

Optimization of Dipole
and
Three Pole Wiggler Interface

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Progress and Status

As of last meeting on March 23, 2007

Favored Design Options

- Dipole with efficient ends.
- Close in 3 pole wiggler and Dipole.

Remaining Issues

- Interaction or cross talk between the fields of dipole and three pole wiggler.
- Linear superposition of the fields of two magnet : Is it valid or can it be accommodated with correctors in dipole ends.
- Field fall of the efficient end : Is slower fall off acceptable? Can some thing be done to make field fall of faster.

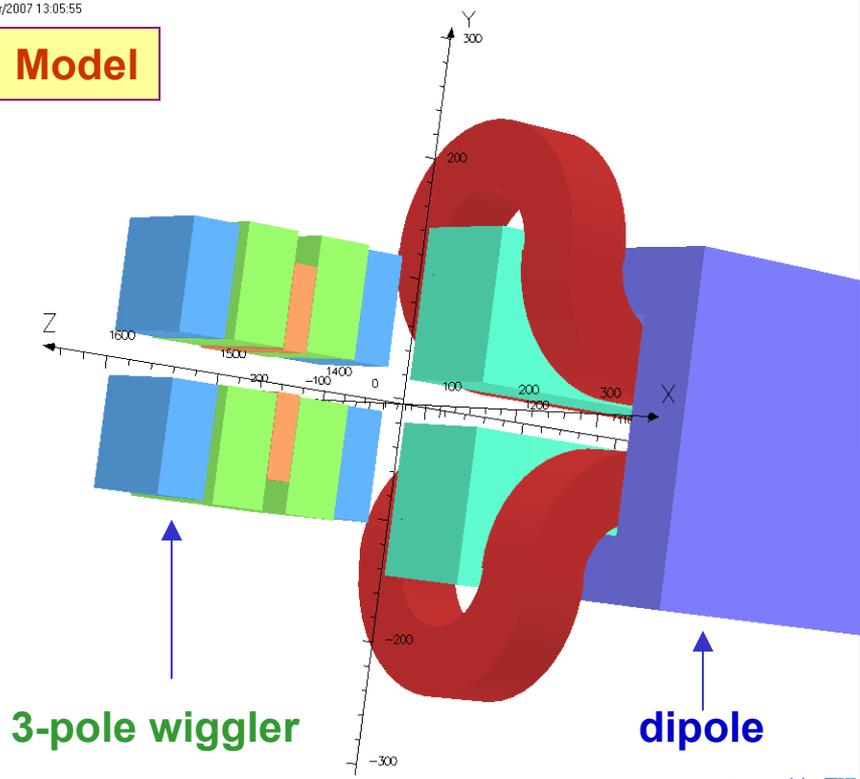
Overview of progress since last meeting:

- Put a magnetic fence to isolate the field of influence of two warring parties – dipole and three pole wiggler.
- Can we do it, including taken by magnetic the fence (shielding), within the same overall space (90 mm or less).
- Improvement in the fall-off of fringe field of new dipole end.

