RF Kicker Update

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Topics:

- Core Material Search
- Head-On-Collision Option

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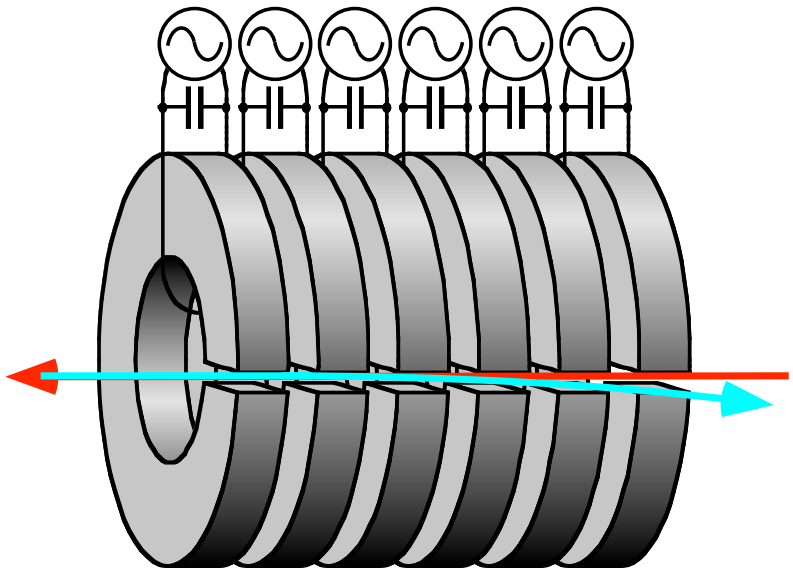
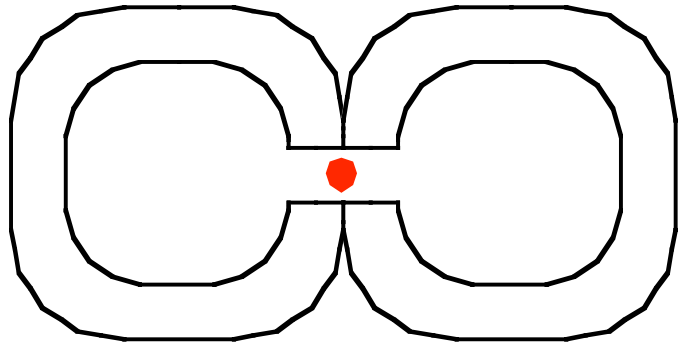
Sketch of a Kicker

6MHz (+12MHz) Variant





Double C-type

Better shielding

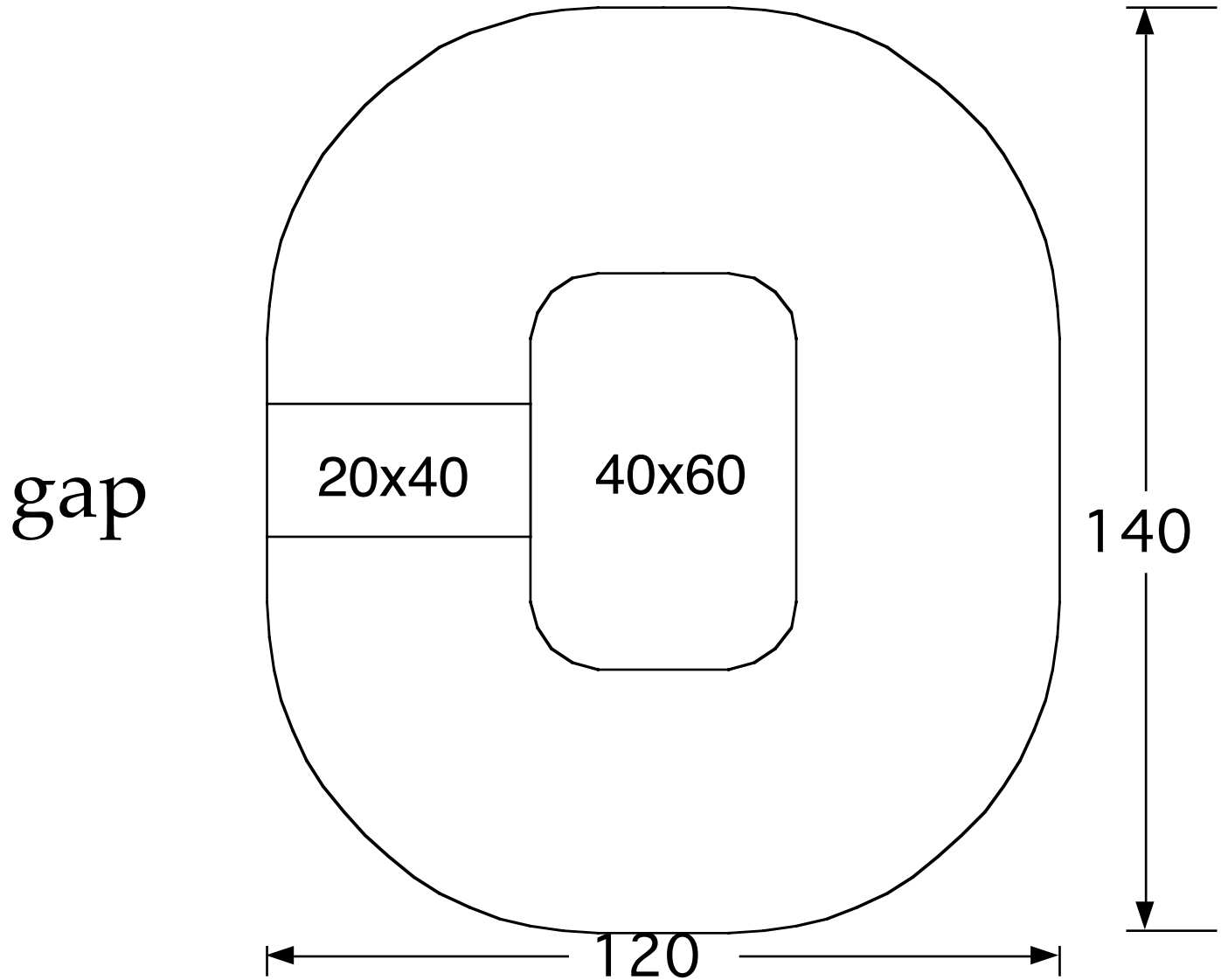
Step at center?

