Limits of RF Deflectors and Availability of Other Devices

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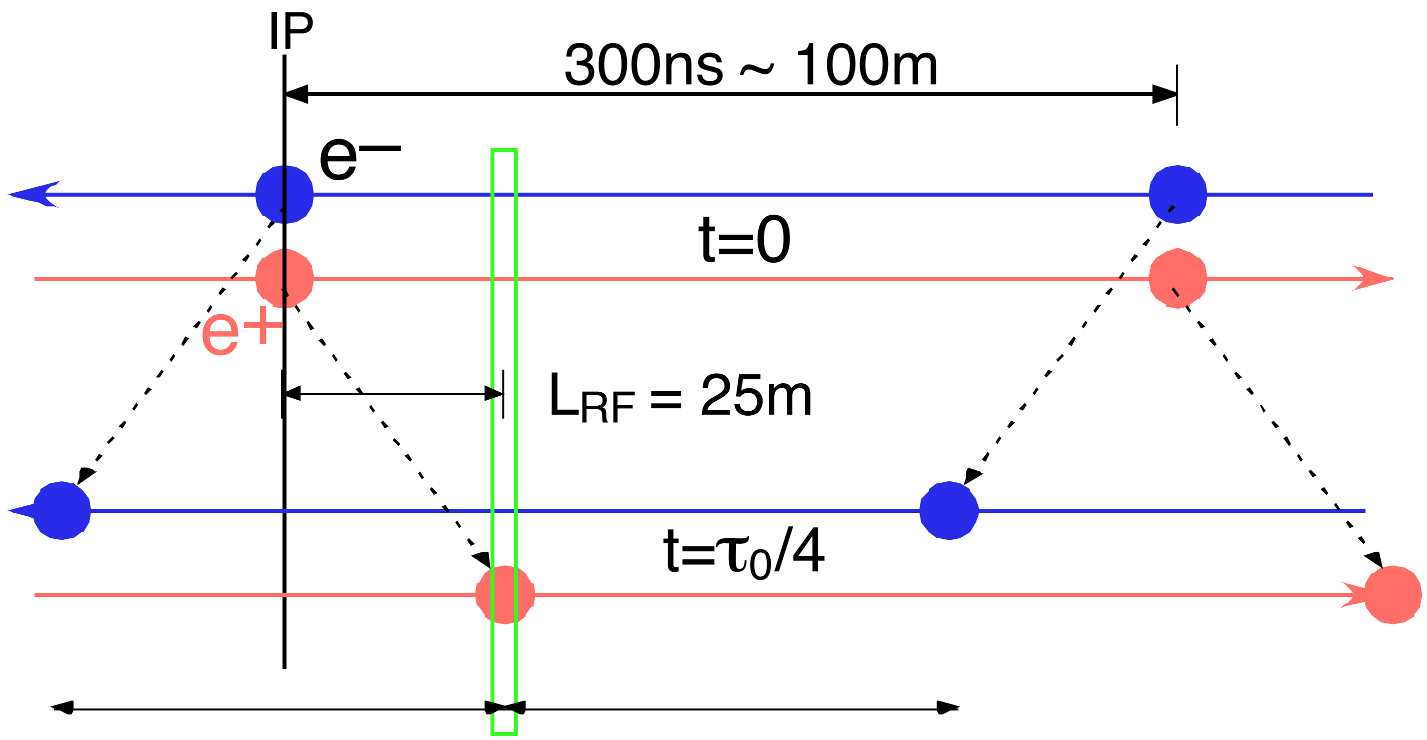
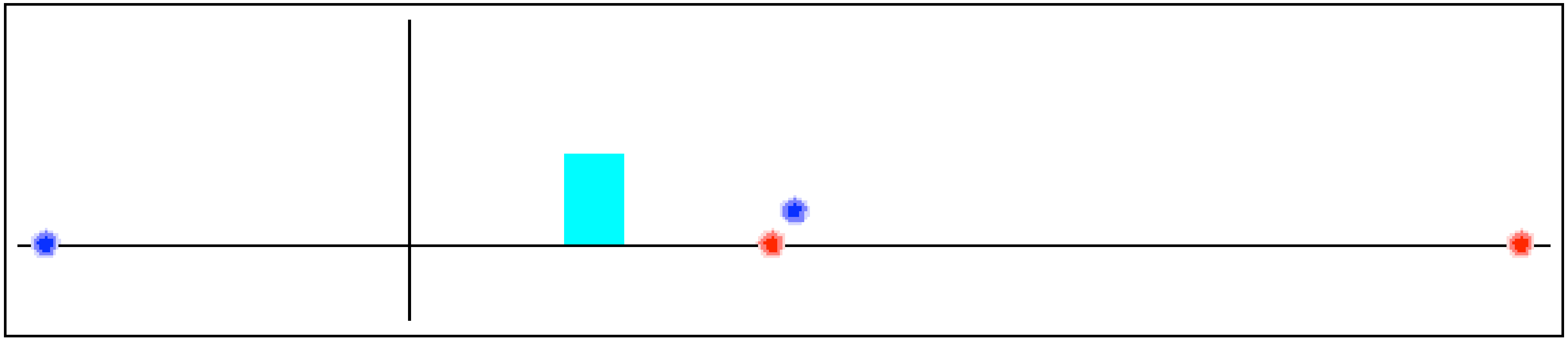
Contents

- Resonant kicker
  - waveform
  - kicker layout/timing chart
  - core material
- other devices
  - QEX4&BM
  - massless septum
  - Unusual quads.