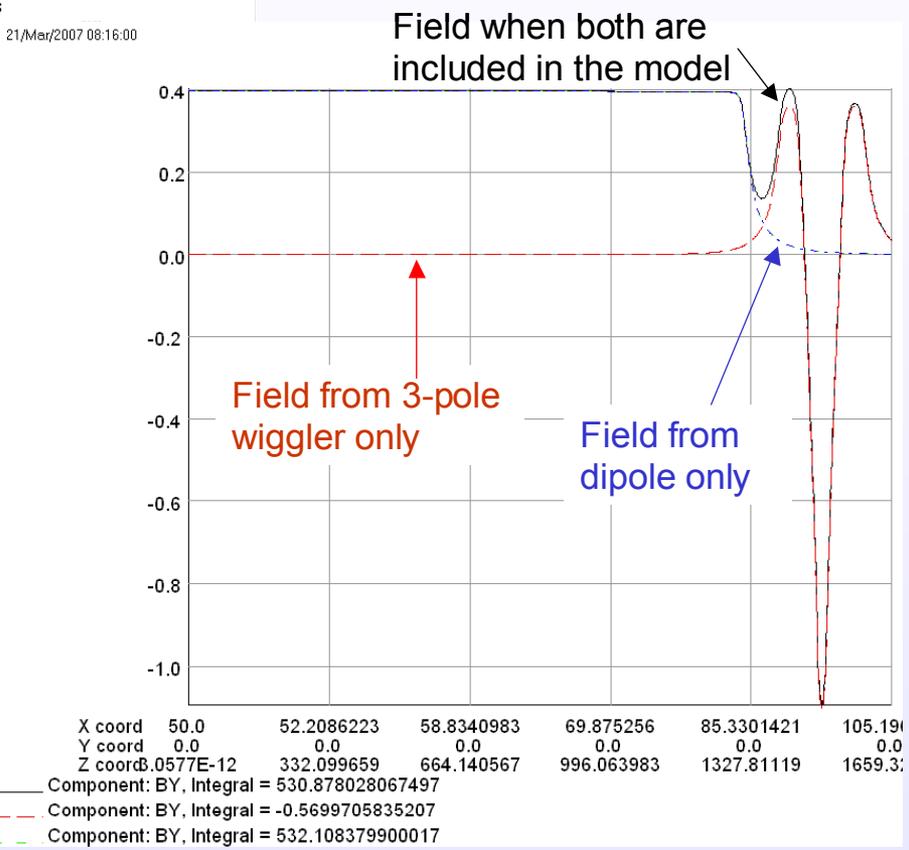
Review of the Design Presented Last Week

21/Mar/2007 13:05:55

Model



UNITS
Leng''
Mag
Mag
Mag
Mag
Mag
Elec
Elec
Conc
Curr
Pow
Forc
Ener
PRO
beds
TOST
Nonli
Simul
2628t
44574
5 con
Node
Activ
Relle
Relle
Field
Local



Some interaction between the fields of dipole and three pole wiggler

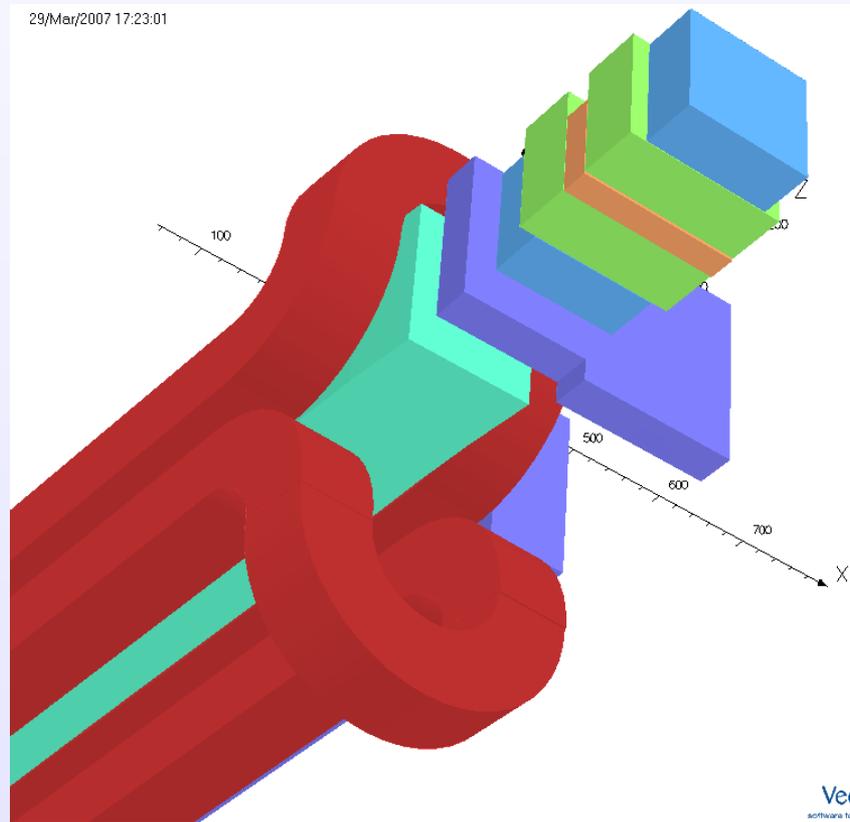
Incorporation of Magnetic Shield

**Superconducting
Magnet Division**

- In this case a 30 mm shield is placed between the 3 pole wiggler and dipole with new ends.
- The clear space on either side of the shield is 30 mm.
- The idea is to reduce the cross-talk between the two magnets.