Stored Energy W 0.75[J] @0.25T

Candidates for the Core

Material	Bs	Hc (A/m)	μ	Pcv (kW/m^3)	ρ (μΩ m)	Tc (°C)
Finemet	1.23T	0.6	~10^4	~10^5 @0.2T, 3MHz	~1	570
Sendust (solid)	0.85T	2.4	~1000	?	~1	
Sendust (sintered powder)	0.5T @5kA	no data	~90	~$4x10^4$ @0.2T, 3MHz	no data but high	
Ferrite (SY20)	0.33T @2kA/m	110	290	5600 @0.03T, 3MHz	10^{11}	150

Core shape to be investigated



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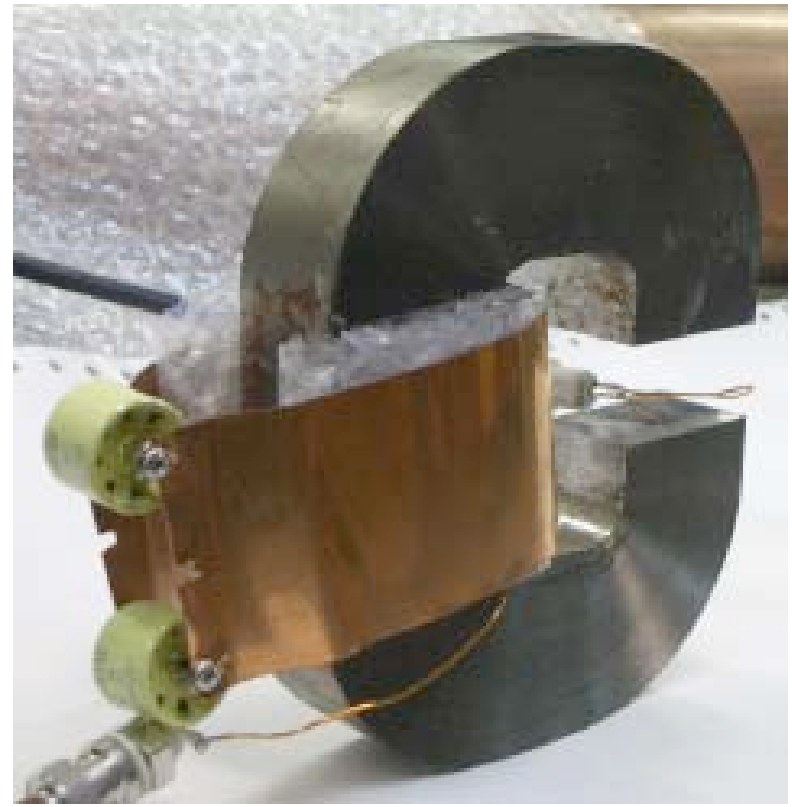
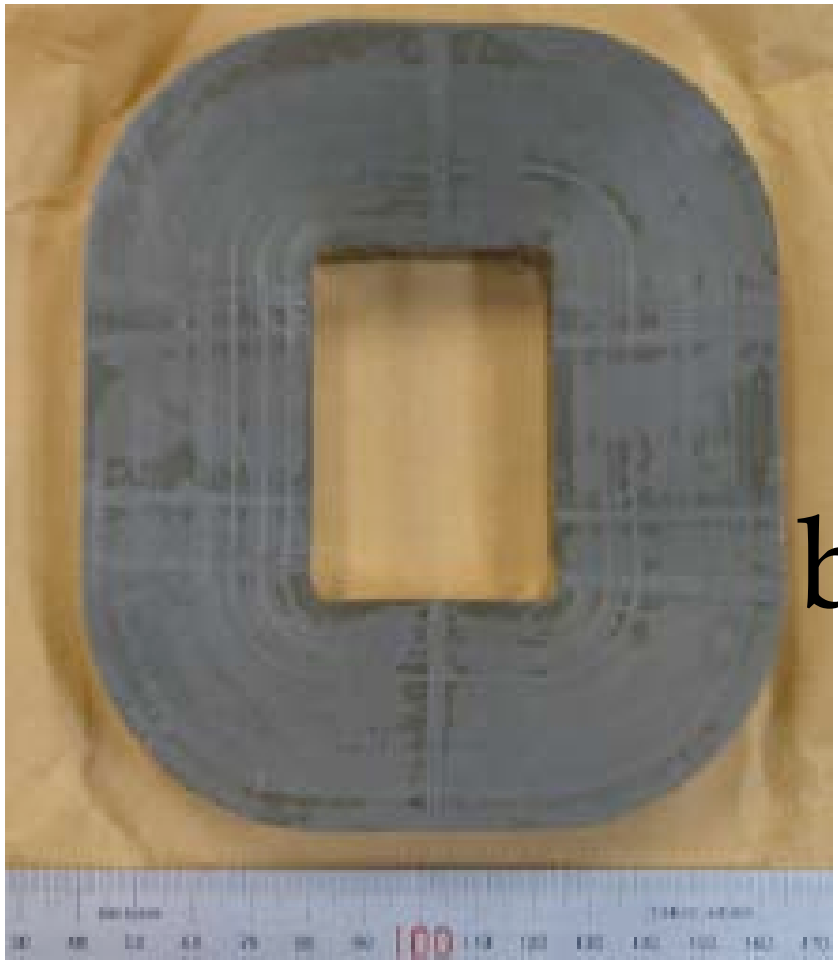
Material	Status
Finemet	First two cores showed very low Q, maybe because of lack of insulation. Third core (w/insulation) is under test (1.7mm gap). 20mm Gap will be tested (followed by corner cut).
Sendust (solid)	Just came.
Sendust (sintered powder)	Sample brick arrived.
Ferrite (SY20)	Raw material plates were ordered and are expected to be ready now. Core shape is to be optimized.

