
Slotted Corrector Designs for Superconducting Solenoid for e-lens

Ramesh Gupta

June 7, 2010

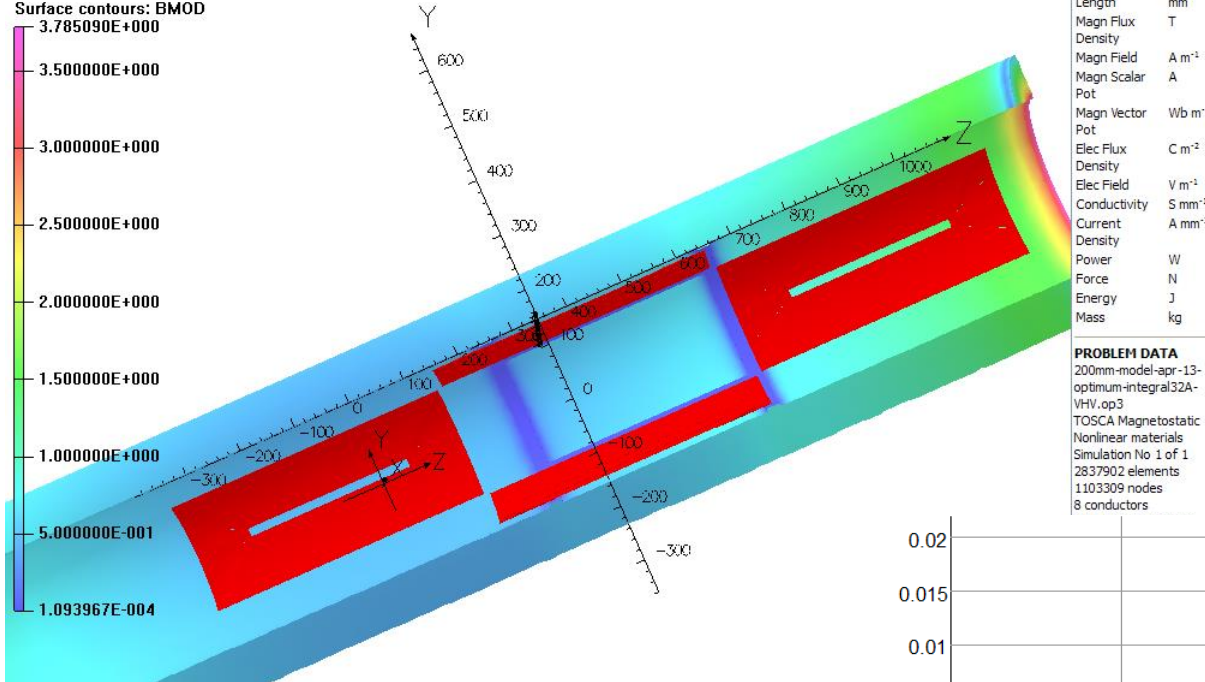
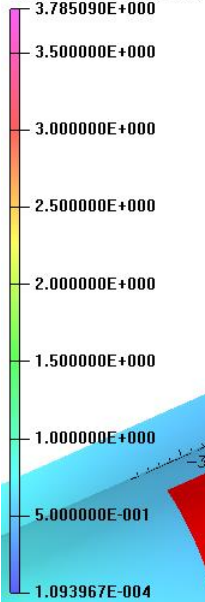
Design Considerations for e-lens correctors

- Short correctors must create a dipole field of 0.02 T and long correctors 0.006+ T (both horizontal and vertical)
- Should have low operating current to minimize heat load (more important for tests when RHIC cryo-system is not on)
- Should have a minimum layers to minimize schedule and cost
- Slotted design is preferred over the direct wind for schedule and cost reasons
- After a very brief overview, details of the design will be discussed

Optimum Integral Design for e-lens Correctors in Series

14/Apr/2010 14:55:03

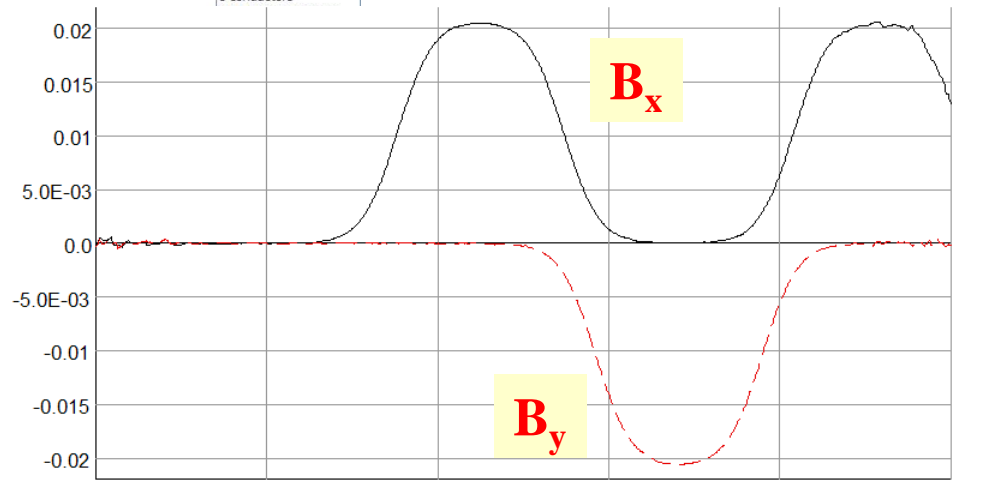
Surface contours: BMOD



UNITS	
Length	mm
Magn Flux	T
Density	
Magn Field	A m ⁻¹
Magn Scalar	A
Pot	
Magn Vector	Wb m ⁻¹
Pot	
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-
optimum-integral32A-
VHV.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
2837902 elements
1103309 nodes
8 conductors

Powered alternately at full horizontal or full vertical field



	X coord	0.0	0.0	0.0	0.0	0.0	0.0
Y coord	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Z coord	-1100.0	-660.0	-220.0	220.0	660.0	1100.0	

— Component: BX, from buffer: Line, Integral = 16.8606261733613
- - Component: BY, from buffer: Line, Integral = -8.8874604794582

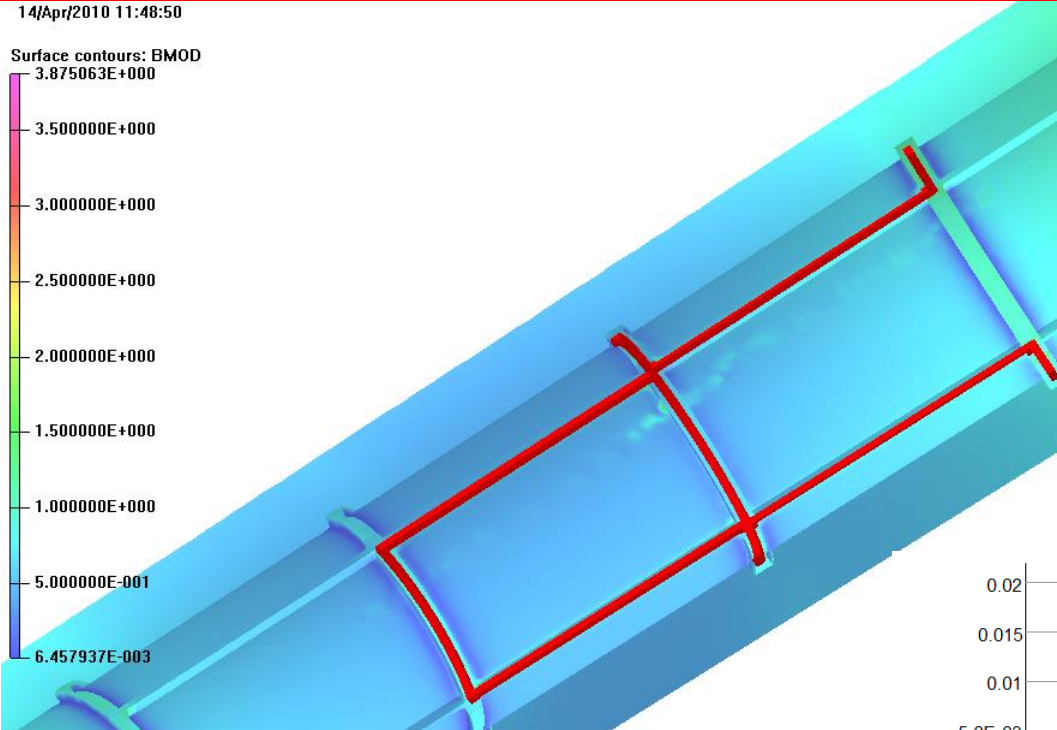
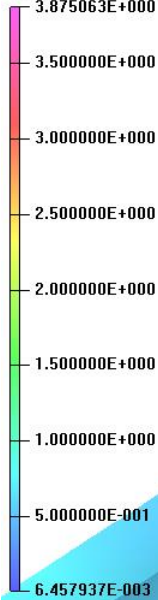
Works well.

Little cross-talk, etc. for transverse field in other direction.

