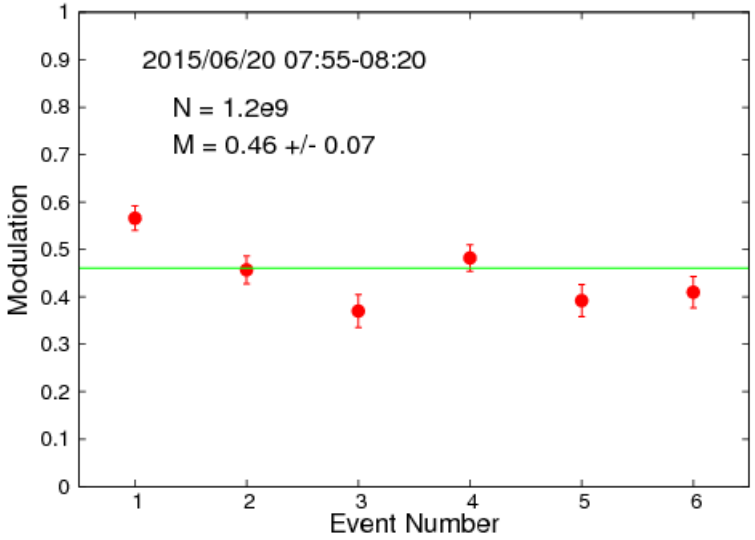
In 2014 summer shutdown, we put the symmetric shims to OTR chambers.

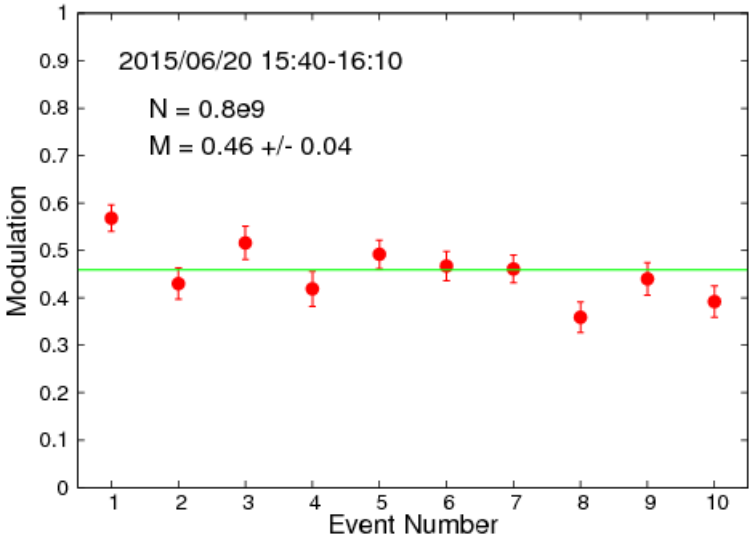
The OTR chamber position dependence was small after we put the shims,
but the optimum intensity dependence was small level before the OTR chamber optimization.

Minimum IP Beam Size

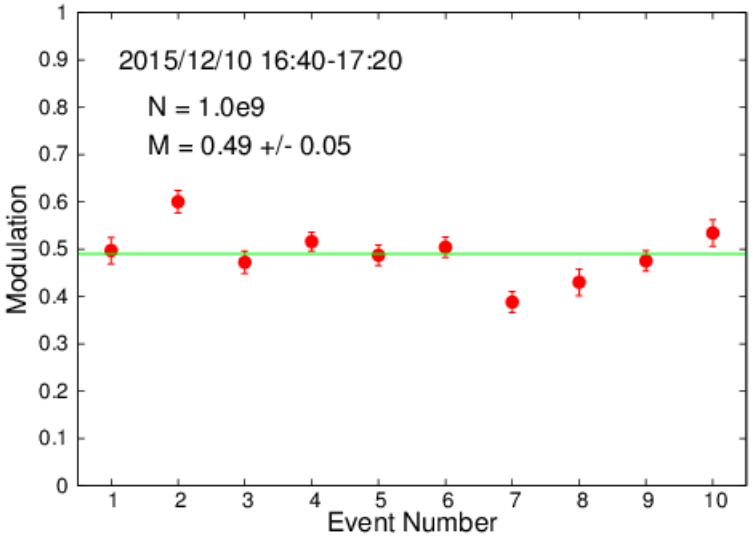
Continuous IP beam size measurement in 2015