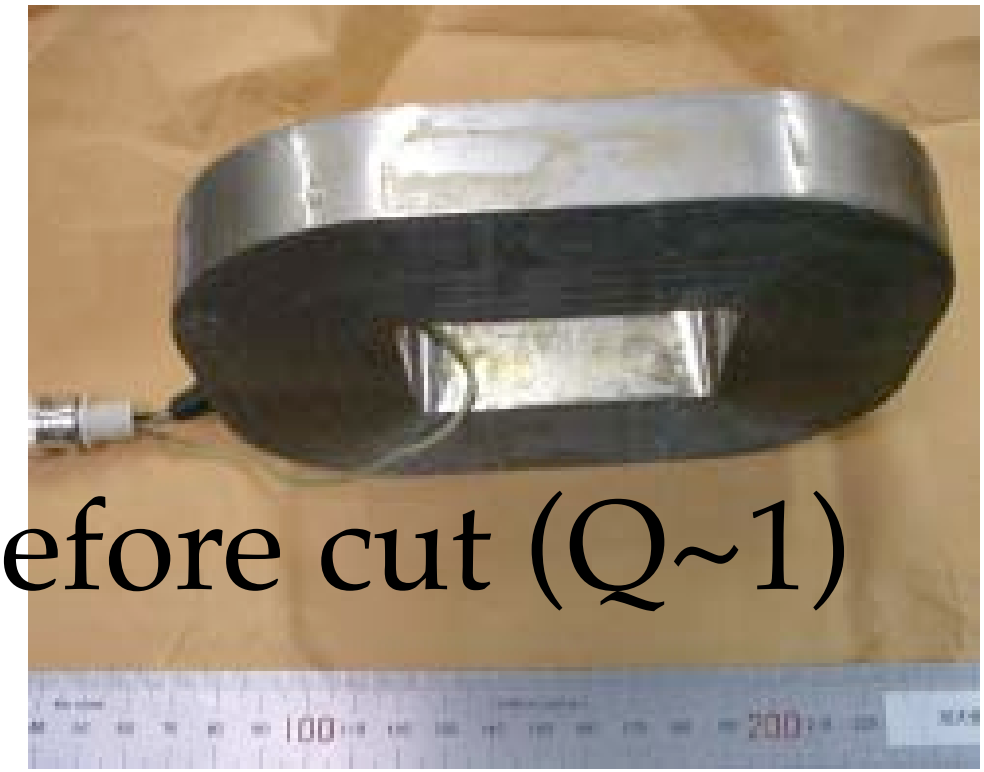
Some Pictures...



The first two Finemet Cores showed very low Q.

Third Finemet Core (with insulation)

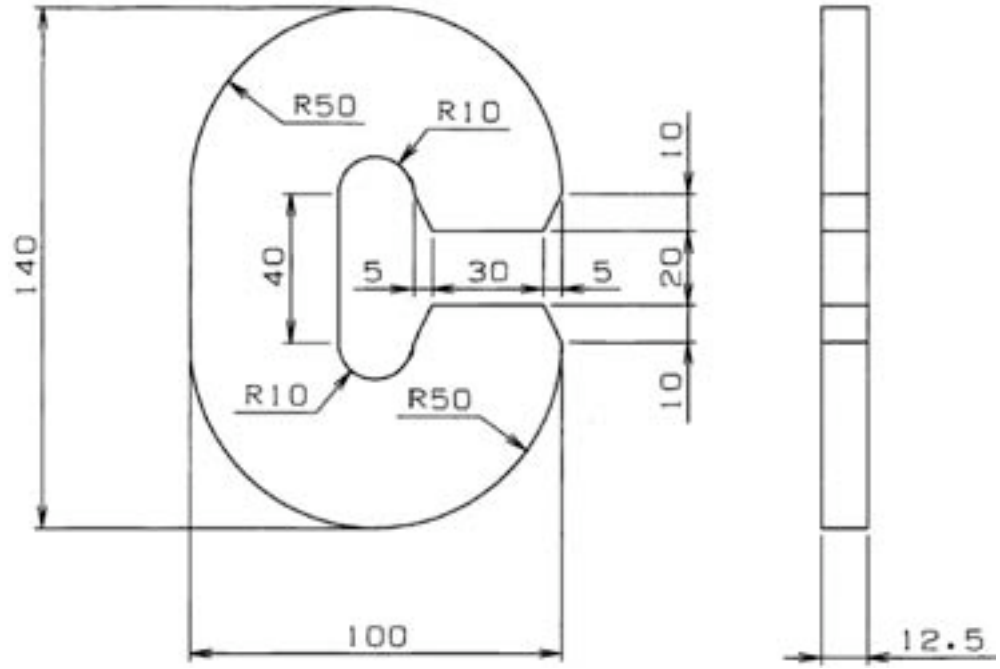




before cut (Q~1)

with 1.7mm gap
under measurement,
but looks not nice...

