LCWS05

RF Kicker Update for 0mrad IR

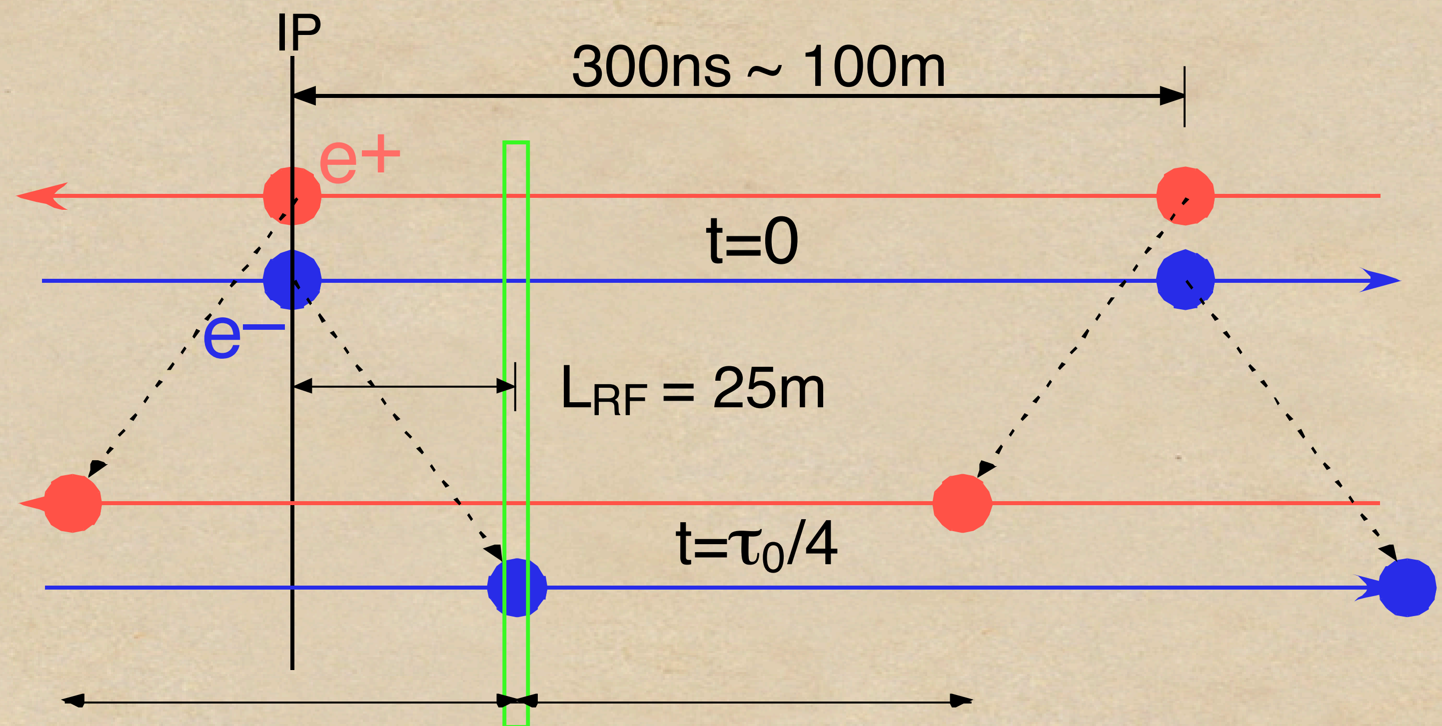
Y. Iwashita

Accelerator Laboratory,
Advanced Research Center of Beam Science,
Institute for Chemical Research, Kyoto University,
Gokanosho, Uji, Kyoto 611-0011, JAPAN
iwashita@kyticr.kuicr.kyoto-u.ac.jp
http://wwwal.kuicr.kyoto-u.ac.jp