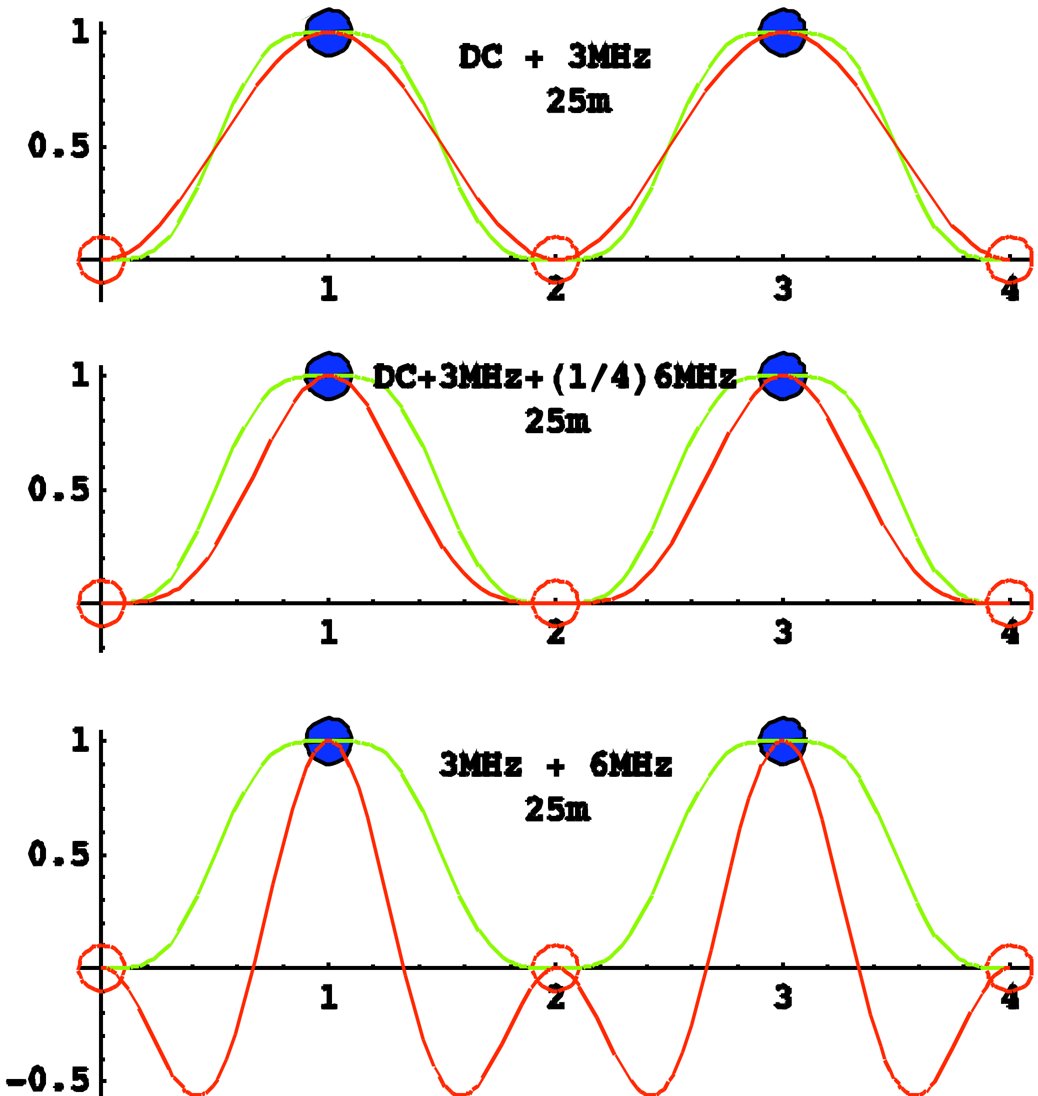
Basic Concept for Head-On-Collision

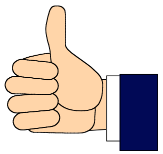
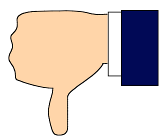


Out-bunch at the Center of In-bunch



Waveforms-1

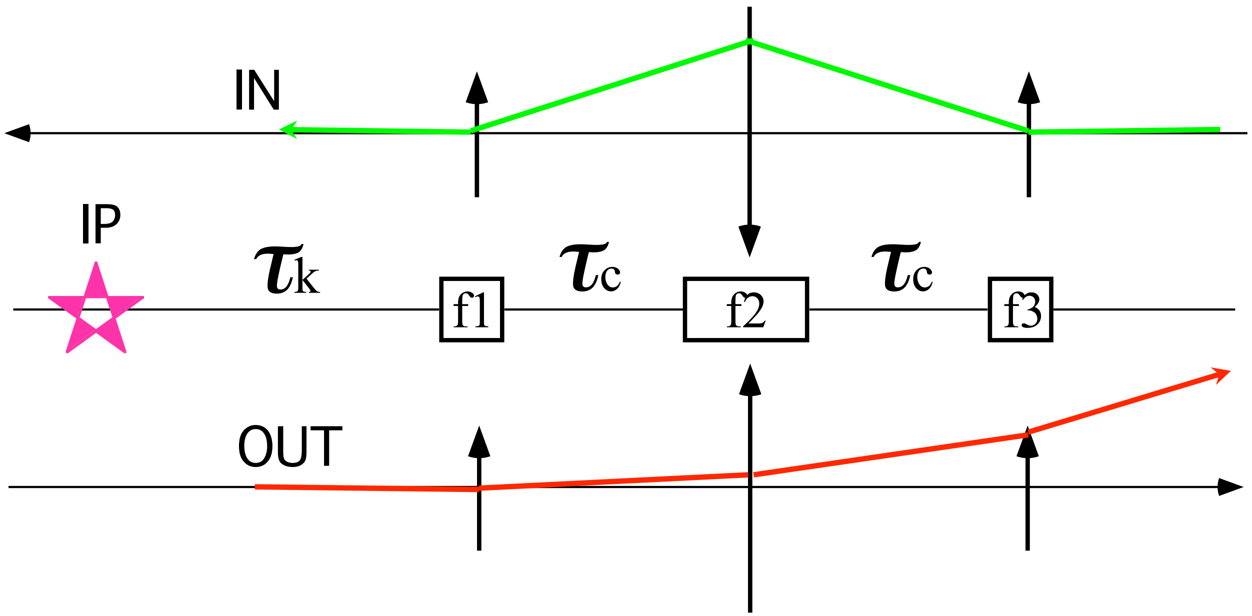


Single RF	needs DC
Wide Base	needs DC Two RF in One
No DC	Narrow Base Two RF in One

