
Corrector Designs for Superconducting Solenoid for e-lens

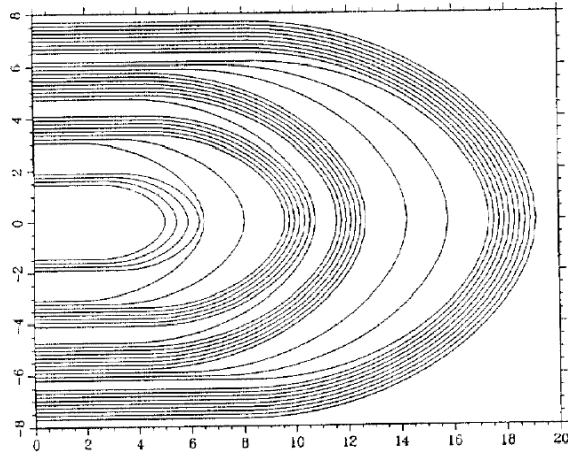
Ramesh Gupta

April 13, 2010

Design Considerations for e-lens correctors

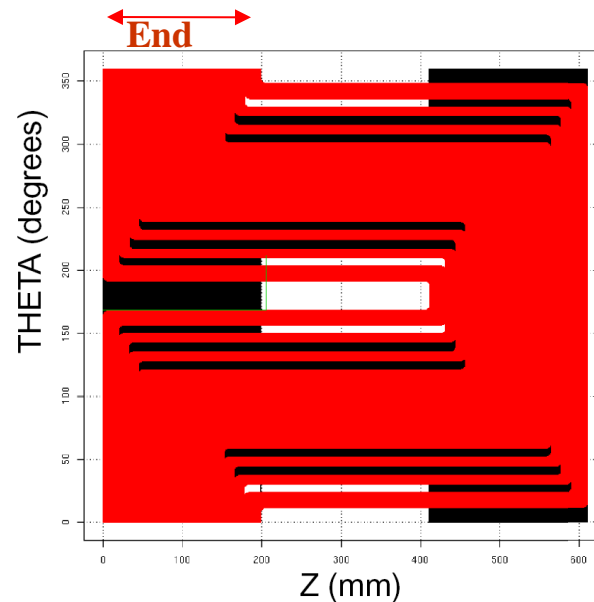
- Short correctors must create a dipole field of 0.02 T and long correctors 0.006+ T (both horizontal and vertical)
- Should have a minimum layers to minimize schedule and cost
- Should have low operating current to minimize heat load
(more important for stand alone test)

Design Types for Conductor Dominated



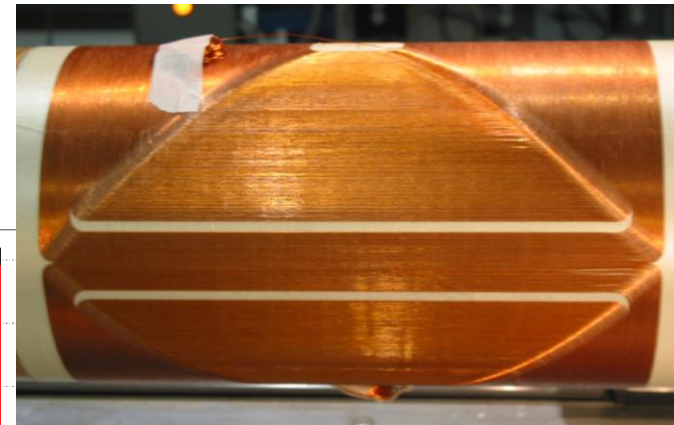
Conventional Design

- Optimize end for field quality
- End takes significant space
- About 1 coil dia wasted in dipoles



Serpentine Design (B. Parker)

- Easy to bring leads out
- ~2-d design
- Used in most magnets (default)
- End takes space (relevant only in short magnets)