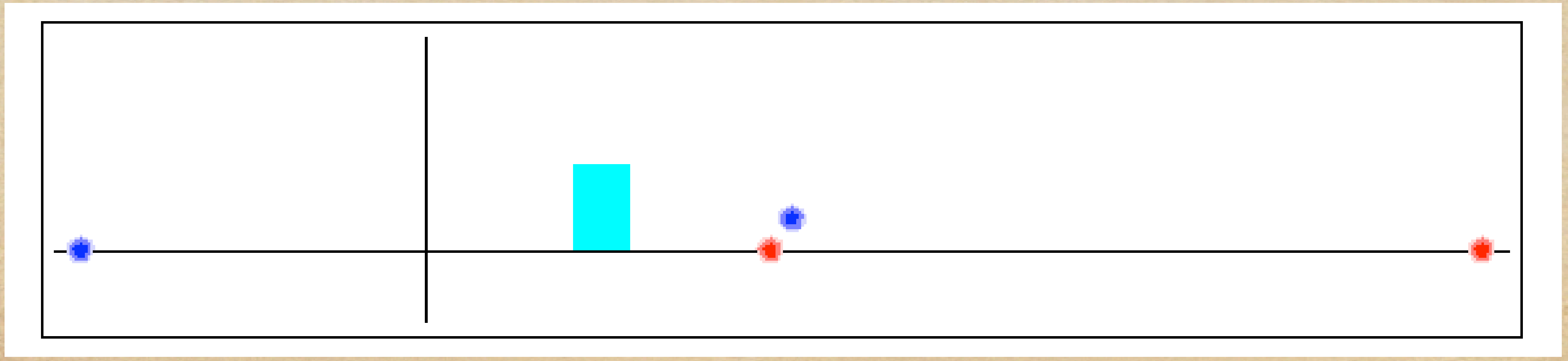
AccLab BmSci ICR
KyotoUniversity

ACCELERATOR LABORATORY
ADVANCED RESEARCH CENTER FOR BEAM SCIENCE
INSTITUTE FOR CHEMICAL RESEARCH
KYOTO UNIVERSITY

Time Structure of Beams



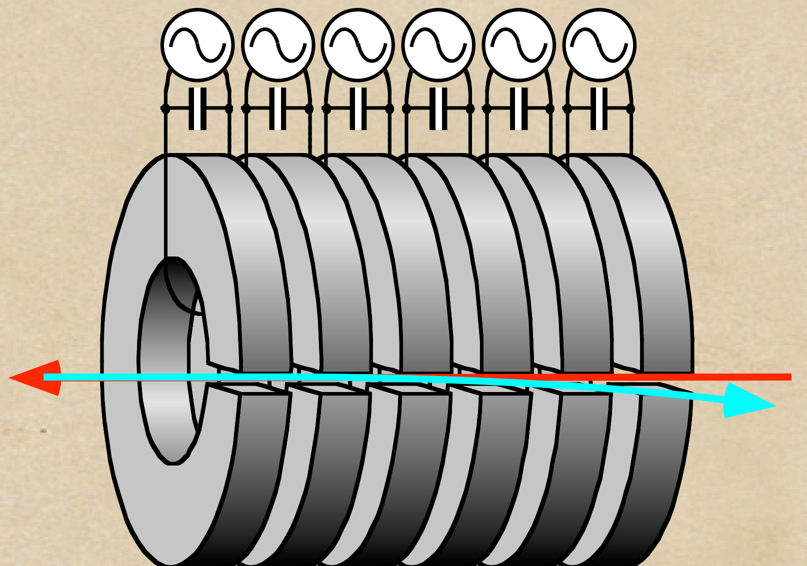
Out-bunch at the Center of In-bunch



http://wwwal.kuicr.kyoto-u.ac.jp/~iwashita/rfkick/RFKICKERGRA1.MOV

Sketch of a Kicker

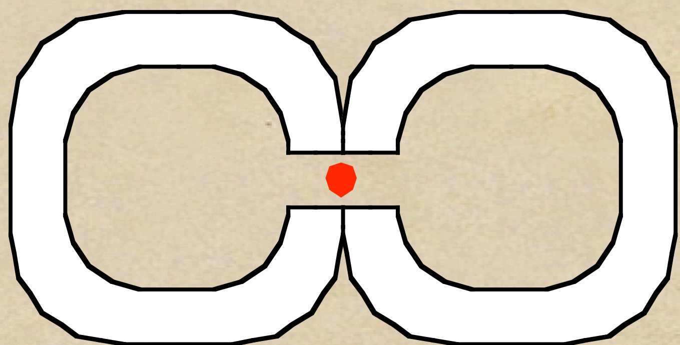
DC+3MHz (+6~9 MHz)



0.2T x 10m

2 mrad with 300 units?

