Simulation of IP beam size with orbit jitter + wakefield in EXT-FF

ATF2 Project Meeting 20150225

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Motivation

- We observed orbit jitter in EXT-FF line about 0.3-0.5σ of nominal beam size.
- Orbit jitter at wakefield sources in high-beta region can increase beam size at IP.

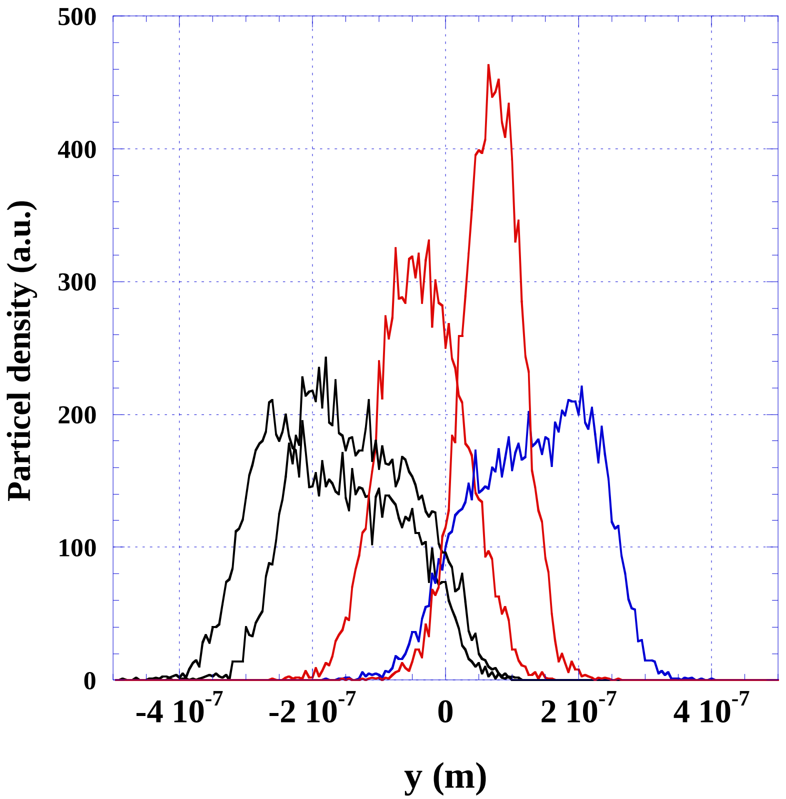
- 0.5σ jitter will increase measured beam size at IP only 12% without wakefield.
- But, with wakefield, effect may be significant.

Simulation procedure (using SAD)

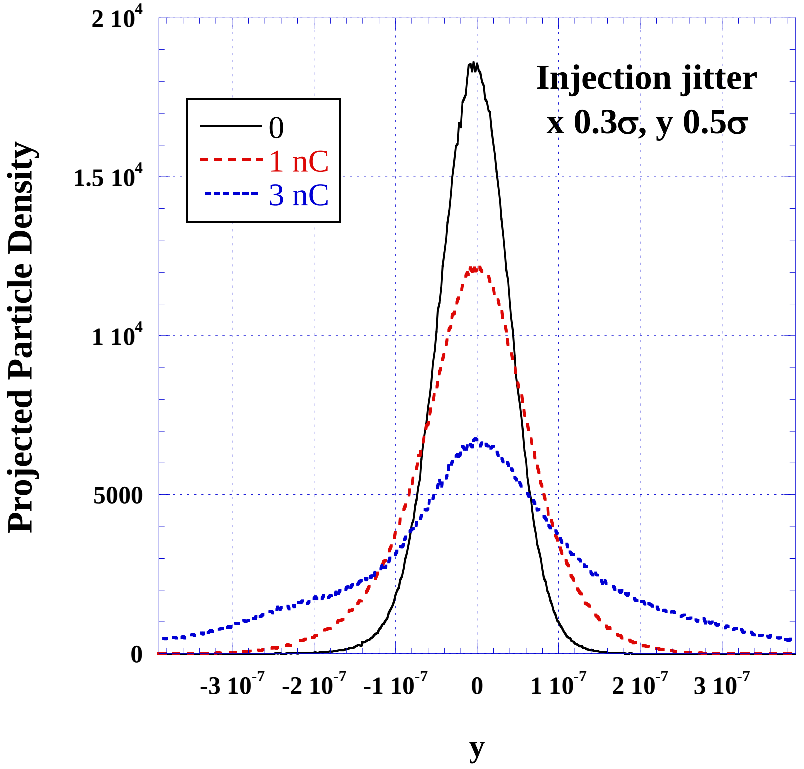
- Perfect beam line (no errors)
- Beam at entrance of EXT line
  - Emittance x/y = 2nm/12pm, energy spread 0.08%, bunch length 7 mm (10,000 macro particles)
  - Orbit jitter is given randomly, 2 cases of amplitide
    - X 0.3σ, y 0.5σ and X 0.3σ, y 0.3σ
- Only cavity BPMs are included as wakefield sources
  - Use calculated by Alexey Liapin, for bunch length 7 mm
- Set bunch charge (0 ~ 5 nC/bunch)
- Perform tracking in EXT-FF line.
- Look at beam size at IP and modulation of IPBSM