Vertical and Horizontal Corrector Powered (next to each other)

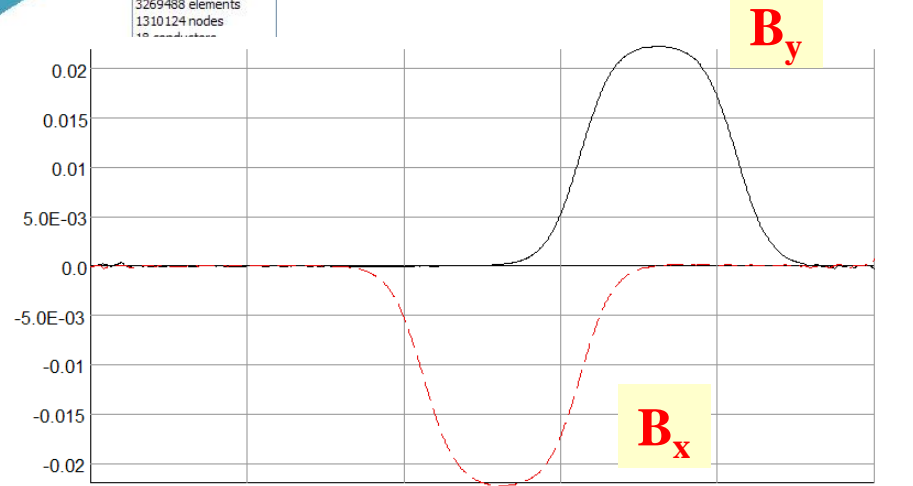
14/Apr/2010 11:48:50

Surface contours: BMOD



UNITS	
Length	mm
Magn Flux	T
Density	
Magn Field	A m ⁻¹
Magn Scalar	A
Pot	
Magn Vector	Wb m ⁻¹
Pot	
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

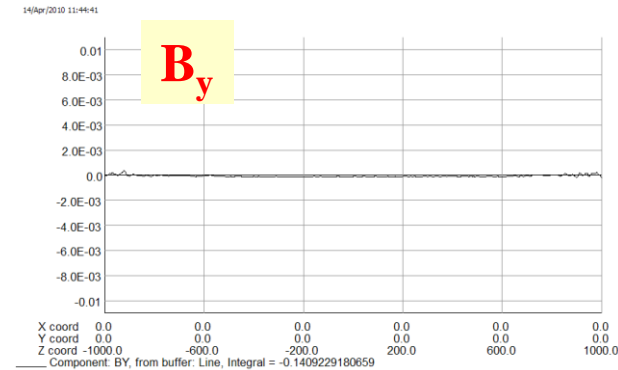
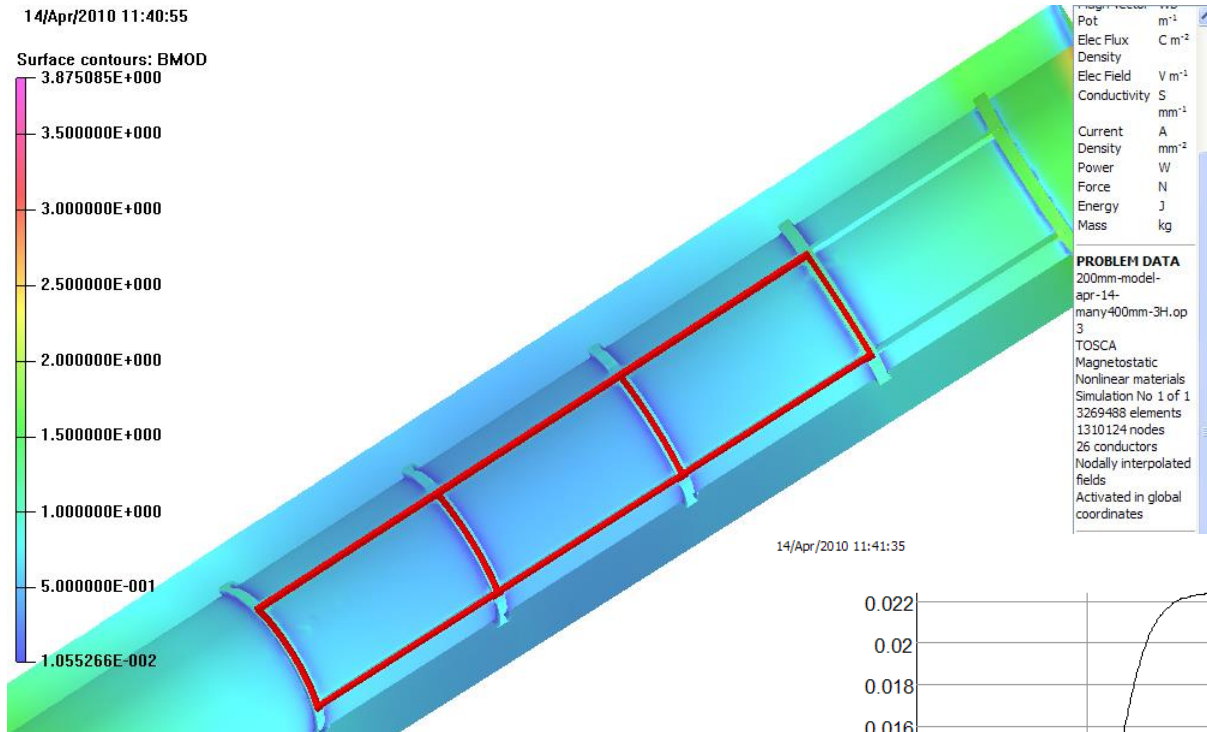
PROBLEM DATA
200mm-model-agr-14-
many400mm-1H1V-
disp.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
3269488 elements
1310124 nodes



X coord	0.0	0.0	0.0	0.0	0.0	0.0
Y coord	0.0	0.0	0.0	0.0	0.0	0.0
Z coord	-1000.0	-600.0	-200.0	200.0	600.0	1000.0
— Component: BY, from buffer: Line, Integral = 9.00970969542073						
- - - Component: BX, from buffer: Line, Integral = -8.9004308376253						

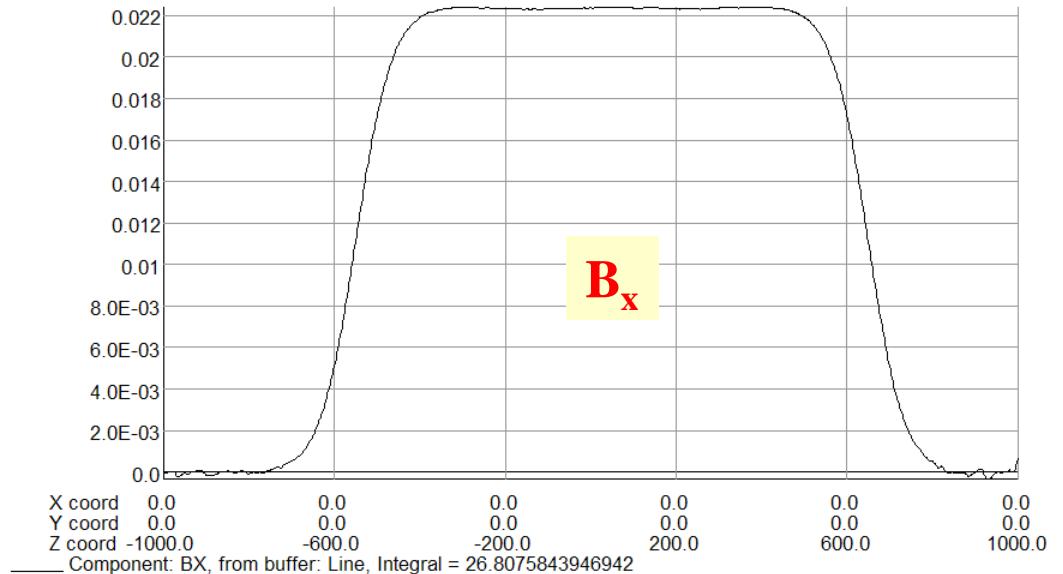
Works well

Three Horizontal Correctors at Full Strength



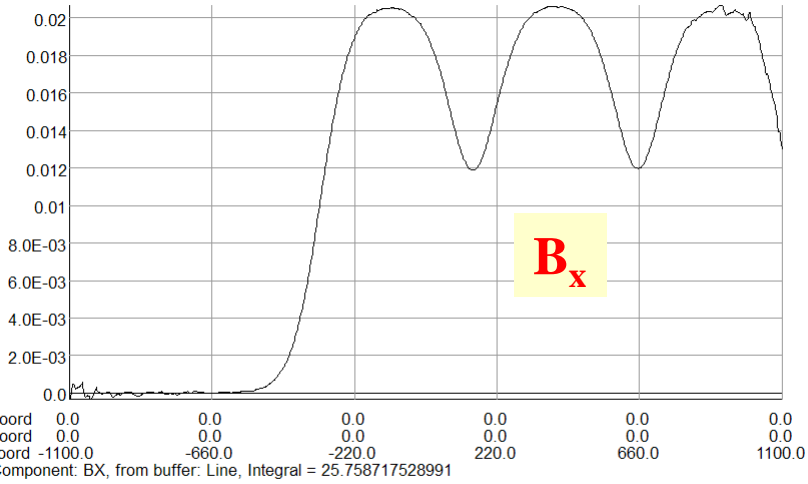
Works really well – even better than optimum integral design (field is very flat in this case).