Two RF in One: Two cosine components superposition

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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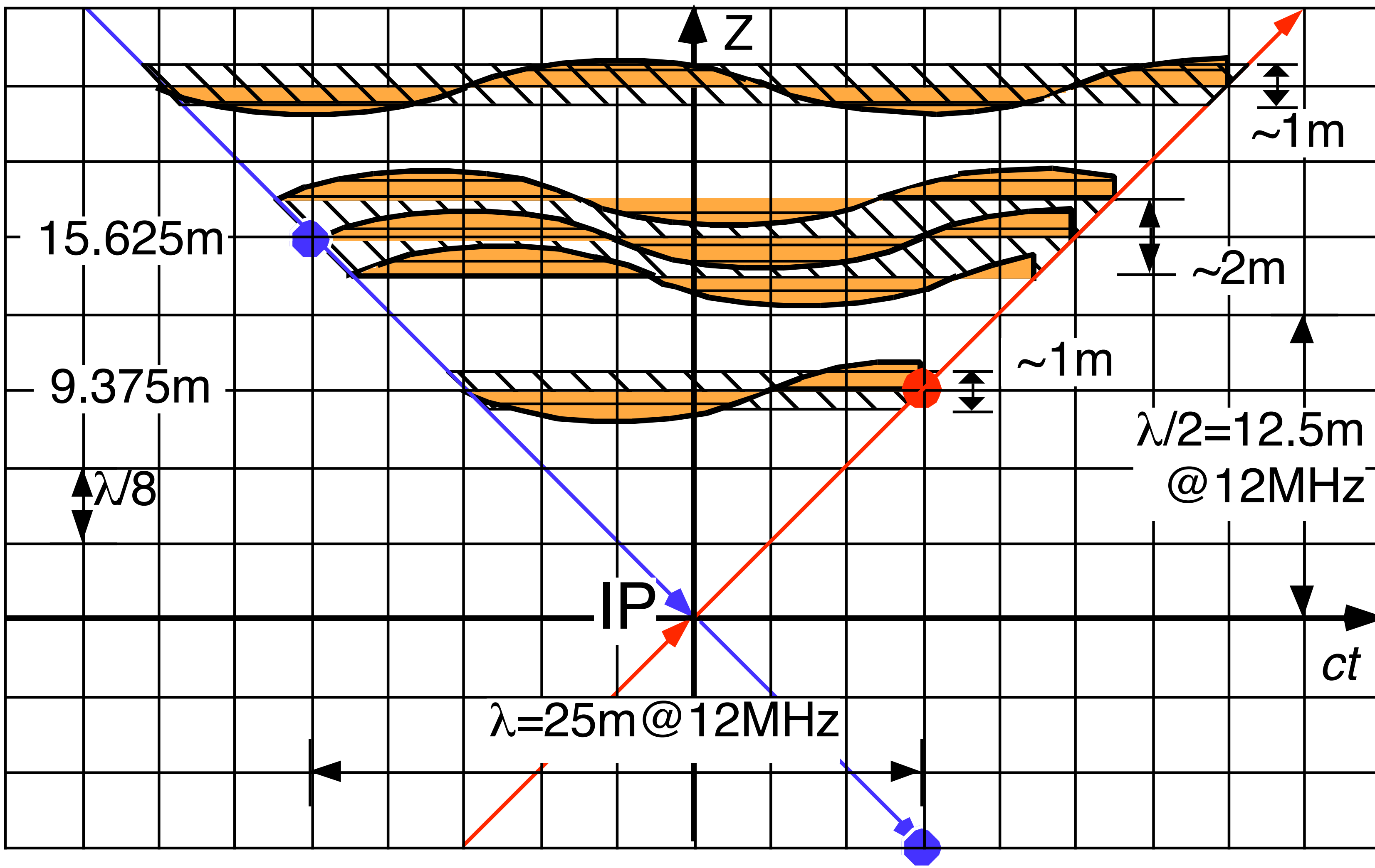
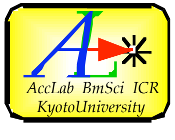
Detailed Timing Chart





Features

(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.

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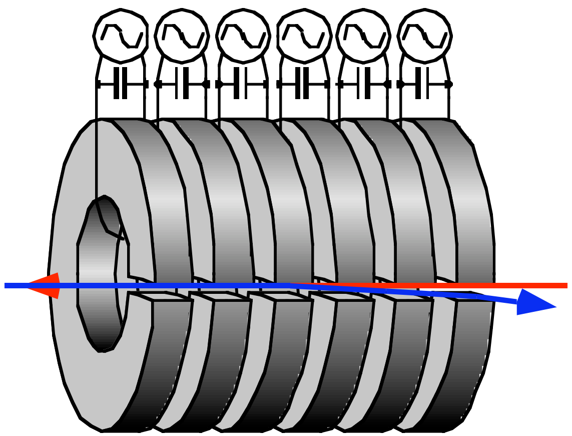
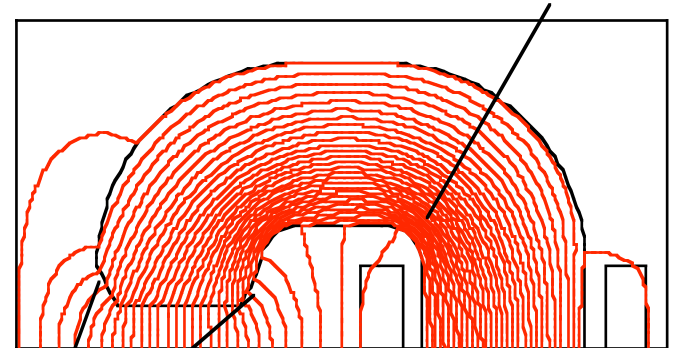
Core chain



Basic Core Chain

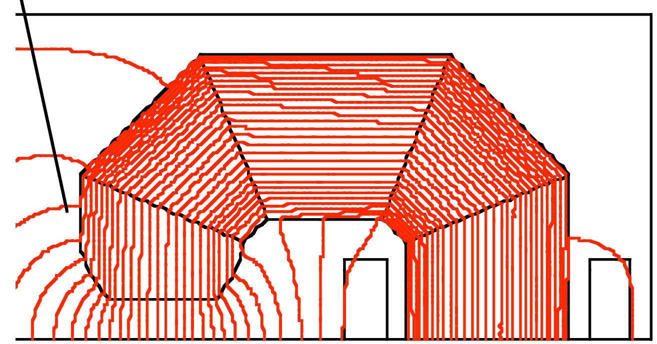
FINEMET Cores

High Flux Density

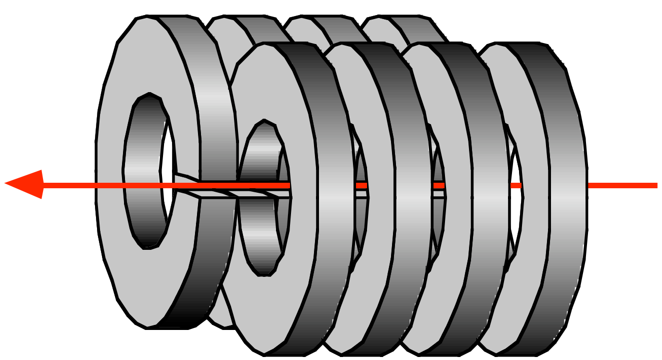


Isotropic Core

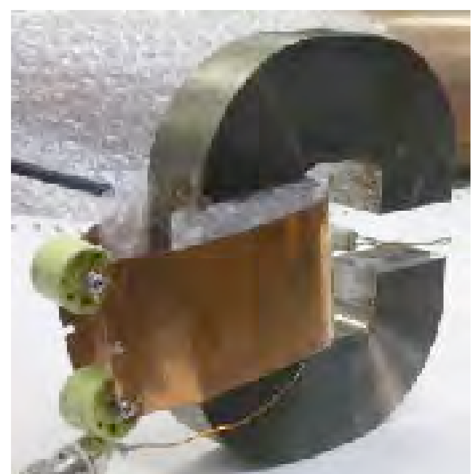
Eddy Current Loss?



Simulated Anisotropic Core



High Density Core Chain



Core with Loop

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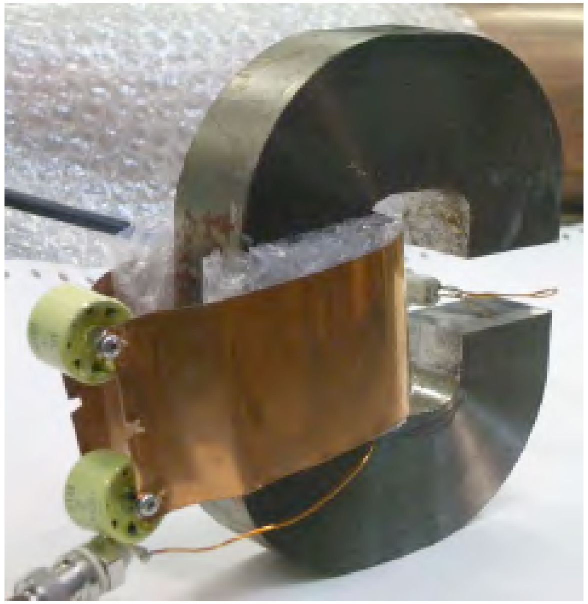
Some Pictures...


