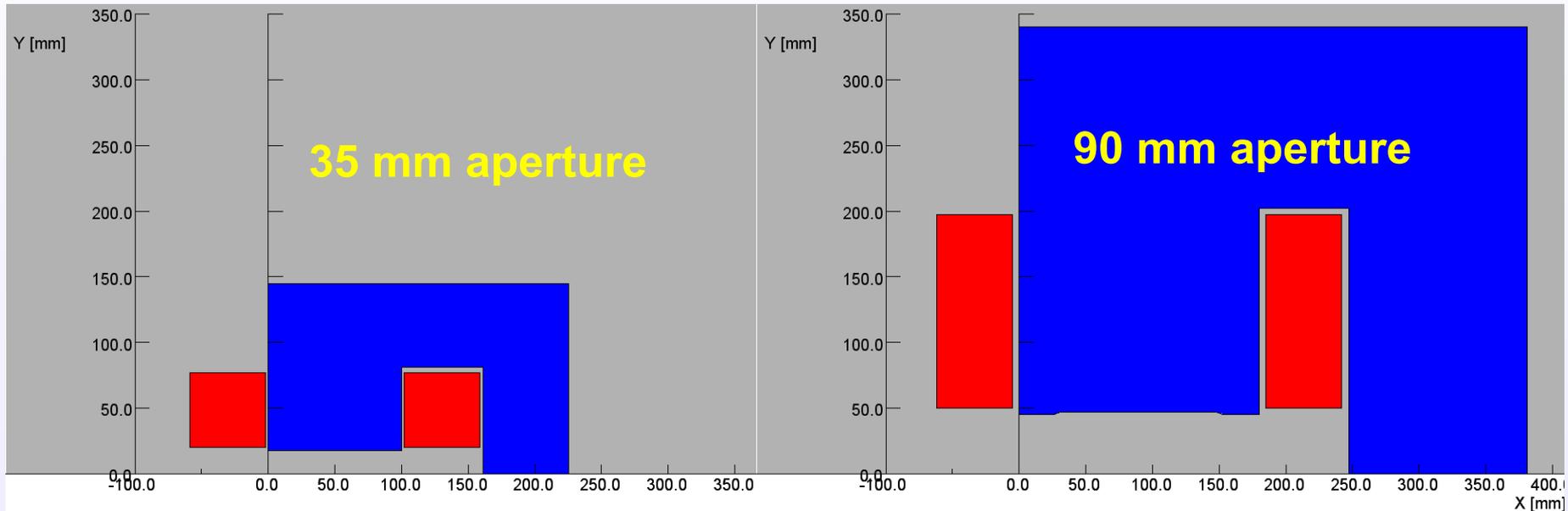


Preliminary 2-d and 3-d Designs of 90 mm Dipole

Ramesh Gupta

Comparison of 35 mm and 90 mm Aperture Dipoles



Note: 90 mm is the nominal aperture of the dipole.

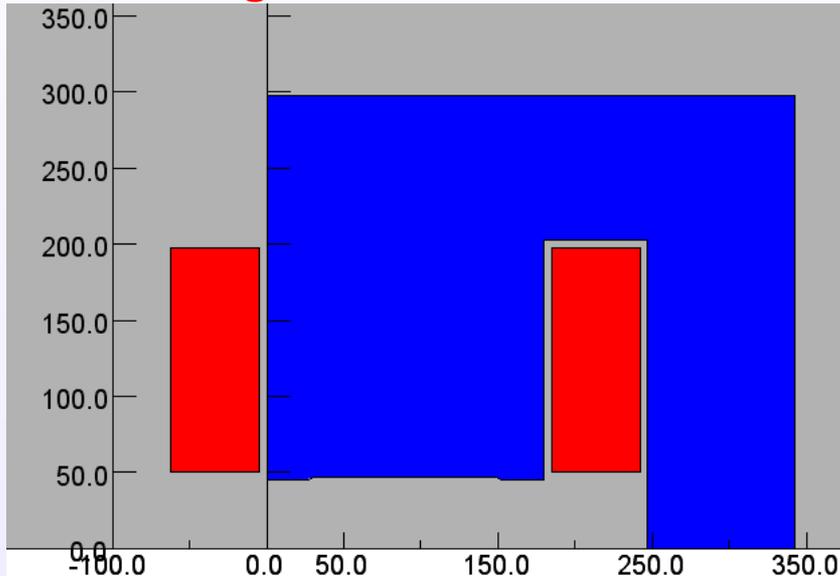
Adjust aperture to match transfer function in case the same power supply is used for both magnets.