Compare in next slide



Compare with the Optimum Integral Design for e-lens Correctors in Series

14/Apr/2010 08:21:02



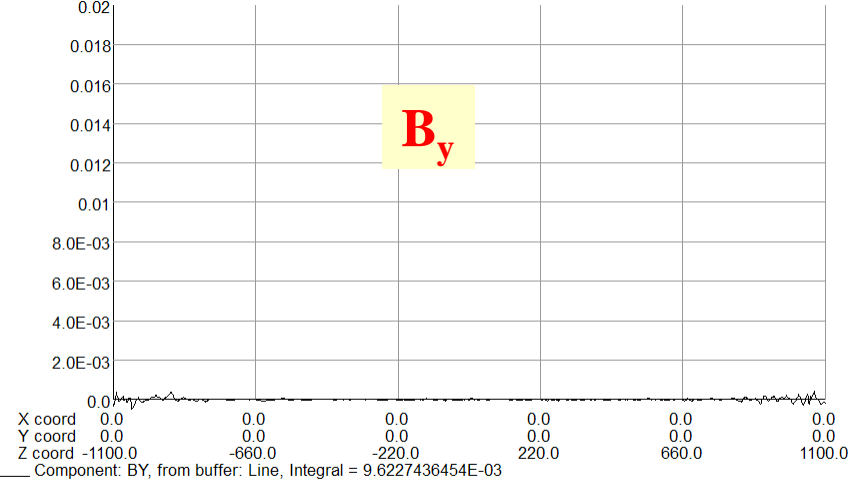
Pot	m ⁻¹
Elec Flux	C m ⁻²
Density	
Elec Field	V m ⁻¹
Conductivity	S
	mm ⁻¹
Current	A
Density	mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

PROBLEM DATA
 200mm-model-
 apr-13-optimum-
 integral32A-
 three.op3
 TOSCA
 Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 2837902 elements
 1103309 nodes
 8 conductors
 Nodally interpolated
 fields
 Activated in global
 coordinates

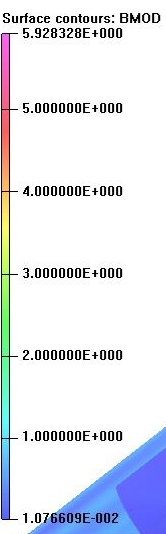
Field Point Local Coordinates
 Local = Global

FIELD EVALUATIONS
 LineLINE 1001 C
 (nodal)
 x=0.0 y=0.0 z= to

14/Apr/2010 08:22:25



14/Apr/2010 08:27:02



Opera

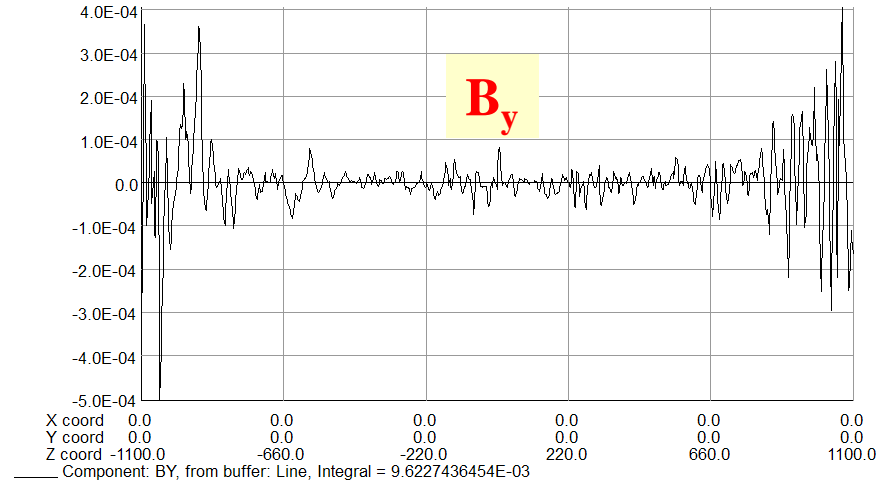
Pot	m ⁻¹
Elec Flux	C m ⁻²
Density	
Elec Field	V m ⁻¹
Conductivity	S
	mm ⁻¹
Current	A
Density	mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

PROBLEM DATA
 200mm-model-
 apr-13-optimum-
 integral32A-
 three.op3
 TOSCA
 Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 2837902 elements
 1103309 nodes
 8 conductors
 Nodally interpolated
 fields
 Activated in global
 coordinates

Field Point Local Coordinates
 Local = Global

FIELD EVALUATIONS
 LineLINE 1001 C
 (nodal)
 x=0.0 y=0.0 z= to

Opera



all dimensions are in mm unless noted

support tube ID	300
support tube OD / coil ID	304
circumference	955
# of windings	1504 .635 mm (.025 inch) wire spacing assumes horizontal and vertical coils are on the same layer, 100% fill, i.e. each block is 1/8
max. # of windings per block	188 of circumference
block width	12.7
windings per layer	20
# of layers	4
final # of windings per block	80
block height	3
block insulator - pushers	3
over-wrap after last layer	1.30 per A. Marone
total block height	7.30
corrector assembly OD	318.59
yoke ID	324.6

conductor length per 0.5m coil (2 blocks)	160 length in meters
total length of 10 coils	1600 length in meters
conductor length per 2.5m coil (2 blocks)	800 length in meters
total length of 2 coils	1600 length in meters

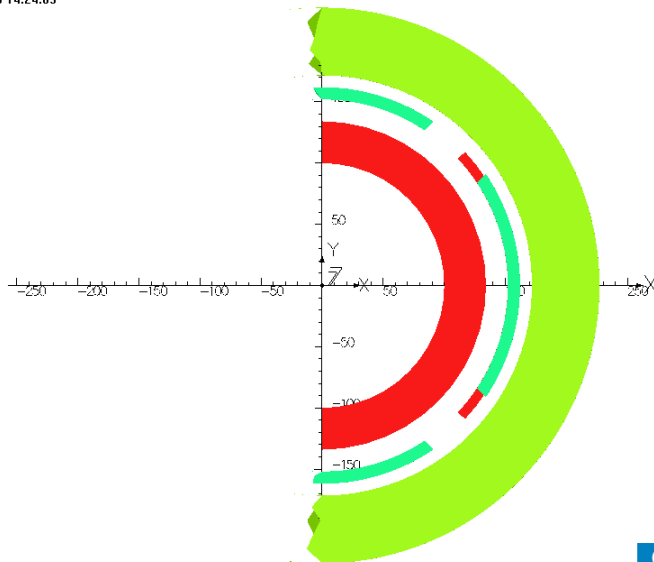
Total conductor length, ONE MAGNET	3200 length in meters
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Item	thickness	Dimension (mm)	
		inner diameter	outer diameter
inner cryostat (assumes 60mm aperture)	3	148	154
radial insulating space	5	154	164
Heat shield	4	164	172
radial insulating space	4	172	180
helium vessel / support tube	10	180	200
solenoid, 26 layers	37	200	274
G-10 buildup (max., tapered)	10	274	294
support shell (max., tapered)	5	294	304
assembly clearance (min., at max. taper)	1	304	306
corrector tube wall (to bottom of grooves)	2	306	310
corrector layers (4) + overwrap	7.3	310	324.6
helium space	3	324.6	330.6
yoke	61.7	330.6	454
assembly clearance thickness	1.5	454	457
helium vessel	19	457	495
insulation thickness	24	495	543
heat shield	3	543	549
insulation thickness	24	549	597
cryostat	6.35	597	610

Iron Pole or NOT

- Iron pole is not connected to the yoke.
- It is small, it is expensive (machining), it saturates and the benefit is not clear
- Therefore, it is removed from the final design. Only slot in the tube for conductor.

7/Jun/2010 14:24:09



UNITS
 Length mm
 Magn Flux Density T
 Magn Field A m⁻¹
 Magn Scalar Pot A
 Magn Vector Pot Vb 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
 Mass kg

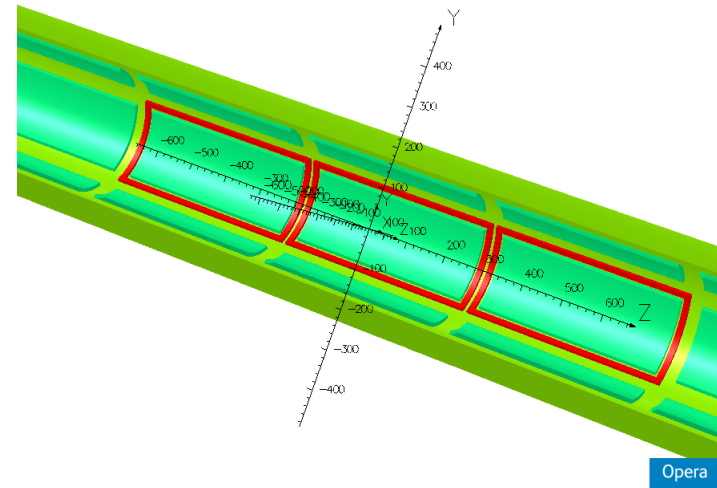
MODEL DATA
 200mm-sol-corr-may-h-h-h.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 4142960 elements
 1749799 nodes
 26 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

FIELD EVALUATIONS
 Line LINE 1001 Cartesian
 (nodal)
)
 x=0.0 y=0.0 z=-10
 00.0
 to
 1000.0