FINEMET (wound tape ... anisotropic)

Iron powder
(sintered...
isotropic)
EI core is modified

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Cores under investigation

Material	Bs	Hc (A/m)	μ	Pcv (kW/m^3)	Tc (°C)
Finemet	1.23T	0.6	~10^4	~10^5 @0.2T, 3MHz	570
iron powder	0.5T? @5kA	no data	~9	~4.6x10^5 @0.2T, 6MHz	
Ferrite (SY20)	0.33T @2kA/m	110	290	5600 @0.03T, 3MHz	150

All the materials seem to show the same order.

Unfortunately all the material showed rather high loss.

→ Longer system?;

0.05T x 20m (300cc/2cm) ..... 0.3m^3 x30MW/m^3

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Issues on RF kicker

- Magnetic RF kicker:
  - Seek for material of kicker core
  - Beam chamber has to be made of insulator.
    < ceramic used in JPARC >
  - Abort kicker (MPS)
- Electric RF kicker (separator)?
  - 5MV/m ~ 0.017T
  - f=12MHz for 6MHz bunch spacing

Other devices?

- QEX4 candidate
- Magnet for low flat field
- Massless septum
- Unusual quads.

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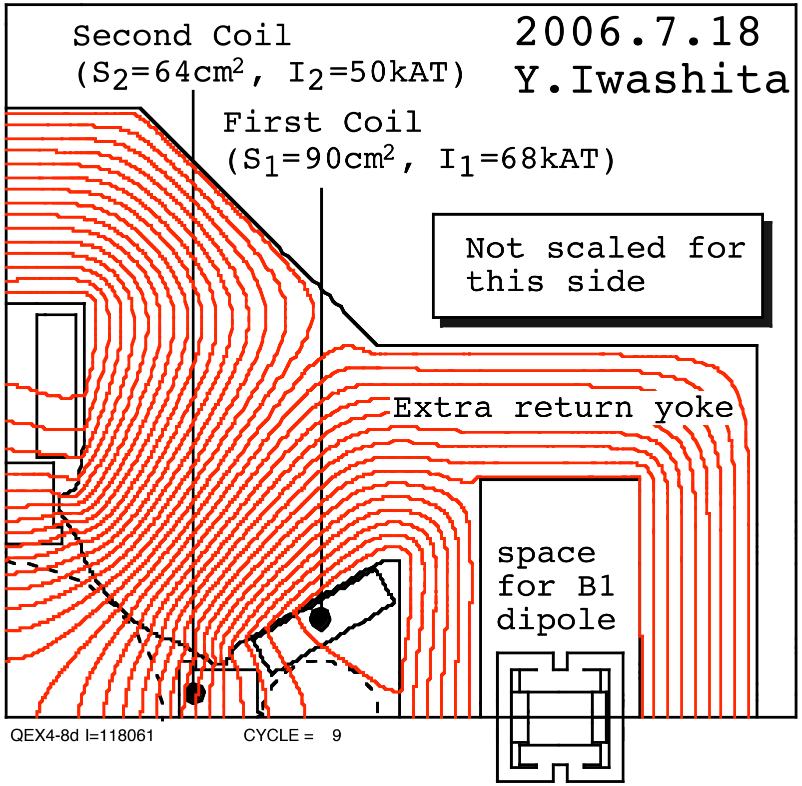

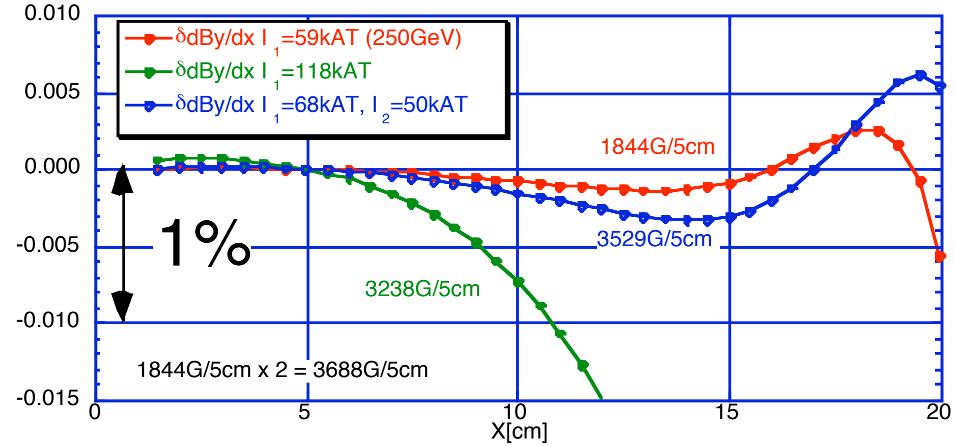

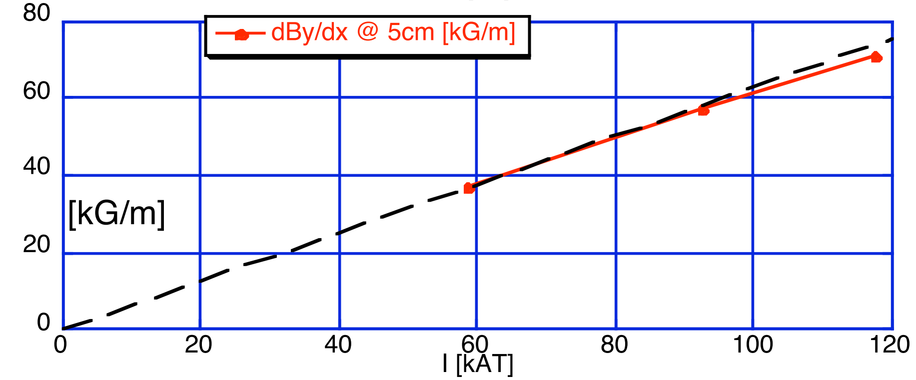

Required: 37kG/m for 250GeV and 74kG/m for 500GeV.

- Pole shape is optimized for 250GeV case with I1=59031AT.
- When I1=118061AT and I2=0, pole edges are highly saturated.
- Second coil improves the distribution for 500GeV case.
  (3529/1844=1.91) ... 5% more current needed.
- Coil space may be extended to reduce the power.