Variant

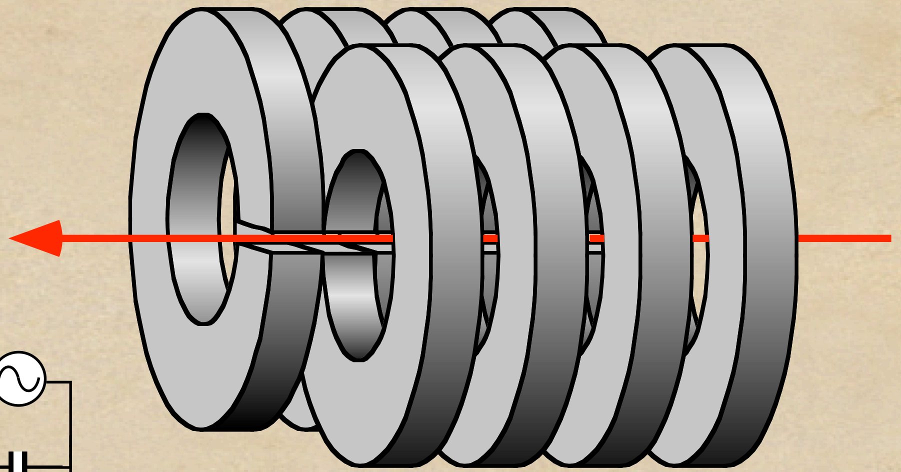


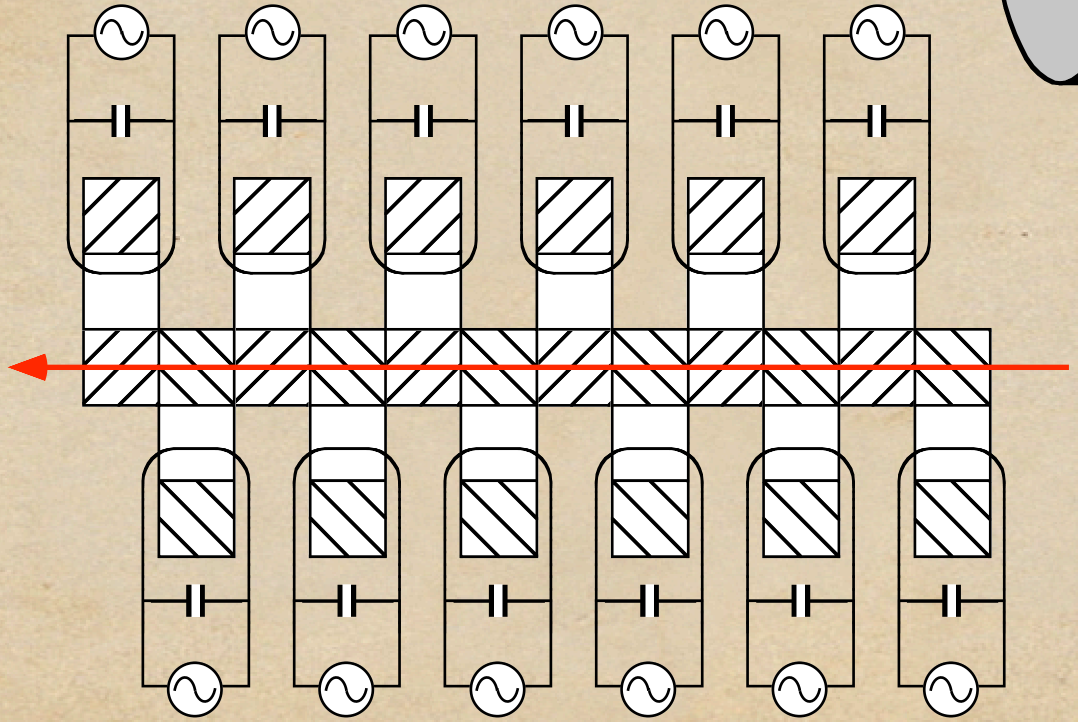
Double C-type

Better shielding

Step at center?

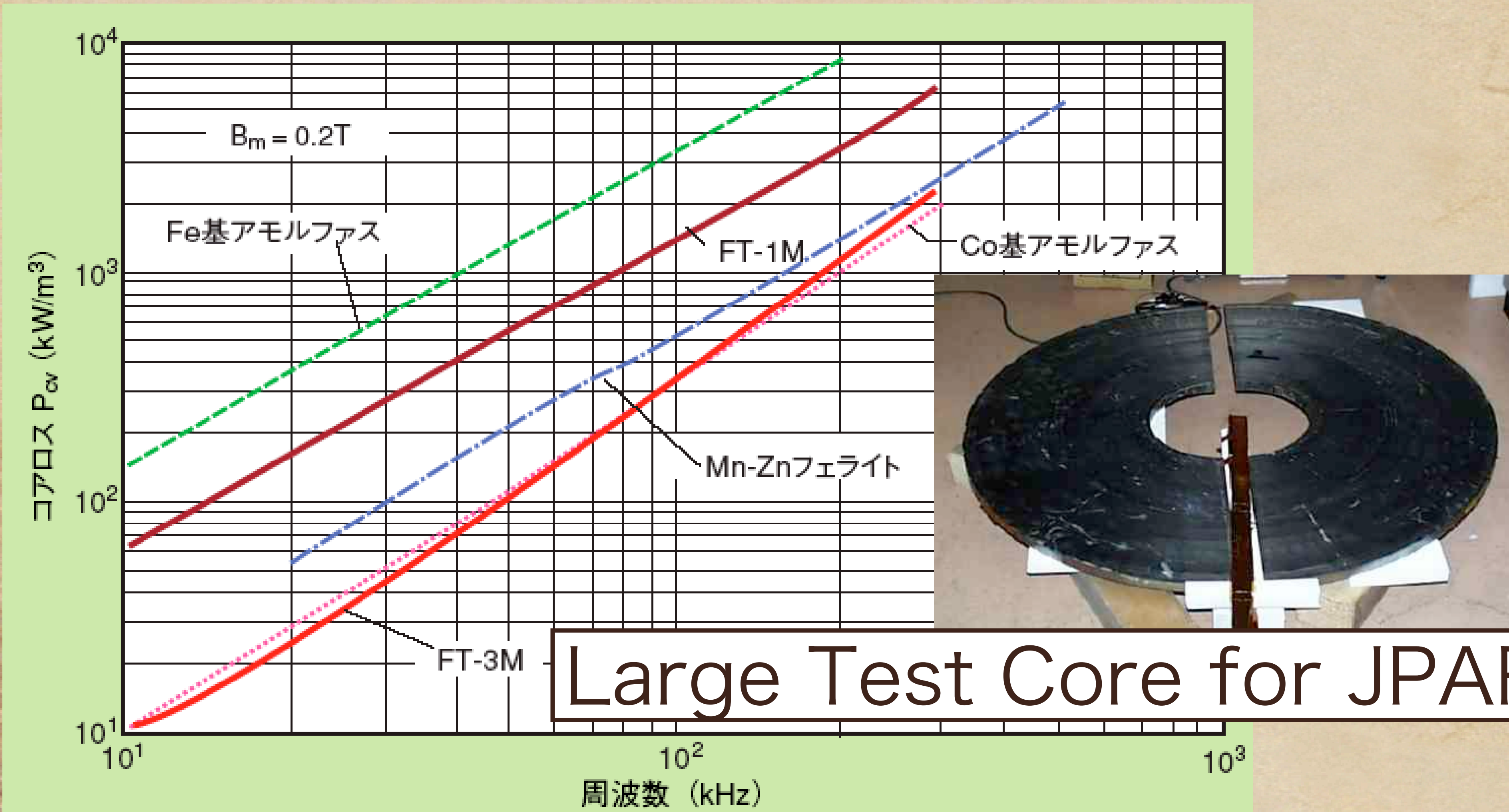
Higher packing factor





increase
average field

Magnetic Alloy (Finemet)