Beam Size for 20x1 optics in June 2015





Beam optics ; 10x1 in design

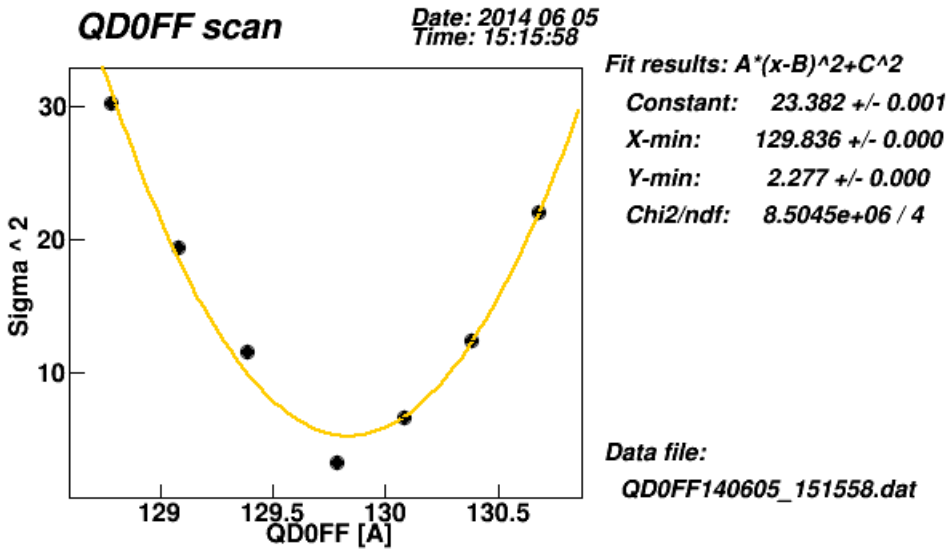


Date	Optics	Charge	Modulation	Beam Size
2014/06/12	**20 x 1**	**0.6e9**	**0.58**	**44 nm**
2015/06/20	20 x 1	1.2e9	0.46	53 nm
2015/06/20	20 x 1	0.8e9	0.46	53 nm
2015/12/10	10 x 1(*)	1.0e9	0.49	50 nm

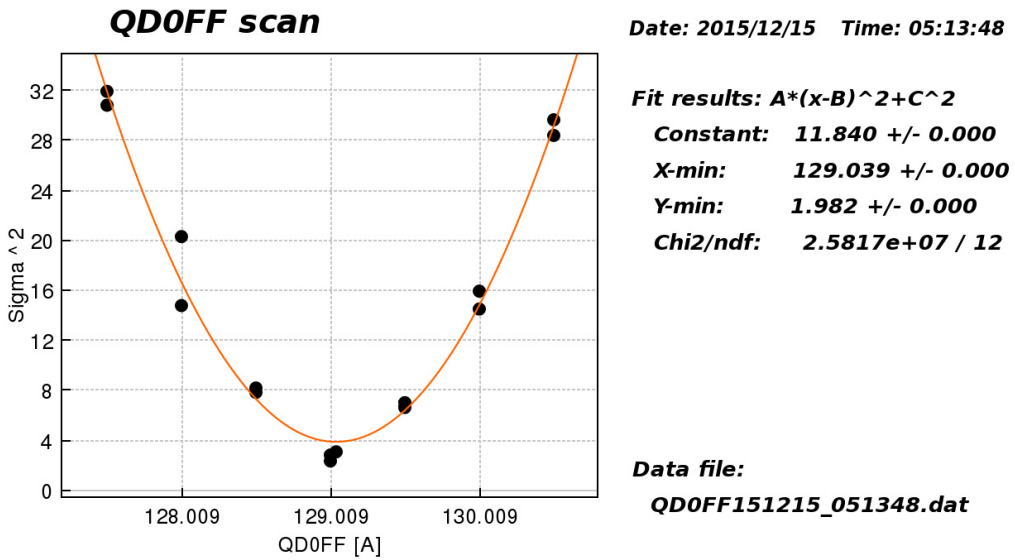
The vertical IP beta at 2015/12/10 was design optics.

The other vertical IP betas were adjusted by QD0FF scan.

2014/06



2015/12 (10x1 optics in design)

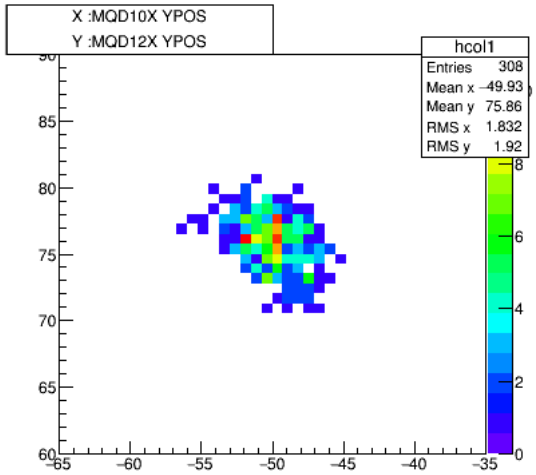


The beam divergence at 2015/12 was half to 2014 spring operation.