- Smaller shielding (10 mm) was also studied.
- First see if the concept works and how well and then do a detailed optimization.
- It seems to work well.
- To make it symmetric, one should perhaps put shielding on either side.

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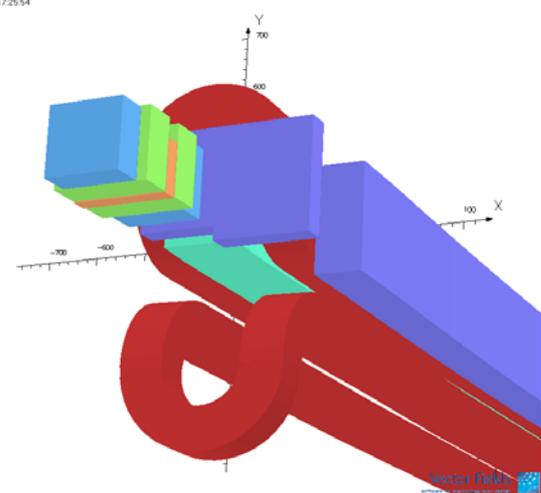


UNITS	
Length	m
Magn Flux Density	T
Magn Field	A
Magn Scalar Pot	A
Magn Vector Pot	V
Elec Flux Density	C/m ²
Elec Field	V/m
Conductivity	S/m
Current Density	A/m ²
Power	W
Force	N
Energy	J

PROBLEM DATA
bedstd-3pole-6q.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
2625334 elements
445485 nodes

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Vector Field
software for electromagnetic



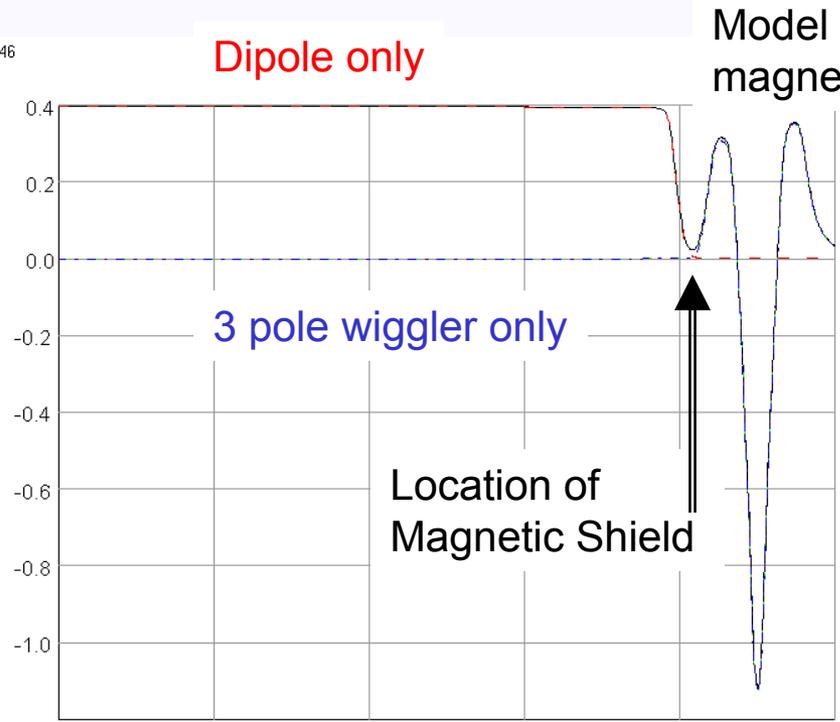
UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A/m ²
Magn Scalar Pot	A
Magn Vector Pot	Wb/m ²
Elec Flux Density	C/m ²
Elec Field	V/m
Conductivity	S/mm ²
Current Density	A/mm ²
Power	W
Force	N
Energy	J

PROBLEM DATA
bedstds-3pole-6q.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
2625334 elements
445485 nodes
5 conductors
Nodally interpolated fields
Activated in global coordinates
Field Point Local Coordinates
Local = Global

Vector Fields
software for electromagnetic

Overlapping Fields?