Projected profile (y distribution) at IP

5 examples of vertically projected single bunch profile at IP

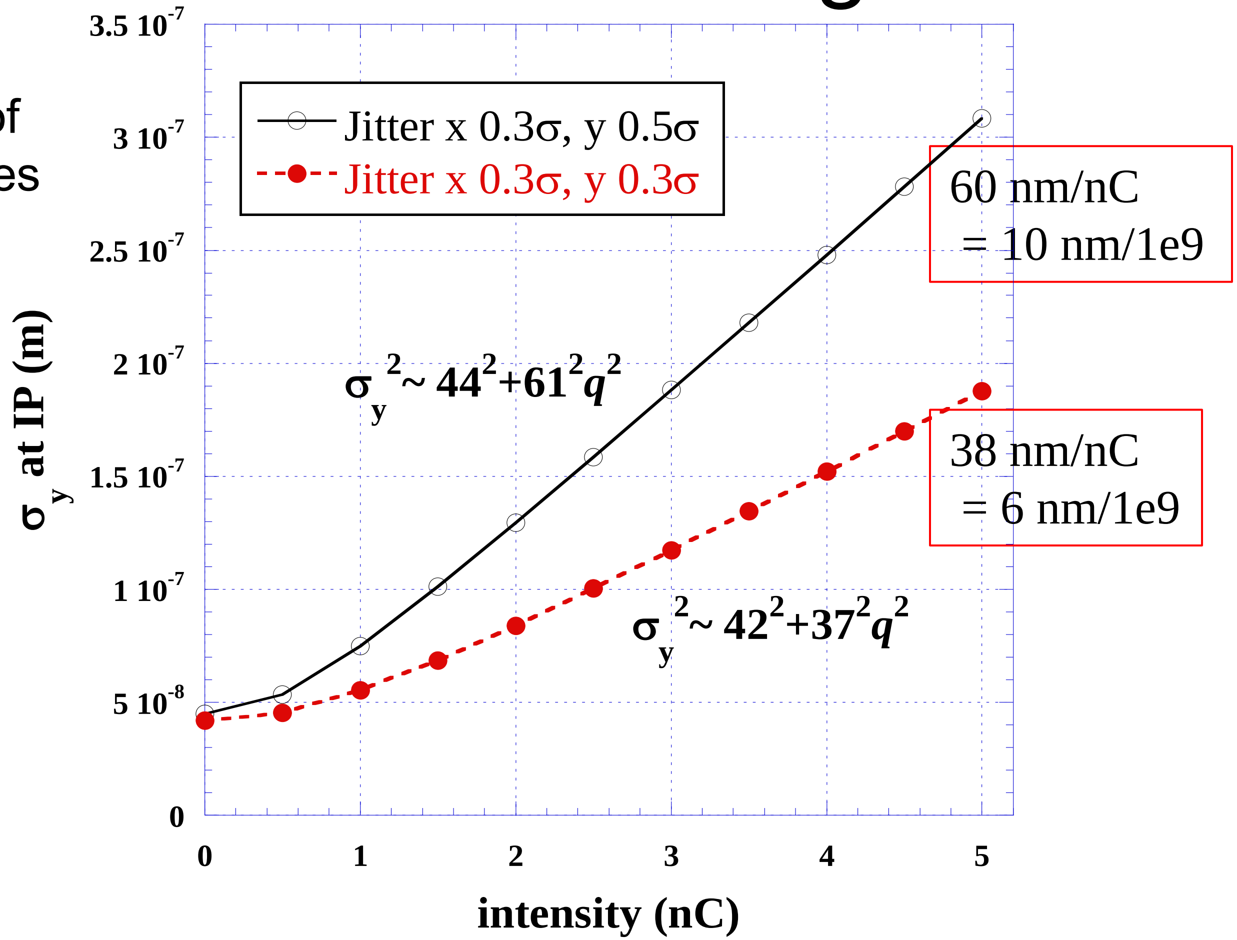