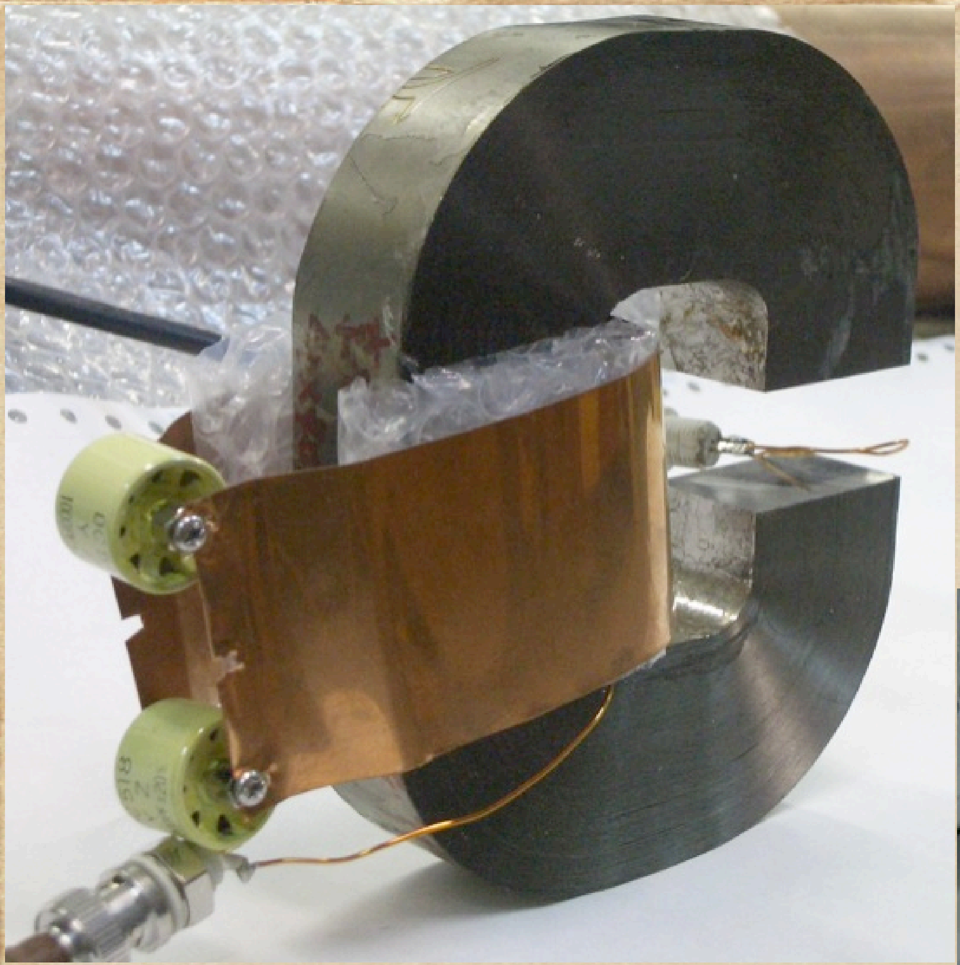
Large Test Core for JPARC

Q <1 for non-cut core

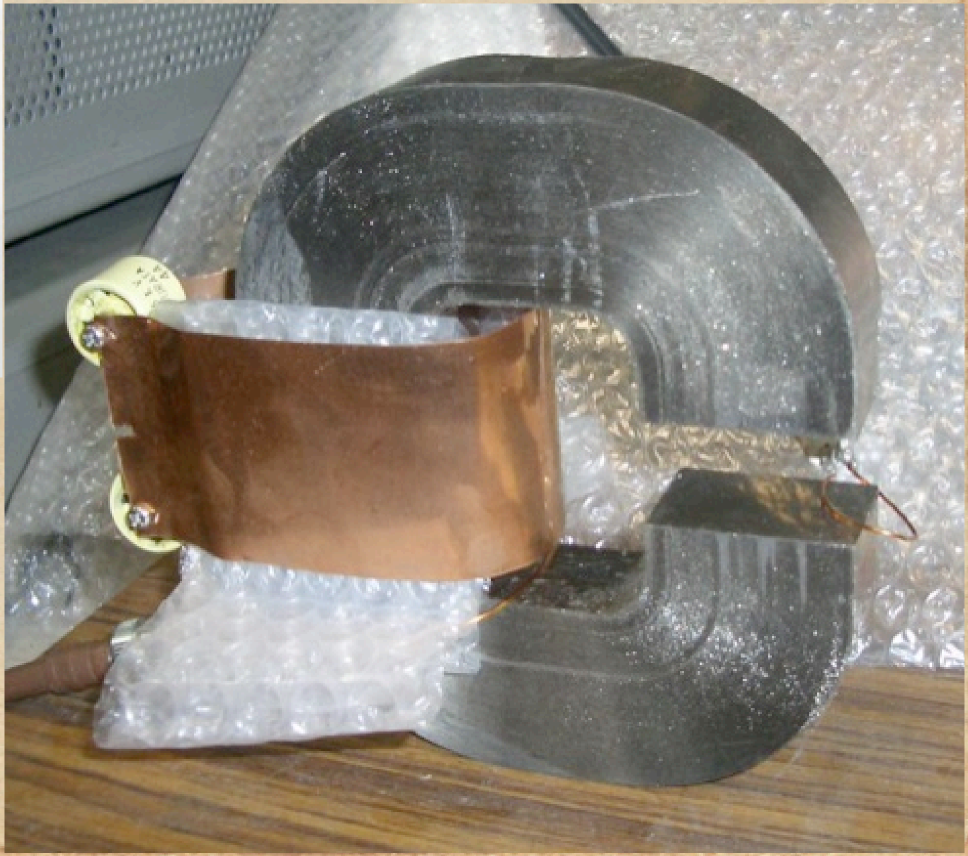
Q~10 for cut core @a few mm gap

Fabricated FINEMET core
(Ready 3/1, No data yet!)

