

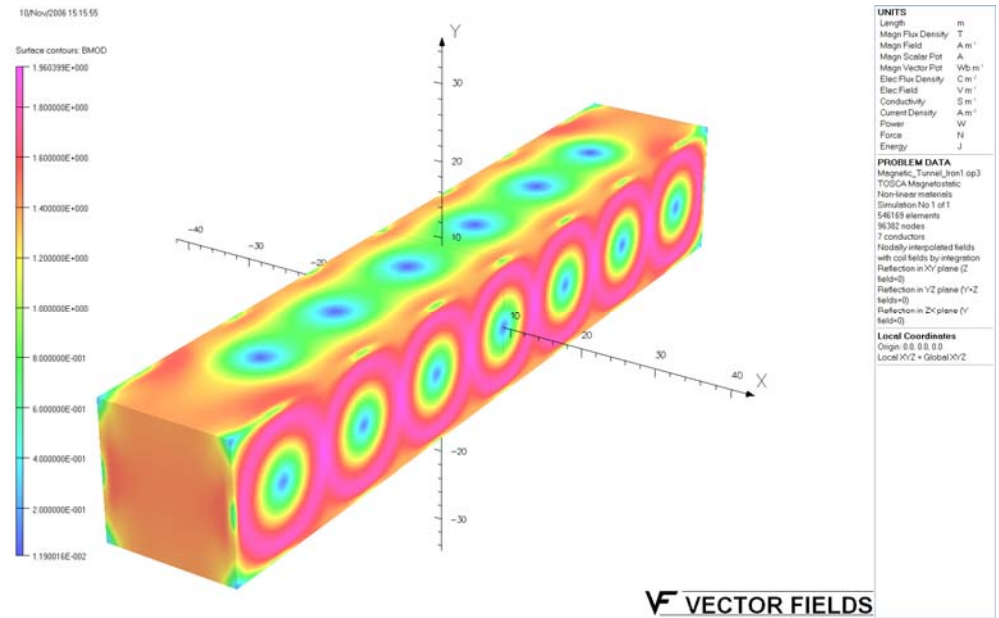
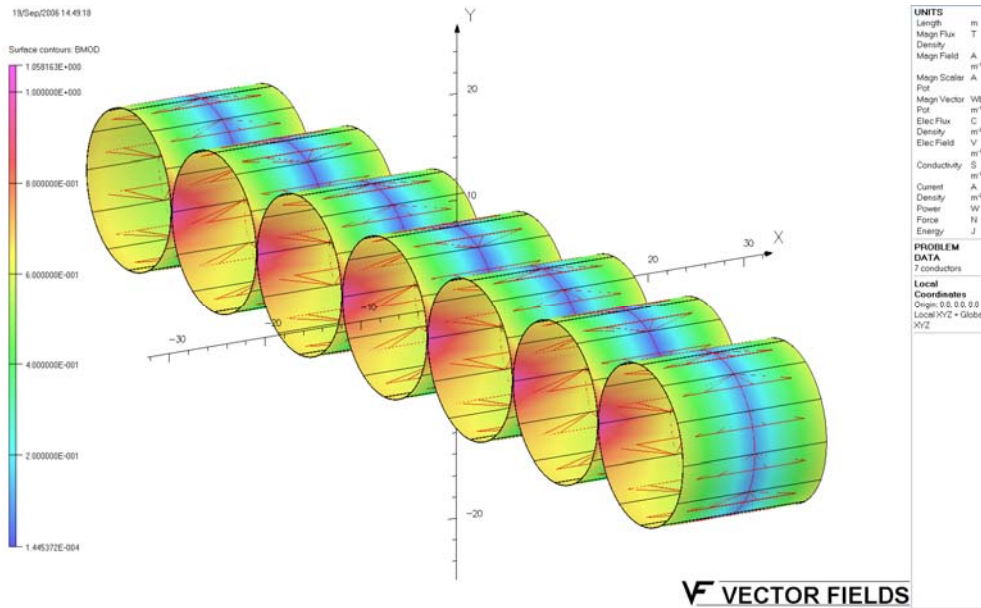
Big Magnet Designs