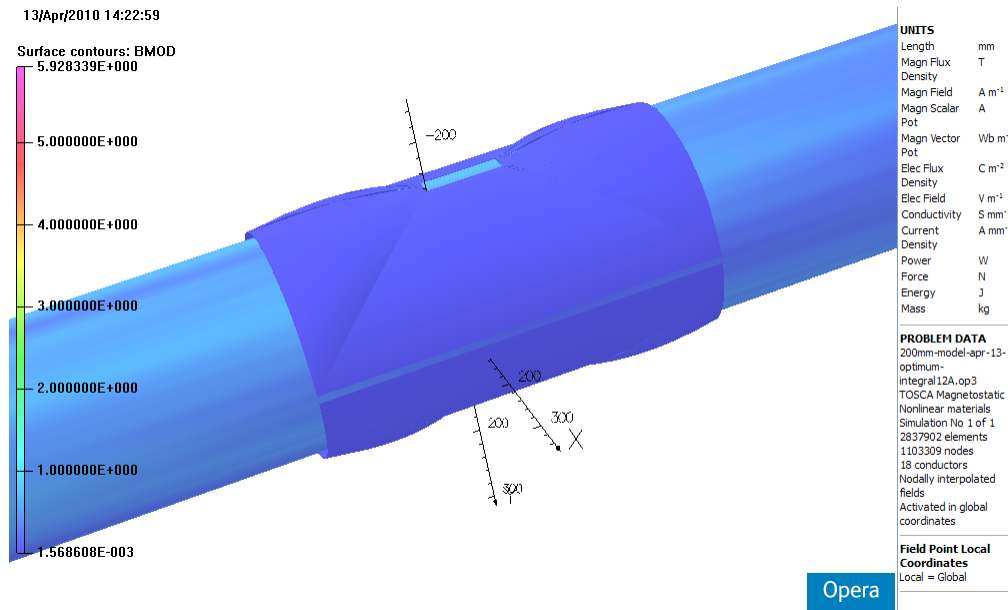


Optimum Integral

- Most optimum use of space
- Full length used at midplane
- Spacers in body and ends are modulated to obtain integral cosine theta distribution
- Leads do not come out easily in a single layer design
- Developed and used in AGS corrector (in helical magnet)

Optimum Integral Design

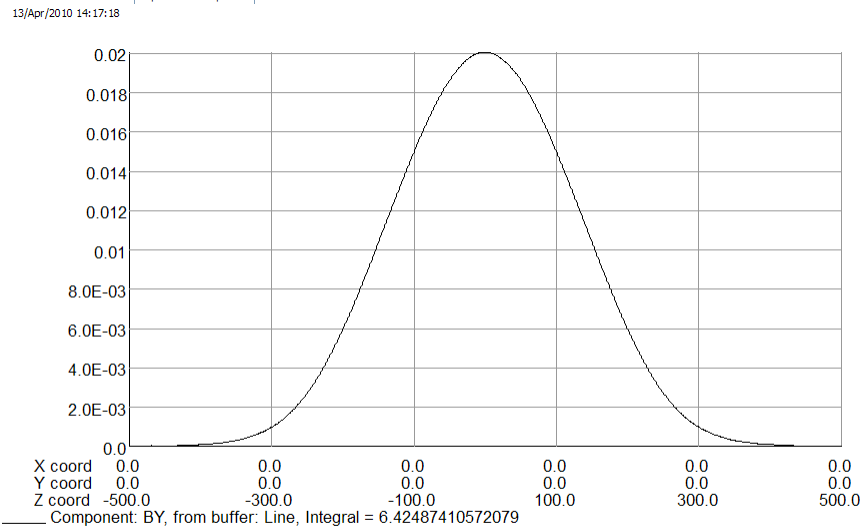
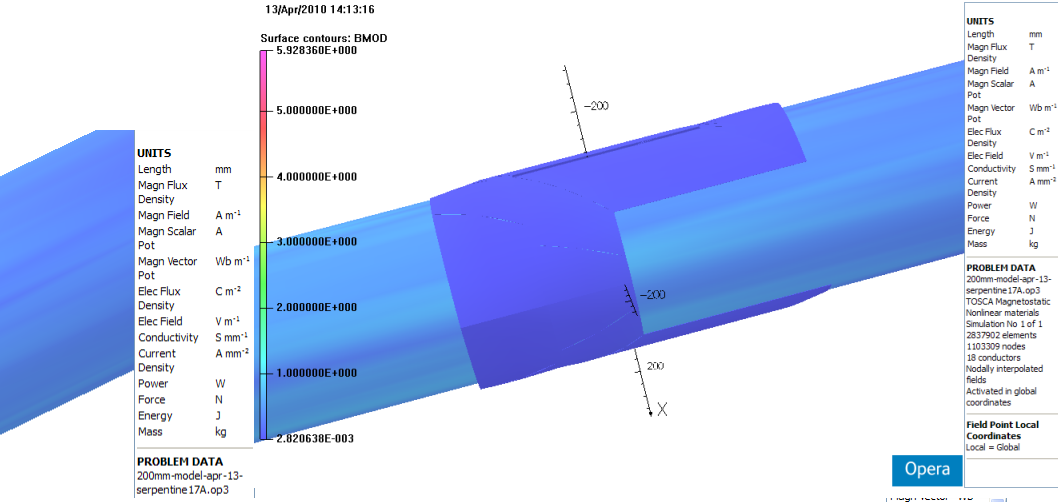
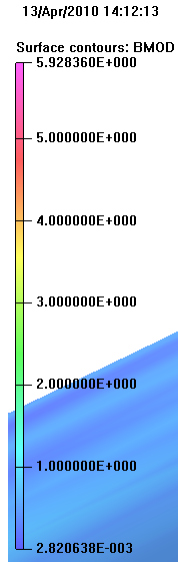
One layer each for horizontal
and vertical dipole correctors