➤ Are we using the same power supply for both?

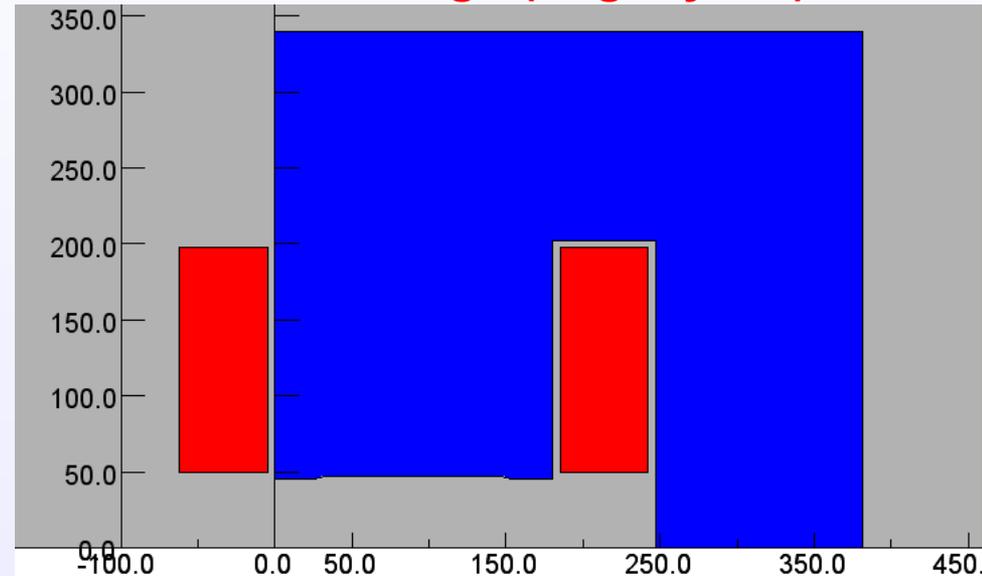
- Same conductor is chosen for both dipoles (number of turns are adjusted) - 16 turns (4 X 4) in 35 mm aperture case and 40 turns (4 X 10) in 90 mm aperture case.
- Transfer function of the two dipoles is similar with a maximum ~1% deviation.
- These constraints are not applicable if two magnets use different power supplies.

Preliminary 2-d Design of ~90 mm Dipole

Design discussed earlier



Current design (larger yoke)



- Yoke size increased due to mechanical concern.
- More increase (cost) should wait for mechanical analysis.

Both designs meet the following stated requirements:

