

Warm quadrupoles for the SPL



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with contributions by Alexey Vorozhtsov

Requirements:

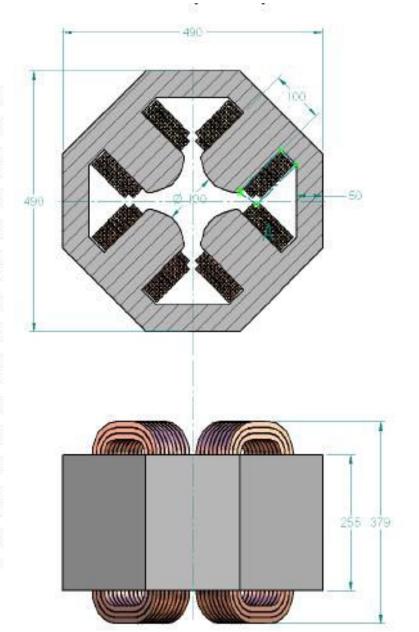
- > Free aperture 100 mm
- ➤ Integrated gradient : tunable up to 3 T
- \triangleright Field quality @ 33 mm (2/3 of radius) better than $\pm 5.10^{-4}$
- ➤ Total length < 500 mm

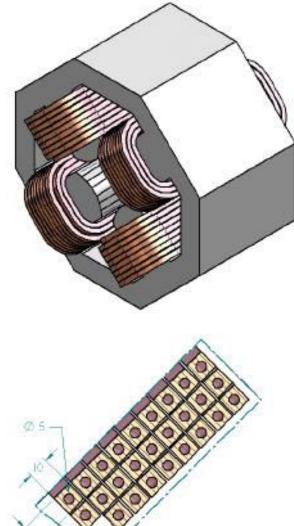


A design meeting the requirements



General parameters	.s. 8
Gradient [T/m]	10
Magnetic length [mm]	300
Iron length [mm]	255
Total length [mm]	379
Aperture radius (mm)	50
Max pole width [mm]	100
Total yoke weight [kg]	246
Total conductor weight [kg]	73
Electical parameters	
Amperturns per pole (A)	10250
Windings per pole	26
Nominal current [A]	394
Current density [A/mm^2]	4.9
Total resistance [mOhm]	25
Total inductance [mH]	9.4
Volatge (R*I) [V]	9.9
Power (kW)	3.9
Conductor type	<u> </u>
D number (LUVATA)	6077
height/width [mm]	10
hole diameter [mm]	
x=y [mm]	2.5
r [mm]	1
Total Conductor Length [m]	106
Cooling parameters	<u> </u>
Cooling circuits per magnet	2
coolant velocity [m/s]	1.4
Total cooling flow [l/min]	3.2
Presure drop [bar]	3.1
Reynolds number	9720
Temperature rise [K]	17

