Intensity dependence- Wakefield

20140214

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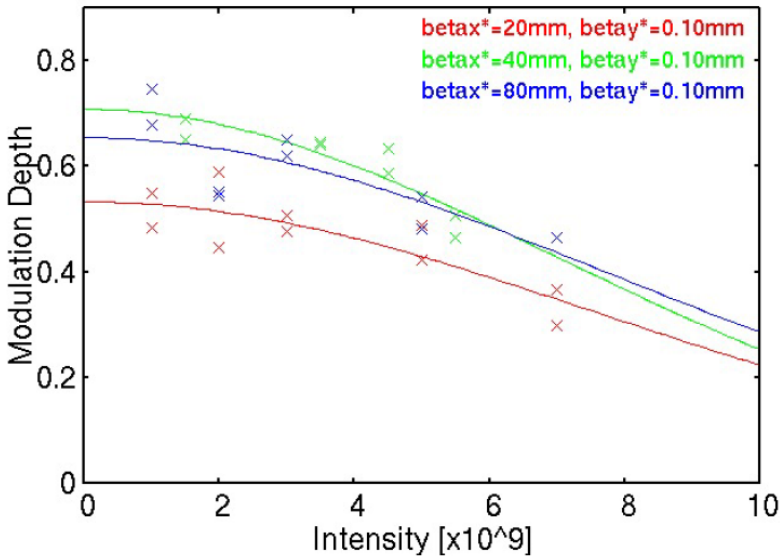
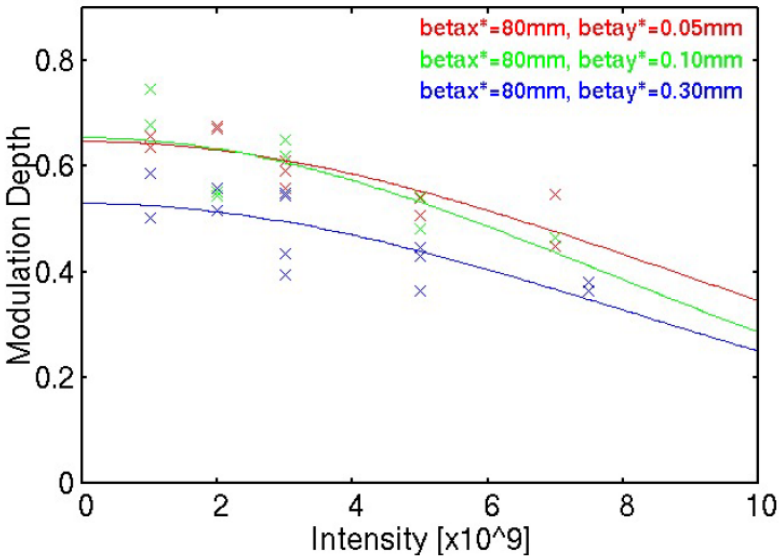
- Very brief summary of studies so far
- Proposed Plan & Ideas
- On IPBPM as beam tilt monitor

Okugi's slide

Intensity Dependence

Intensity Dependence measured with IP-BSM 30 degree mode.





Fitted:

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

$$w \approx 20\ \text{nm/1E9}$$

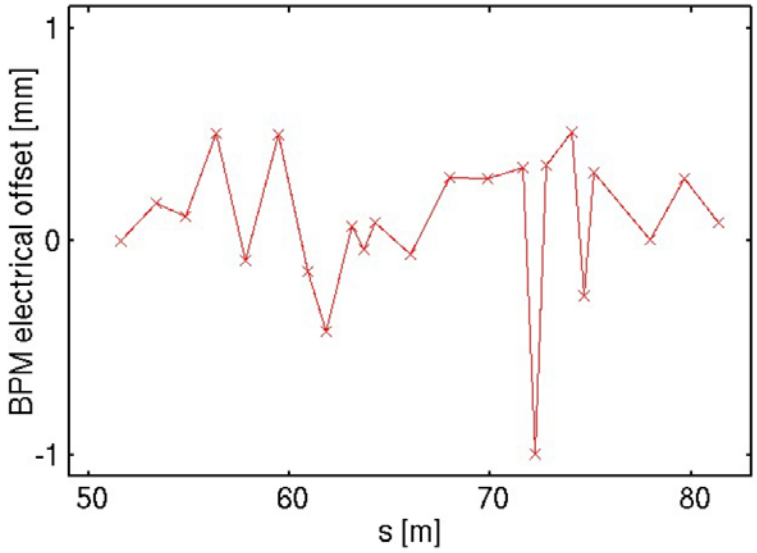
(K.K.)