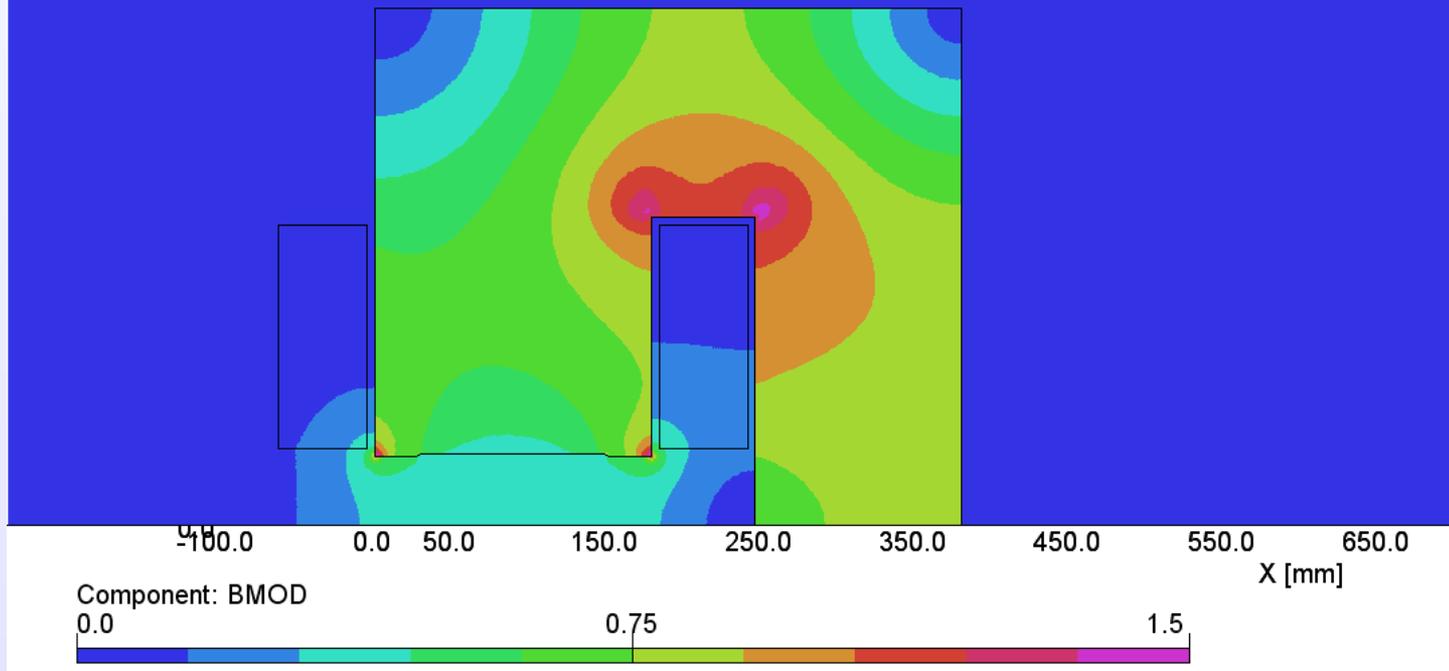
- Nominal Field – $B_0 = 0.40\text{T}$ to 0.50T
- Field Homogeneity $B_X, B_Y = 1 \times 10^{-4}$
- Good field region $B_X \pm 20\text{mm}$, $B_Y \pm 10\text{mm}$
- Nominal Current density in the coil cross section 2 Amps/mm^2

Yoke Design

The maximum field in yoke is 0.8 T for 0.4 T central field.
Therefore, the need for further increase in yoke size must be justified on the mechanical ground.
(see more comparison of fields in the next slide)