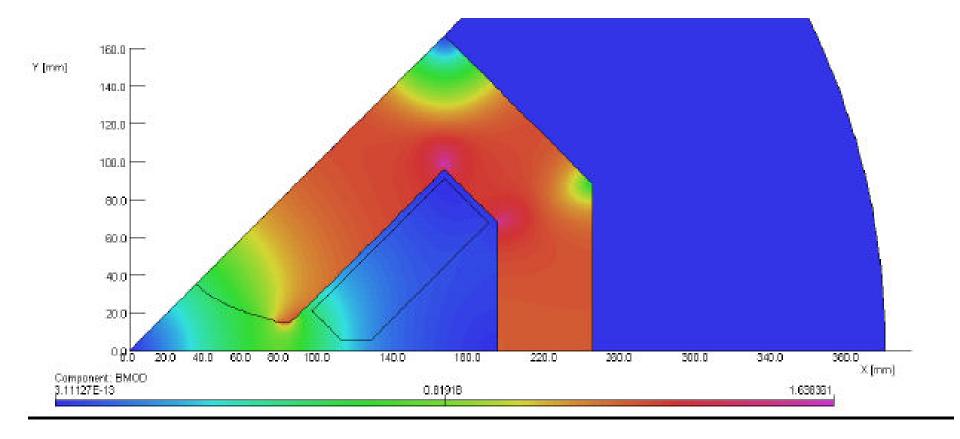






"Easy" racetrack coils are possible



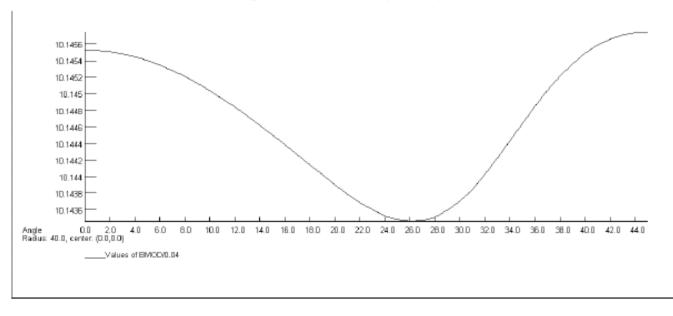




Field quality exceeds specifications



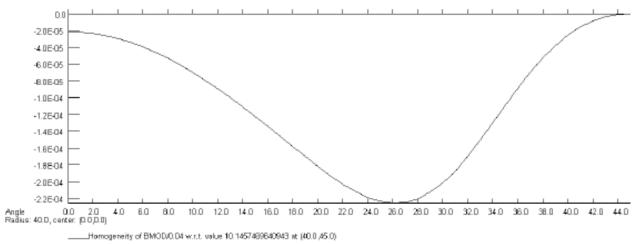
Field gradient and quality at R=40mm





PROBLEM DATA
O'JL Inst + 40 useful pole
10 Tipermilled, 1/100 _
480 _ Nose2.st
Quadratic elements
XY symmetry
Verbit potential
Magnetic felds
Static solution
Scale factor = 1.0
19053 elements
38442 nodes
6 regions





UNITS	3
Length	: mm
Flux density	: T
Field strength	:Ami
Potential	: With mir
Conductivity	:8 m
Source densit	y: Amm
Power	:W
Force	: N
Energy	; J
Mass	: kg
	-

PROBLEM DATA
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10Tpermillod y100
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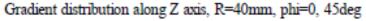


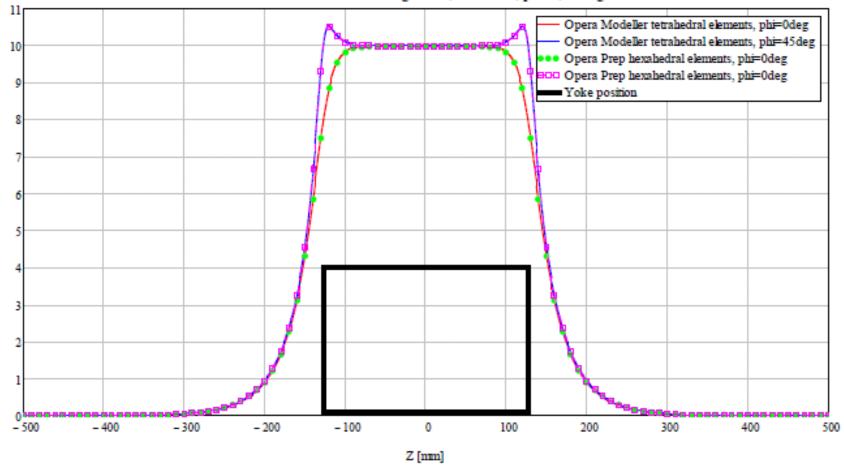


Grad(z) [T/m]

Magnetic length and quality OK in 3D no



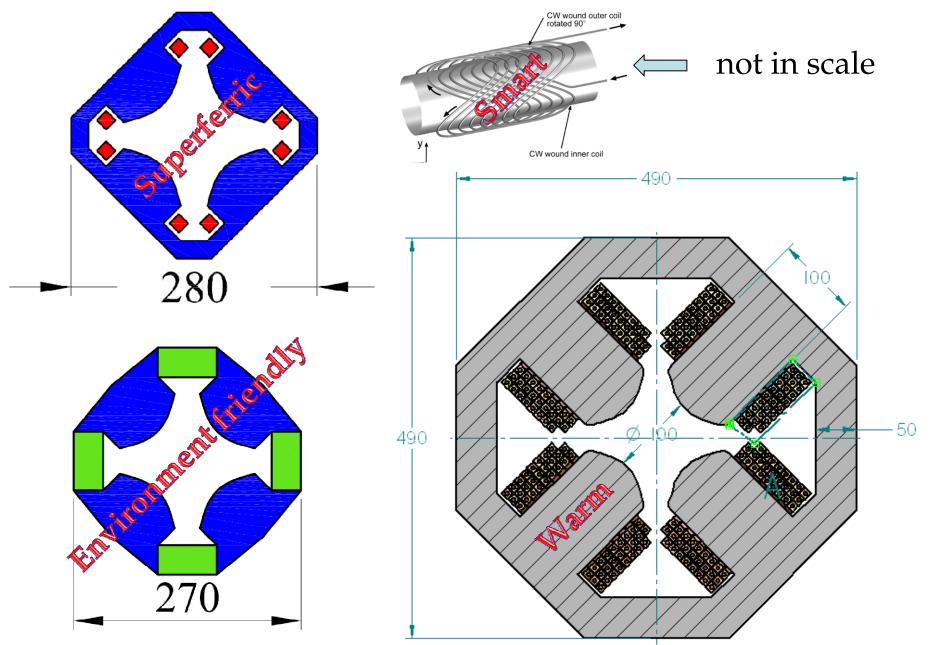






How does it compare?





Conclusions

Easy magnet

Physical length < 400 mm