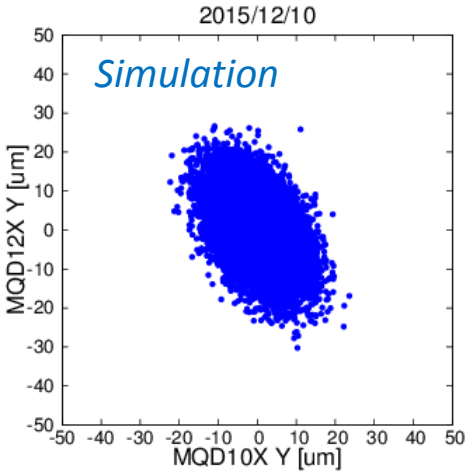
IP beta evaluation with random jitter source

RND jitter distribution (2015 December)

Beam Jitter Distribution (2015/12/10)



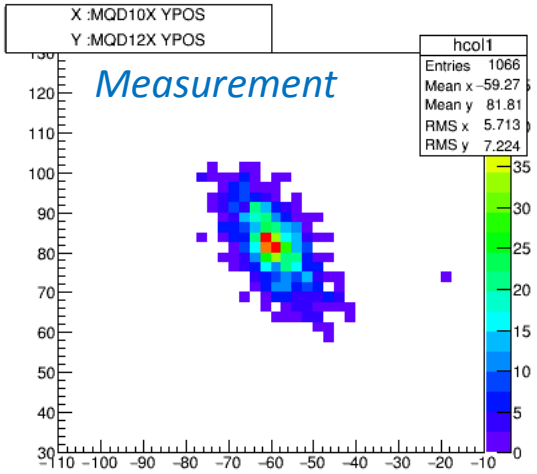
RND jitter Distribution in 2015 December



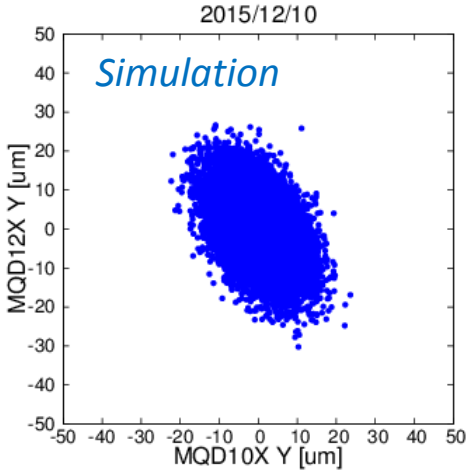
RND jitter was set to be same profile to the beam jitter.

Ay = 8.2pm at (Amplitude)=0.5

Bmag = 1.16



RND jitter Distribution in 2015 December



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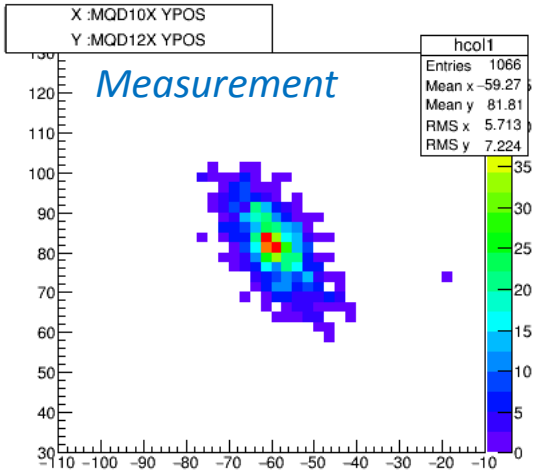
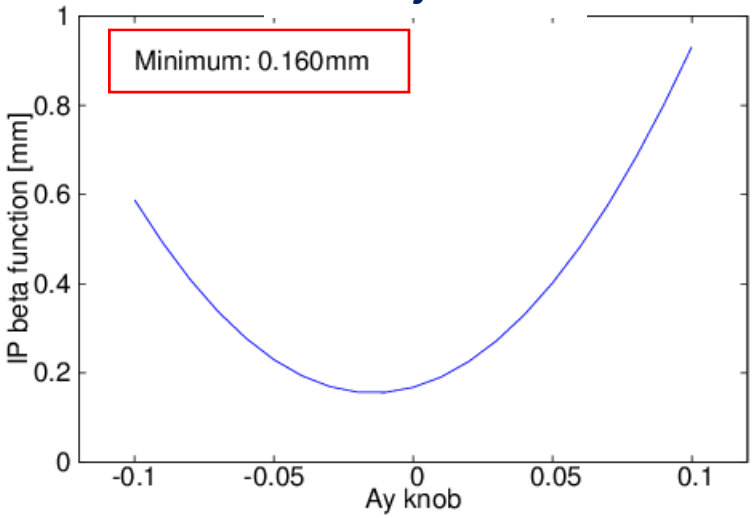
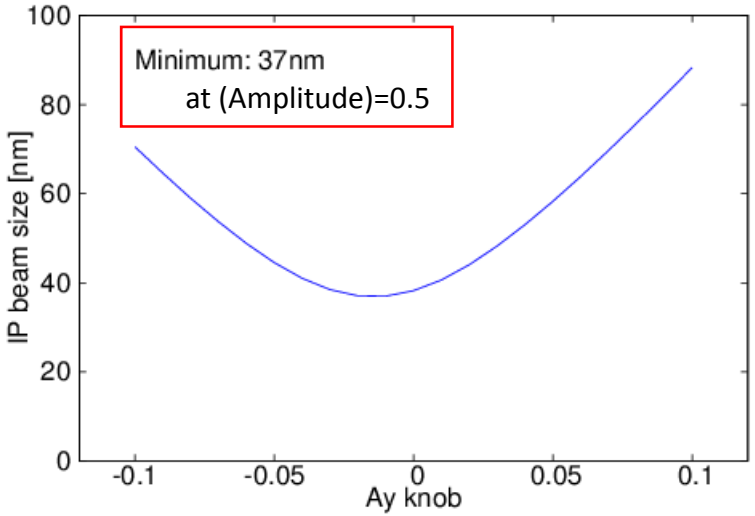