betax*	betay*	Beam Size Growth
20mm	0.10mm	21.6nm/1e9
40mm	0.10mm	23.5nm/1e9
80mm	0.10mm	21.0nm/1e9
80mm	0.05mm	18.3nm/1e9
80mm	0.30mm	20.0nm/1e9

Okugi's slide

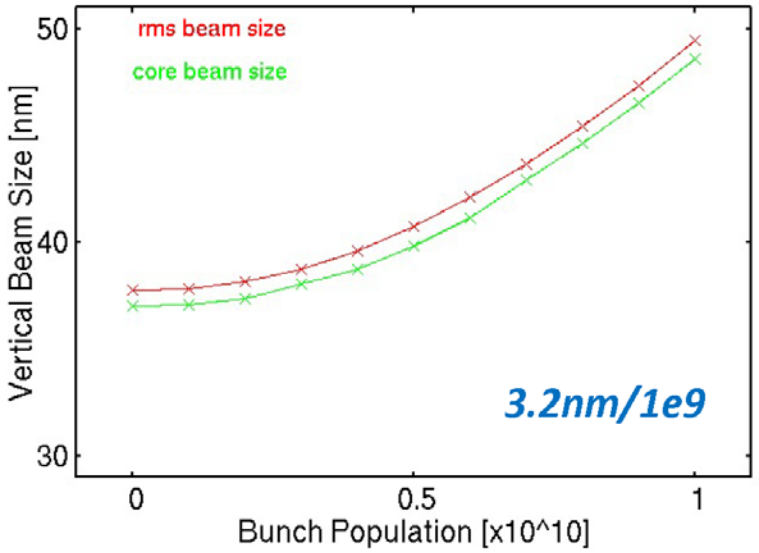
Expected beam size growth from the cavity