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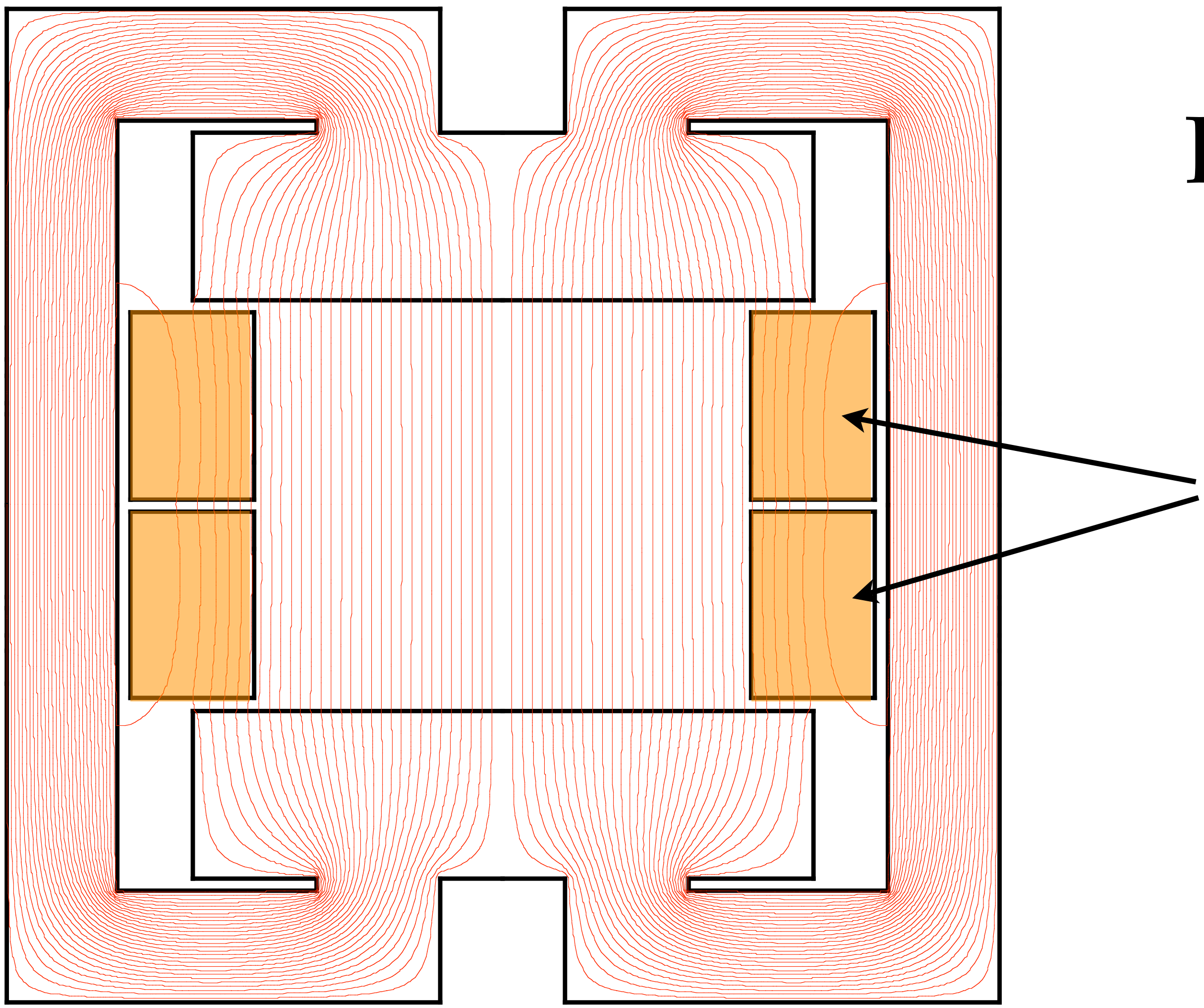
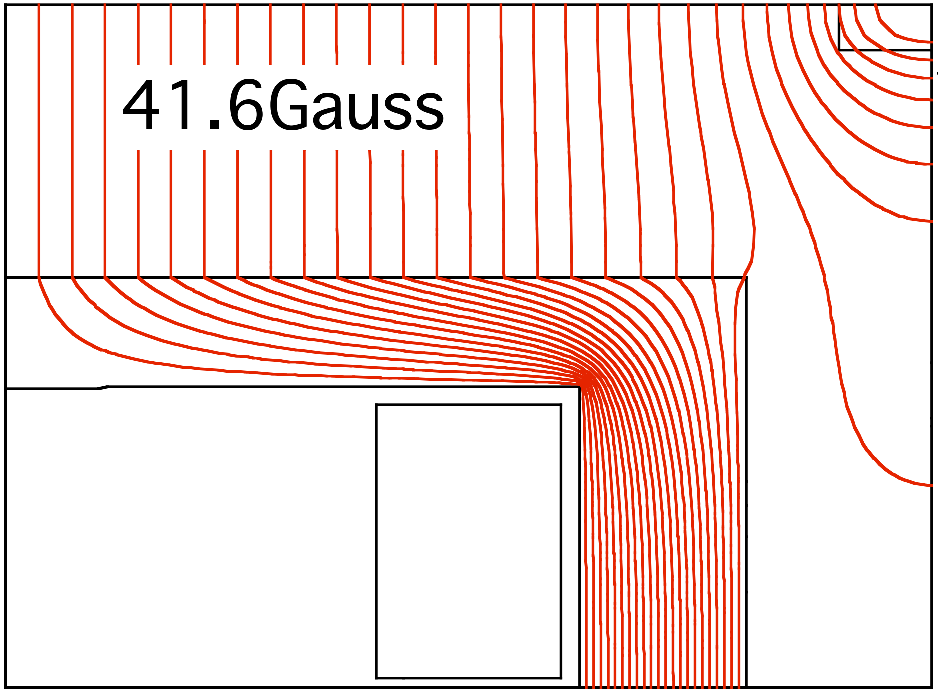
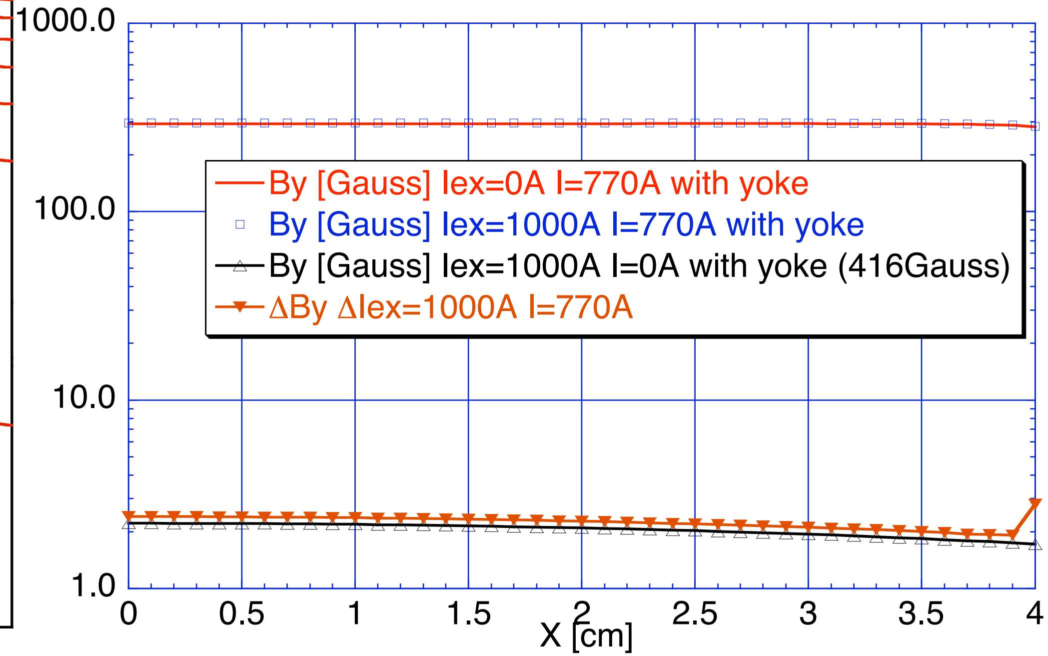
Window frame magnet for very uniform field