Beam jitter propagation to IP by optics model

IP beta function



IP rms jitter distribution

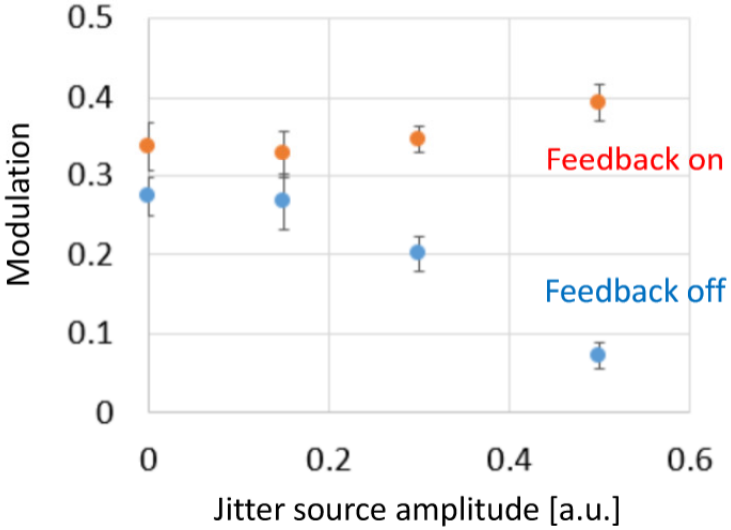


Beam Size Enhancement with RND jitter

Presented by Y. Kano
at ATF operation meeting
(2015/12/18)