Beam orbit with respect to electrical center of C-band BPMs



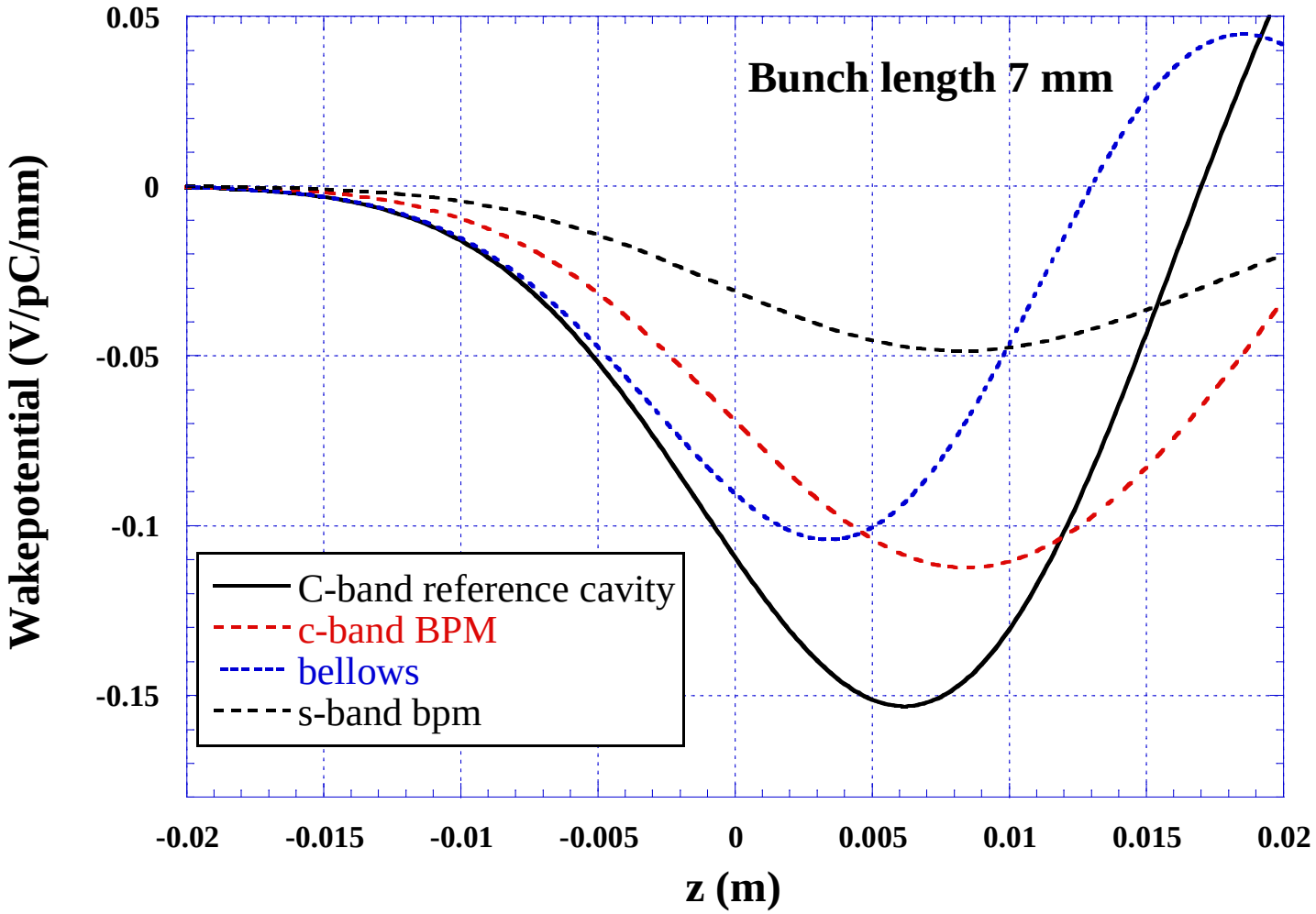
Expected IP vertical beam size growth

For V=-0.16V/pC/mm



This calc. Included cavity BPMs only.
May underestimate wakefield.
But factor 6 difference seems too much.