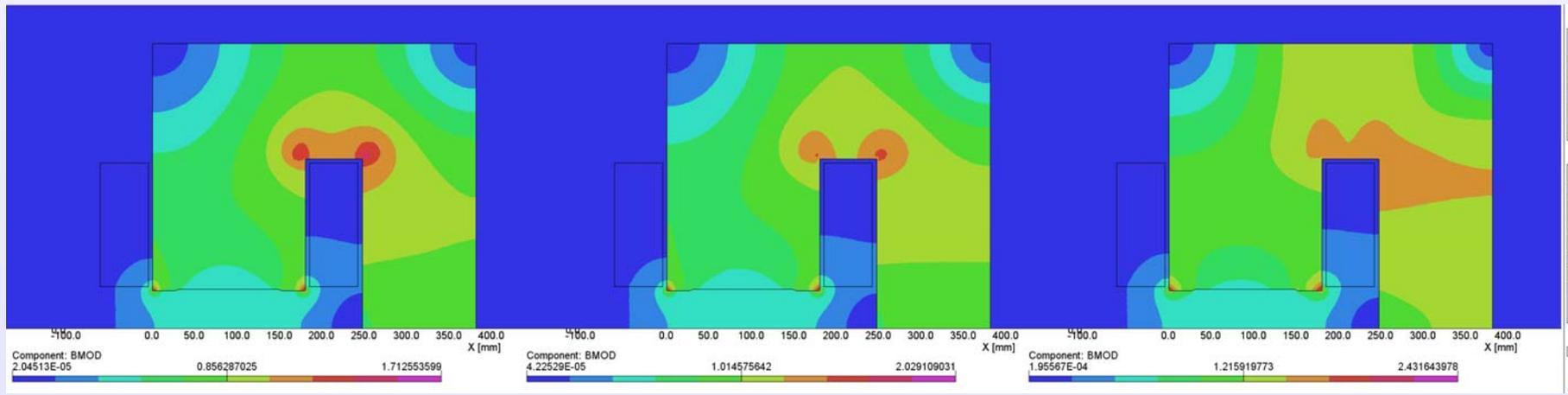
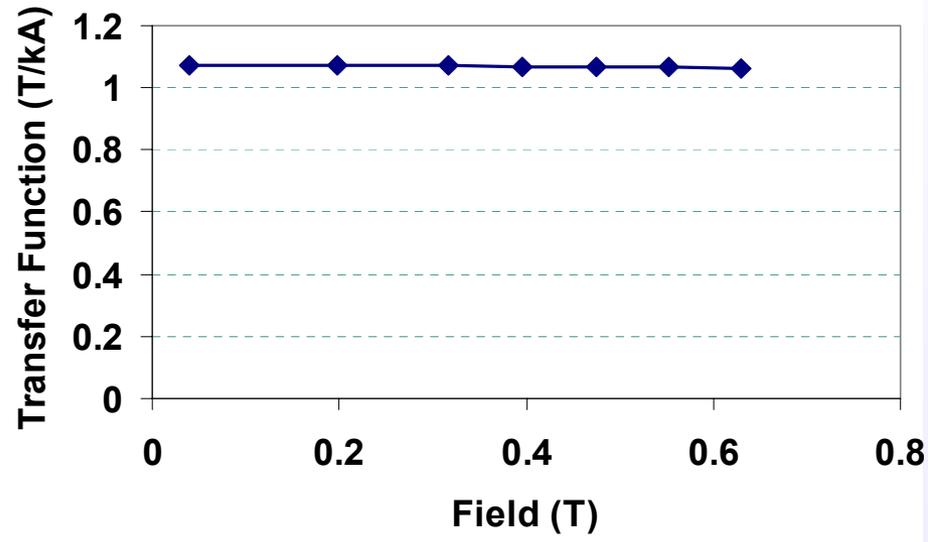
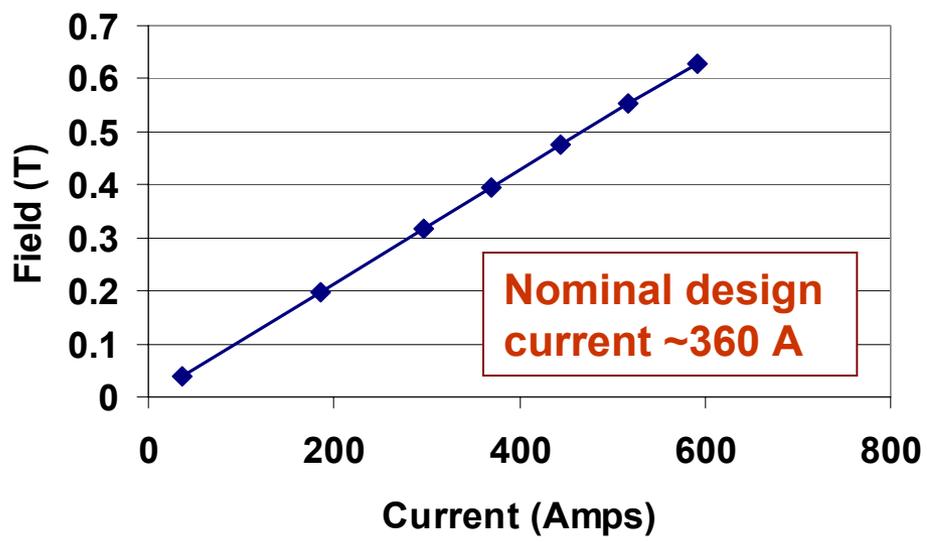
UNITS	
Length	: mm
Flux density	: T
Field strength	: A m ⁻¹
Potential	: Wb m ⁻¹
Conductivity	: S m ⁻¹
Source density	: A mm ²
Power	: W
Force	: N
Energy	: J
Mass	: kg