Sendust Core (solid)



Has just arrived on 8/13
(no data yet)

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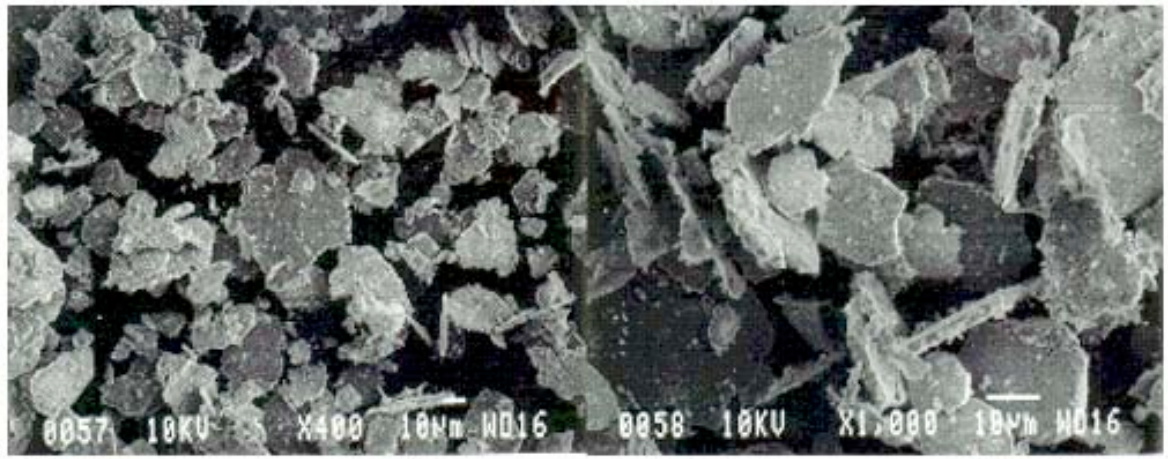
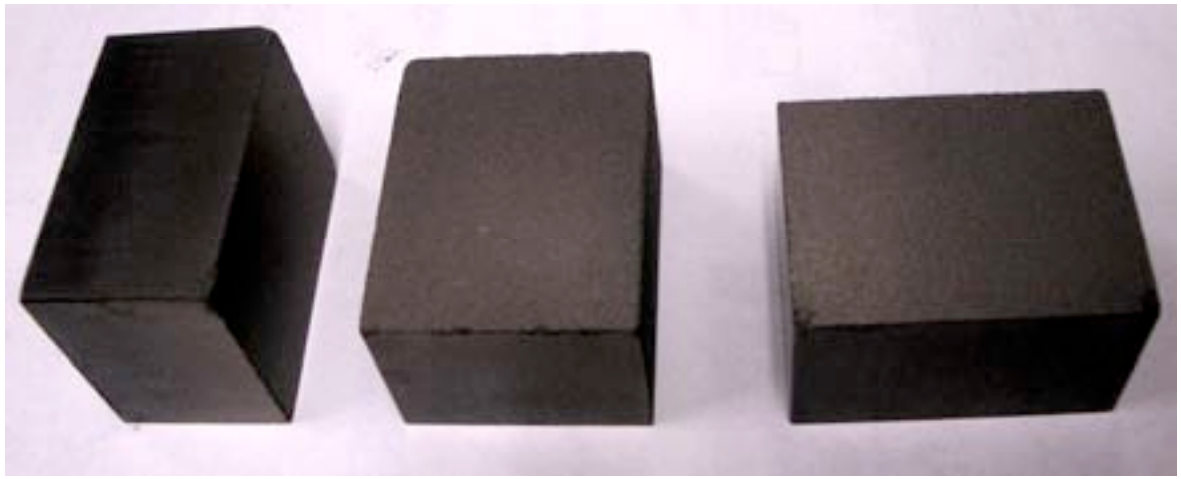
Sendust Core (dust core)



(代表値)	粒度分布			かさ密度	化学成分(wt%)			
センダスト扁平粉	25D%	50D%	75D%	g/cm^3	Fe	Si	Al	C
	23.61	35.94	51.50	1.30	85.6	9.10	5.24	0.007



34x27x20

Larger brick costs ~$10k…..?