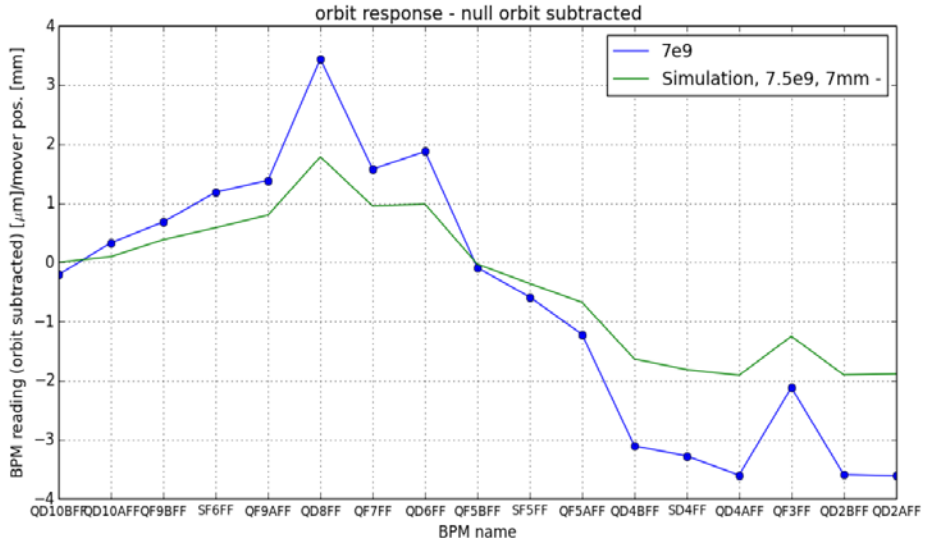
Examples of wake calculations



Calc. by A. Lyapin

More calculations

Comparison with simulation

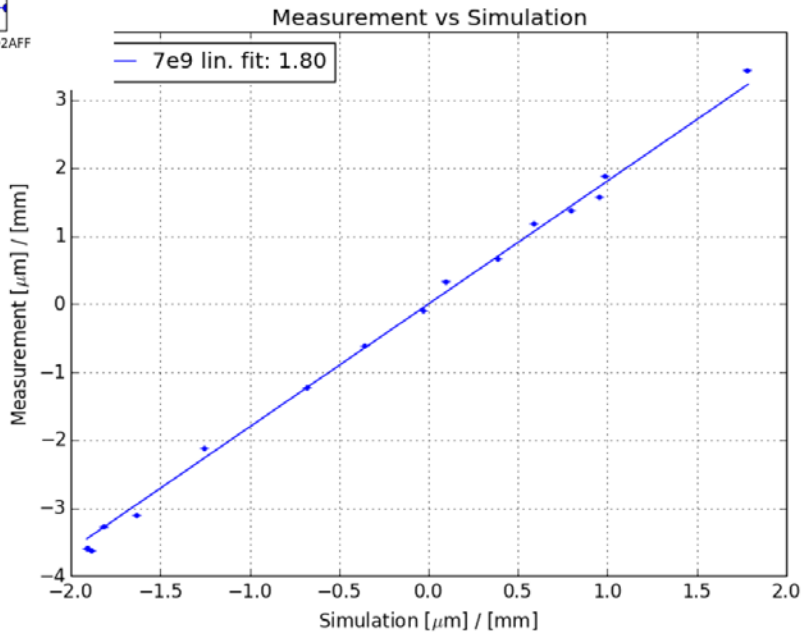


J.Snuverink, et.al., LCWS2014

Wake source on mover experiment
-- orbit change

- Measured orbit shape agrees well
- Measured effect is 0.7 V/pC/mm
- About a factor 1.8 larger than simulation (numerical calculation + tracking)
- Reduced from earlier factor of 2.0

- Possible discrepancy might be due to bunch length or underestimation by simulation



IP beam size vs mover position experiment and calc.

ATF2 weekly meeting 20130708 K.Kubo

Effect of wake source at the mover, offset 1 mm, bunch charge 1 nC.
IP beam size increase (nm/mm/nC)

	C-band ref.	No mask Bellows	Masked Bellows
Experiment	55	47~50	7
Calc	32.2	22.6	?

Factor 1.7 – 2.2 larger than calculation
consistent wit orbit change measurement

Reduction of wakefield

- Shield bellows
- Remove unused cavities (ref. cav. BPM)
- Move from high beta to low beta position
- Alignment

- No clear improvement observed so far.

Plans and ideas for further study of intensity dependence (wakefield)

- Wake-free steering
  - Proposal in TB meeting
  - Need to well tuned BPMs?
    - Resolution, intensity dependence,,,,,.
- IPBPM as a beam tilt monitor?
  - See next slides
- Deflection RF cavity (Dipole mode)
  - Need to check
    - Effective? (What can be studied? How much improvement?)
    - Hardware available?
- Reduction of wake
  - Shield discontinuities in beam pipe

IPBPM as beam tilt monitor ?