V.V. Kashikhin

Magnetic tunnel designs

Without iron

With iron

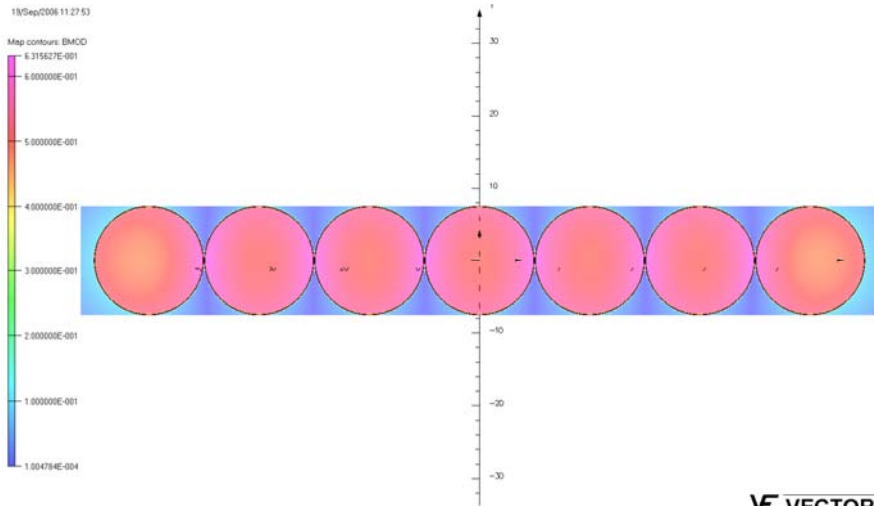


1 m iron wall thickness.
~2 T peak field in the iron.