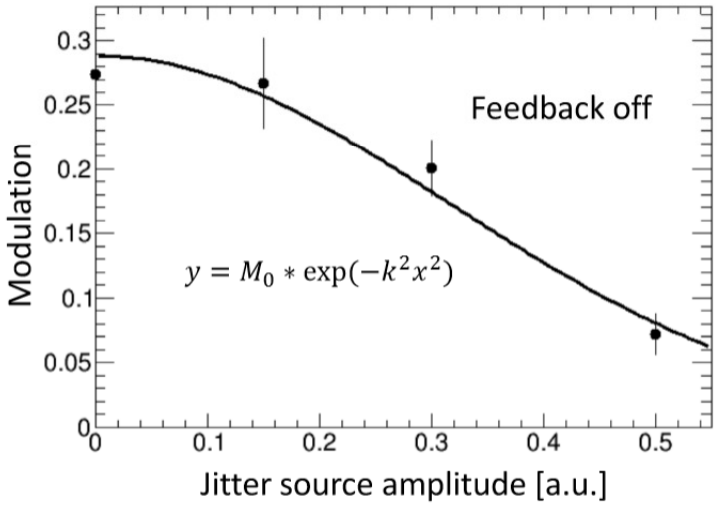
Jitter source amplitude dependence

$$\text{Bar} = \text{fit error} * \sqrt{\chi^2/n_{dof}}$$



Fit result of jitter amplitude dependence

$M_0 = 0.29$
$\sigma_{\Delta y,IP} = 68$ @ 0.5 a.u.
$\chi^2/n = 1.5/2$



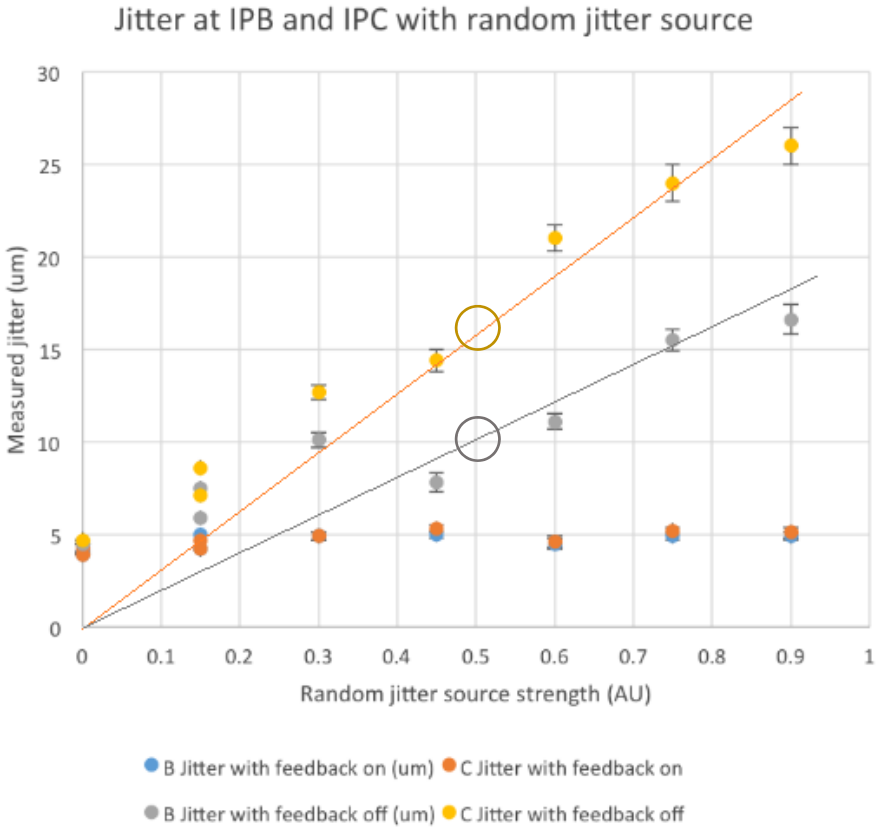
(Delta sigma_y*) = 68nm at (Amplitude)=0.5

- *(IP phase jitter) → **IP position jitter (37nm)***
- *(FD phase jitter) → IP position jitter*
  → Beam size growth

through wakefield and multipole field

Jitter propagation with optics model

Beam Jitter Observation from FONT IP-BPM data



Presented by N. Blaskovic
at ATF operation meeting
(2015/12/18)

(Kano-san's analysis)

(Delta sigma_y*) = 68nm at (Amplitude)=0.5

(IP phase jitter) → ***37nm*** → ***51nm***

(FD phase jitter) → *IP position jitter*
→ *Beam size growth*
through wakefield and multipole field

(Amplitude Ay) = 0.5

(IP Divergence) = (16um+10um)/2 / 0.08m = 160urad

(BetaY) = 8.2pm / (IP Divergence)^2 =* *0.32mm*

3 times larger than design

Optics mismatch between EXT to IP

Large IP beam size

In the 2015/12 operation,
It seems the IP beta function was evaluated to be larger than design
both for QD0FF scan (IP divergence) and the evaluation with random jitter.

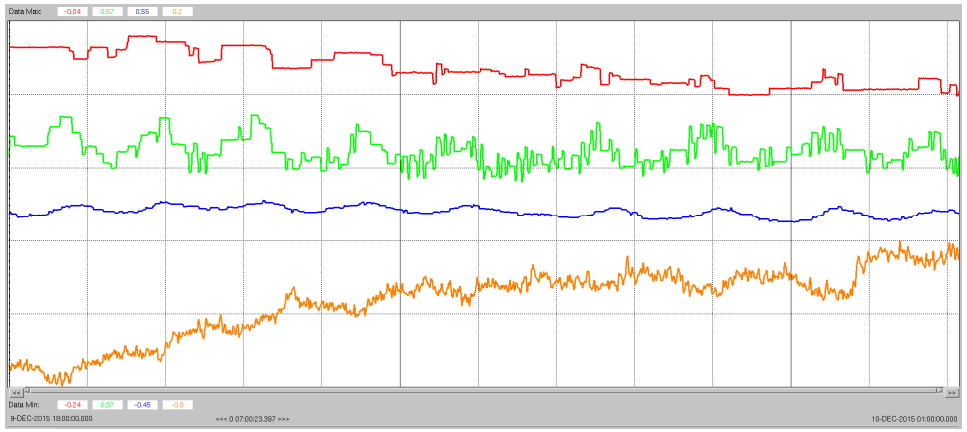
Since we can know the amplitude of the jitter for random jitter source,
we will be able to evaluate the beta propagation on only to IP,
but also through all of beam line with the random jitter source.