Opera

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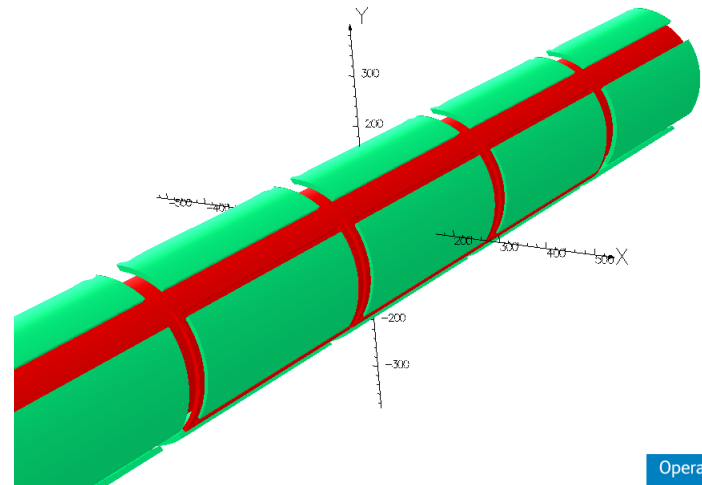
UNITS
 Length mm
 Magn Flux Density T
 Magn Field A m⁻¹
 Magn Scalar Pot A
 Magn Vector Pot Vb m⁻¹
 Elec Flux Density C m⁻²
 Elec Field V m⁻¹
 Conductivity S mm⁻¹
 Current Density A mm⁻²
 Power W
 Force N
 Energy J
 Mass kg

MODEL DATA
 200mm-sol-corr-may-h-h-h.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 4142960 elements
 1749799 nodes
 26 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

Opera

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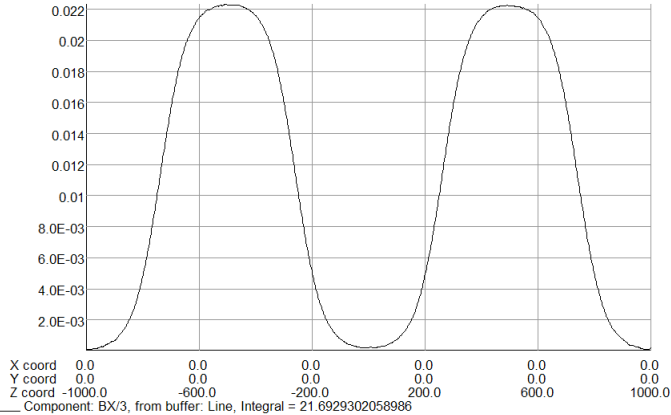
UNITS
 Length mm
 Magn Flux Density T
 Magn Field A m⁻¹
 Magn Scalar Pot A
 Magn Vector Pot Vb m⁻¹
 Elec Flux Density C m⁻²
 Elec Field V m⁻¹
 Conductivity S mm⁻¹
 Current Density A mm⁻²
 Power W
 Force N
 Energy J
 Mass kg

MODEL DATA
 200mm-sol-corr-may-h-h-h.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 4142960 elements
 1749799 nodes
 26 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

Opera

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Opera

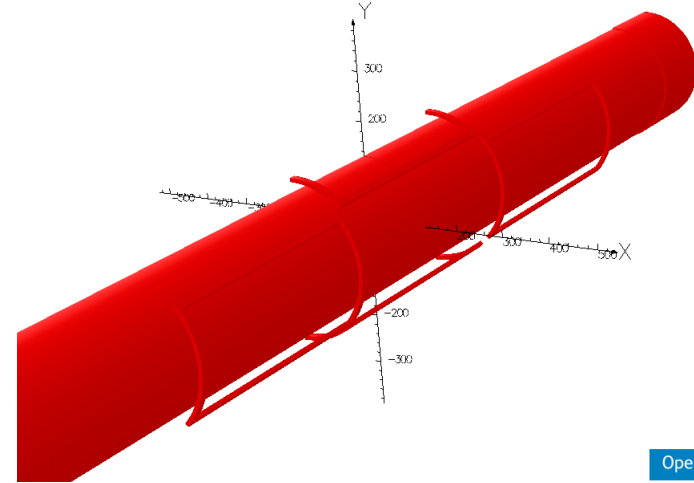
UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

MODEL DATA	
200mm-sol-corr-may-e-h-v-h-pole-air.op3	
TOSCA Magnetostatic	
Nonlinear materials	
Simulation No. 1 of 1	
3481324 elements	
1245126 nodes	
26 conductors	
Nodally interpolated fields	
Activated in global coordinates	

Field Point Local Coordinates	
Local = Global	

FIELD EVALUATIONS	
Line LINE 1001 Cartesian (nodal) an	
x=0.0 y=0.0 z=-10.00.0 to 1000.0	

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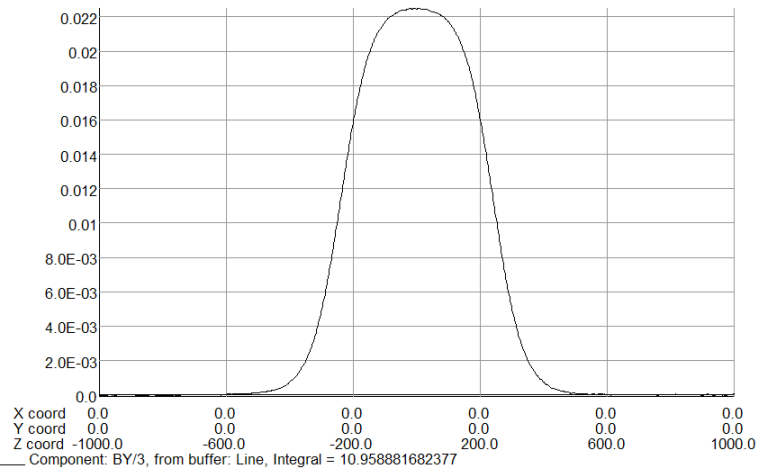
Opera

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
Force	N
Energy	J
Mass	kg

MODEL DATA	
200mm-sol-corr-may-e-h-v-h-pole-air.op3	
TOSCA Magnetostatic	
Nonlinear materials	
Simulation No. 1 of 1	
3481324 elements	
1245126 nodes	
26 conductors	
Nodally interpolated fields	
Activated in global coordinates	

Field Point Local Coordinates	
Local = Global	

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Opera

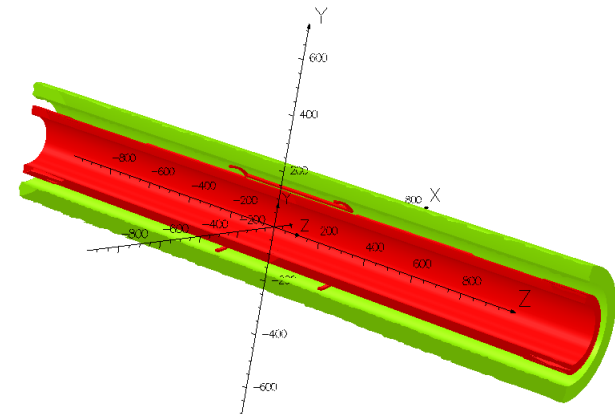
UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Wb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

MODEL DATA	
200mm-sol-corr-may-e-h-v-h-pole-air.op3	
TOSCA Magnetostatic	
Nonlinear materials	
Simulation No. 1 of 1	
3481324 elements	
1245126 nodes	
26 conductors	
Nodally interpolated fields	
Activated in global coordinates	

Field Point Local Coordinates	
Local = Global	

FIELD EVALUATIONS	
Line LINE 1001 Cartesian (nodal) an	
x=0.0 y=0.0 z=-10.00.0 to 1000.0	