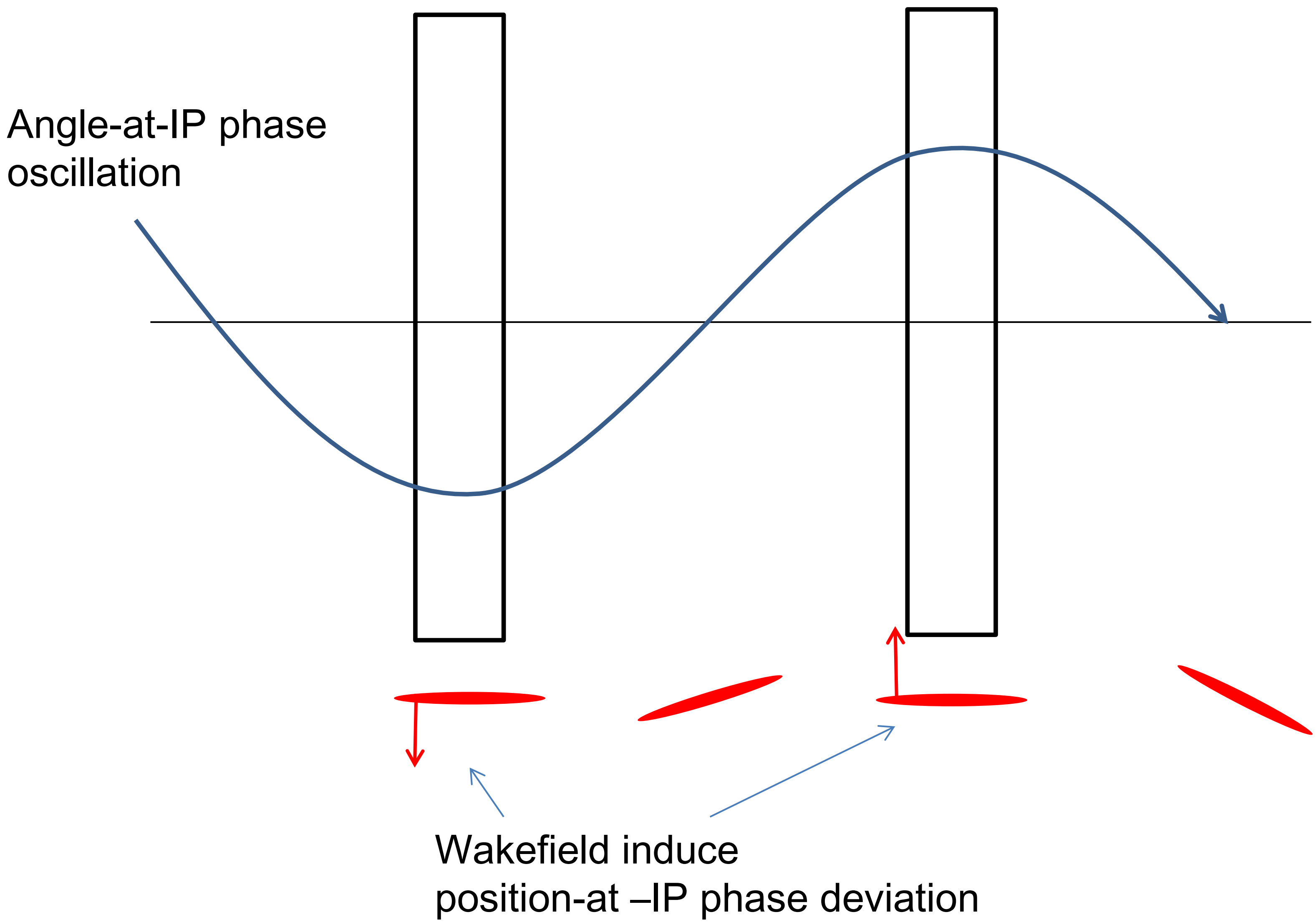
vertically projected profile of 100 pulses at IP (3 charge/bunch)