I expect that we can investigate the detail beam optics with random jitter source.

Beam stabilization

Feedback Kicker Amplitudes in Beam Tuning

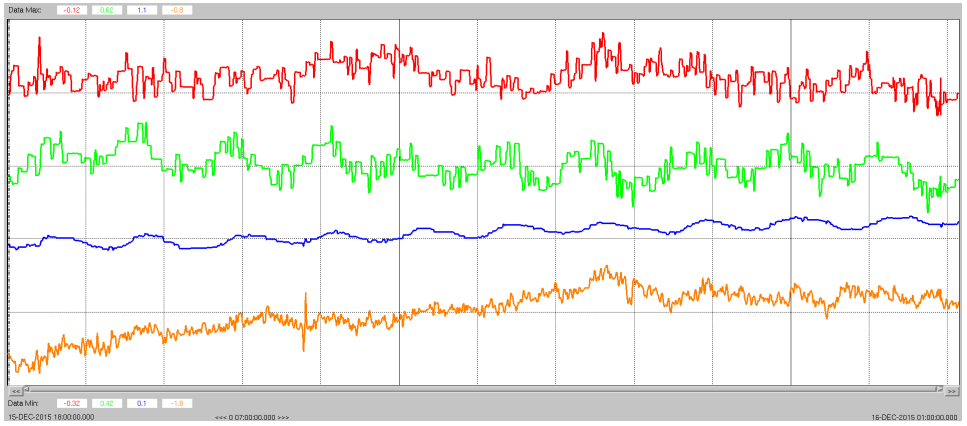
Feedback Kicker Amplitude : 12/09 18:00 – 12/10 01:00



Horizontal ZH4X, ZH5X (0.2A full range)
Vertical ZVFB1X, ZVFB2X (1.0A full range)

- *Horizontal jitter for 12/15 was larger that that for 12/15.*
- *We observed 40-50 minutes interval oscillations both for horizontal and vertical orbits.*

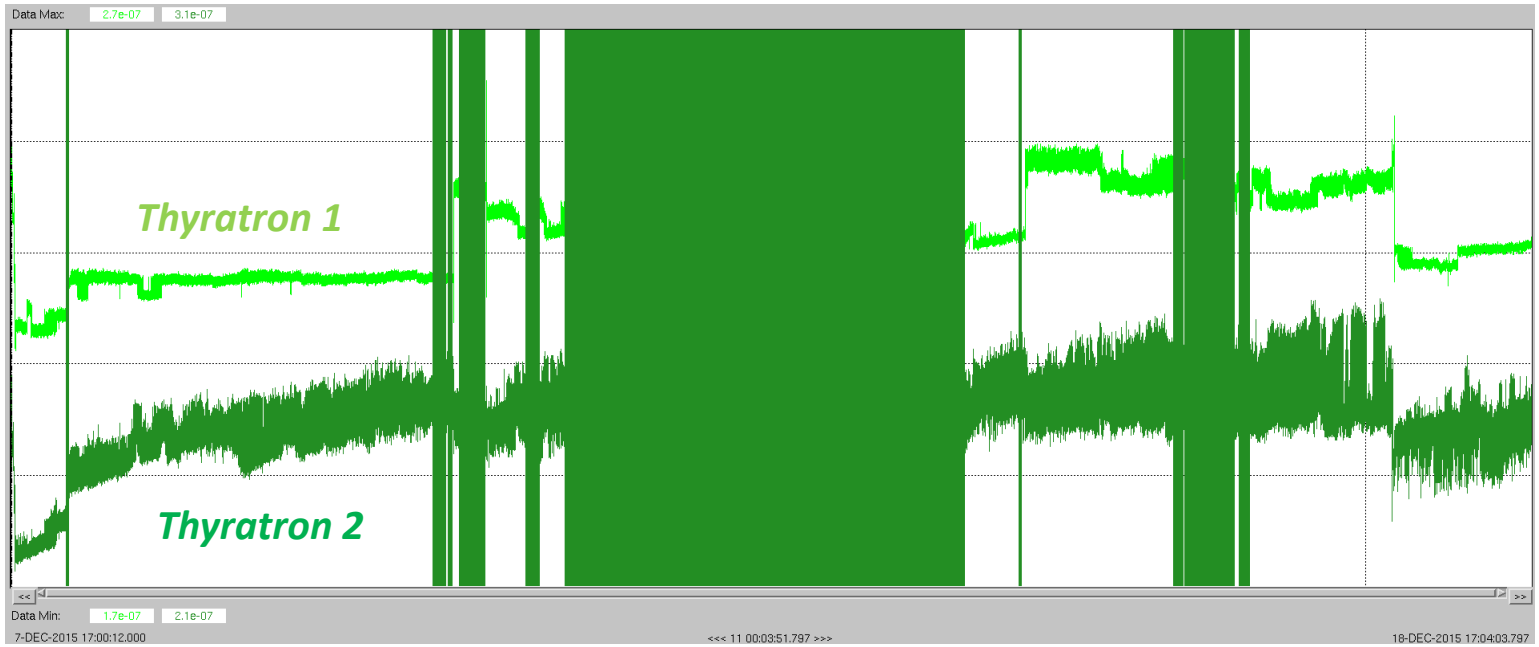
Feedback Kicker Amplitude : 12/15 18:00 – 12/16 01:00