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Model with two magnets together

mm
T
A m ⁻¹
A
Wb m ⁻¹
C m ⁻²
V m ⁻¹
S mm ⁻¹
A mm ⁻²
W
N
J

PROBLEM DATA
bedstd-3pole-6q-only.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
2625334 elements
445485 nodes
Nodally interpolated fields
Activated in global coordinates

Field Point Local Coordinates
Local = Global

Magnetic shield clearly draws to a good line of demarcation between the field of influence of two competing parties.

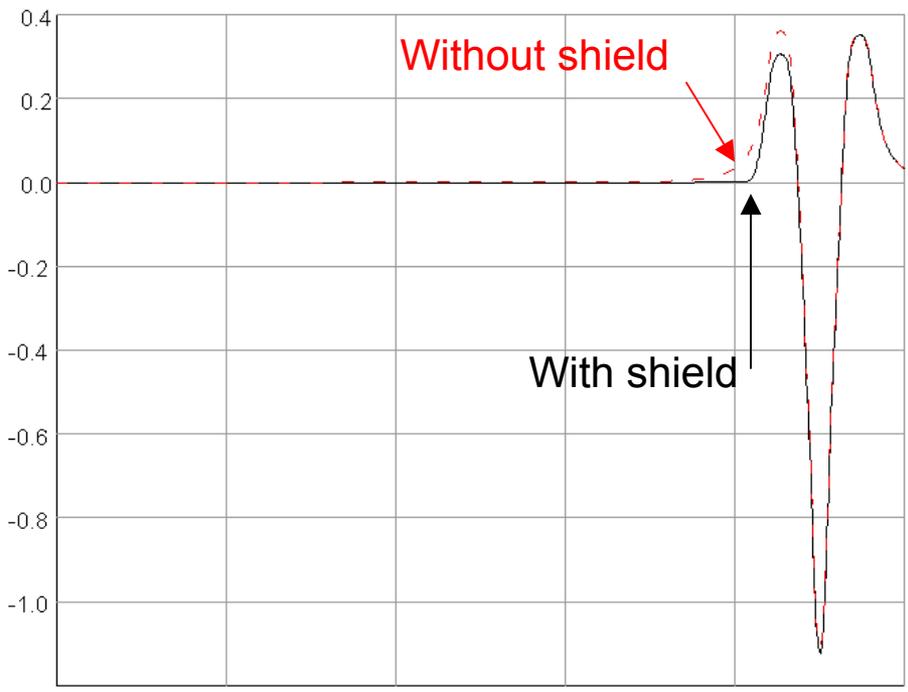
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Y coord	0.0	0.0	0.0	0.0	0.0	0.0
Z coord	0.0577E-12	332.099659	664.140567	996.063983	1327.81119	1659.32349

- Component: BY, Integral = 515.470310044452
- - Component: BY, Integral = 524.711552367813
- - Component: BY, Integral = -10.862475582598
- - Component: BY, Integral = -10.862475582598



Comparison of field profiles with and without shielding for 3 pole wiggler only

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X coord	50.0	52.2086223	58.8340983	69.875256	85.3301421	105.196023
Y coord	0.0	0.0	0.0	0.0	0.0	0.0
Z coord	3.0577E-12	332.099659	664.140567	996.063983	1327.81119	1659.32349
— Component: BY, Integral =	-10.862475582598					
- - Component: BY, Integral =	-0.5699705835207					