Point charge

$$V(t) \propto \frac{q}{L/c}\int_{-L/2c}^{L/2c}(y+\theta ct')\cos(\omega(t-t'))dt'$$

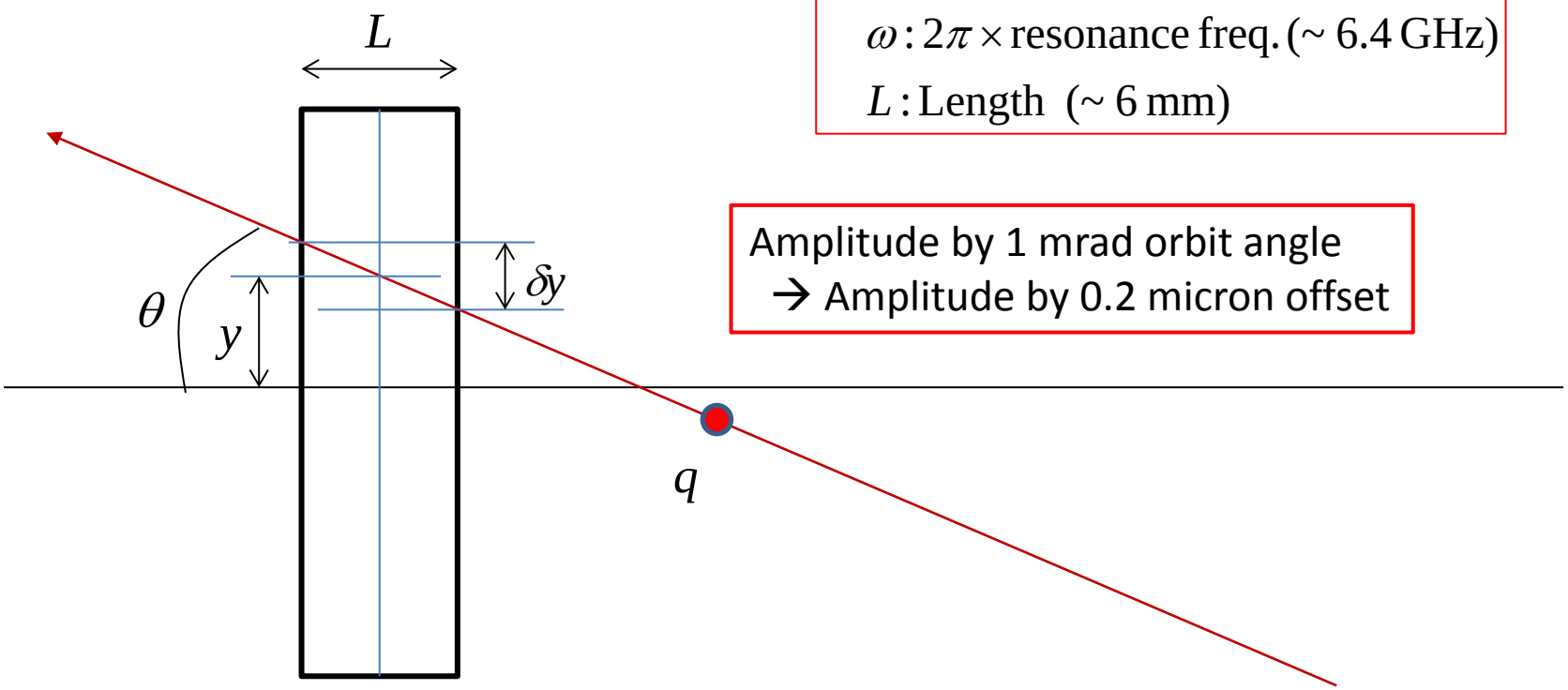
$$= qy\frac{\sin(\omega L/2c)}{(\omega L/2c)}\cos(\omega t) + q\theta\frac{c}{\omega}\left[\cos(\omega L/2c) - \frac{\sin(\omega L/2c)}{\omega L/2c}\right]\sin(\omega t)$$

$$\approx 0.97\times qy\cos(\omega t) - 0.034\times q\delta y\sin(\omega t)$$

Parameters of cavity

ω : $2\pi\times$ resonance freq. (~ 6.4 GHz)