PROBLEM DATA	
E:\opera\1s2\90mm\1s2-cu	
-90mm-e2.st	
Linear elements	
XY symmetry	
Vector potential	
Magnetic fields	
Static solution	
Scale factor = 1.0	
61864 elements	
31188 nodes	
23 regions	



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Iron Saturation in 90 mm Aperture Dipole



UNITS

- Length: mm
- Flux density: T
- Field strength: A m⁻¹
- Potential: Vb m⁻¹
- Conductivity: S m⁻¹
- Source density: A mm⁻²
- Power: W
- Force: N
- Energy: J
- Mass: kg

PROBLEM DATA:
LS2-CU-SOMME2-MANY
IS
Linear elements
1/3 symmetry
Vector potential
Magnetic fields
Static solution
Case 7 of 7
Scale factor = 1.6
81864 elements
31168 nodes
23 regions

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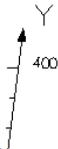
Design field

20% over the design field

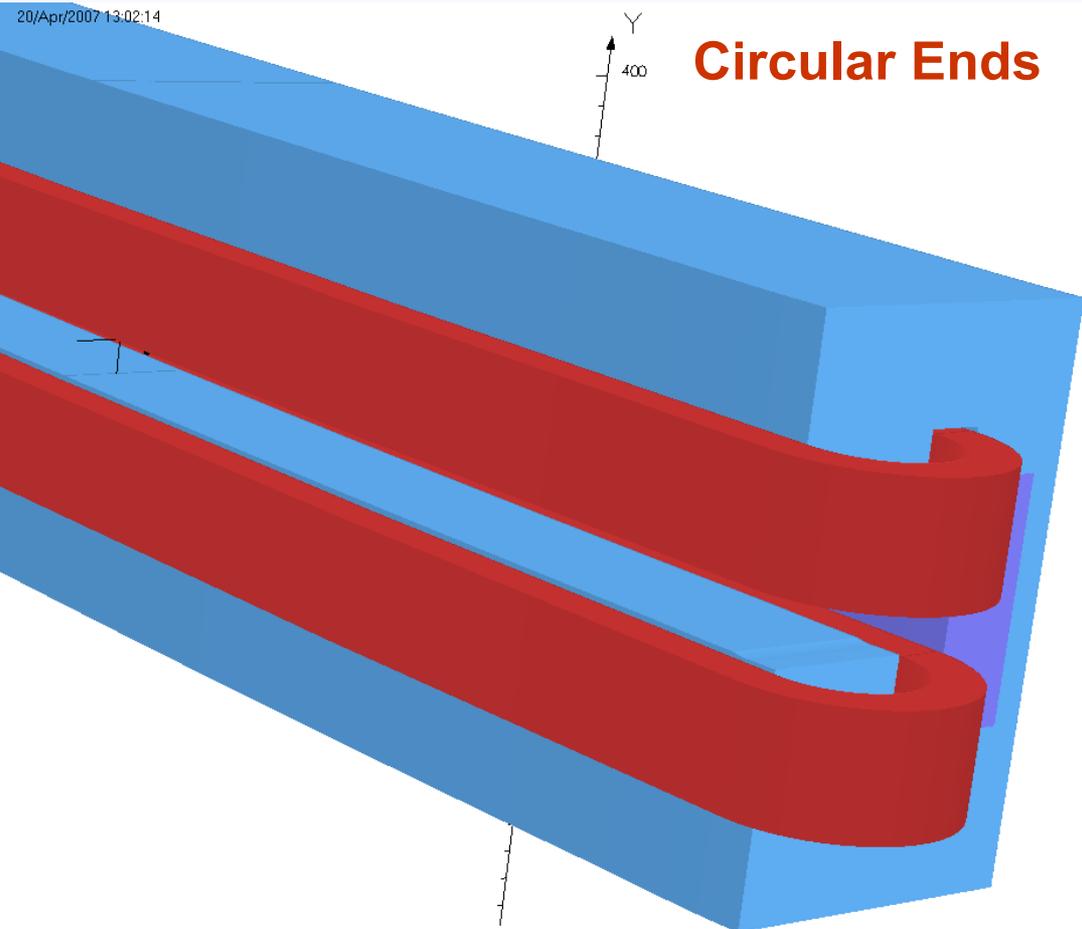
60% over the design field

Preliminary 3-d Analysis of ~90 mm Aperture Dipole

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Circular Ends



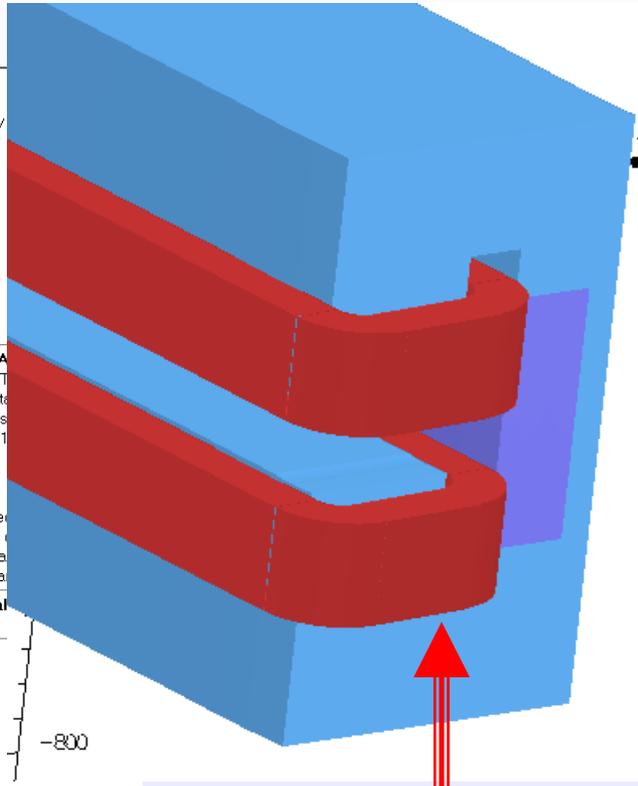
UNITS

Length
Magn Flux Density
Magn Field
Magn Scalar Pot
Magn Vector Pot
Elec Flux Density
Elec Field
Conductivity
Current Density
Power
Force
Energy

PROBLEM DATA

race-90mm-a1w_4T
TOSCA Magnetost
Nonlinear materials
Simulation No 1 of 1
5459068 elements
917946 nodes
3 conductors
Nodally interpolate
Activated in global
Reflection in XY pla
Reflection in ZX pla