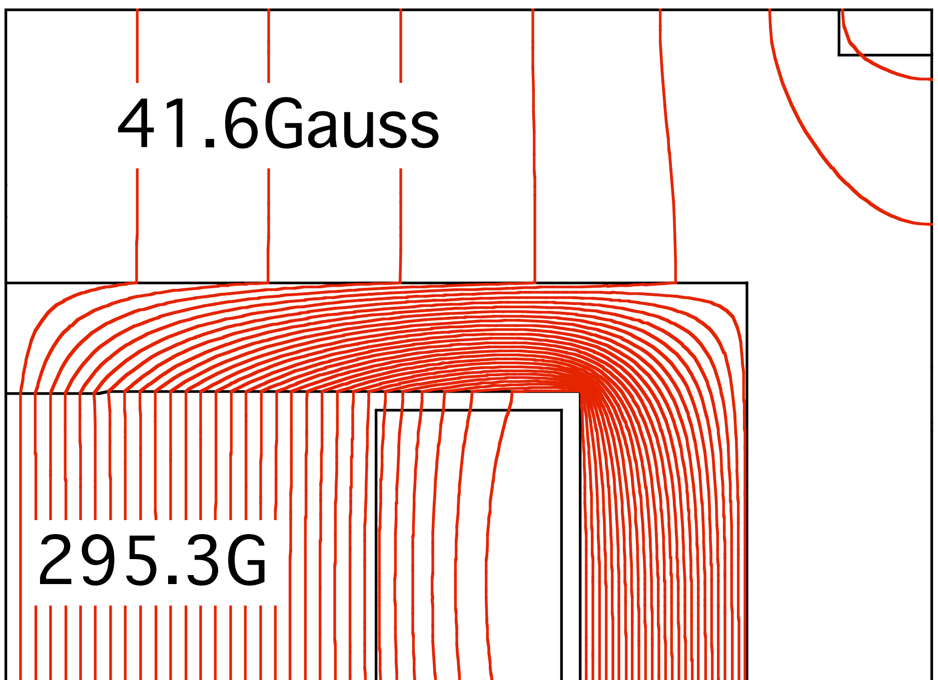


Equalized flux path length

Coils



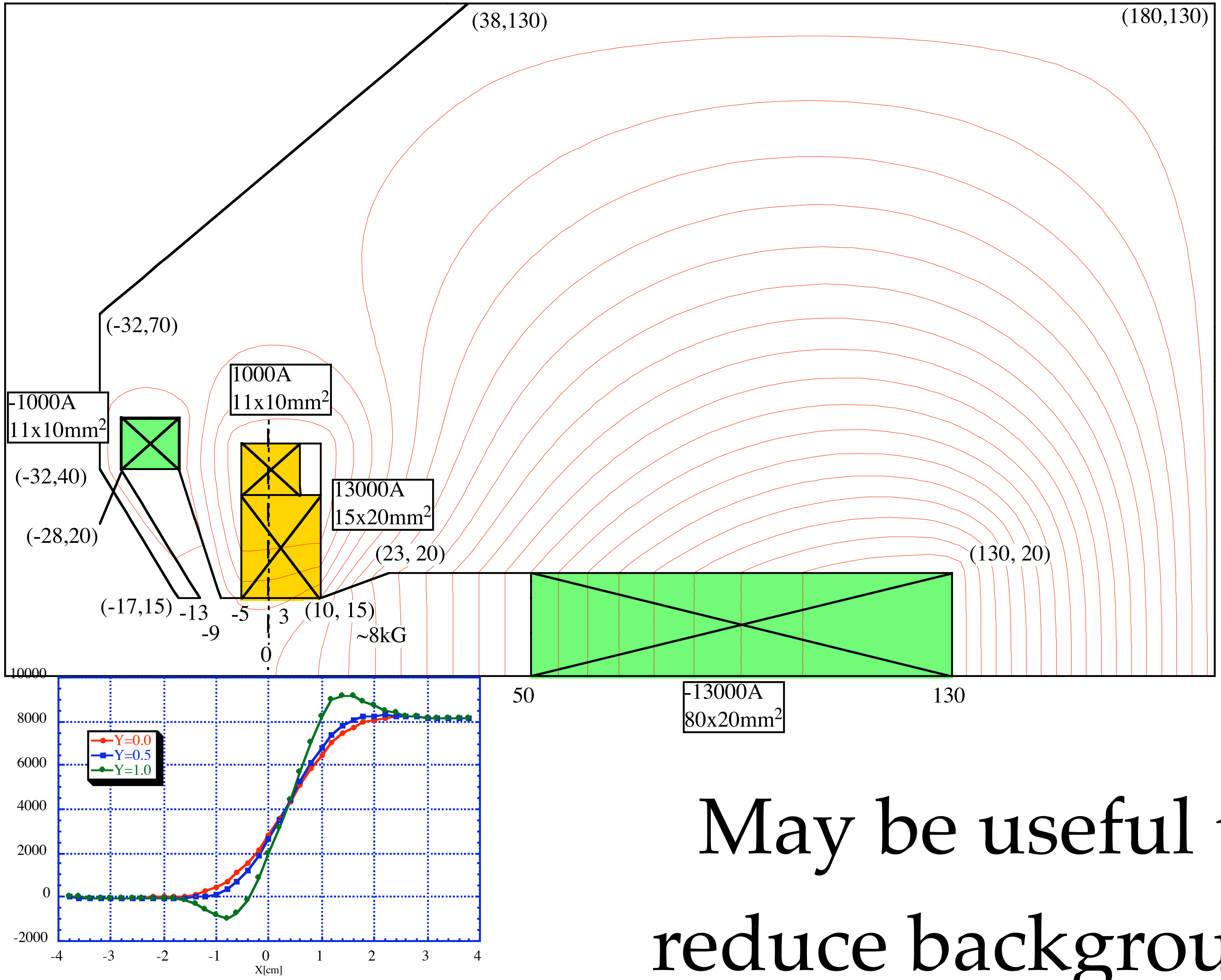




External field is well shielded

Residual field in iron is not included

Massless septum



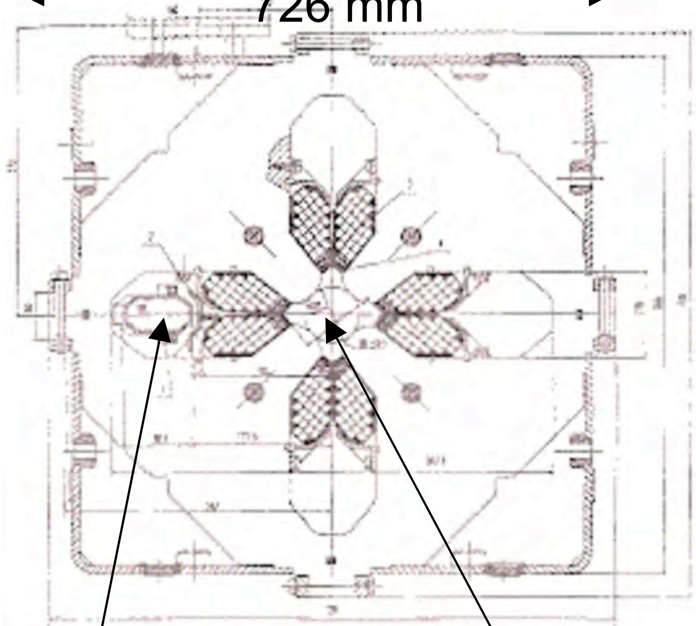
May be useful to reduce background

International Linear Collider at Stanford Linear Accelerator Center

Unusual Quad Styles for areas with close adjacent beams

Quad for HERA Luminosity Upgrade.

726 mm

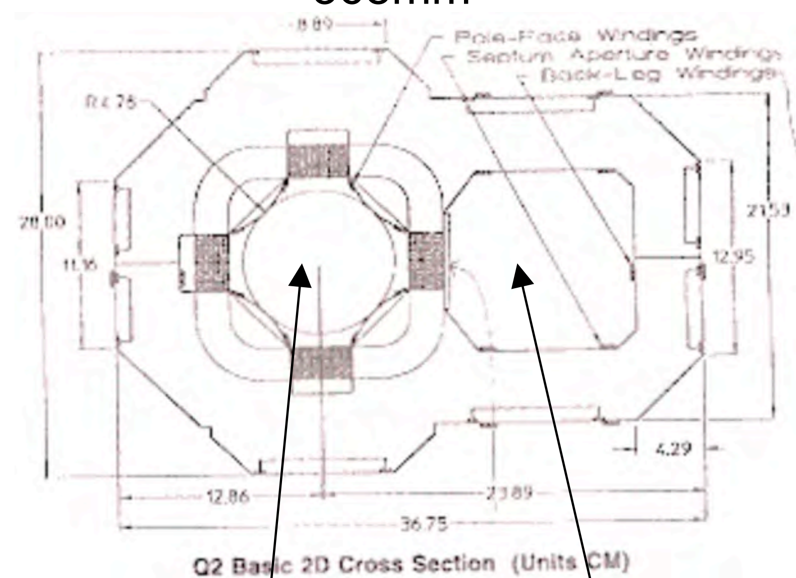


~221mm

Field-free region for secondary beam.
Primary beam passes through center of regular quad, bore radius=35mm

Q2 in PEPII

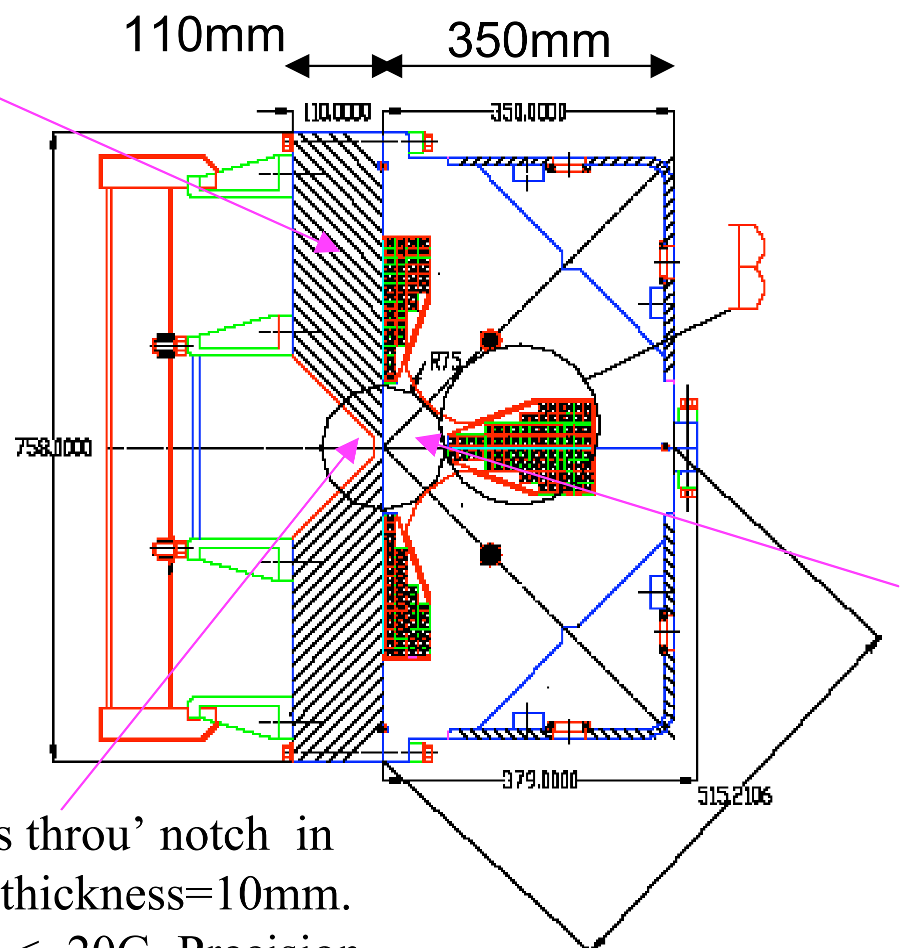
368mm



~142mm

Field-free region for secondary beam.
Primary beam passes through center of regular quad, bore radius=47.8mm

Septum Half Quad from TESLA TDR for 1st extraction quad



In my opinion one cannot satisfy Δx=21mm with such a design.

Extracted beam passes through HALF quad *to the right of its center* and so beam sees a dipole field on top of the quad field. The magnet's effect on the beam shape has to be modelled using some field data from a magnet simulation program.

Incoming beam passes throu' notch in steel septum. Septum thickness=10mm. Field here needs to be <~20G. Precision engineering needed to achieve this. Design is based on a HERA luminosity upgrade quad. Bore radius = 75mm.