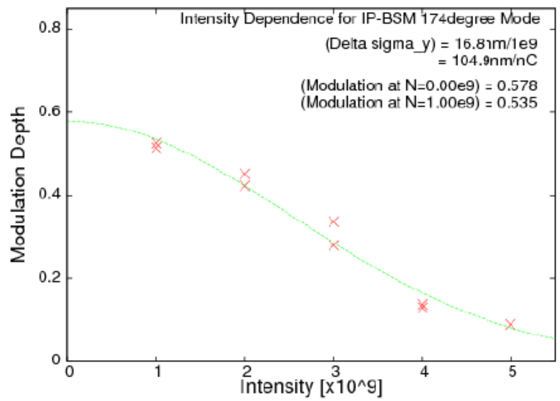
projected beam size at IP vs. Wakefield strength

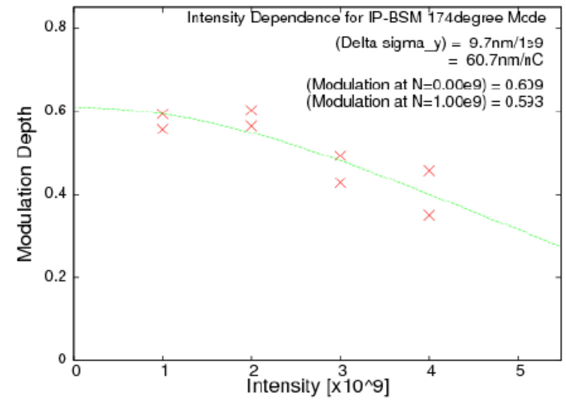
Projection of 100 bunches




Angle-at-IP phase
oscillation
Wakefield induce
position-at –IP phase deviation

Before OTR2X position optimization　　After optimization　　(174 deg mode)





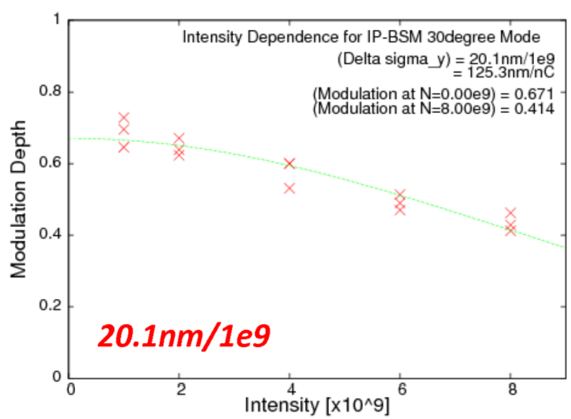
By Okugi, 2014.6.23

図 2　先々週測定した OTR2X の移動前後のビーム強度依存性（左は移動前、右は移動後）。

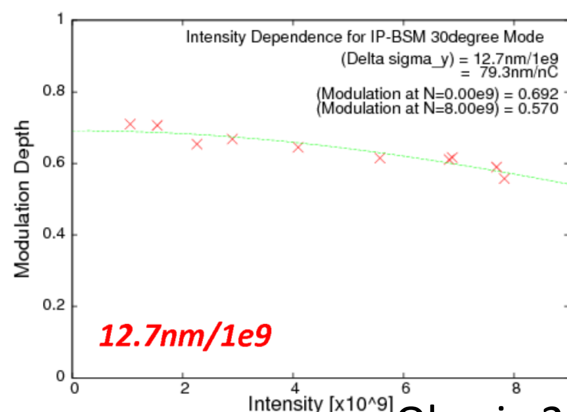
16.8 nm/1e9 → 9.7 nm/1e9

Removal of all OTRs　　(30 deg mode)