Arrived on 8/12 (no data yet)

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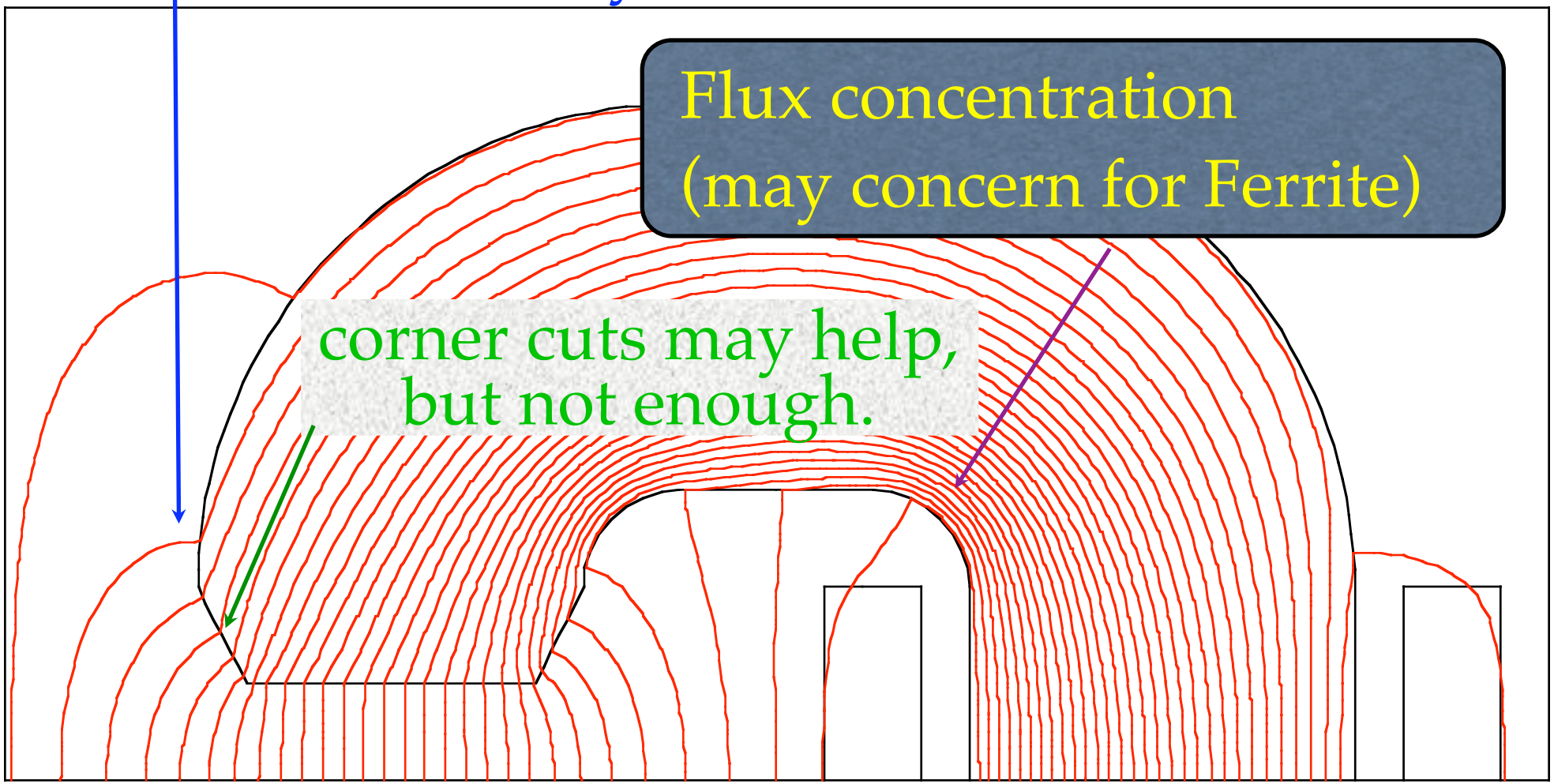
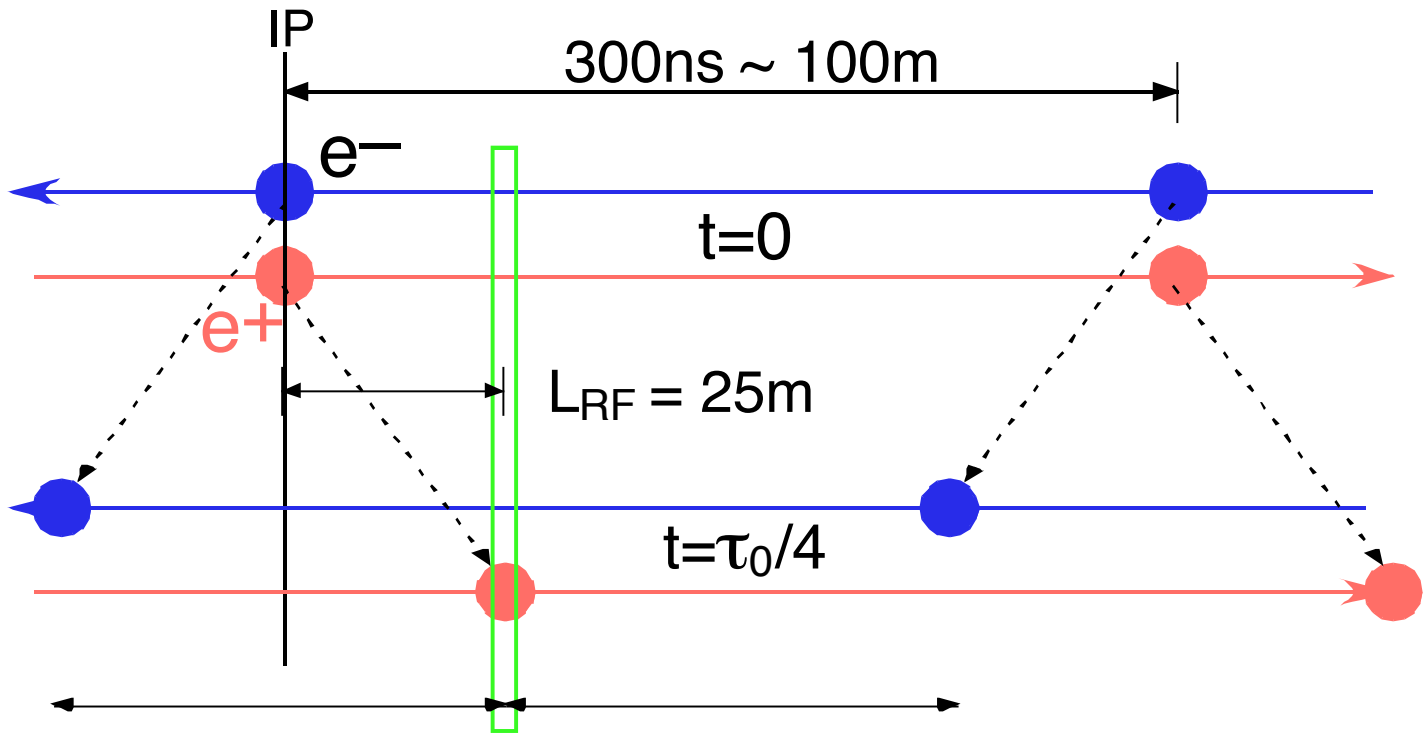
Flux plot (isotropic material)