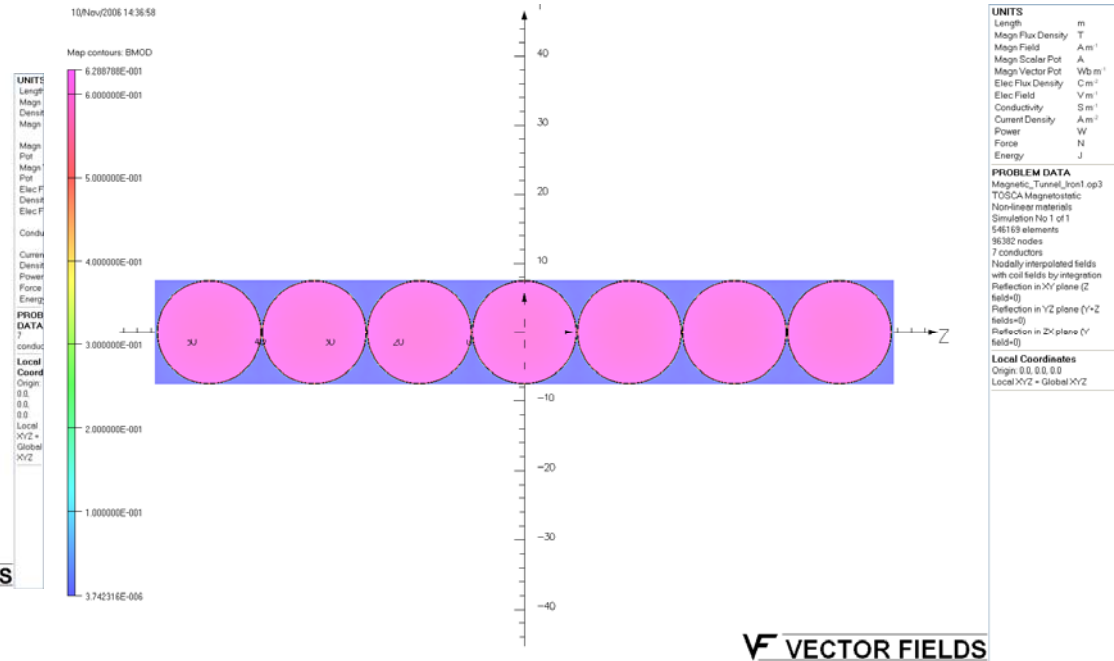
$|B|$ in YZ cross-section

Without iron

With iron



\vec{V} VECTOR FIELDS



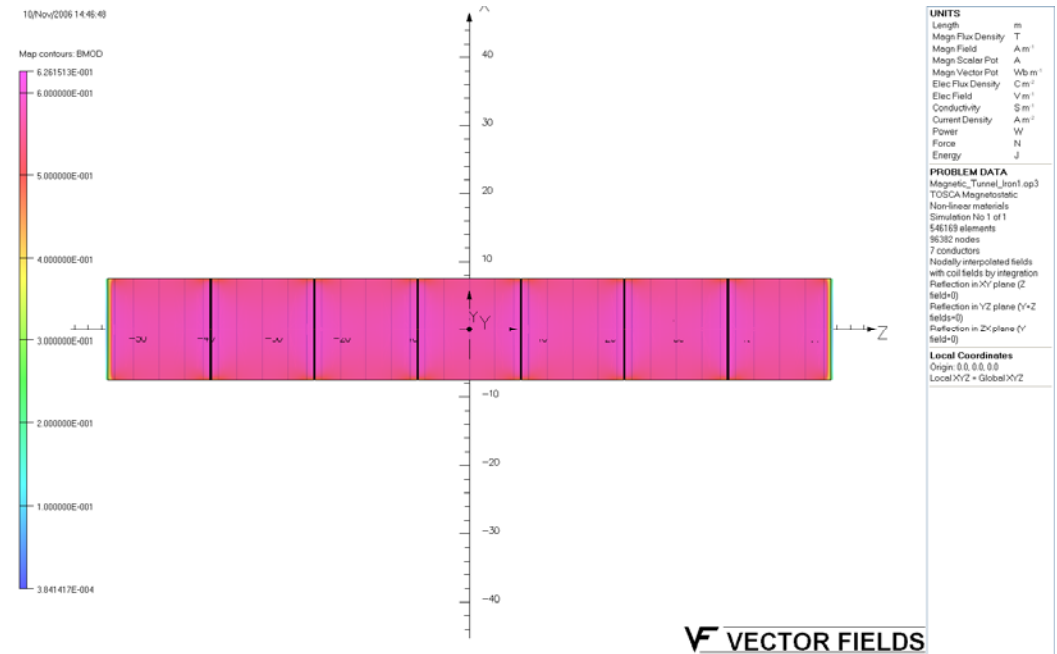
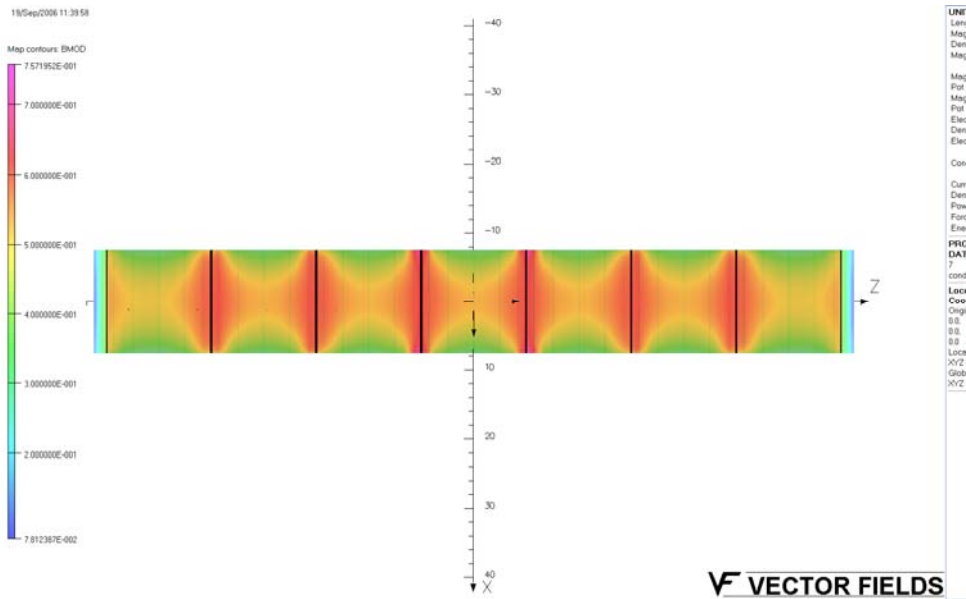
\vec{V} VECTOR FIELDS