Intensity dependence before OTRs removal



Intensity dependence after OTRs removal



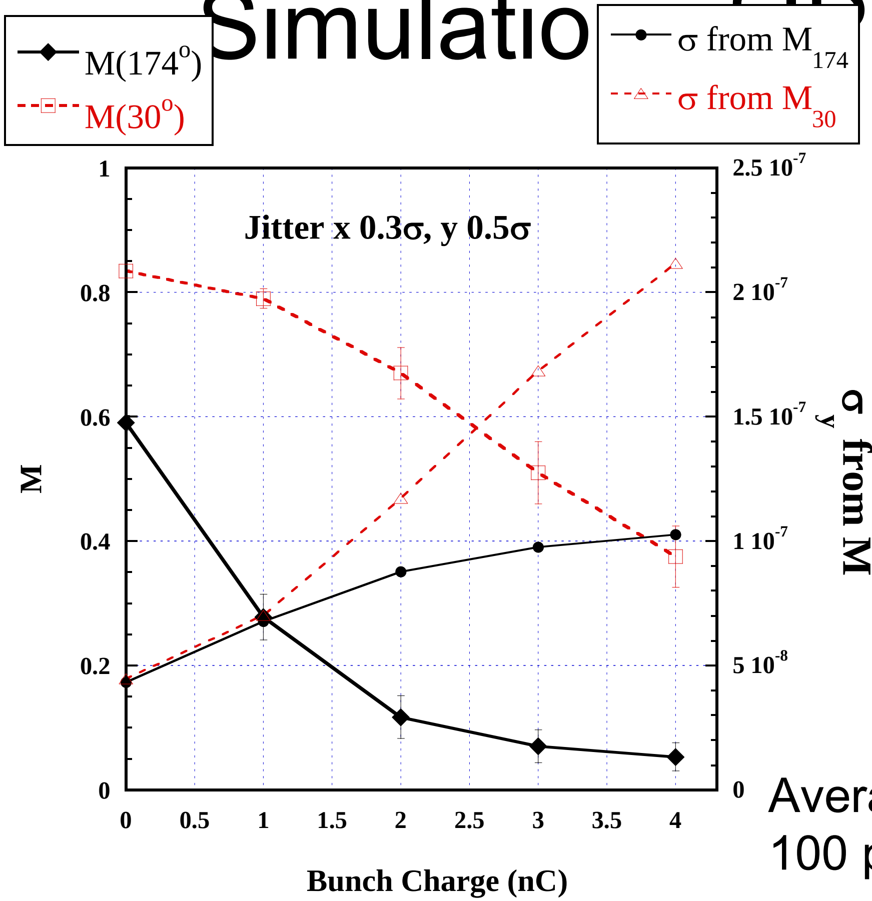
Okugi, 2014.6.26 ATF Op. meeting

20.1 nm/1e9 → 12.7 nm/1e9

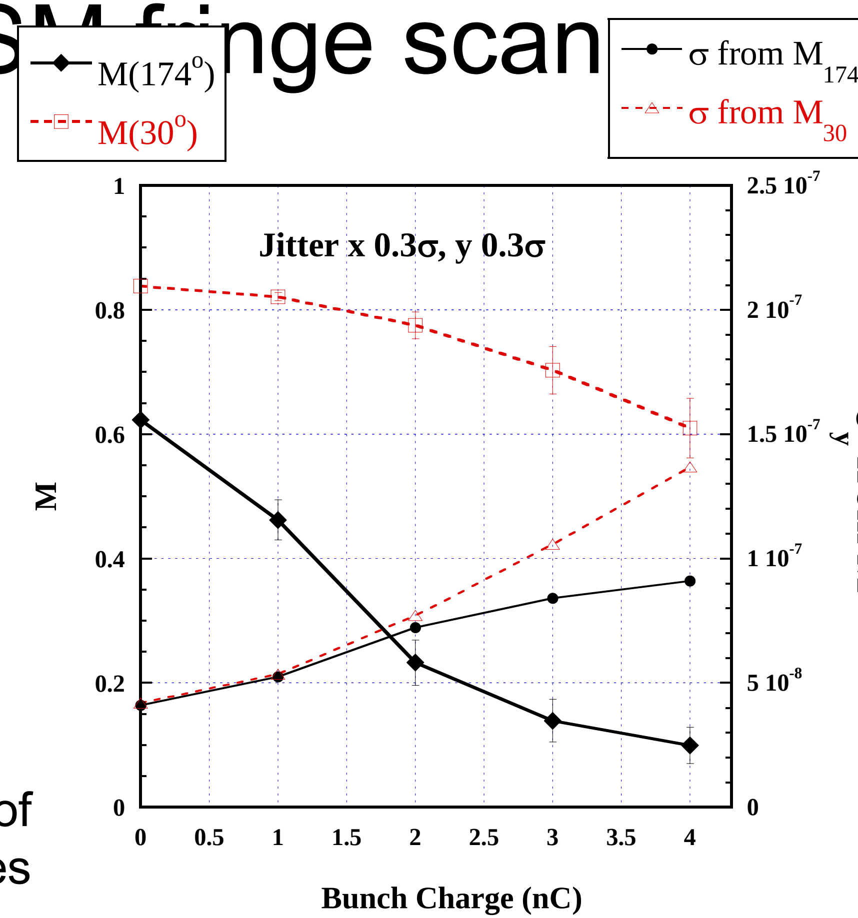
30 deg mode tend to give stronger dependence than 174 deg mode.