Q-value with this big gap?



RF core under test

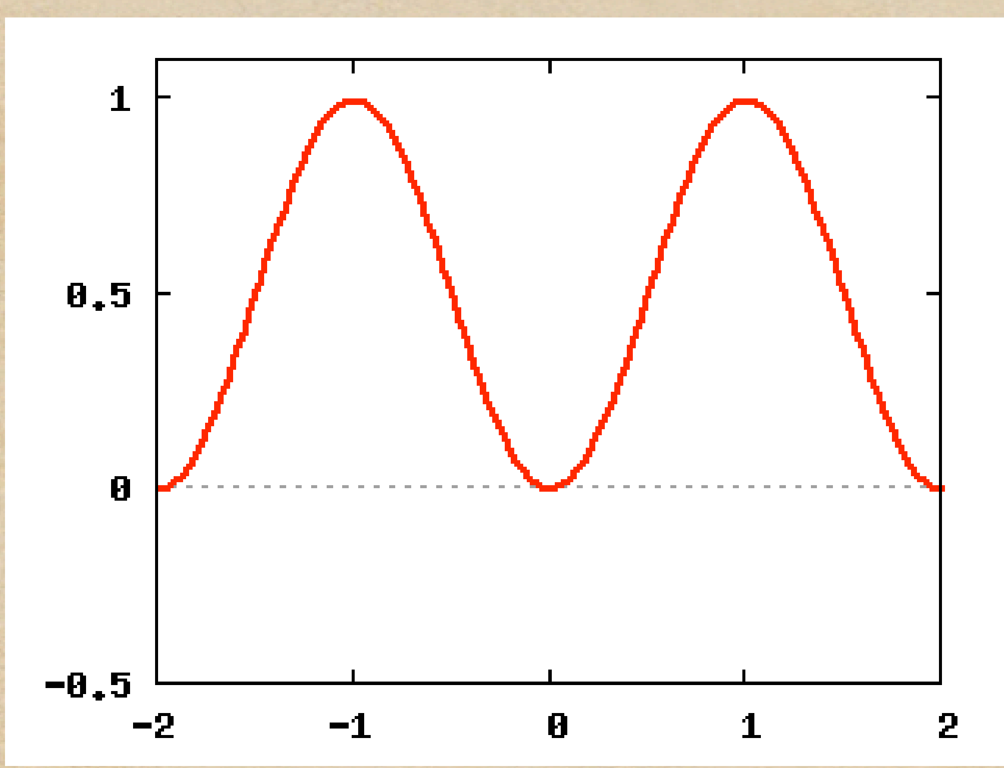


6MHz @ C=2nF

Q?