- *Minimum step for FB horizontal steerings were too large to stabilized the horizontal orbit.*
- *Since the steerings were iron core magnets, the hysteresis affects to the magnets.*

Timing Jitters in 2015 December

12/7 - 12/11 **12/14 - 12/18**



circuit board replaced for interlocked

2 bunch operation

Weekend shutdown

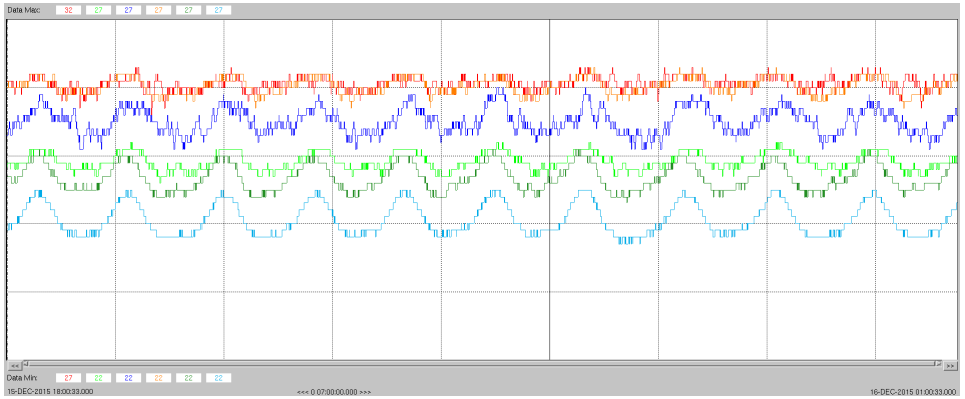
2 bunch operation

Reserver voltage was increased.

- *The timing jitter of extraction kicker was increased after we replaced the control boards in control chassis.*
- *The timing jitters for 2nd week was larger than 1st week (maybe reason of large horizontal jitter) .*
- *Naito-san will check the control boards and he also plan to change the kicker cable connection to be single kicker system in 2016 spring.*

Air conditioner in DR

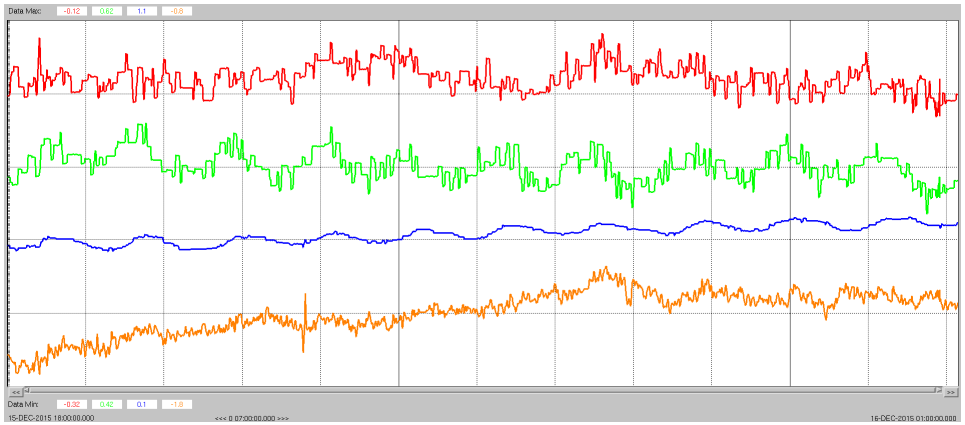
Air Temperature: 12/15 18:00 – 12/16 01:00



The air temperature in DR
was oscillated within +/-1 degreeC.
(vertical range is 5 degreeC)

The specification of air conditioner is
+/- 1 degreeC.

Feedback Kicker Amplitude : 12/15 18:00 – 12/16 01:00



The amplitude of feedback correctors
were synchronized to the DR temperature.

Naito-san will try to stabilize the temperature more.

Other Hardware Improvements

2015 operation

- Put 2 vertical air-core steering magnets
to be stable the IP jitters both for IP and FD phases.