Slide by K.Kubo in ATF operation meeting Nov 7, 2014

Simulation of IPBSM fringe scan



Average of 100 pulses



(174 deg mode underestimate large beam size)

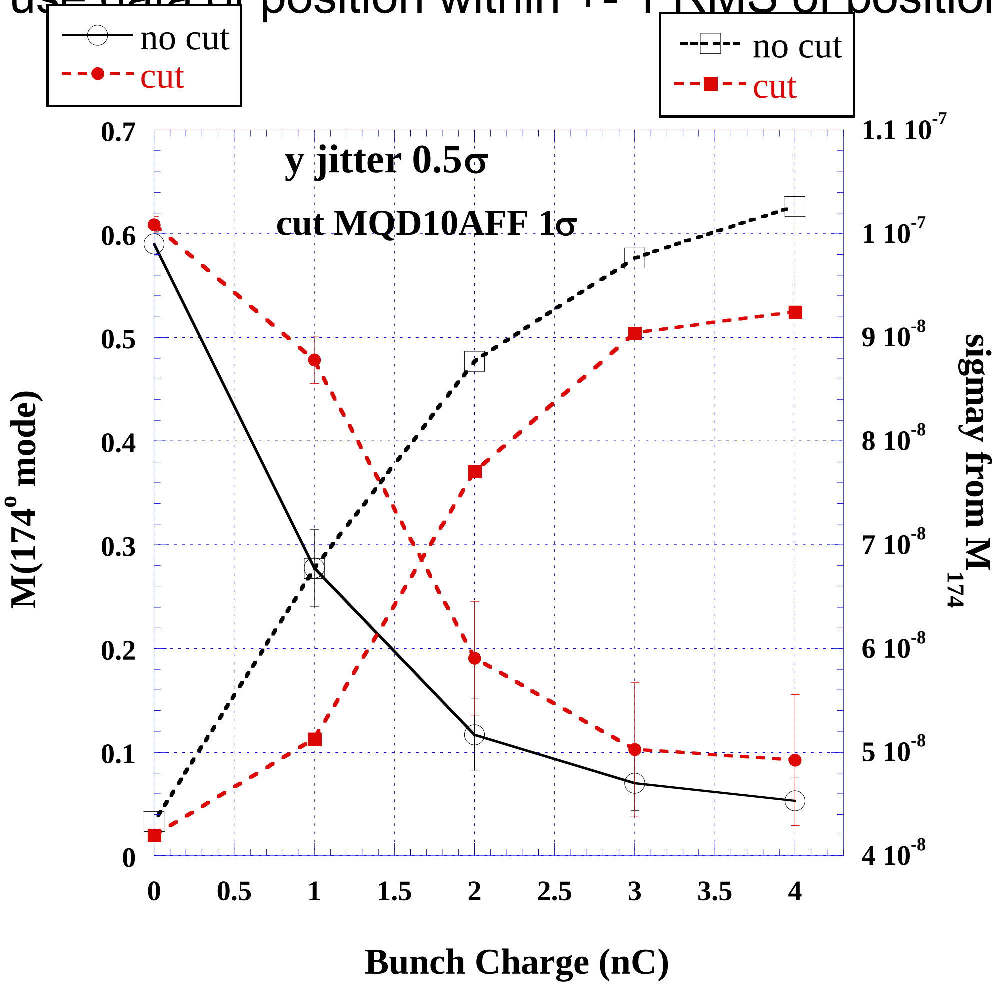
w for lower intensity, assuming

$$\sigma_y^2 = \sigma_{y,0}^2 + w^2 q^2$$

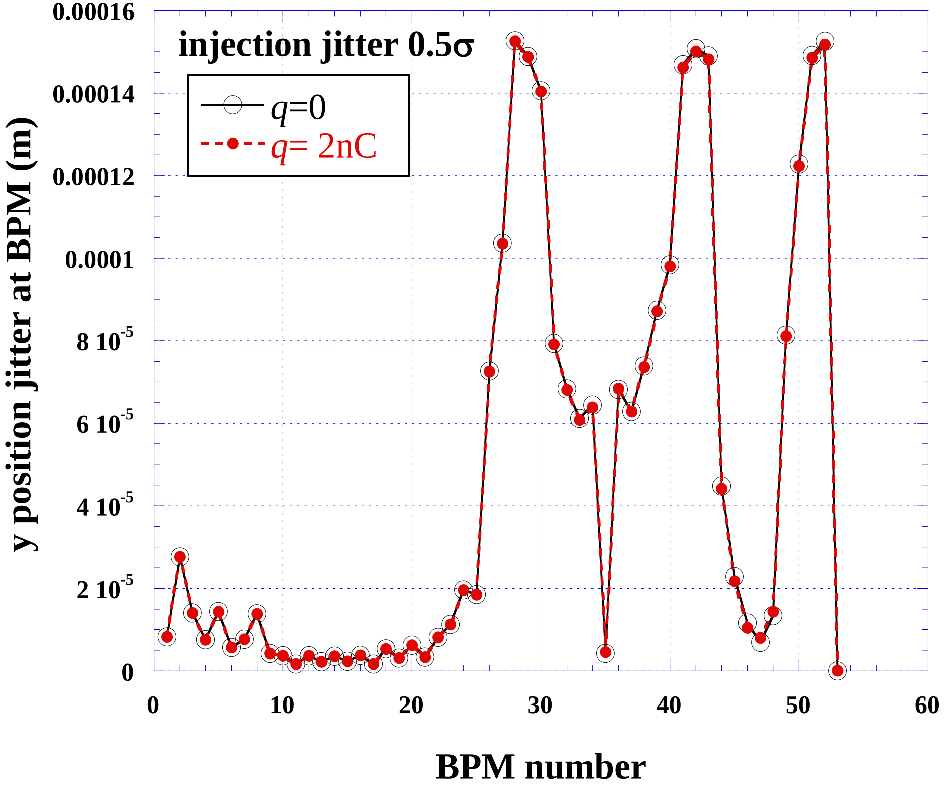
	Jitter 0.5σ	Jitter 0.3σ
174 deg mode	52	33
30 deg mode	54	33

Data selection by BPM in FF

Simulate data selection by MQD10AFF, compared
all data used and
use data of position within +- 1 RMS of position jitter



Jitter at BPMs



From simulation of 500 pulses

Wakefield enhance orbit jitter of almost only "position-at-IP-phase". It is hard to detect by BPMs in the beam line. (Except for IPBPM)

Summary

- Tracking simulation of injection orbit jitter + wakefield performed for studying intensity dependence of IP beam size.
- Large orbit jitter and strong wakefield can explain observed intensity dependence.
  - 0.5σ orbit jitter and 1.1~1.4 times stronger wake than CavBPM
  - 0.3σ orbit jitter and 1.7~2.1 times stronger wake than CavBPM

  May explain intensity dependence of 60~75 nm/nC
- Jitter enhancement by wakefield will not be directly detected by BPM, except IPBPM.
- But, data selection for in IPBSM analysis, using BPM position, should be effective, if this effect is significant.
  - For analysis of real data, synchronization of BPM and IPBSM data is the problem.
- Wakefield sources at high beta region are important.
  - Can we reduce/remove them?