Waveform 1: simple cosine

$$f(t) = 1 - \cos(\omega t)$$



Phasing division≧4

1 Section=1.0m

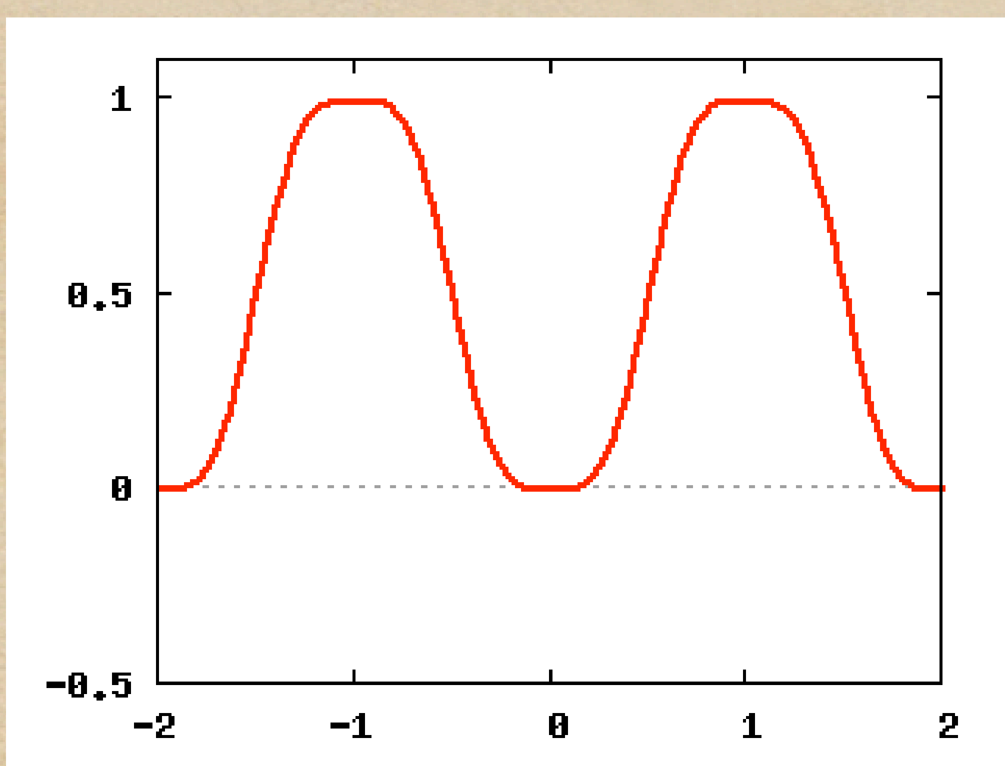
Both end $x = 0.50$m

$\theta_x = 2.47\times10^{-7}$

$< 3.0\times10^{-7}$

Waveform 2: two cosines

$$f(t) = \frac{8}{9} - \cos(\omega t) + \frac{1}{9}\cos(3\omega t)$$



Phasing division≧1

$x = 2.0\text{m}$

$\theta_x = 4.65\times10^{-8}$

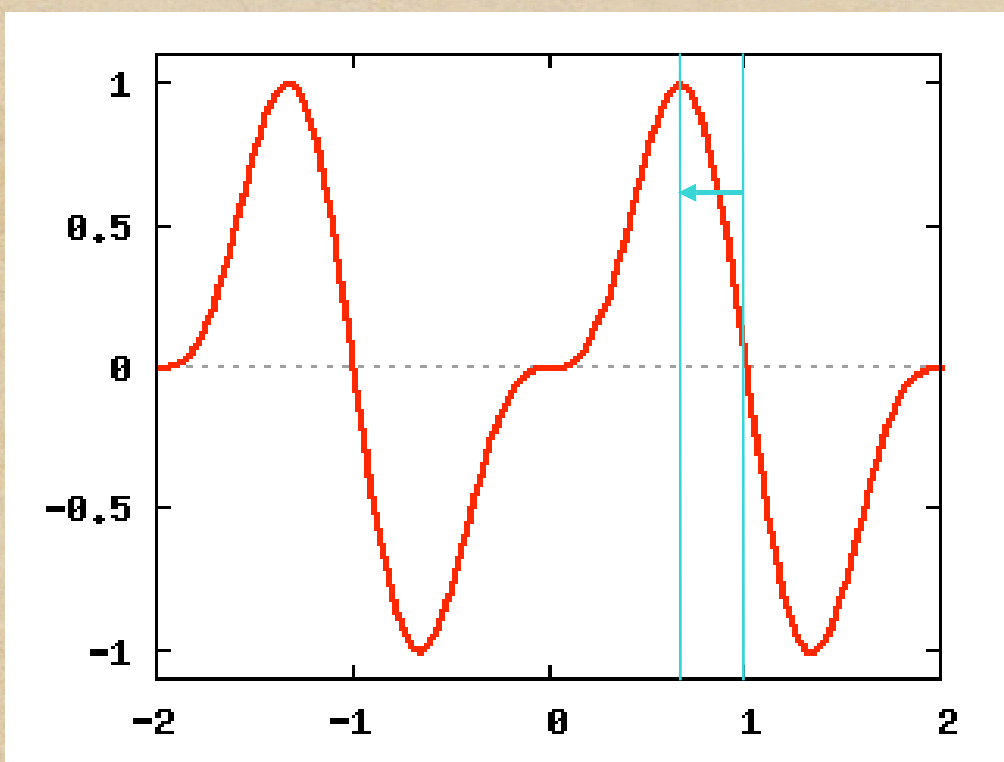
$< 3.0\times10^{-7}$

Very flat base.

But difficult?

Waveform 3: sines

$$f(t) = -\sin(\omega t) + \frac{1}{2}\sin(2\omega t)$$



Phasing division≧2

$x = 1.0\text{m}$

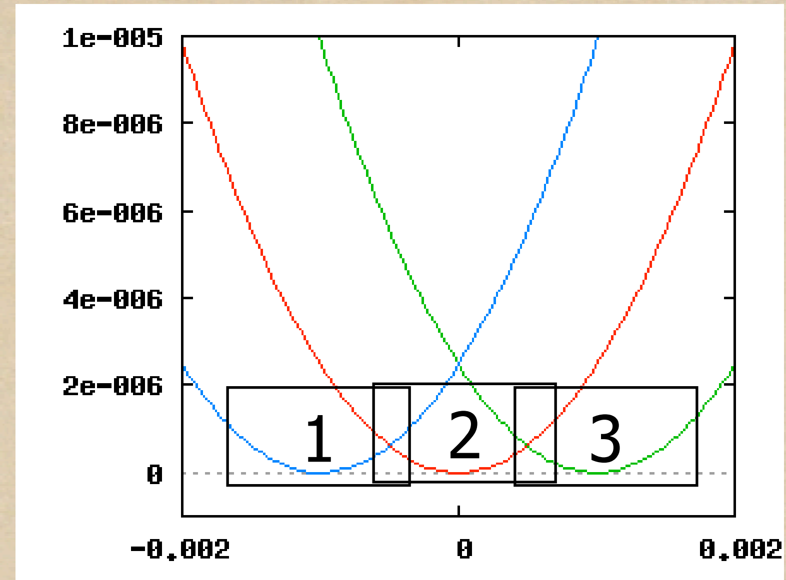
$\theta_x = 9.54\times10^{-8}$

$< 3.0\times10^{-7}$

No DC System.