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Opera

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
Force	N
Energy	J
Mass	kg

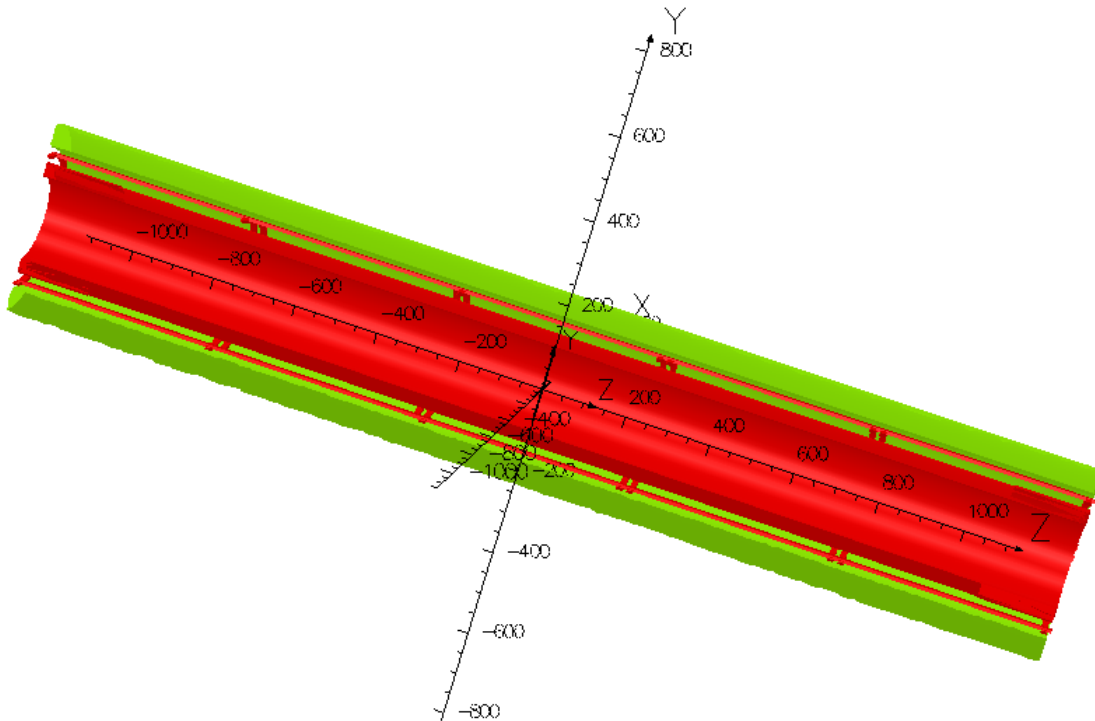
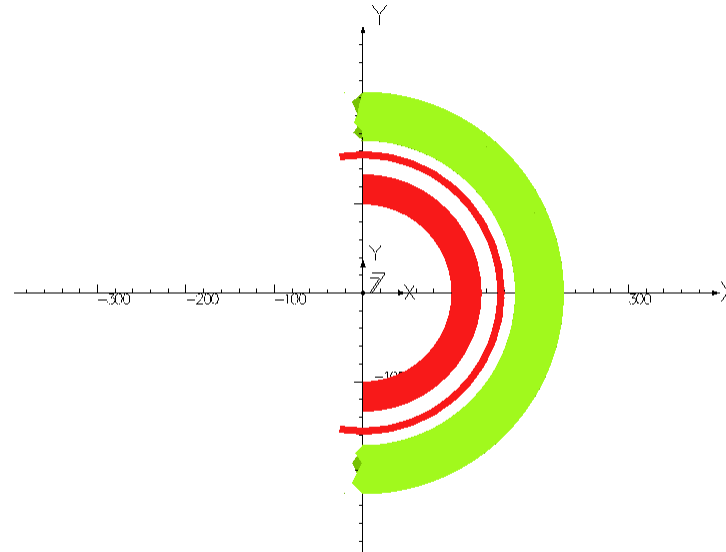
MODEL DATA	
200mm-sol-corr-may-e-h-v-h-pole-air.op3	
TOSCA Magnetostatic	
Nonlinear materials	
Simulation No. 1 of 1	
3481324 elements	
1245126 nodes	
26 conductors	
Nodally interpolated fields	
Activated in global coordinates	

Field Point Local Coordinates	
Local = Global	

Model with Short and Long correctors

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7/Jun/2010 13:23:05



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
Force	N
Energy	J
Mass	kg

MODEL DATA
 200mm-sol-corr-all-scale-6T.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 66 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

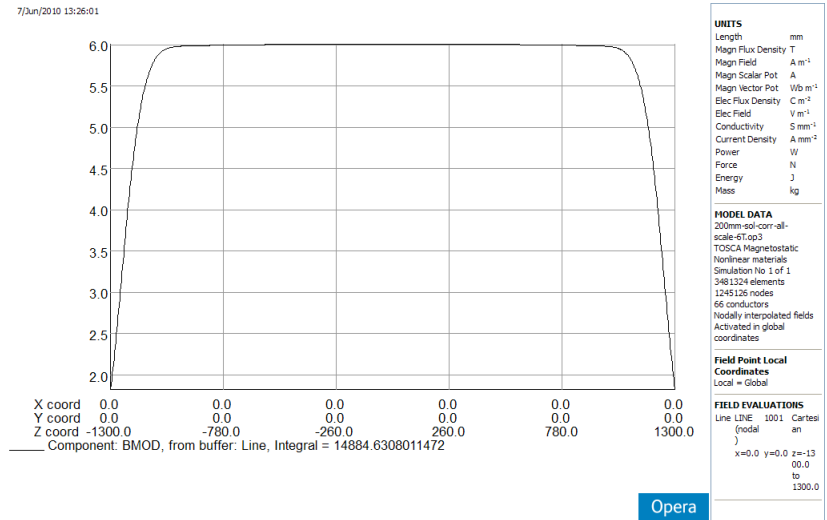
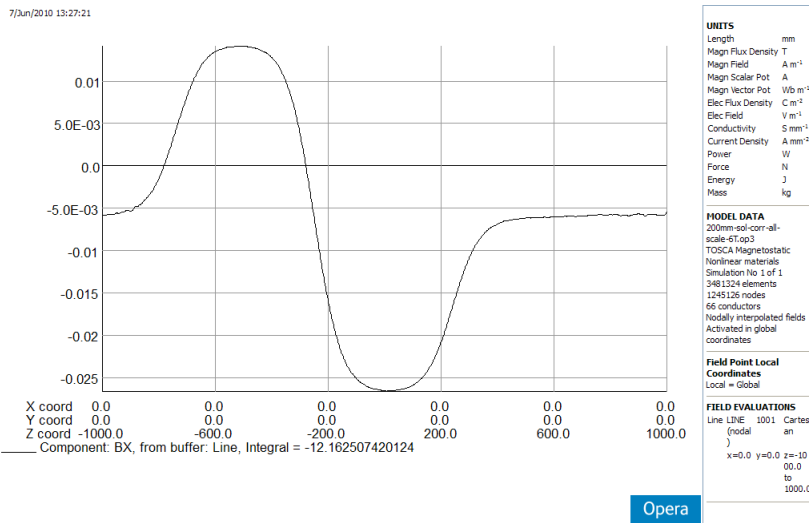
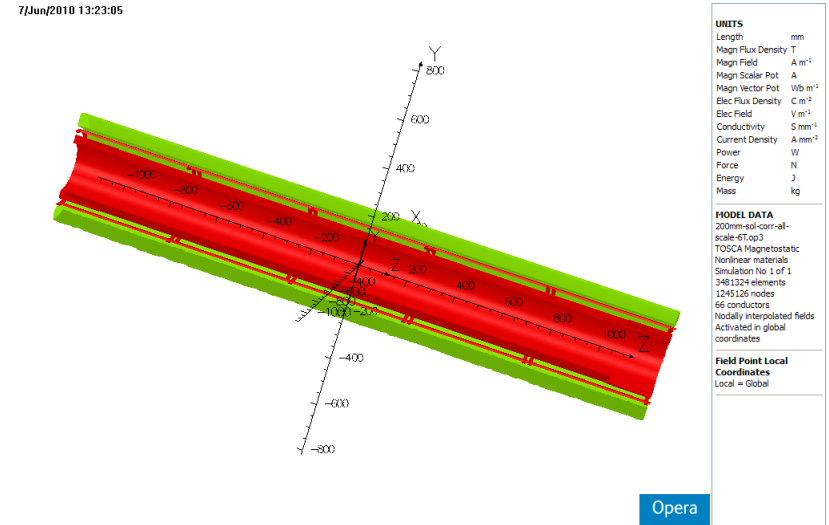
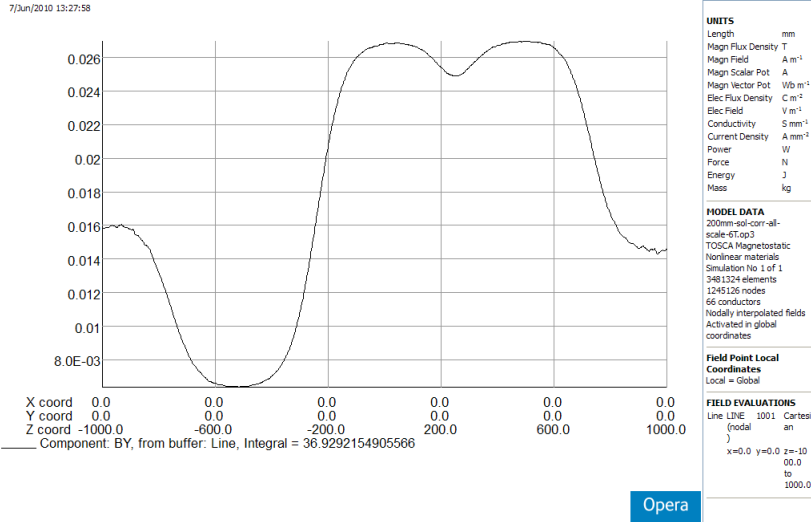
Opera

MODEL DATA
 200mm-sol-corr-all-scale-6T.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 66 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