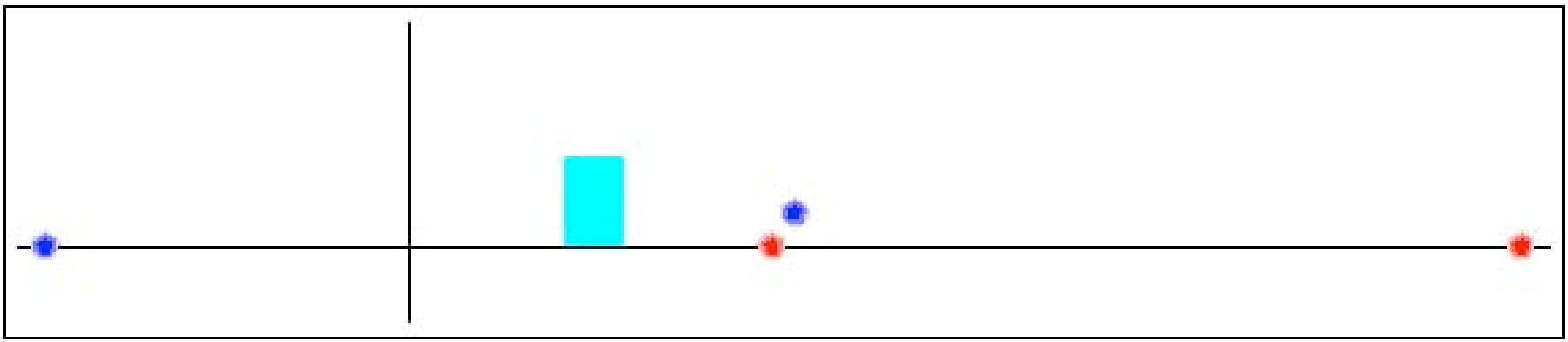
Flux lines crossing the material sheet cause eddy current loss.



Basic Concept for Head-On-Collision



Out-bunch at the Center of In-bunch



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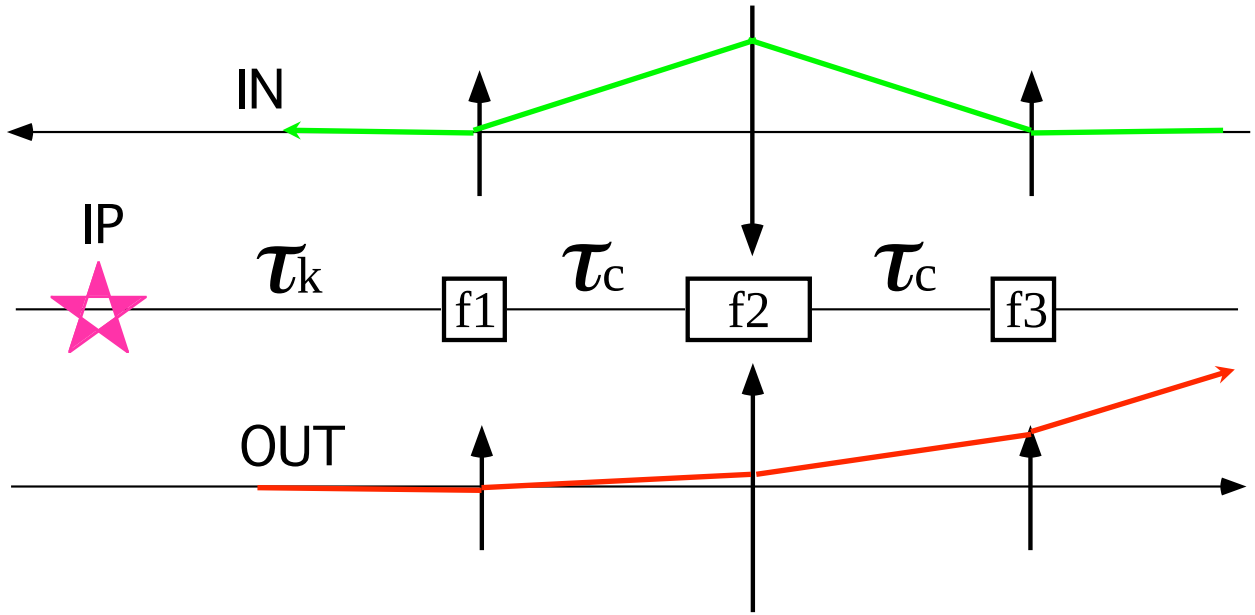
Three kick scheme