Desired Field is obtained at 9.4 A

Serpentine Design

One layer each for horizontal and vertical dipole correctors



Desired Field is obtained at 13.8 A (~50% more than optimum integral)

Opera

Pot m⁻¹
Elec Flux C m⁻²
Density
Elec Field V m⁻¹
Conductivity S mm⁻¹
Current A mm⁻²
Power W
Force N
Energy J
Mass kg

PROBLEM DATA
200mm-model-apr-13-serpentine13_8A.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
283792 elements
1103309 nodes
18 conductors
Nodally interpolated fields
Activated in global coordinates

Field Point Local Coordinates
Local = Global

FIELD EVALUATIONS
Line: LINE 1001 C (nodal)
x=0.0 y=0.0 z= to

Opera

Optimum Integral Design (take 2)

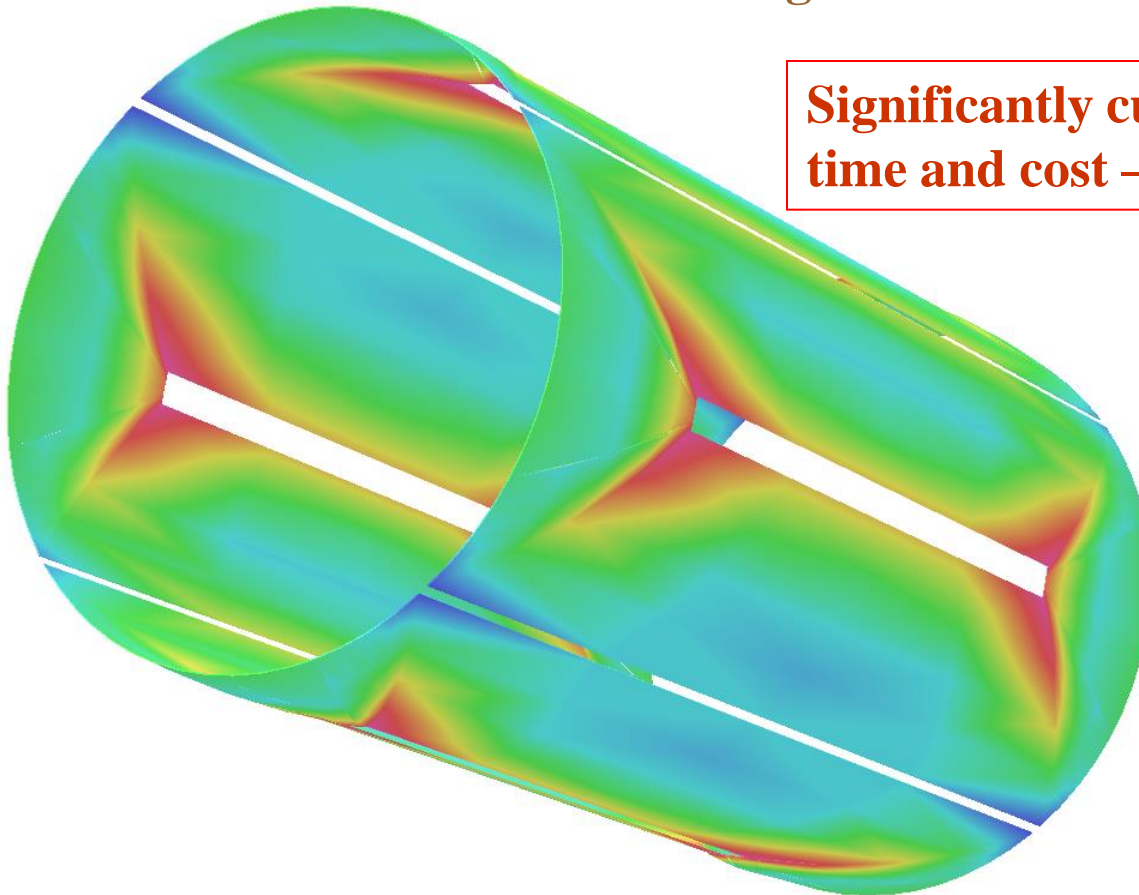
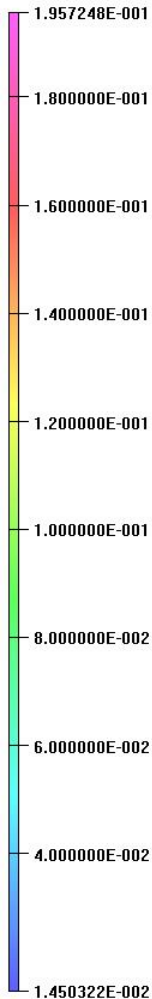
Both horizontal and vertical dipole correctors are accommodated in a single layer

- Top & Bottom for Vertical
- Left & Right for Horizontal

Significantly cuts down on construction time and cost – the main motivation

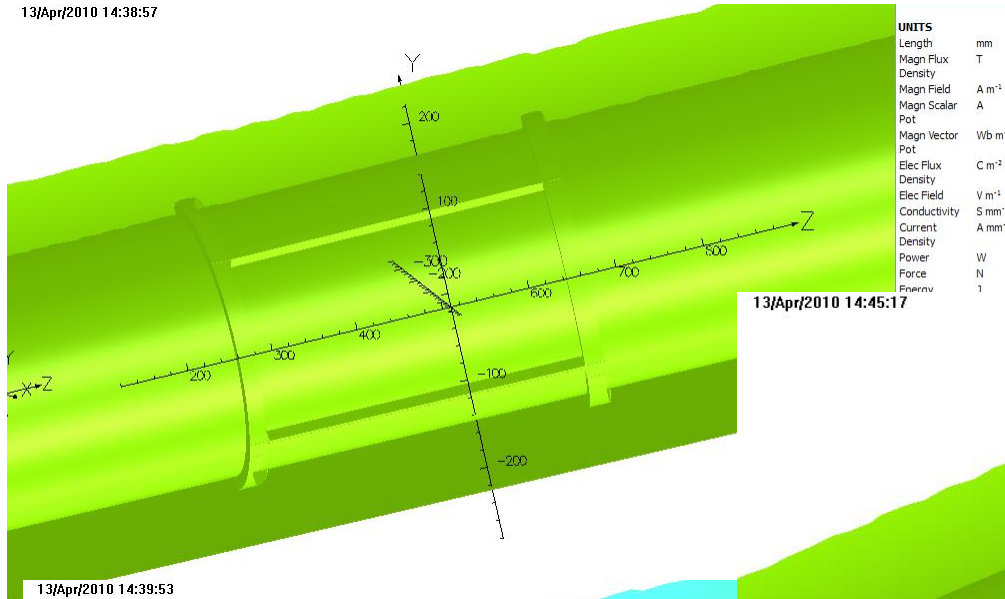
- Down side:
- Higher operating current
 - Field Quality (not a major issue)