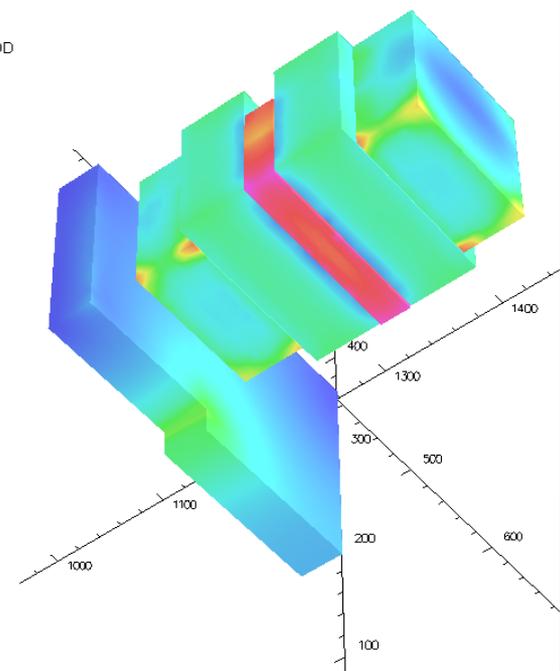
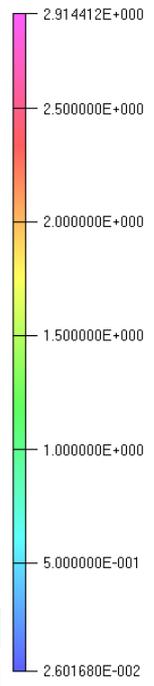
UNITS

Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W

Put shield on both sides for symmetry. (perhaps one can reduce the iron width on either side)

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Surface contours: BMOD



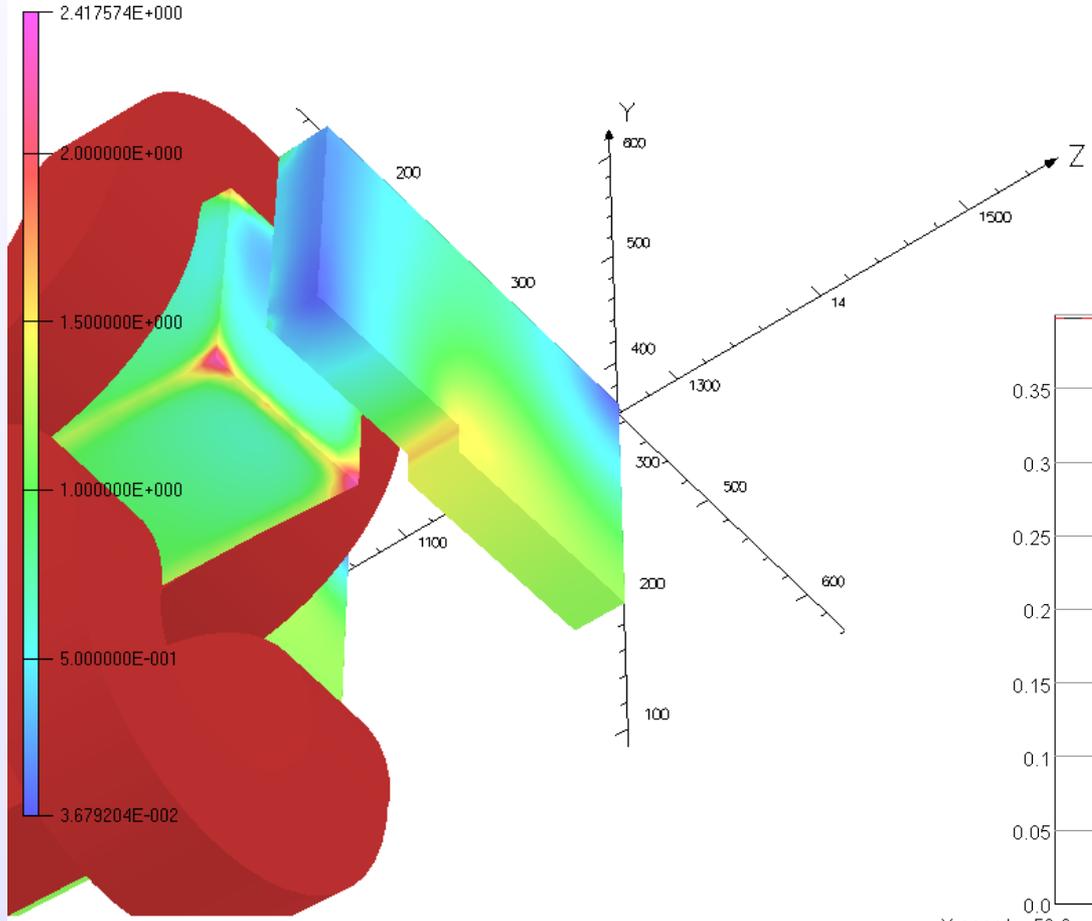
Vector Fields
software for electromagnetic design

Magnetic Shielding Makes Field Drop Faster!!!