kicks felt by in-bunch

kicks felt by out-bunch

$$\begin{cases} f_1(-\omega\tau_k) + 2f_2(-\omega(\tau_k+\tau_c)) + f_3(-\omega(\tau_k+2\tau_c)) = 0 \\ f_1(\omega\tau_k) + 2f_2(\omega(\tau_k+\tau_c)) + f_3(\omega(\tau_k+2\tau_c)) = 4 \end{cases}$$

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

$$\begin{cases} \omega\tau_k = \pi/4\ (\lambda/8), \\ \omega\tau_c = \pi/2\ (\lambda/4) \end{cases}$$

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No kick for Incoming Beam

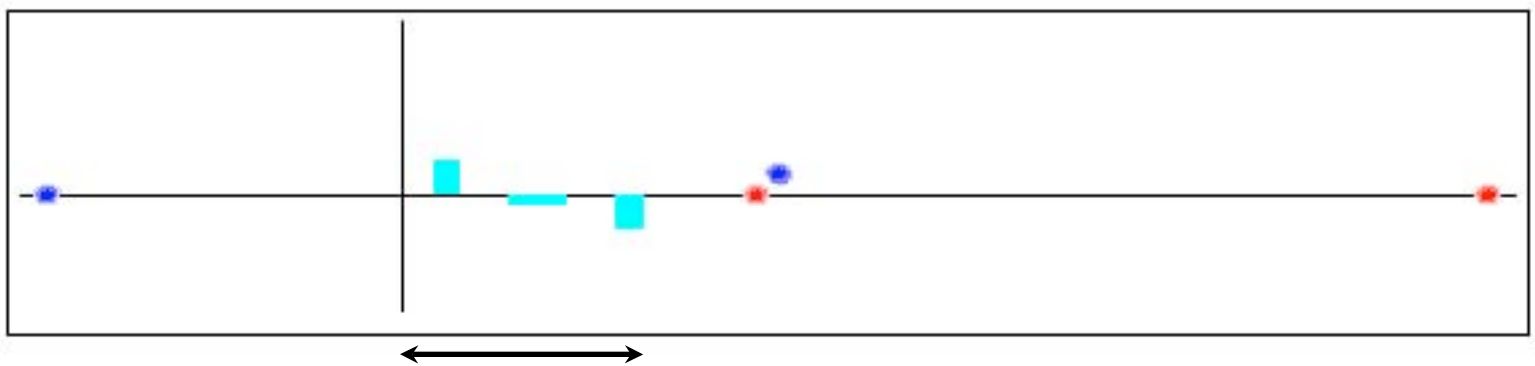
Forms the outgoing traveling wave!!!

In bunch can be placed at non-kick position;
no net kick even if the phase is wrong
(does not meet the phase velocity).

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

Out bunch does get net kicks (does meet).

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



Total length becomes long: 5λ/8
(=31.25m@6MHz) → higher freq.?

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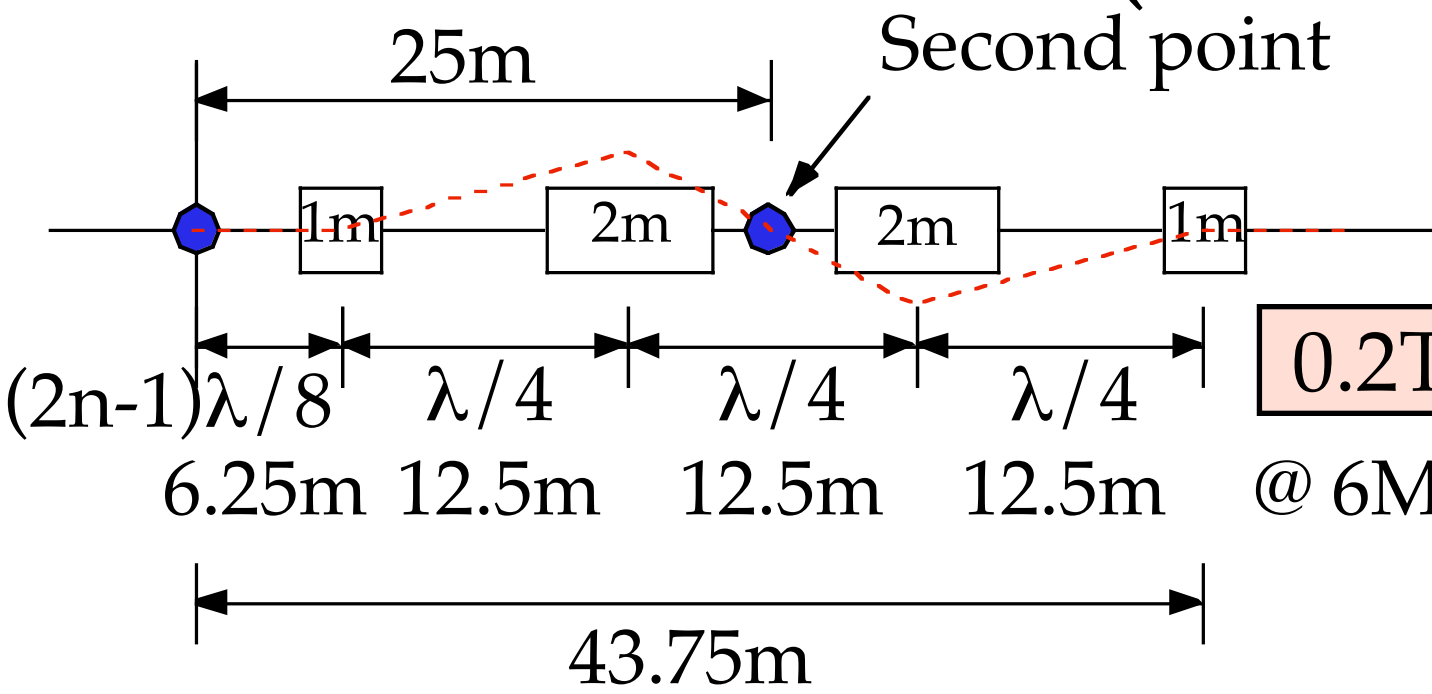
http://wwwal.kuicr.kyoto-u.ac.jp/~iwashita/rfkick/RFKICKER3.MOV

