

# Q2pF 3-d Design Studies

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NATIONAL LABORATORY

*a passion for discovery*

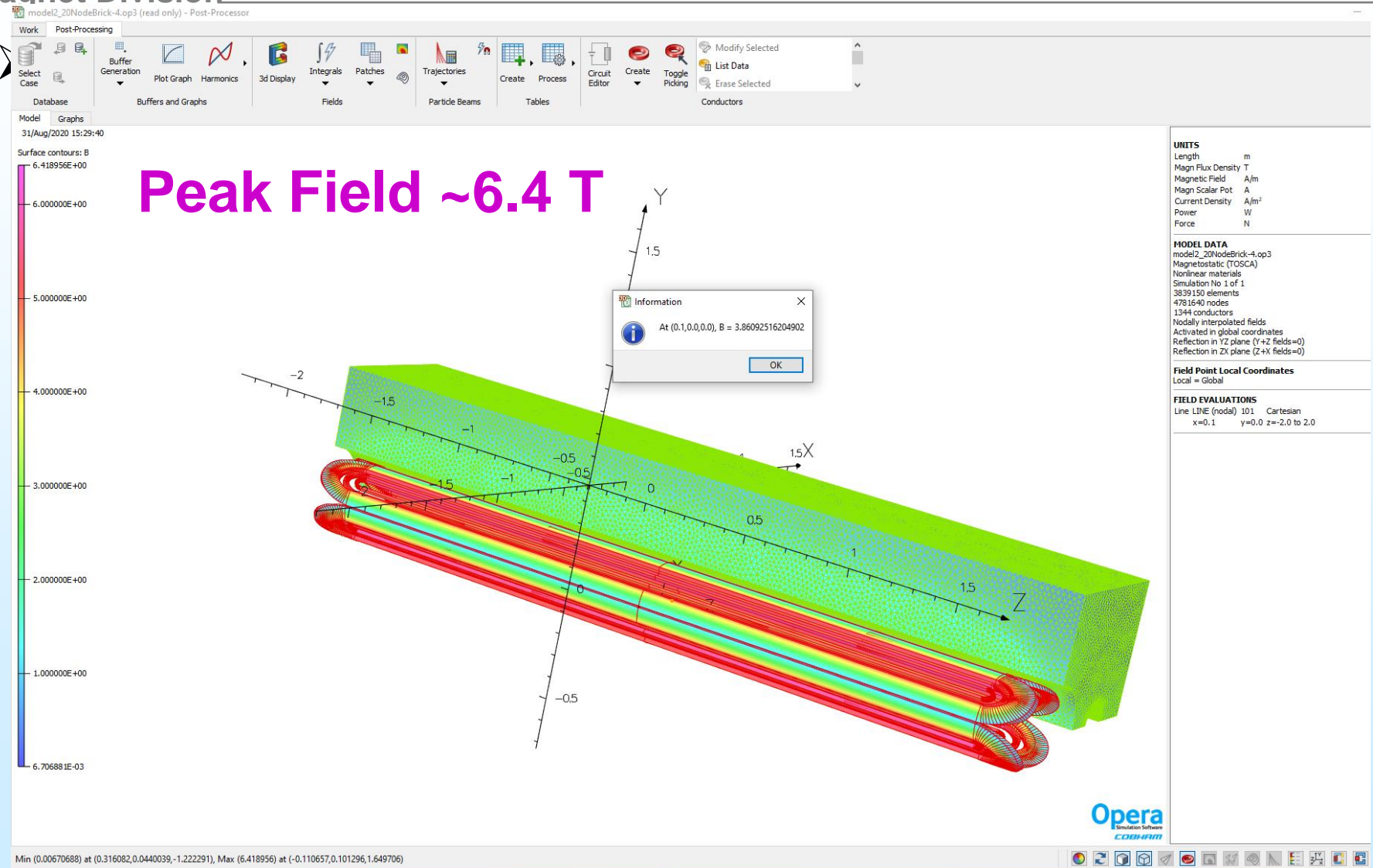
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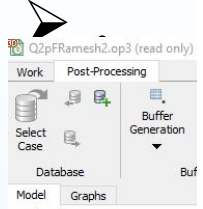
# Overview

- **Design studies of two Q2pF 3-d designs.**
- **Observation: Two different designs have significantly different peak fields**
- **Where is the difference?**
  - **First suspect – the ends**
  - **Other differences also found**