Surface contours: BMOD



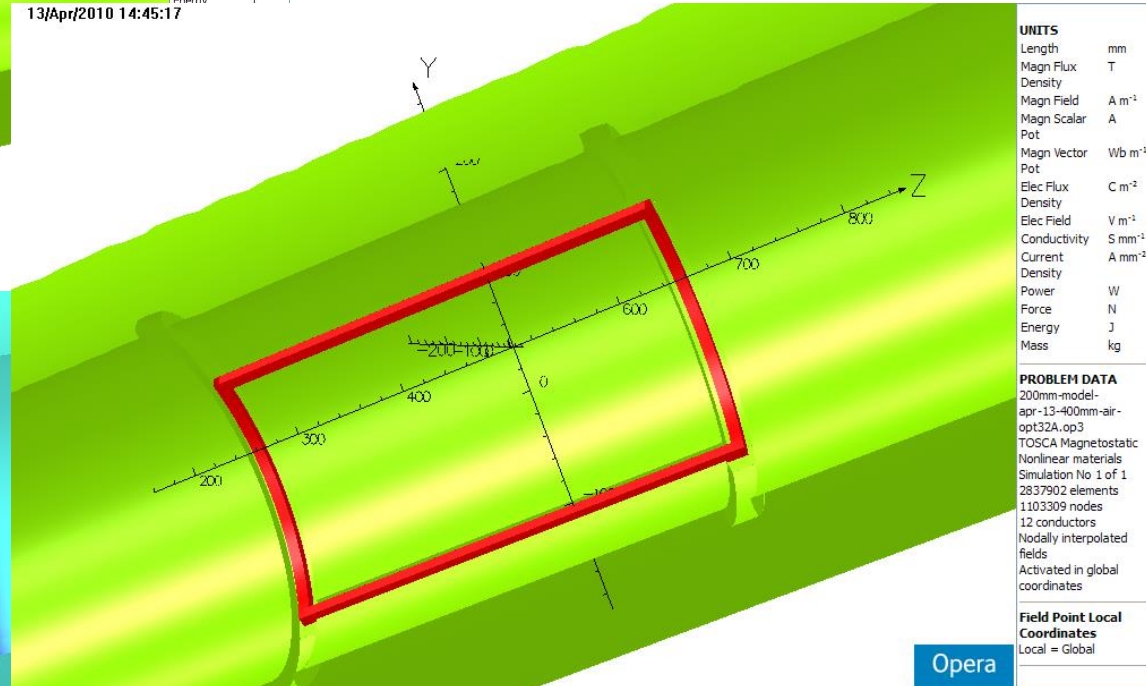
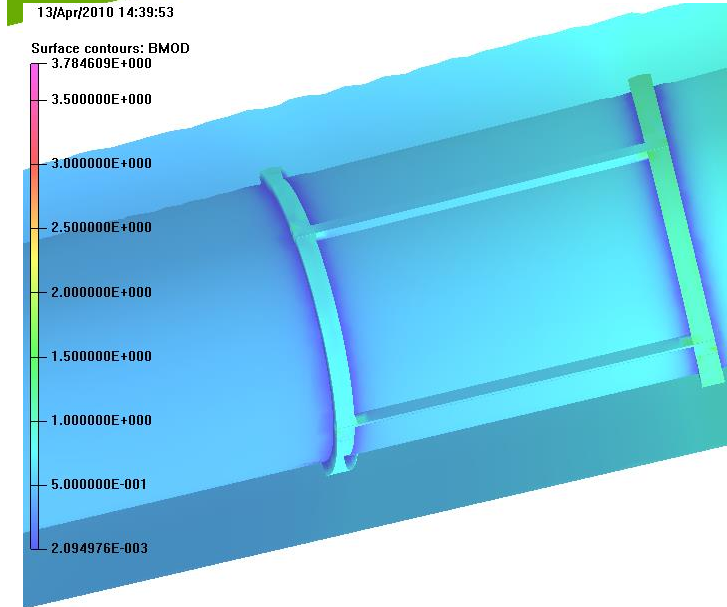
Iron Dominated Corrector Design