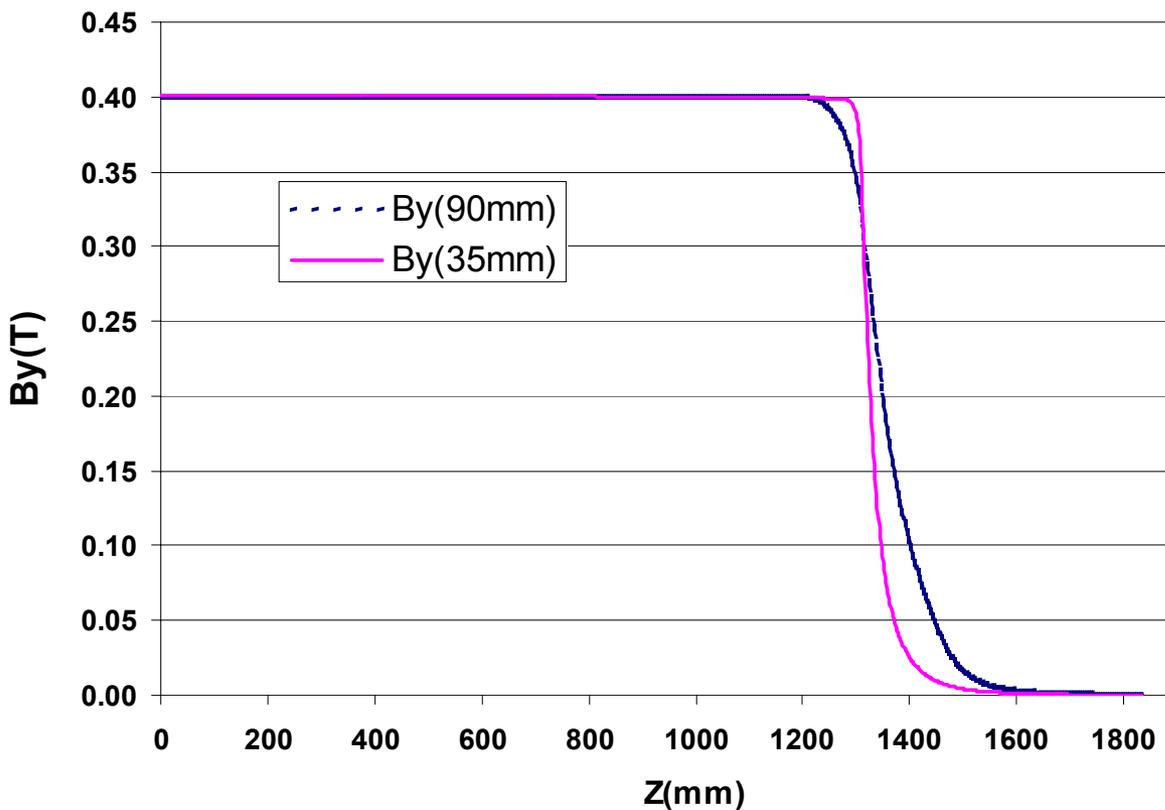
Field Point Local
Local = Global



-800

Racetrack Ends
(to reduce the
mechanical
length of the
coil/magnet)