Opera

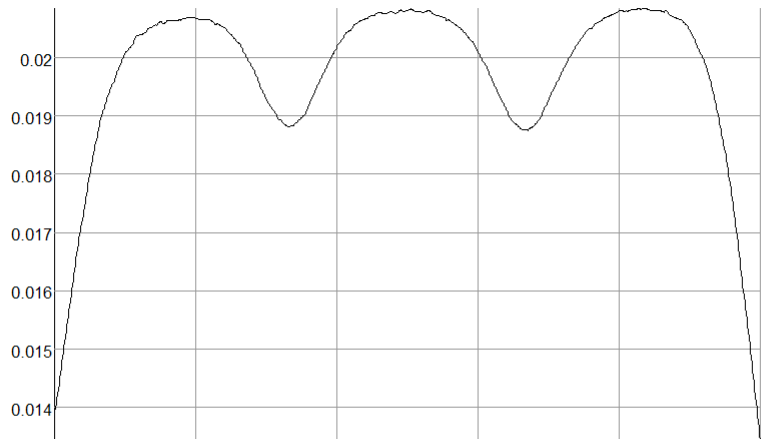
Field with Short and Long correctors



Comparison of Field between Optimum Integral Design and Block Design

Field with Short and Long correctors

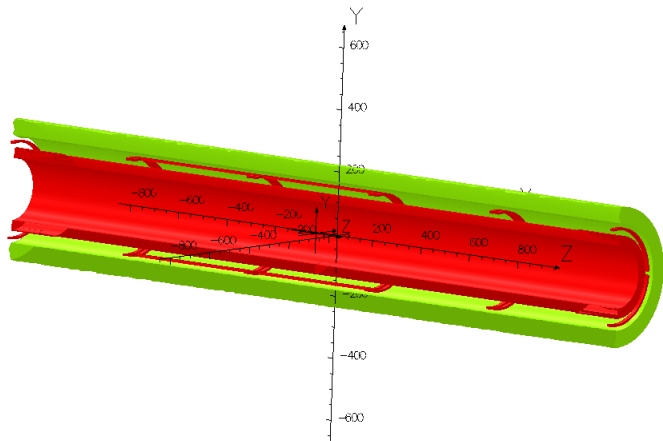
7/Jun/2010 13:32:12



X coord 0.0 0.0 0.0 0.0 0.0 0.0
 Y coord 0.0 0.0 0.0 0.0 0.0 0.0
 Z coord -750.0 -450.0 -150.0 150.0 450.0 750.0

Component: BY, from buffer: Line, Integral = 29.5544880596964

7/Jun/2010 13:34:34



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
- Force N
- Energy J
- Mass kg

MODEL DATA

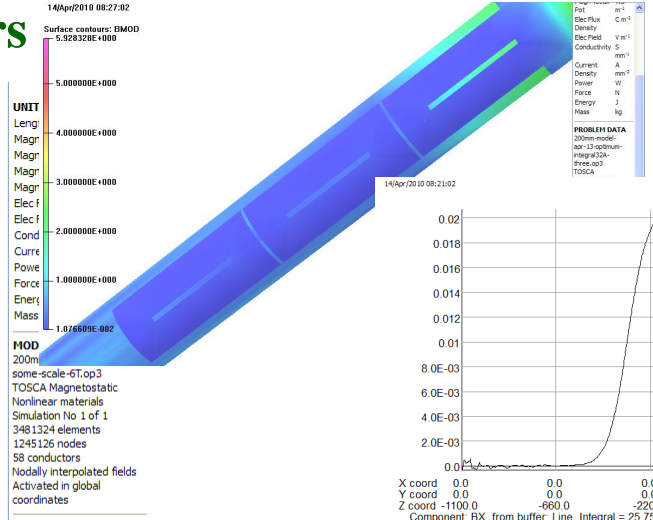
200mm-sol-corr-v-all-h-some-scale-6T.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 58 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

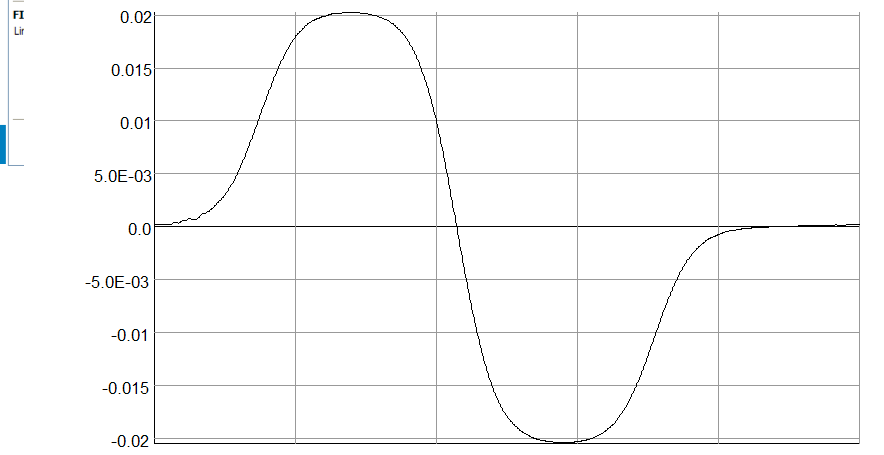
FIELD EVALUATIONS

Line LINE 1001 Cartesian (nodal) an
 x=0.0 y=0.0 z=-10.00.0 to 750.0

Opera



Field Point Local Coordinates
 Local = Global



X coord 0.0 0.0 0.0 0.0 0.0 0.0
 Y coord 0.0 0.0 0.0 0.0 0.0 0.0
 Z coord -1000.0 -650.0 -300.0 50.0 400.0 750.0

Component: BX, from buffer: Line, Integral = -0.0157316354013

Opera

PROBLEM DATA

200mm-model-op-12-nodum-integrat33A-true.op3
 TOSCA
 Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 1237362 elements
 1103309 nodes
 8 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

FIELD EVALUATIONS

Line LINE 1001 Cartesian (nodal) an
 x=0.0 y=0.0 z=0.00.0 to 750.0

Opera

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
 Mass kg

MODEL DATA

200mm-sol-corr-v-all-h-some-scale-6T.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 58 conductors
 Nodally interpolated fields
 Activated in global coordinates

Field Point Local Coordinates
 Local = Global

FIELD EVALUATIONS

Line LINE 1001 Cartesian (nodal) an
 x=0.0 y=0.0 z=-10.00.0 to 750.0

Case for separate short and long correctors (1)

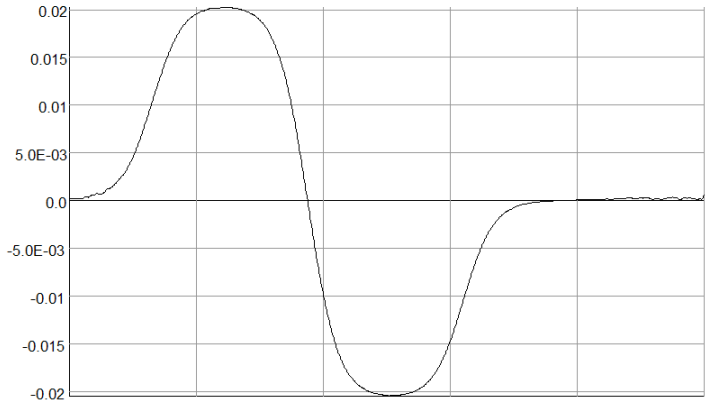
- **Main solenoid will operate from 3 T to 6 T**
- **Correctors (both short and long) must correct for the position error at each field**
- **Since the iron saturation is significant at 6 T, current will not scale linearly.**
- **Remember, each short corrector, will in general have a different value.**
- **Therefore, a simple scaling of current in corrector with solenoid field (3 T to 6 T) would create some error.**
- **The error could increase when the correcting field from the long corrector is added.**
- **Next few slides will examine this problem.**

- **Compare this for the case of building separate long correctors and the benefit we had hoped for (set short corrector and forget it).**

Case for separate short and long correctors (2)

(Correction at 6 T)

7/Jun/2010 13:44:41



X coord 0.0 0.0 0.0 0.0 0.0 0.0
 Y coord 0.0 0.0 0.0 0.0 0.0 0.0
 Z coord -1000.0 -600.0 -200.0 200.0 600.0 1000.0

Component: BX, from buffer: Line, Integral = 0.04690665802994

UNITS
 Length mm
 Magn Flux Density T
 Magn Field A m⁻¹
 Magn Scalar Pot A
 Magn Vector Pot Vb 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
 Mass kg

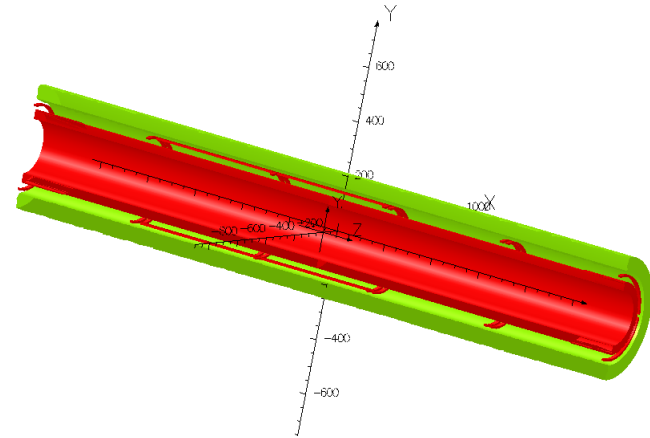
MODEL DATA
 200mm-sol-corr-many-
 scale-1_0.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 50 conductors
 Nodally interpolated fields
 Activated in global
 coordinates

**Field Point Local
 Coordinates**
 Local = Global

FIELD EVALUATIONS
 Line LINE 1001 Cartesi
 (nodal
)
 x=0.0 y=0.0 z=-10
 00.0
 to
 1000.0

Opera

7/Jun/2010 13:47:25



UNITS
 Length mm
 Magn Flux Density T
 Magn Field A m⁻¹
 Magn Scalar Pot A
 Magn Vector Pot Vb 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
 Mass kg