Comparison of field profiles with and without shielding for dipole with new ends

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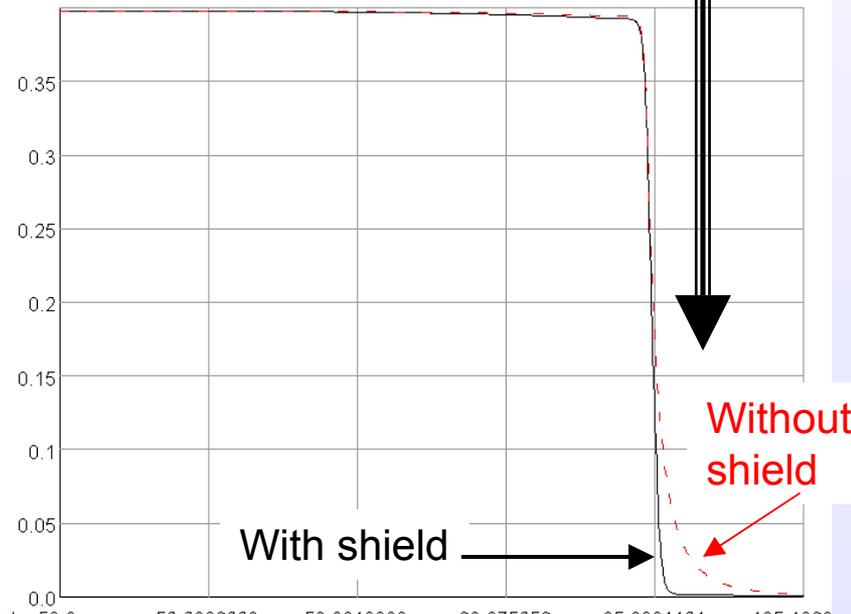
Surface contours: BMOD



UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A/m
Magn Scalar Pot	A
Magn Vector Pot	Wb
Elec Flux Density	C/m ²
Elec Field	V/m
Conductivity	S/m
Current Density	A/m ²
Power	W
Force	N
Energy	J