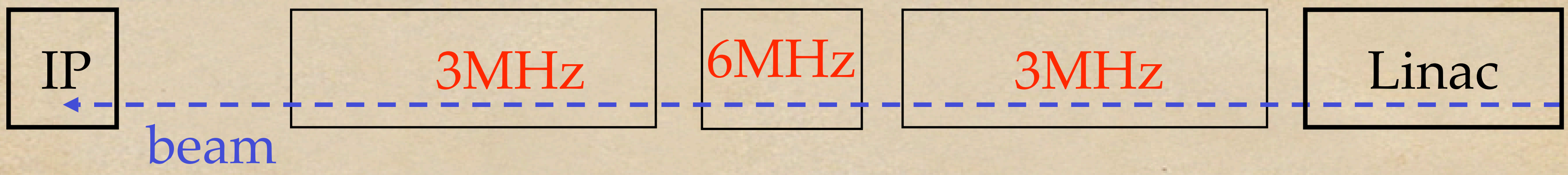
Not at the center

Compensation by Phasing



- Phasing = different phase at each section.
- Apply each bottom to incoming beam
- Divide into some group

Advantage of sine option

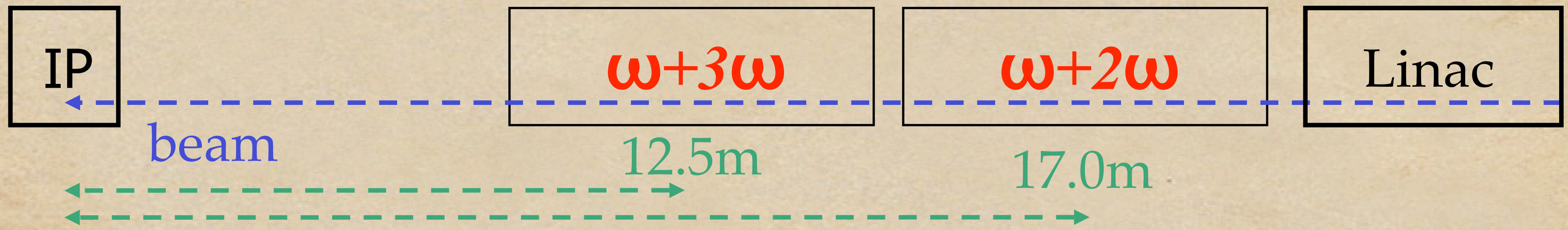


- Can apply the harmonics separately.
- Waveform **ω+2ω** needs 2 groups

  → Separate RF's are useful for

  Easier construction & Phasing

Expansion: 500GeV→1TeV



- Kicker's location depends on the harmonics.
  → multiple kickers can distribute.
- One kicker for 500GeV
- Two kickers for 1TeV

Advantage and Disadvantage

Advantage

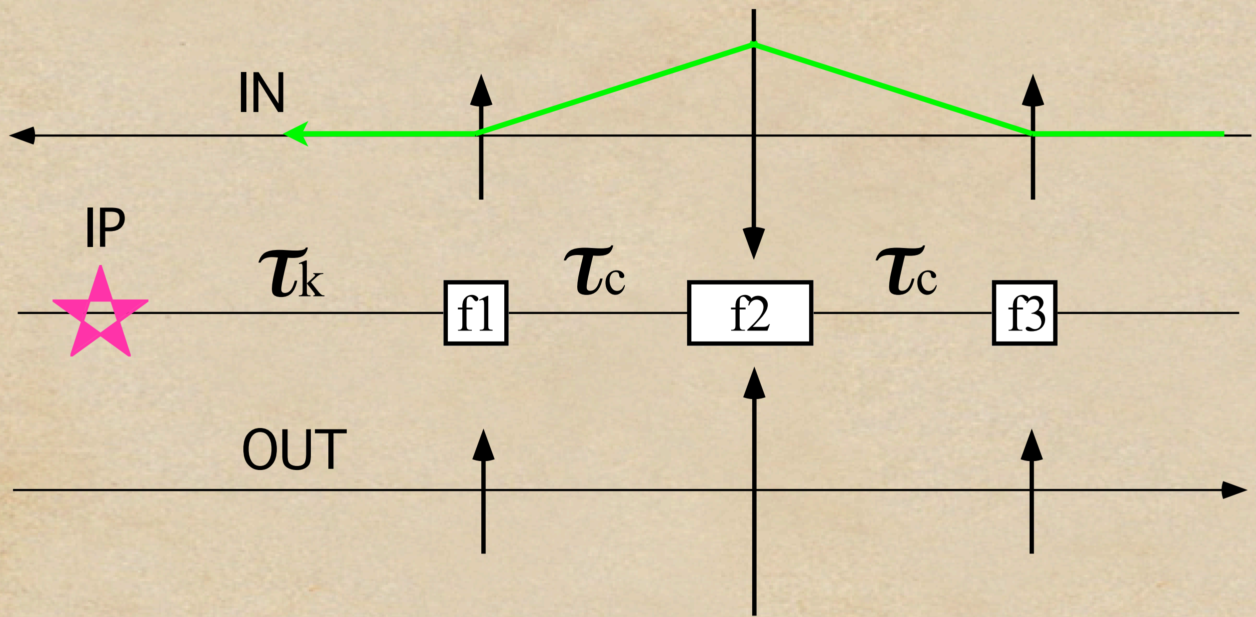
- Head-on collision.
- Easier than Crab Cavity (low frequency).