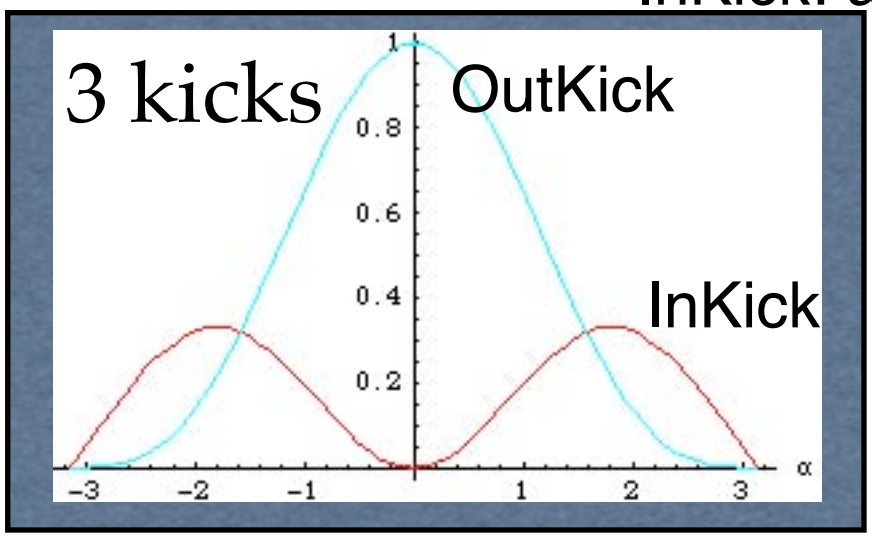
Four kick scheme (with finite length)

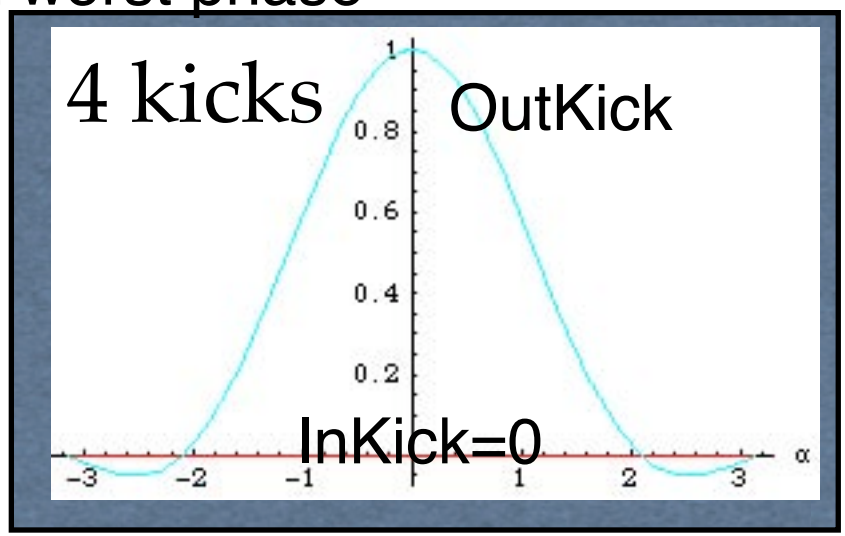


0.2T x 6m = 1.2Tm

@ 6MHz

InKick: at worst phase





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Issues on RF kicker

- Single kicker:
  - Seek for material of kicker core
  - 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?

Comment on dark current

Because output energy of the dumping ring is 5GeV, the dark current emitted in the main linac is always 2% less than 250GeV main bunch, if the kicker works fine.

Such low energy electrons should be cut by appropriate collimators in the final focus system.

Summary

- Core materials under seek:
  - Finemet, Sedust (solid, dust), Ferrite
- Points for Head-On-Collision Option
  - (based on traveling wave concept)
  - 1: Out-bunch meets the phase velocity(Vp) ; kicked!
  - 2a: In-bunch is placed at the zero position;
    - no kick to the first order
  - 2b: The net deflection for in-bunch is small even in
    - wrong buckets, because of the wrong Vp.