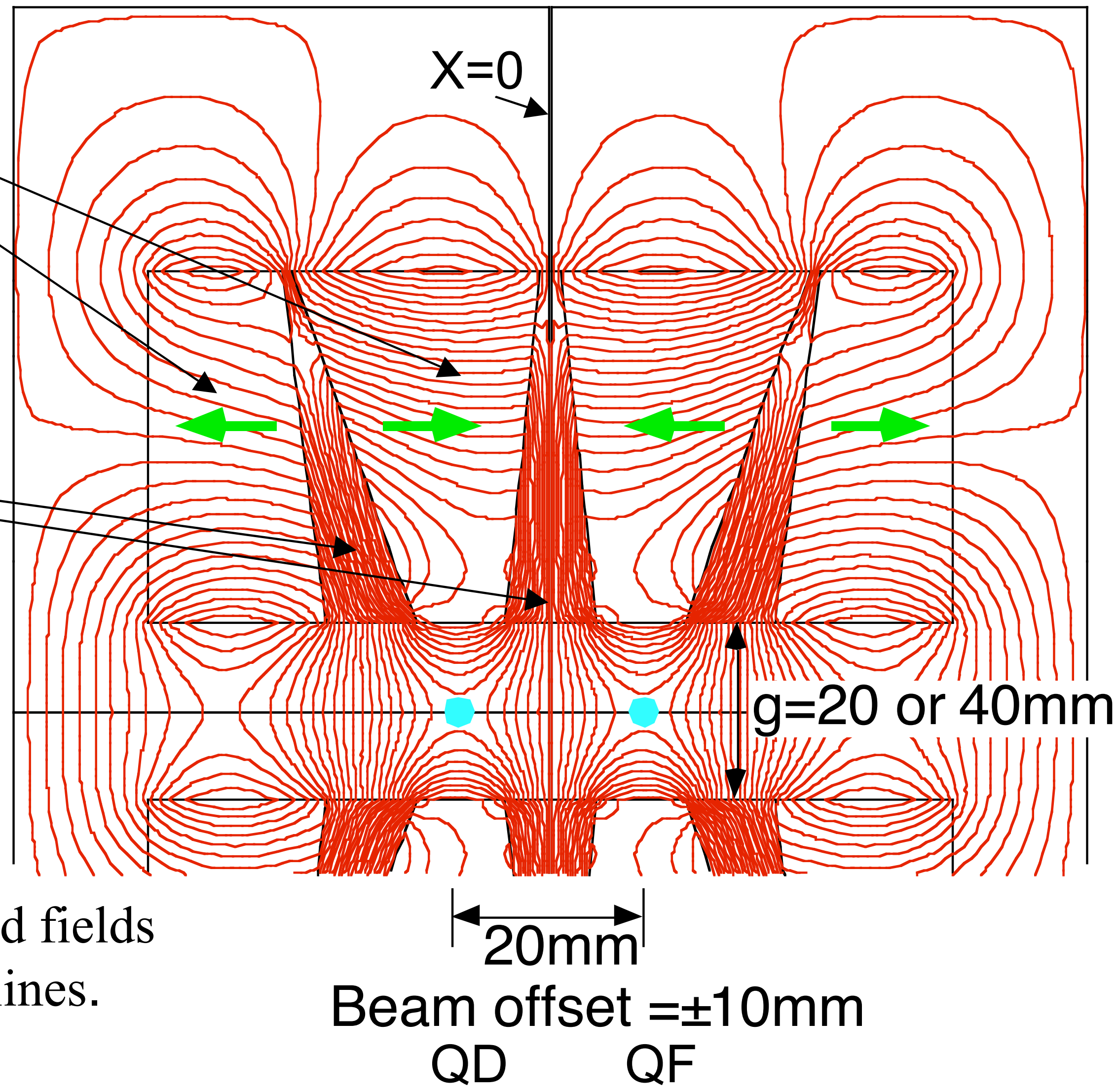
Extracted beam horizontal profile is NOT Gaussian, nevertheless outlying particles will hit face of magnet if half-aperture is too small.

Side-by-side Quads: a different approach, using permanent magnets

NEOMAX46
pm bricks

Permendur,
soft mag
material

Sides are open

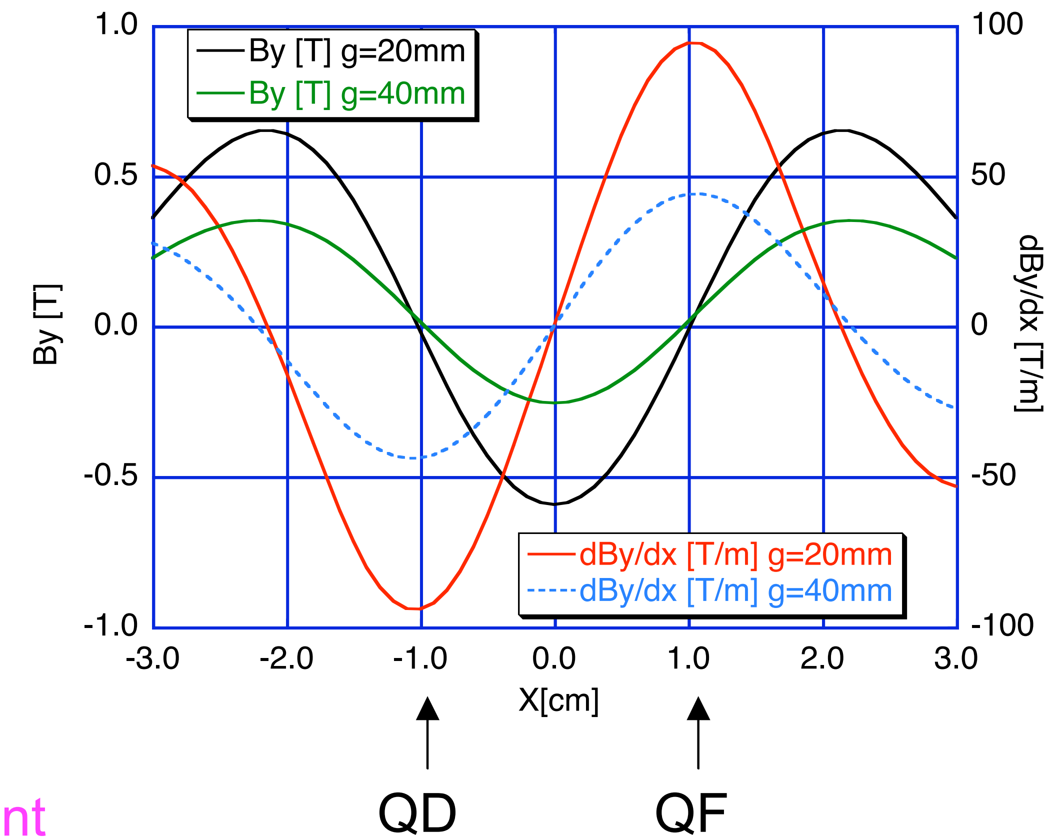


Conceptual figure.
Very preliminary.

Vary gap height
to vary gradient

Have full quad fields
in both beamlines.

Gradient variation with x for side-by-side quads



Gradient varies along x : has sextupole component.

Maximum value of ~100T/m at x=+-10mm

Possible way to have 2 quads in very close adjacent beamlines.

Summary

- Resonant kicker
  - waveform
  - kicker layout/timing chart
  - core material ... no good material found yet...
- Other devices mentioned:
  - QEX4&BM
  - massless septum
  - Unusual quads.