Noticeably better field uniformity with iron

$|B|$ in XZ cross-section

Without iron

With iron



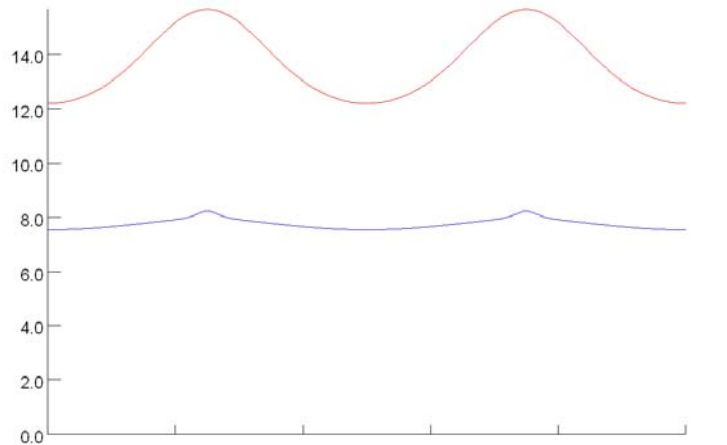
Much better field uniformity with iron

F_r in the middle/end turns

Without iron

With iron

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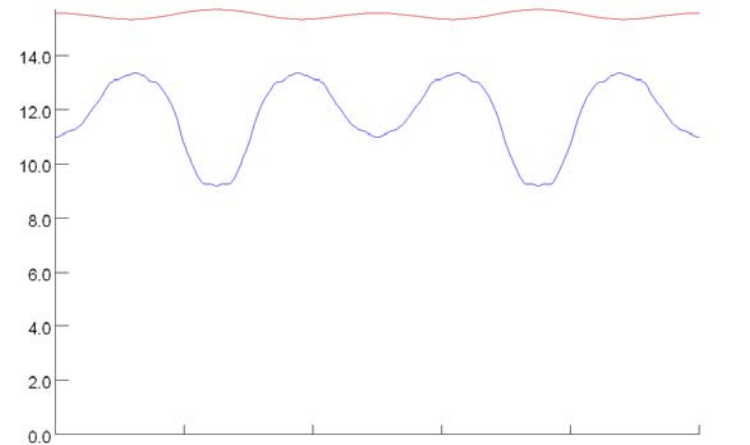
Local X coord	7.525	2.32535295	-6.0878528	-6.087853	2.3253526	7.525
Local Y coord	0.0	7.15670026	4.42308414	-4.4230838	-7.1567004	-3.663E-07
Local Z coord	0.0	0.0	0.0	0.0	0.0	3.7616E-39

— Component: BX*50, Integral = 648.049038909199 : Fr middle, kN/m
 — Component: BX*50, Integral = 366.985466456878 : Fr end, kN/m

V VECTOR FIELDS

UNITS	
Length	m
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 m ⁻¹
Current Density	A m ⁻²
Power	W
Force	N
Energy	J
PROBLEM DATA	
7 conductors	
Local Coordinates	
Origin: 0.0, 0.0, 0.0	
Local XYZ = Global YZX	

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Local X coord	7.525	2.32535295	-6.0878528	-6.087853	2.3253526	7.525
Local Y coord	0.0	7.15670026	4.42308414	-4.4230838	-7.1567004	-3.663E-07
Local Z coord	0.0	0.0	0.0	0.0	0.0	3.7616E-39

— Component: BX*50, Integral = 731.458954568028 : Fr middle, kN/m
 — Component: BX*50, Integral = 557.018385603391 : Fr end, kN/m

V VECTOR FIELDS

UNITS	
Length	m
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 m ⁻¹
Current Density	A m ⁻²
Power	W
Force	N
Energy	J
PROBLEM DATA	
Magnetic_Tunnel_kon1.op3	
TOSCA Magnetostatic	
Non-linear materials	
Simulation 1 of 1	
546169 elements	
96382 nodes	
7 conductors	
Fields by integration	
Refraction in XY plane (Z field=0)	
Refraction in YZ plane (Y=Z field=0)	
Refraction in ZX plane (Y field=0)	
Local Coordinates	
Origin: 0.0, 0.0, 0.0	
Local XYZ = Global YZX	