Disadvantage

- If stopped, beam will hit the other side.
  (Failure of all the units does not likely happen.)
- It may kick the incoming beam
  – misplaced bunch from dark current ? –

(unlikely to come through the FF optics, though)

Three kick scheme



kicks felt by in-bunch

kicks felt by out-bunch

$$f_1(-\omega\tau_k) + 2f_2(-\omega(\tau_k+\tau_c)) + f_3(-\omega(\tau_k+2\tau_c)) = 0$$

$$f_1(\omega\tau_k) + 2f_2(\omega(\tau_k+\tau_c)) + f_3(\omega(\tau_k+2\tau_c)) = 4$$

$$f_n(t) = \sin\omega t + \alpha_n$$

$$\omega\tau_k = \pi/4 \; (\lambda/8),$$

$$\omega\tau_c = 3\pi/2 \; (3\lambda/4)$$

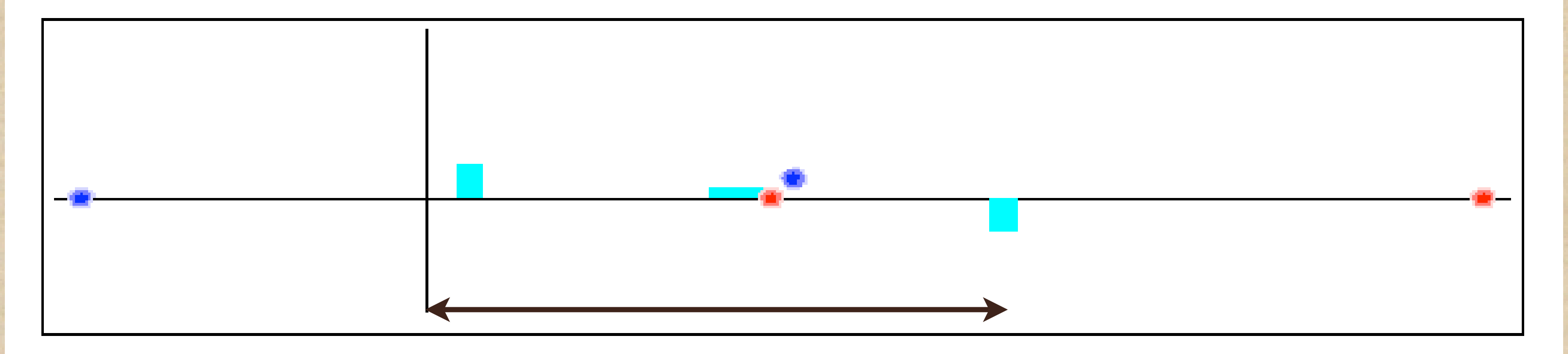
No kick for Incoming Beam

In bunch can be placed at non-kick position; no net kick even if the phase is wrong.

$$f_1(-\omega\tau_k+\varphi)+2f_2(-\omega(\tau_k+\tau_c)+\varphi)+f_3(-\omega(\tau_k+2\tau_c)+\varphi)=0$$

Out bunch does get net kicks.

$$f_1(\omega\tau_k)+2f_2(\omega(\tau_k+\tau_c))+f_3(\omega(\tau_k+2\tau_c))=4$$

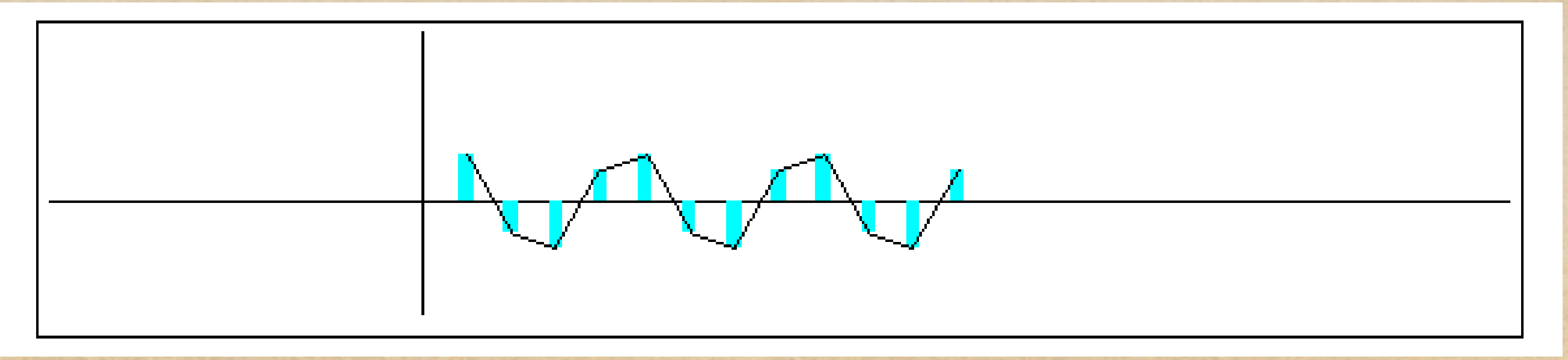


Total length becomes long: 13λ/8 (=81.25m@6MHz) → higher freq.?

http://wwwal.kuicr.kyoto-u.ac.jp/~iwashita/rfkick/RFKICKER3.MOV

Traveling wave kicker

- Further extension to the familier concept: in-beam does not match the phase velocity, while out-beam matches it (the main in-buch can be at zero-kick).
- Higher frequency to install many cells ~ 150MHz ($3\lambda/4$=1.5m)?



http://wwwal.kuicr.kyoto-u.ac.jp/~iwashita/rfkick/TW.MOV

Issues on RF kicker

- Single kicker:
    - Seek for material for kicker core (FINEMET?)
    - Q-values at large gap? (electrical)
    - Vertical kick by fringing field? (mechanical)
    - Beam chamber has to be made of insulator.
      <Shield by thin metal(copper)?>
- Abort kicker (MPS)
- Chain of kickers with higher frequency?
  (similar to crab cavity)

– Announcement –

NANOBEAM 2005

36th ICFA Advanced Beam Dynamics Workshop

October 17-21, 2005
Uji Campus, Kyoto University

http://wwwal.kuicr.kyoto-u.ac.jp/nanobm