L : Length (~ 6 mm)



Amplitude by 1 mrad orbit angle
→ Amplitude by 0.2 micron offset

Two point charges

$$V(t) \propto q\int_{-L/2c}^{L/2c}(y-\Delta y/2+\theta ct')\cos(\omega(t-t'+z/2c))dt'$$
$$+q\int_{-L/2c}^{L/2c}(y+\Delta y/2+\theta ct')\cos(\omega(t-t'-z/2c))dt'$$

y : Offset of bunch center

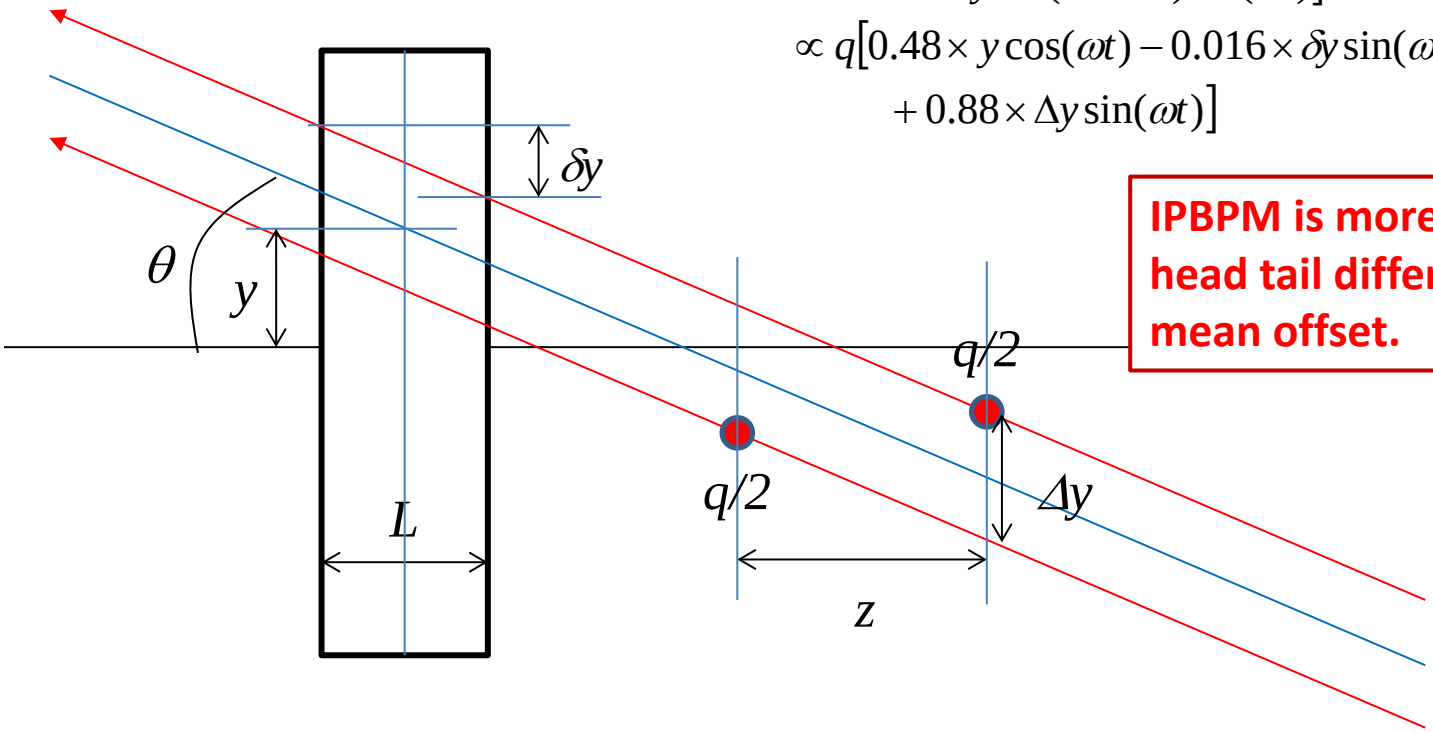
θ : Angle of bunch center

Δy : Head - tail orbit difference

$\omega : 2\pi \times$ resonance freq. (~ 6.4 GHz)