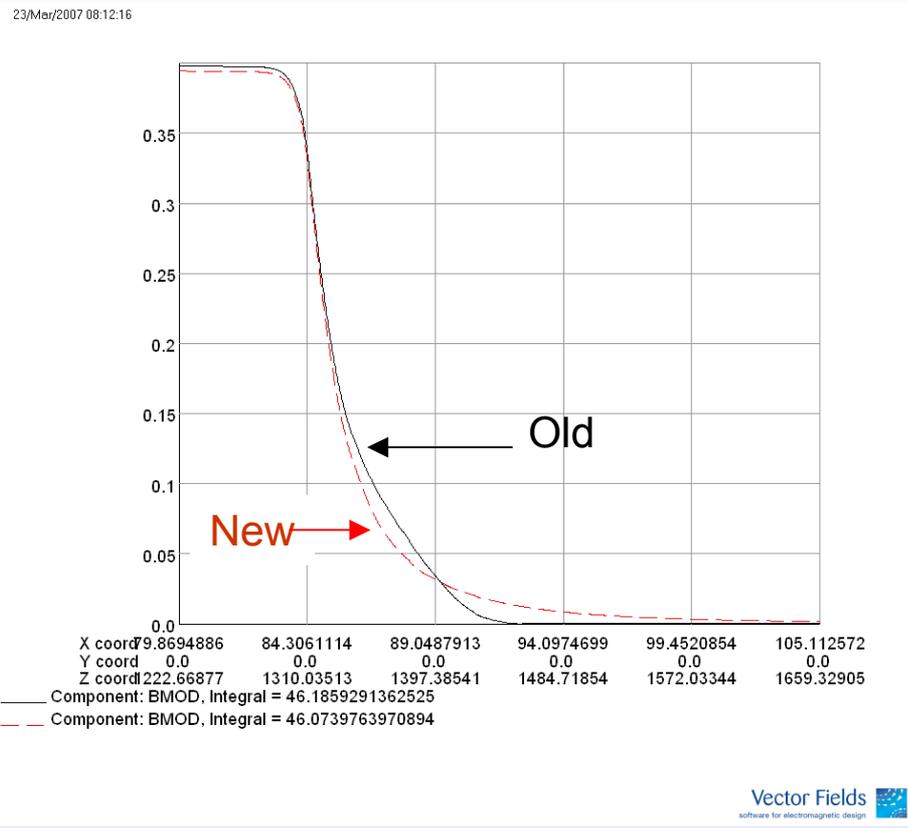
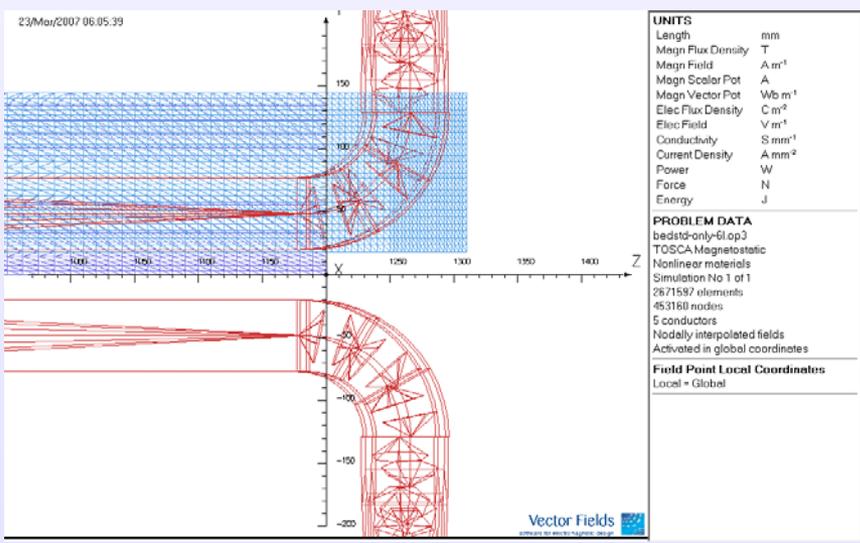
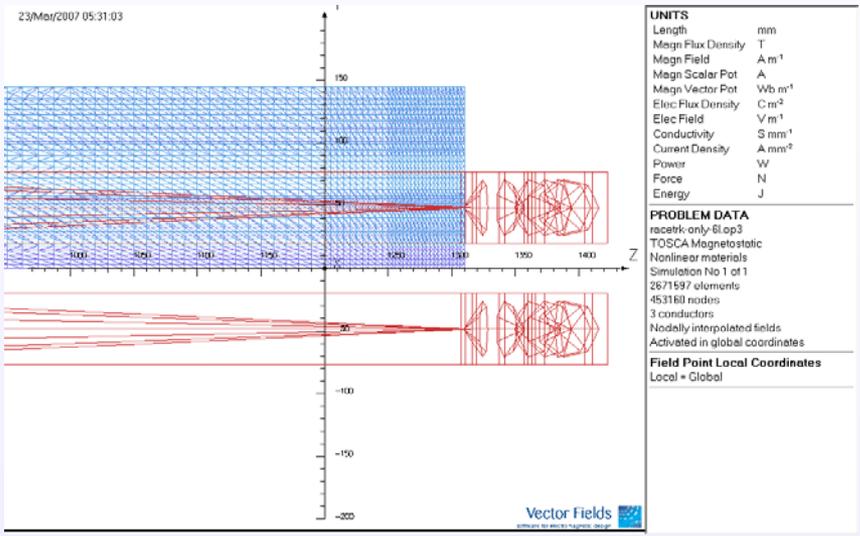
PROBLEM DATA
bedstd-only-6q.op3