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- Cut a slot in the iron and put corrector coil there
- There is still enough mu left in the iron to generate 0.02 T field

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Nonlinear materials
Simulation No 1 of 1
2837902 elements
1103309 nodes
4 conductors
Nodally interpolated fields
Activated in global coordinates

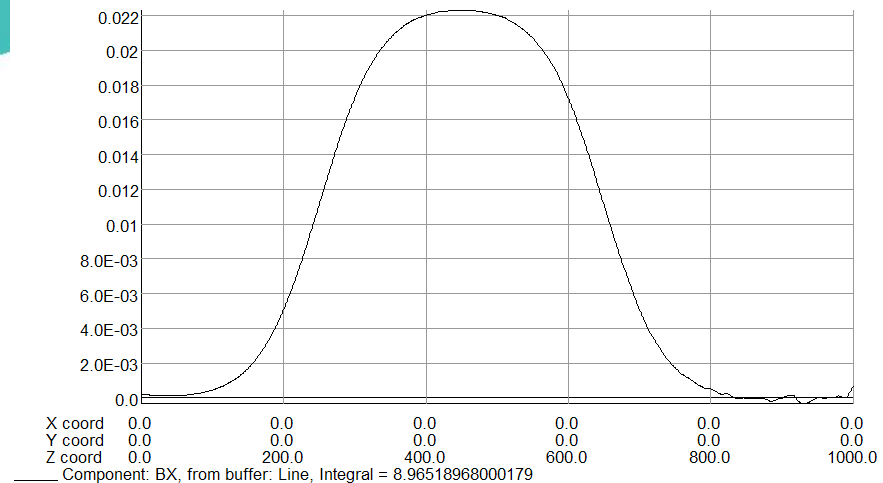
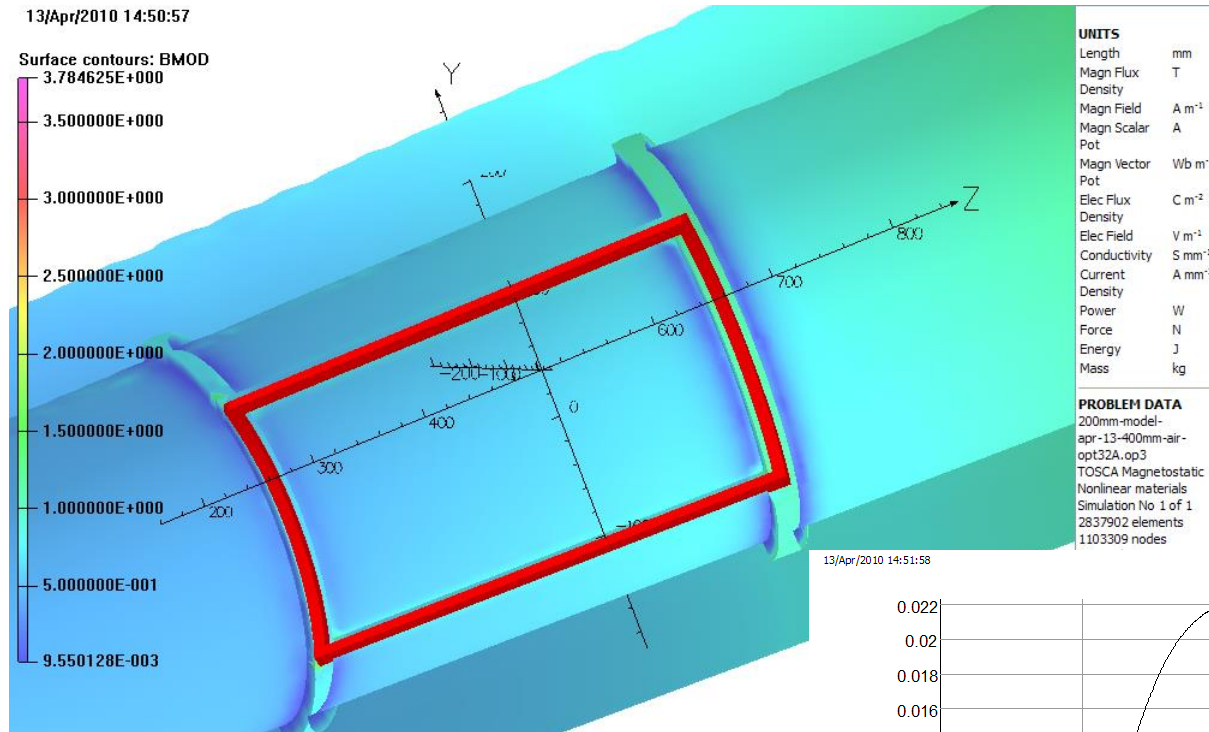
Field Point Local Coordinates
Local = Global