z : Distance between head and tail $\approx 2\sigma_z \approx 16$ mm

$$V = q\left[ay\cos(\omega z/2c)\cos(\omega t) + b\theta\cos(\omega z/2c)\sin(\omega t) + a\Delta y\sin(\omega z/2c)\sin(\omega t)\right]$$
$$\propto q\left[0.48\times y\cos(\omega t) - 0.016\times\delta y\sin(\omega t) + 0.88\times\Delta y\sin(\omega t)\right]$$



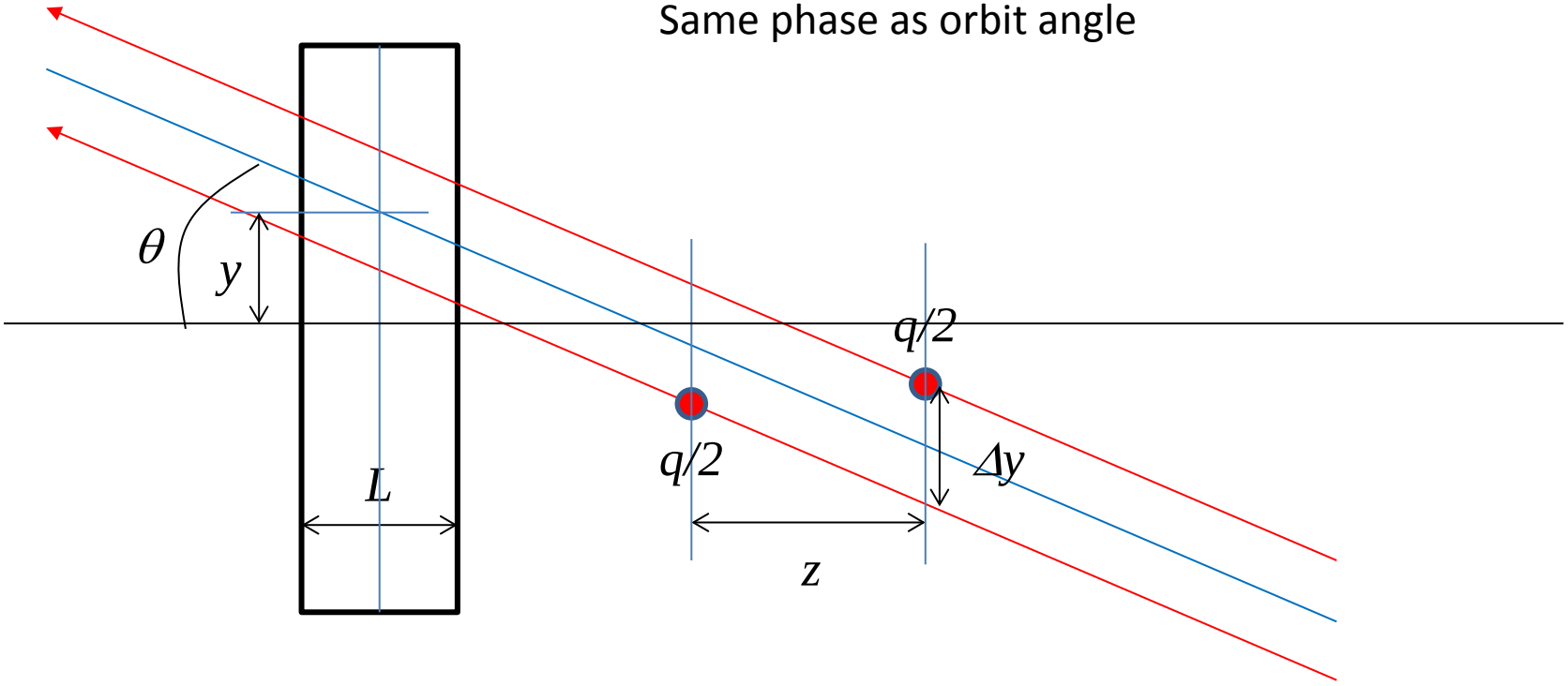
IPBPM is more sensitive to head tail difference than mean offset.