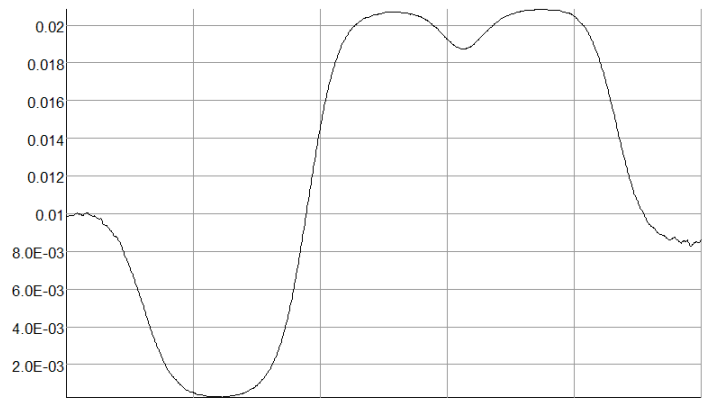
MODEL DATA
 200mm-sol-corr-many-
 scale-1_0.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 50 conductors
 Nodally interpolated fields
 Activated in global
 coordinates

**Field Point Local
 Coordinates**
 Local = Global

FIELD EVALUATIONS
 Line LINE 1001 Cartesi
 (nodal
)
 x=0.0 y=0.0 z=-15
 00.0
 to
 1500.0

Opera

7/Jun/2010 13:43:55



X coord 0.0 0.0 0.0 0.0 0.0 0.0
 Y coord 0.0 0.0 0.0 0.0 0.0 0.0
 Z coord -1000.0 -600.0 -200.0 200.0 600.0 1000.0

Component: BY, from buffer: Line, Integral = 24.7187005598561

UNITS
 Length mm
 Magn Flux Density T
 Magn Field A m⁻¹
 Magn Scalar Pot A
 Magn Vector Pot Vb 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
 Mass kg

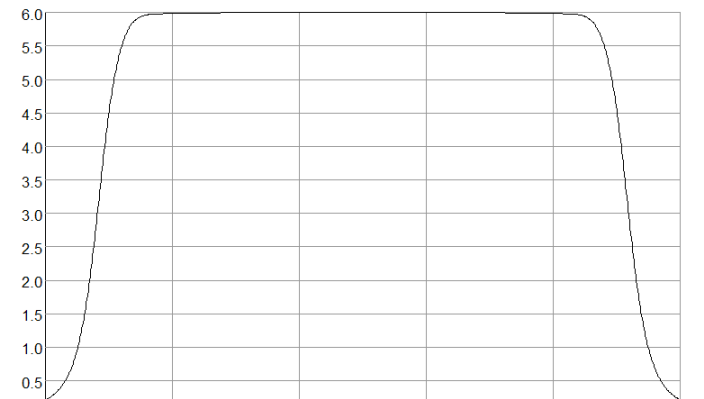
MODEL DATA
 200mm-sol-corr-many-
 scale-1_0.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 50 conductors
 Nodally interpolated fields
 Activated in global
 coordinates

**Field Point Local
 Coordinates**
 Local = Global

FIELD EVALUATIONS
 Line LINE 1001 Cartesi
 (nodal
)
 x=0.0 y=0.0 z=-10
 00.0
 to
 1000.0

Opera

7/Jun/2010 13:45:25



X coord 0.0 0.0 0.0 0.0 0.0 0.0
 Y coord 0.0 0.0 0.0 0.0 0.0 0.0
 Z coord -1500.0 -900.0 -300.0 300.0 900.0 1500.0

Component: BMOD, from buffer: Line, Integral = 15164.084478158

UNITS
 Length mm
 Magn Flux Density T
 Magn Field A m⁻¹
 Magn Scalar Pot A
 Magn Vector Pot Vb 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
 Mass kg

MODEL DATA
 200mm-sol-corr-many-
 scale-1_0.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 50 conductors
 Nodally interpolated fields
 Activated in global
 coordinates

**Field Point Local
 Coordinates**
 Local = Global

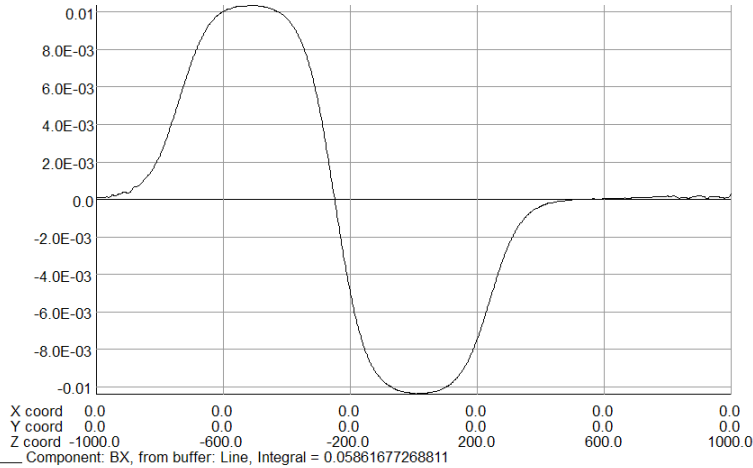
FIELD EVALUATIONS
 Line LINE 1001 Cartesi
 (nodal
)
 x=0.0 y=0.0 z=-15
 00.0
 to
 1500.0

Opera

Case for separate short and long correctors (2)

(Correction at 3 T)

7/Jun/2010 13:49:48



UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Vb 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
Mass	kg

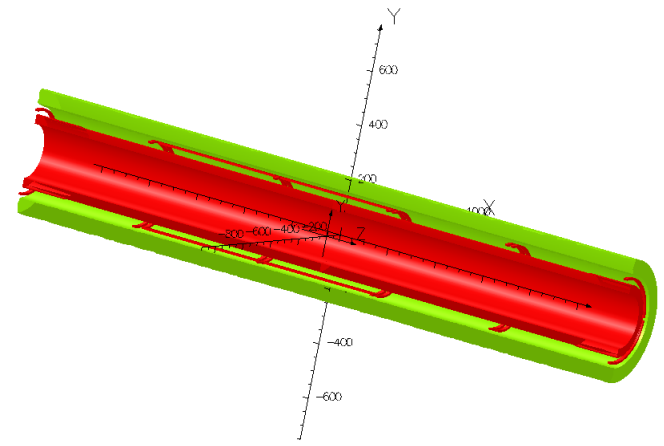
MODEL DATA	
200mm-sol-corr-many-scale-3T.op3	
TOSCA Magnetostatic	
Nonlinear materials	
Simulation No 1 of 1	
3481324 elements	
1245126 nodes	
50 conductors	
Nodally interpolated fields	
Activated in global coordinates	

Field Point Local Coordinates	
Local = Global	

FIELD EVALUATIONS	
Line LINE	1001 Cartesian
(nodal)	an
x=0.0	y=0.0 z=-10.0
	to
	1000.0

Opera

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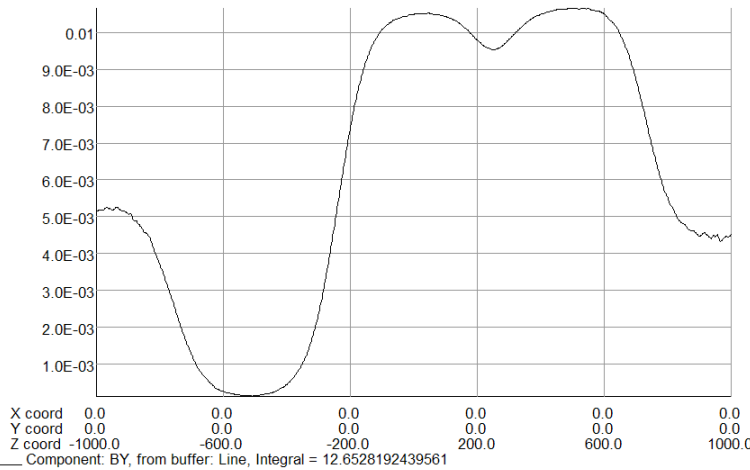
UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Vb m ⁻¹
Elec Flux Density	C m ⁻²
Elec Field	V m ⁻¹
Conductivity	S mm ⁻¹
Current Density	A mm ⁻²
Power	W
Force	N
Energy	J
Mass	kg

MODEL DATA	
200mm-sol-corr-many-scale-3T.op3	
TOSCA Magnetostatic	
Nonlinear materials	
Simulation No 1 of 1	
3481324 elements	
1245126 nodes	
50 conductors	
Nodally interpolated fields	
Activated in global coordinates	

Field Point Local Coordinates	
Local = Global	

Opera

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UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Vb 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
Mass	kg

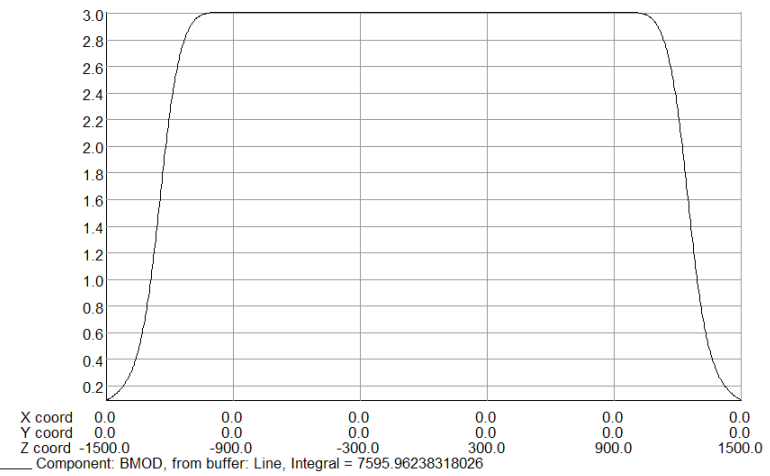
MODEL DATA	
200mm-sol-corr-many-scale-3T.op3	
TOSCA Magnetostatic	
Nonlinear materials	
Simulation No 1 of 1	
3481324 elements	
1245126 nodes	
50 conductors	
Nodally interpolated fields	
Activated in global coordinates	