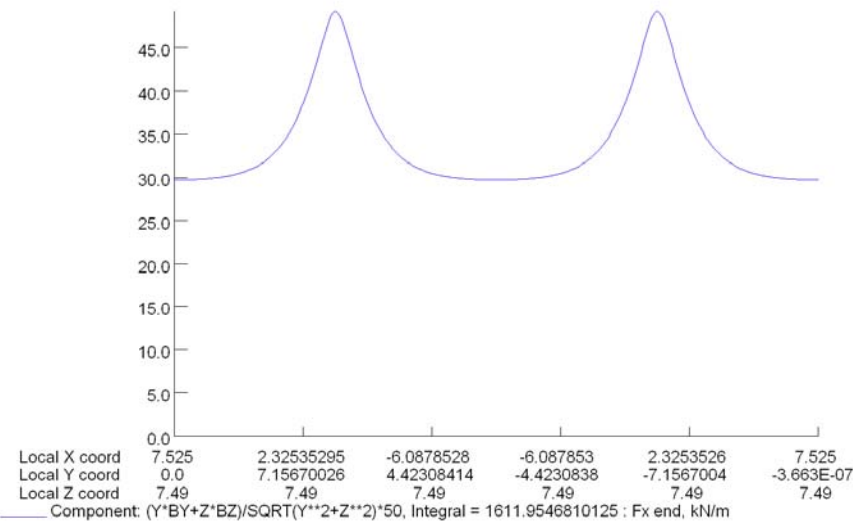
Similar force level in both cases

F_x in the end turn

Without iron

With iron

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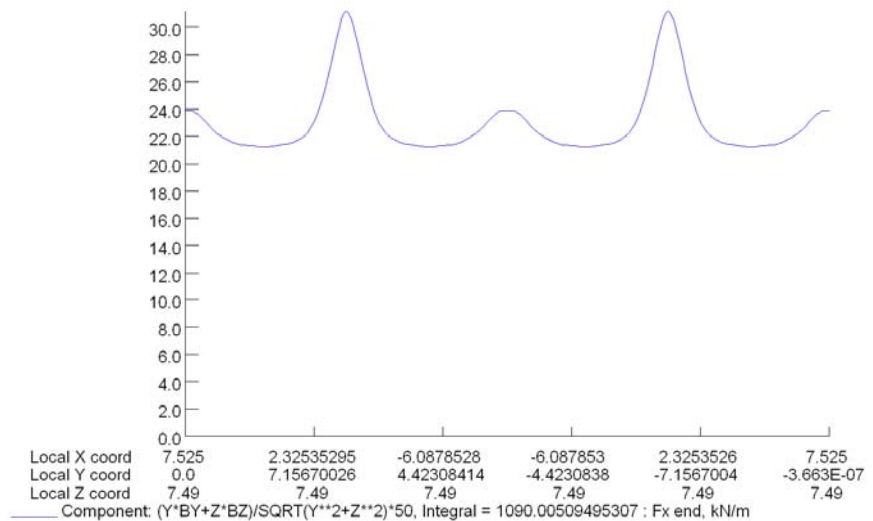
UNITS	
Length	m
Magn Flux Density	T
Magn Field	A/m
Magn Scalar Pot	A
Magn Vector Pot	Wb/m
Elec Flux Density	C/m
Elec Field	V/m
Conductivity	S/m
Current Density	A/m
Power	W
Force	N
Energy	J

PROBLEM DATA	
7 conductors	

Local Coordinates	
Origin	0.0, 0.0, 0.0
Local XYZ	= Global YZX

V VECTOR FIELDS

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

PROBLEM DATA	
Magnetic Tunnel Iron op3	
TOSCA Magnetostatic	
Non-linear materials	
Simulation No 1 of 1	
548189 elements	
96382 nodes	
7 conductors	
Fields by integration	
Reflection in XY plane (Z field=0)	
Reflection in YZ plane (Y=Z field=0)	
Reflection in ZX plane (Y field=0)	

Local Coordinates	
Origin	0.0, 0.0, 0.0
Local XYZ	= Global YZX

V VECTOR FIELDS

The largest force component => drives the mechanical design. ~60% lower force with iron.

Parameters

PARAMETER	UNIT	DESIGN	
		No iron	With iron
I_{solenoid}	MA	7.5	
$N_{\text{turns/solenoid}}$		150	
I_{turn}	kA	50	
$ B _{\text{average}}$ in XZ	T	0.483	0.586
W_{total}	GJ	2.11	2.75
L_{total}	H	1.69	2.20
F_r maximum	kN/m	15.6	15.7
F_x maximum	kN/m	49.2	31.1