Same amplitude by

100 nm mean offset
0.5 mrad angle
55 nm head-tail offset

} Same phase } p/2 phase difference

Sensitive to head-tail offset (transverse wake)
Same phase as orbit angle



One Cavity

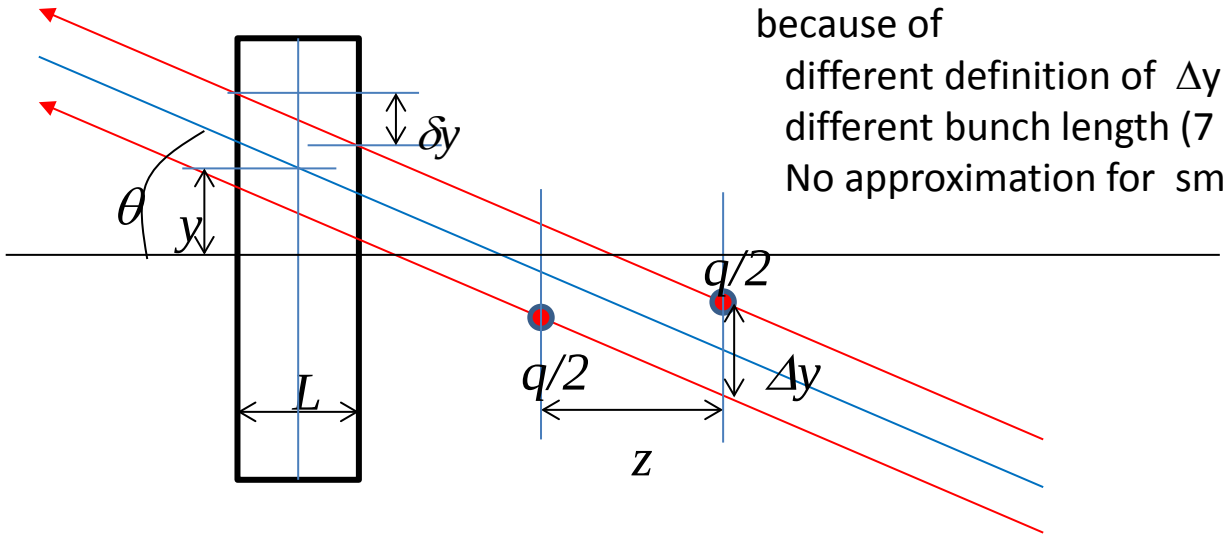
Cannot tell orbit angle or head-tail

Same signal:

$\Delta y \sim 40$ nm (~1-sigma for nominal beta*, 0.03 sigma for x1000 optics),

$\theta \sim 0.37$ mrad (~1-sigma for nominal beta*, 30 sigma for x1000 optics),

- Need to know absolute angle better than this. ???
- Effect of beam jitter?



1 order different from Okugi-san's slides, because of

different definition of Δy (factor 2)

different bunch length (7 → 8 mm, factor ~2 ?)

No approximation for small z (factor 2)

More than one cavity

E.g. 2 cavities, possible procedure for checking sensitivity

- Take data with different conditions of wakefield (bunch charge or wake source on mover)
- Check consistency between
  - Orbit angle change evaluated from I signal of both cavities and
  - Angle change evaluated from Q signal of each cavity
- Inconsistency can be explained by wakefield?
- Effect of beam jitter?

Much more to be considered

- Effect of cavity angle so simple?
- What if beam is not so stable?
- Effect of head-tail in BPM calibration?
- Sensitivity depends on optics (betay*)?
- , , ,
- , , , , , ,

Discussion

- ?