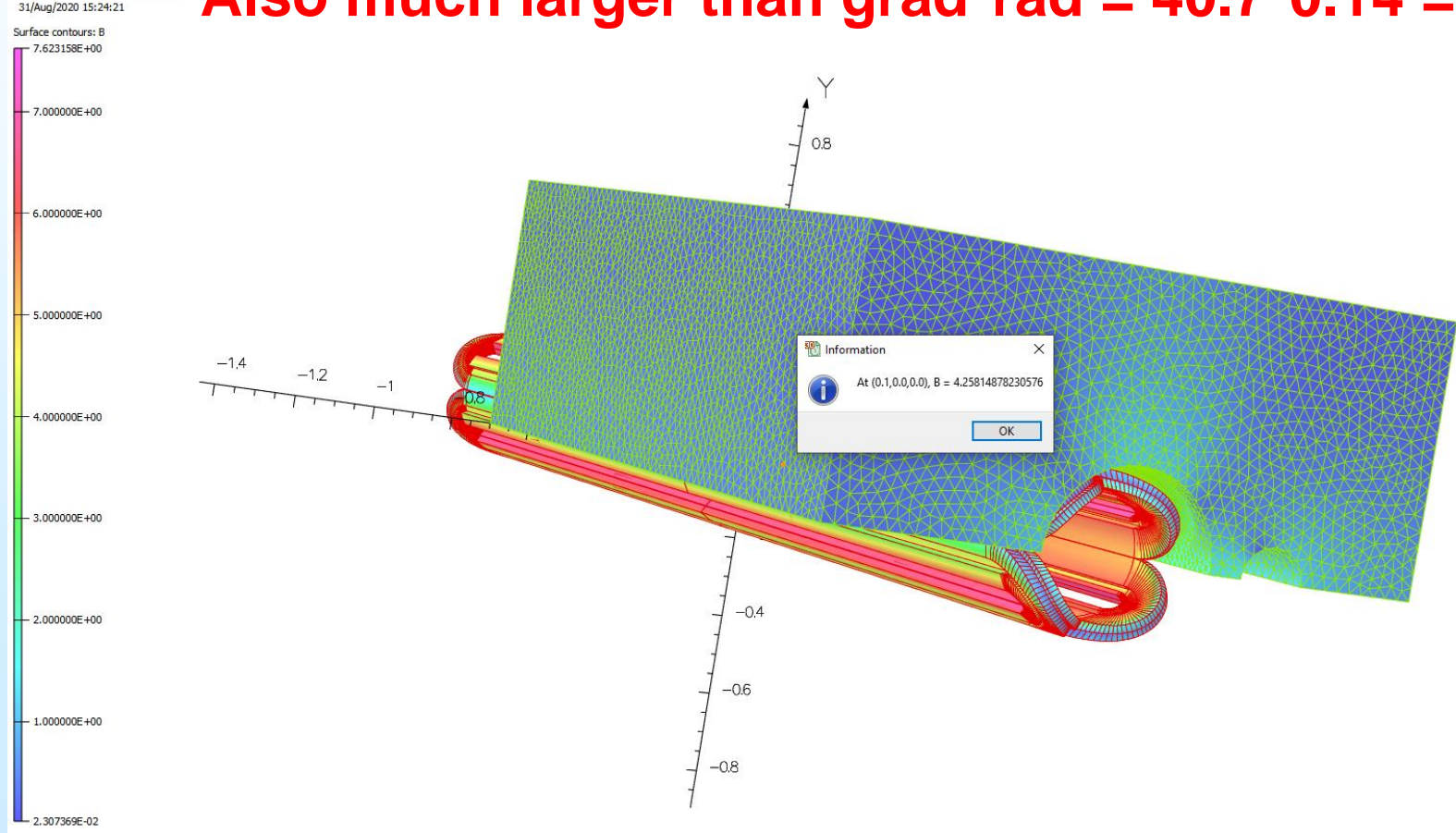
# OPERA Design A



# OPERA Design B



**Peak Field ~7.6 T**  
**Significantly higher than that in design A**  
**Also much larger than grad\*rad = 40.7\*0.14 = 5.7 T**