Opera

Benefits

- Lower current
- Possibly easier and cheaper

Field in Iron Dominated Corrector Design



Magn Vector $Wb\ m^{-1}$
Pot m^{-1}
Elec Flux $C\ m^{-2}$
Density
Elec Field $V\ m^{-1}$
Conductivity $S\ mm^{-1}$
Current $A\ mm^{-2}$
Density
Power W
Force N
Energy J
Mass kg

PROBLEM DATA
200mm-model-
apr-13-400mm-air-
opt32A.op3
TOSCA
Magnetostatic
Nonlinear materials
Simulation No 1 of 1
2837902 elements
1103309 nodes
12 conductors
Nodally interpolated
fields
Activated in global
coordinates

Field Point Local
Coordinates
Local = Global

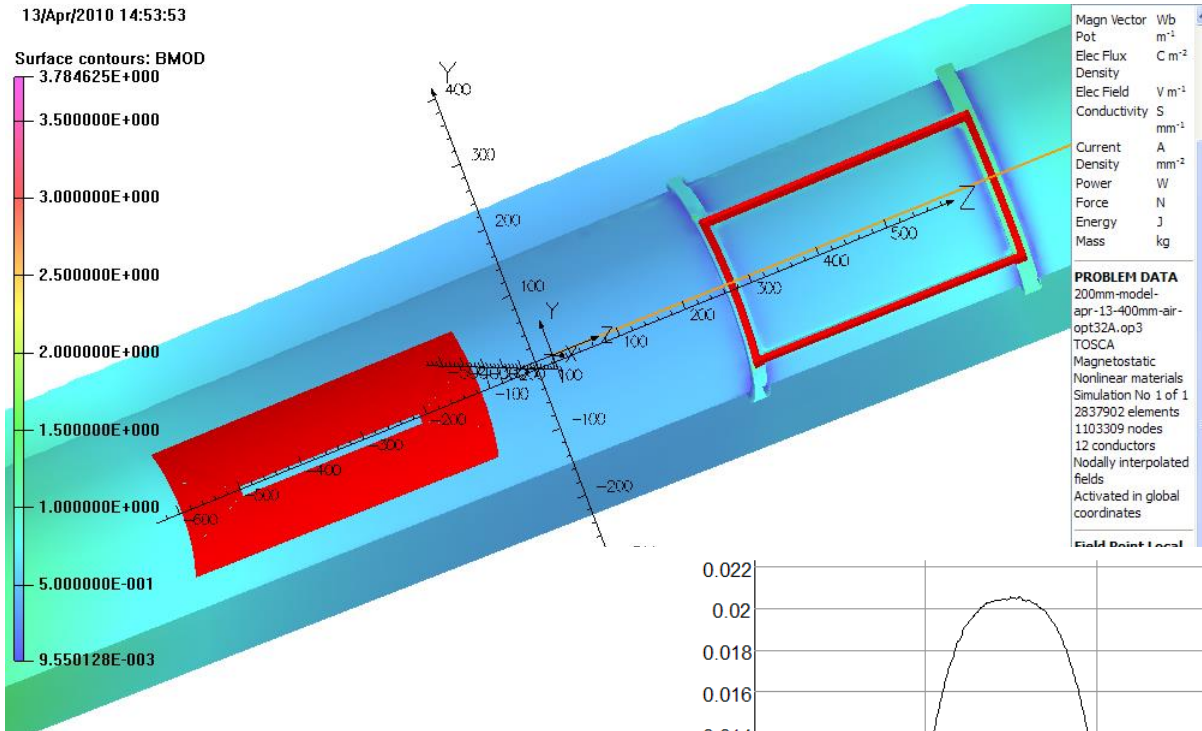
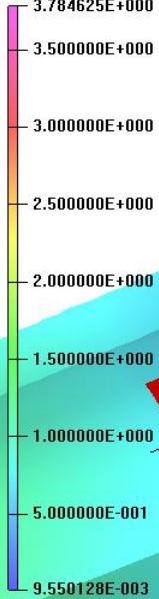
FIELD
EVALUATIONS
Line: LINE 1001 C
(nodal)
x=0.0 y=0.0 z=10