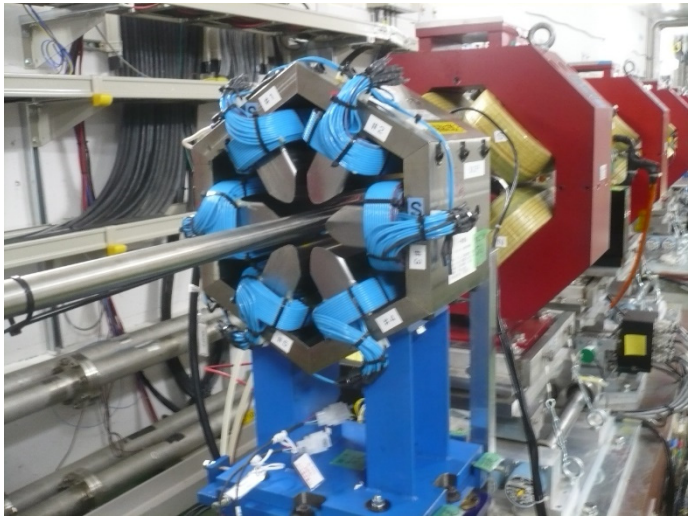
2016 January

- Put 2 horizontal air core steering magnets.
It will be installed tomorrow.

- Modify the skew sextupole magnets to be strong.
3 magnets were already installed.
One more magnet is installing now.

- Remove the bellows around FD area to reduce the wake.

New skew sextupole magnets

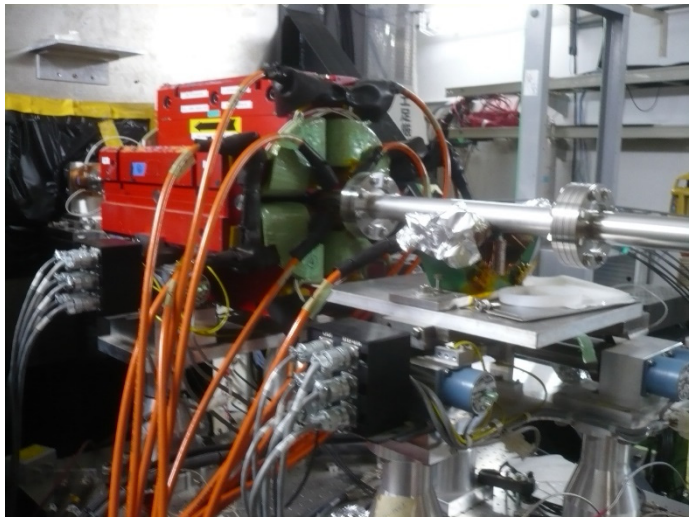


SK1FF – SK4FF were put to same location to previous magnets.

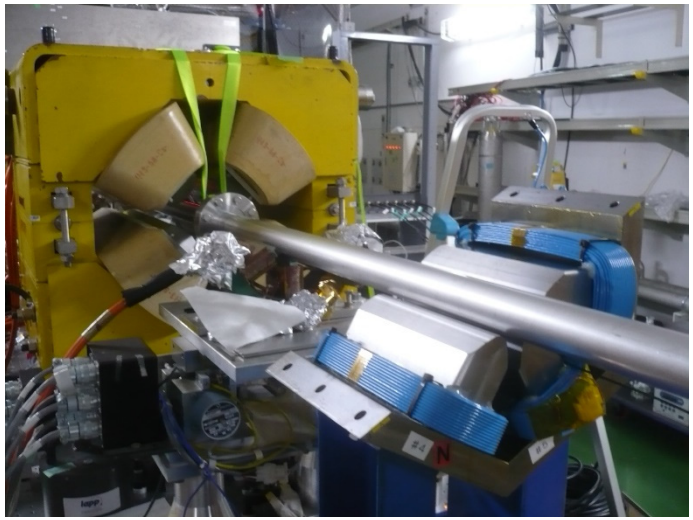
Bore diameter was reduced from 160mm to 60mm.

The strength will be increased by factor 7.

FD chamber modifications



QDoFF & SD0FF



QF1FF & SF1FF & SK1FF

Summary

Intensity dependence in 2015 operation was larger
than that for 2014 spring operation after OTR position optimization.

- We will remove the bellows in FD section in 2016 January.

The minimum IP beam size was larger than that for 2014 spring operation.

- We will investigate IP beta function carefully with random jitter source,
and will match the beam optics all through the beam line.

- We will stabilize the beam
  - by stabilize the extraction kicker timing.
  - by stabilize the air temperature in DR room.
  - by stabilize the horizontal beam position with air core steering magnets.

We will tune the 2nd order optics by using skew sextupole magnets.