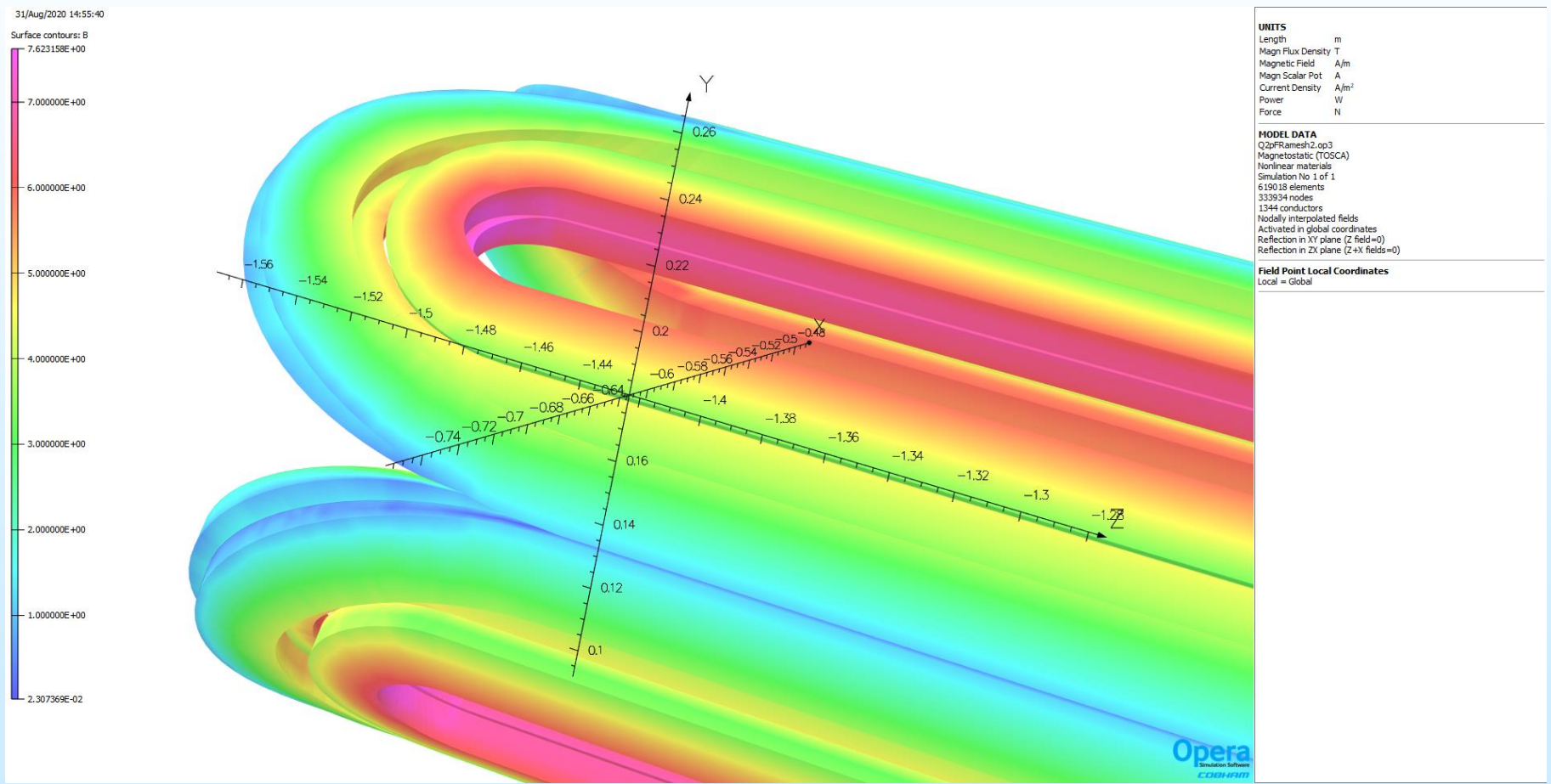


Magn Flux Density	T
Magnetic Field	A/m
Magn Scalar Pot	A
Current Density	A/m <sup>2</sup>
Power	W
Force	N
<b>MODEL DATA</b>	
Q2pFRamesh2.op3	
Magnetostatic (TOSCA)	
Nonlinear materials	
Simulation No 1 of 1	
619018 elements	
333934 nodes	
1344 conductors	
Nodally interpolated fields	
Activated in global coordinates	
Reflection in XY plane (Z field=0)	
Reflection in ZX plane (Z+X fields=0)	
<b>Field Point Local Coordinates</b>	
Local = Global	