Opera

Two Designs – side by side

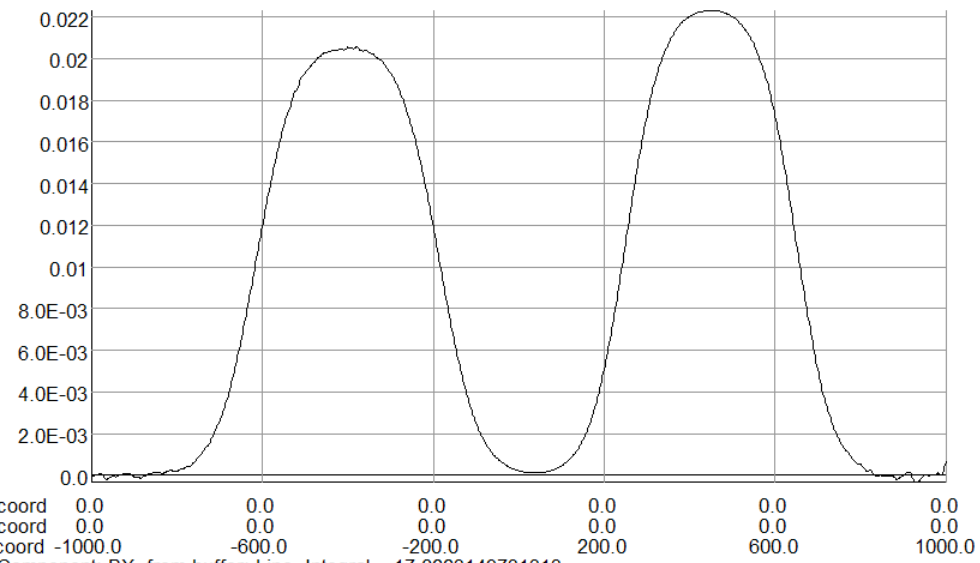
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Surface contours: BMOD



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

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coordinates



Component: BX, from buffer: Line, Integral = 17.8223149731313

Elec Flux	C m ⁻²
Density	
Elec Field	V m ⁻¹
Conductivity	S
	mm ⁻¹
Current	A
Density	mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

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Field Point Local Coordinates
Local = Global
FIELD EVALUATIONS

Topic for Discussions

- How do we construct iron dominated design
- Comparison of two designs