Comparison of Axial Field Profiles of 90 mm and 35 mm Aperture Dipoles

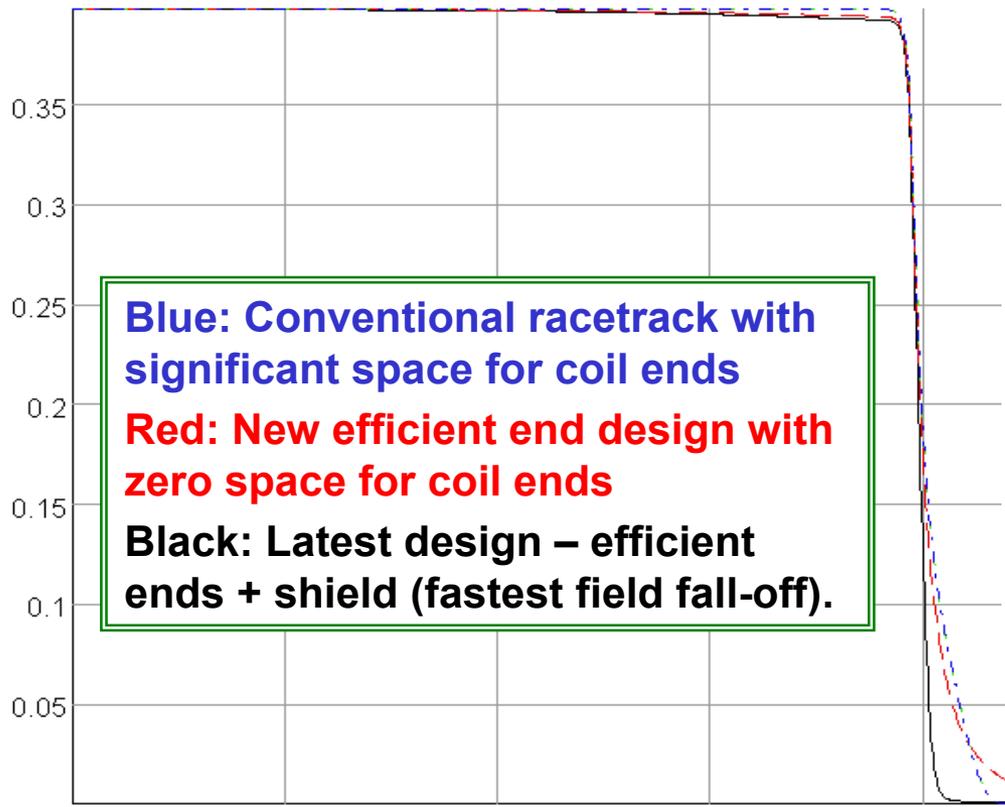


Compare the end field profile of the two magnets. End harmonics will be minimized.

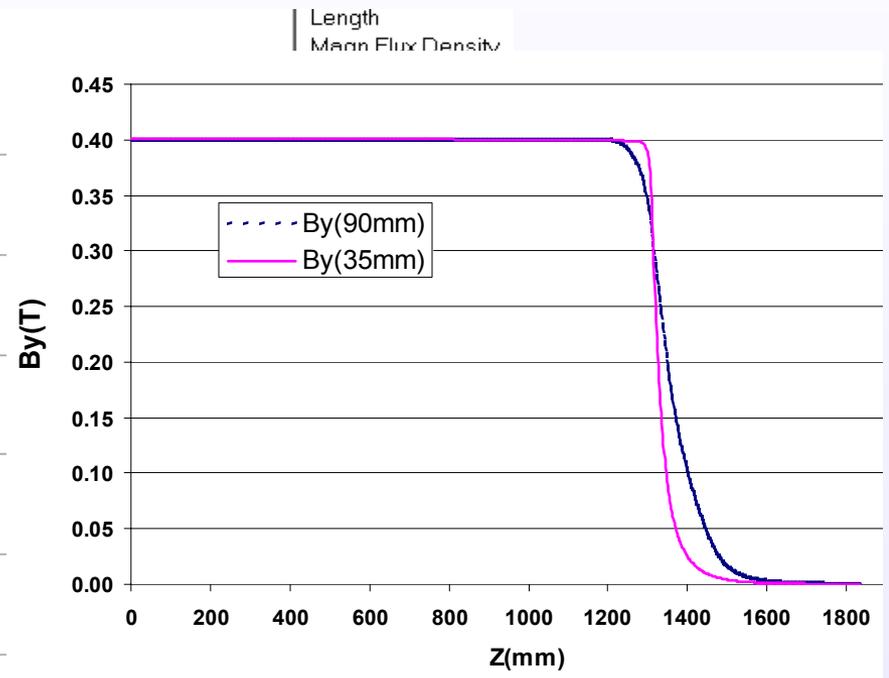
An additional goal has been to match the integral transfer function of the 90 mm aperture dipole with that of 35 mm aperture dipole for the same current (number of turns are different in two).

As expected, the field of 90 mm aperture dipole falls slower than the field of 35 mm aperture dipole.

Review of Axial Field Profiles in Various End Designs



Blue: Conventional racetrack with significant space for coil ends
Red: New efficient end design with zero space for coil ends
Black: Latest design – efficient ends + shield (fastest field fall-off).



We can make attempt to reduce the difference between the ends profiles of 35 mm and 90 mm aperture dipoles, if required.

rd	50.0	52.2086223	58.8340983	69.875256	85.3301421	105.1
rd	0.0	0.0	0.0	0.0	0.0	0.0
rd	0.0577E-12	332.099659	664.140567	996.063983	1327.81119	1659.
int:	BMOD, Integral = 524.711552367817					
int:	BMOD, Integral = 531.804875860282					
int:	BMOD, Integral = 533.087048290844					
int:	BMOD, Integral = 533.087048290844					