Note a sharp improvement in the field fall off



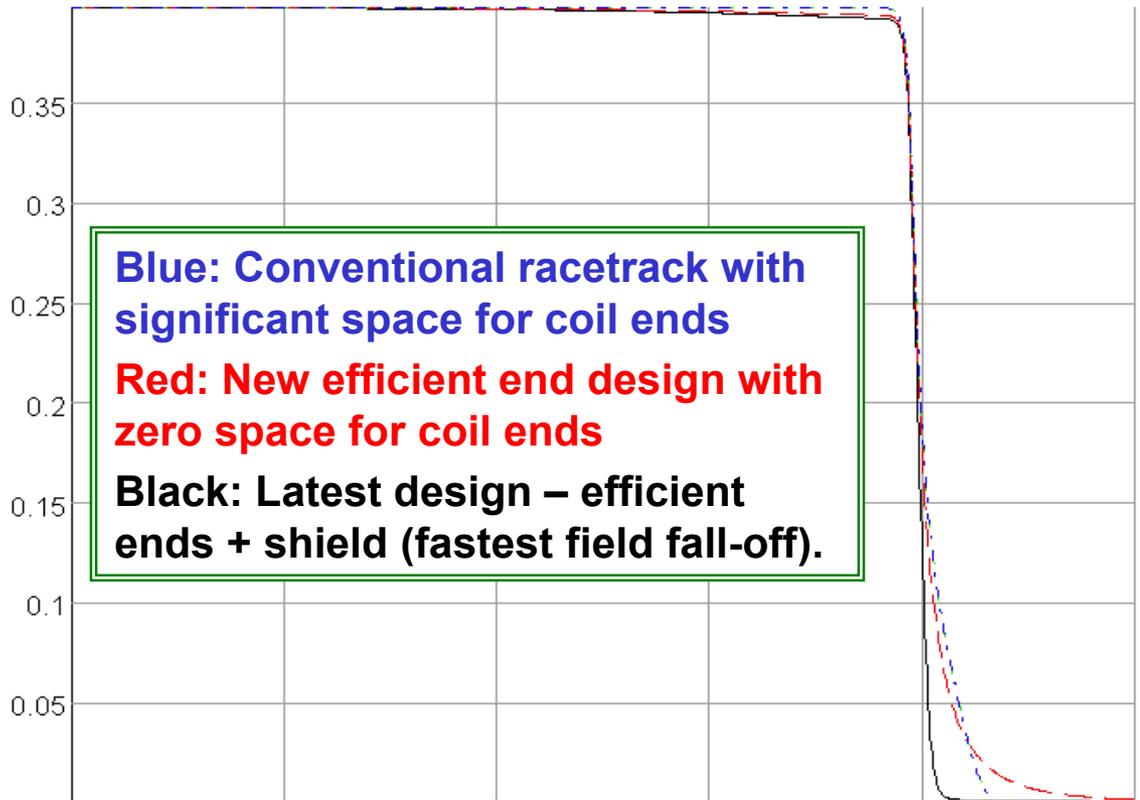
X coord	50.0	52.2086223	58.8340983	69.875256	85.3301421	105.1960
Y coord	0.0	0.0	0.0	0.0	0.0	0.0
Z coord	0.0577E-12	332.099659	664.140567	996.063983	1327.81119	1659.323
—	Component: BY, Integral = 524.711552367813					
- -	Component: BY, Integral = 531.804875860278					

This (faster fall off) is a significant improvement over last design (see below)



- There is no loss in magnetic length in releasing the space occupied by coil ends.
- End fields are similar in both cases.
- Are we ready to accept this deduction in real estate as valid now (or we wait till April 15th)?

Comparison of the End Fields in Various 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).

X coord	50.0	52.2086223	58.8340983	69.875256	85.3301421	105.196023
Y coord	0.0	0.0	0.0	0.0	0.0	0.0
Z coord	3.0577E-12	332.099659	664.140567	996.063983	1327.81119	1659.32349

- Component: BMOD, Integral = 524.711552367817
- Component: BMOD, Integral = 531.804875860282
- Component: BMOD, Integral = 533.087048290844
- - Component: BMOD, Integral = 533.087048290844

Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J

PROBLEM DATA
 racetrk-only-6l.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 2671597 elements
 453160 nodes
 3 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

Summary

- **New dipole end and magnetic shielding seems to be helping the overall design of NSLS2 storage ring.**
- **Significant space can be released and cross talk can be managed.**
- **In principle, one can obtain similar benefits in quadrupole and sextupole magnets. Since there are many of those in the machine, impact of such designs can be significant.**