Field Point Local Coordinates	
Local = Global	

FIELD EVALUATIONS	
Line LINE	1001 Cartesian
(nodal)	an
x=0.0	y=0.0 z=-10.0
	to
	1000.0

Opera

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UNITS	
Length	mm
Magn Flux Density	T
Magn Field	A m ⁻¹
Magn Scalar Pot	A
Magn Vector Pot	Vb 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
Mass	kg

MODEL DATA	
200mm-sol-corr-many-scale-3T.op3	
TOSCA Magnetostatic	
Nonlinear materials	
Simulation No 1 of 1	
3481324 elements	
1245126 nodes	
50 conductors	
Nodally interpolated fields	
Activated in global coordinates	

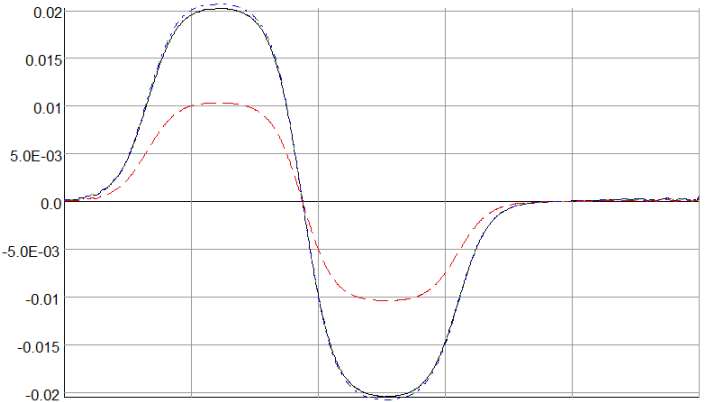
Field Point Local Coordinates	
Local = Global	

FIELD EVALUATIONS	
Line LINE	1001 Cartesian
(nodal)	an
x=0.0	y=0.0 z=-15.0
	to
	1500.0

Opera

Influence of Iron Saturation (short corrector needs to be adjusted)

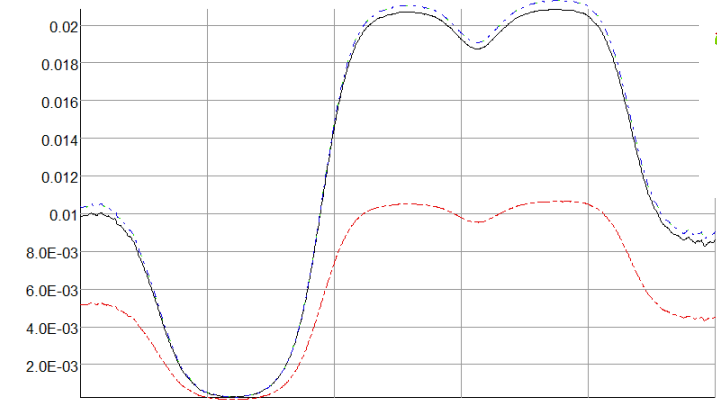
7/Jun/2010 13:56:30



X coord 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 Y coord 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 Z coord -1000.0 -600.0 -200.0 200.0 600.0 1000.0

— Component: BX, from buffer: Line, Integral = 0.04690665802994
 - - - Component: BX, from buffer: Line, Integral = 0.05861677268811
 - - - Component: 2*BX, from buffer: Line, Integral = 0.11723354537623
 - - - Component: 2*BX, from buffer: Line, Integral = 0.11723354537623

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X coord 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 Y coord 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 Z coord -1000.0 -600.0 -200.0 200.0 600.0 1000.0

— Component: BY, from buffer: Line, Integral = 24.7187005598561
 - - - Component: BY, from buffer: Line, Integral = 12.6528192439561
 - - - Component: 2*BY, from buffer: Line, Integral = 25.3056384879123
 - - - Component: 2*BY, from buffer: Line, Integral = 25.3056384879123

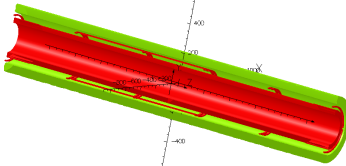
UNITS
 Length mm
 Magn Flux Density T
 Magn Field A m⁻¹
 Magn Scalar Pot A
 Magn Vector Pot Wb m⁻¹
 Elec Flux Density C m⁻²
 Elec Field V m⁻¹
 Conductivity S mm⁻¹
 Current Density A mm⁻²
 Power W
 Force N
 Energy J
 Mass kg

MODEL DATA
 200mm-sol-corr-many-
 scale-3T.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 50 conductors
 Nodally interpolated fields
 Activated in global
 coordinates

**Field Point Local
 Coordinates**
 Local = Global

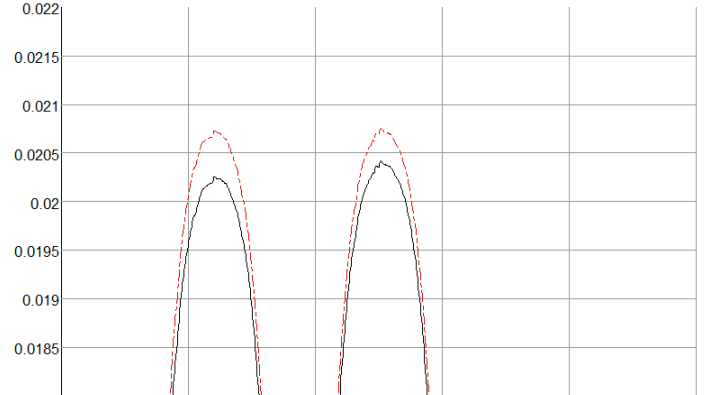
FIELD EVALUATIONS
 Line LINE 1001 Cartesi
 an
 (nodal)
 x=0.0 y=0.0 z=-10
 00.0

Opera



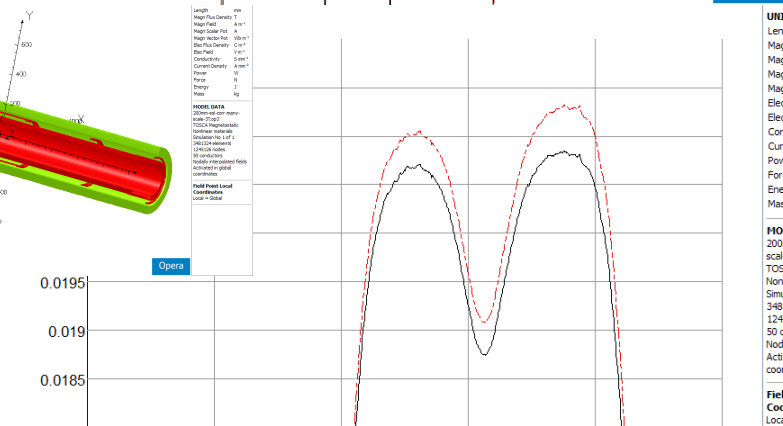
Opera

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X coord 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 Y coord 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 Z coord -1000.0 -600.0 -200.0 200.0 600.0 1000.0

— Component: ABS(BX), from buffer: Line, Integral = 17.6474874759232
 - - - Component: 2*ABS(BX), from buffer: Line, Integral = 18.0054594450578



X coord 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 Y coord 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 Z coord -1000.0 -600.0 -200.0 200.0 600.0 1000.0

— Component: ABS(BY), from buffer: Line, Integral = 24.7187005598561
 - - - Component: 2*ABS(BY), from buffer: Line, Integral = 25.3056384879123

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
 Force N
 Energy J
 Mass kg

MODEL DATA
 200mm-sol-corr-many-
 scale-3T.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 50 conductors
 Nodally interpolated fields
 Activated in global
 coordinates

**Field Point Local
 Coordinates**
 Local = Global

FIELD EVALUATIONS
 Line LINE 1001 Cartesi
 an
 (nodal)
 x=0.0 y=0.0 z=-10
 00.0
 to
 1000.0

Opera

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
 Force N
 Energy J
 Mass kg

MODEL DATA
 200mm-sol-corr-many-
 scale-3T.op3
 TOSCA Magnetostatic
 Nonlinear materials
 Simulation No 1 of 1
 3481324 elements
 1245126 nodes
 50 conductors
 Nodally interpolated fields
 Activated in global
 coordinates

**Field Point Local
 Coordinates**
 Local = Global

FIELD EVALUATIONS
 Line LINE 1001 Cartesi
 an
 (nodal)
 x=0.0 y=0.0 z=-10
 00.0
 to
 1000.0

Opera

Summary

- **Slot design of correctors seems to be working well .**
- **Iron pole is eliminated (as it does not give much benefit). Removing it saves cost with practically no penalty.**
- **Short corrector may be sufficient. Having separate long and short corrector do not de-couple the task. Simple computer algorithm should allow short correctors (with slightly increased amp-turns) to serve for both.**