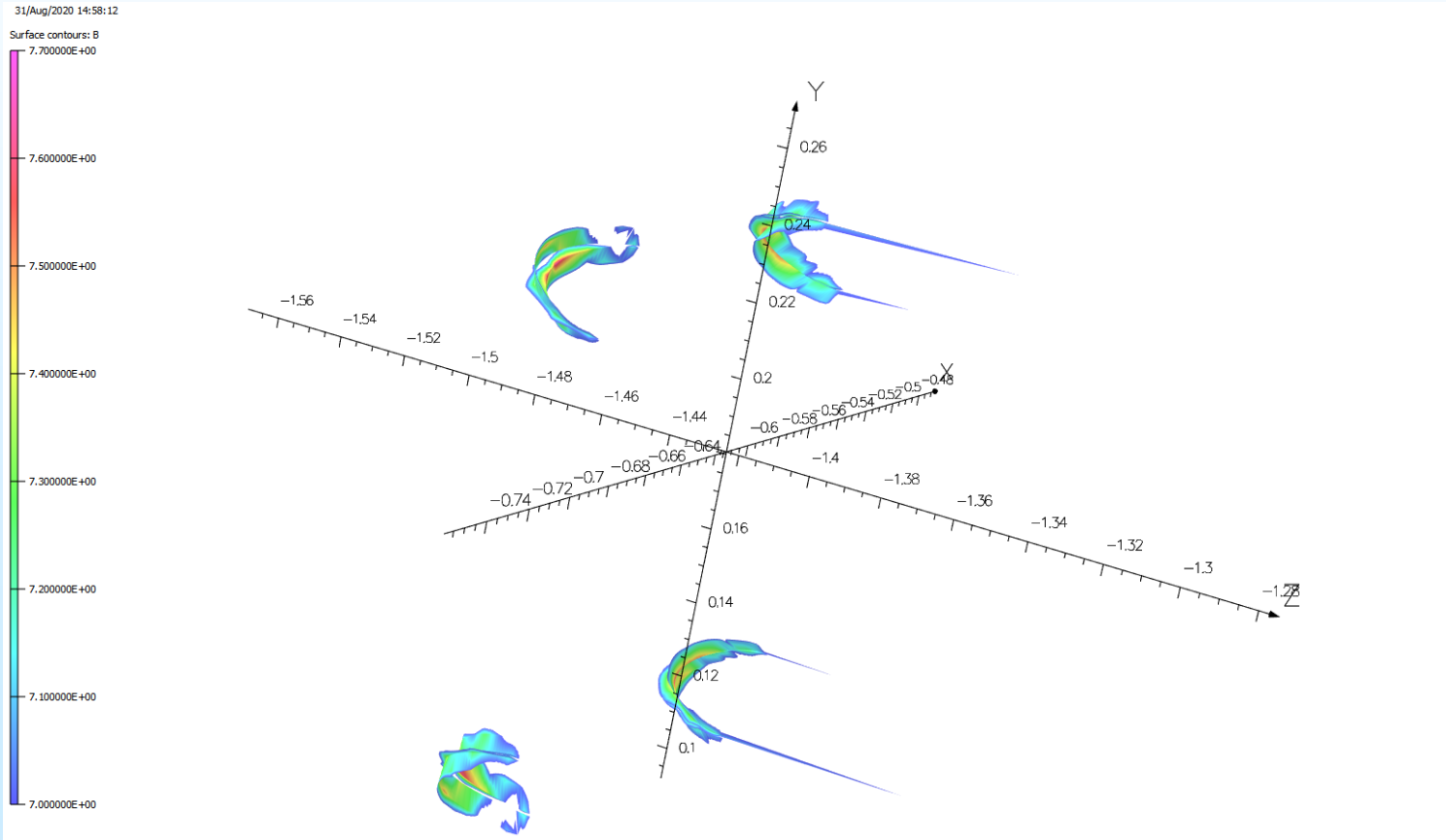
# Design B : Ends (1)

Ends appear to have relatively high peak field



# Design B : Ends (2)

Ends appear to have relatively high peak field  
 (range 7 to 7.7 T all in ends...  
 This is a large enhancement; must be avoided)



UNITS	
Length	m
Magn Flux Density	T
Magnetic Field	A/m
Magn Scalar Pot	A
Current Density	A/m <sup>2</sup>
Power	W
Force	N

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MODEL DATA	
Q2pFRamesh2.op3	
Magnetostatic (TOSCA)	
Nonlinear materials	
Simulation No 1 of 1	
619018 elements	
333934 nodes	
1344 conductors	
Nodally interpolated fields	
Activated in global coordinates	
Reflection in XY plane (Z field=0)	
Reflection in ZX plane (Z+X fields=0)	

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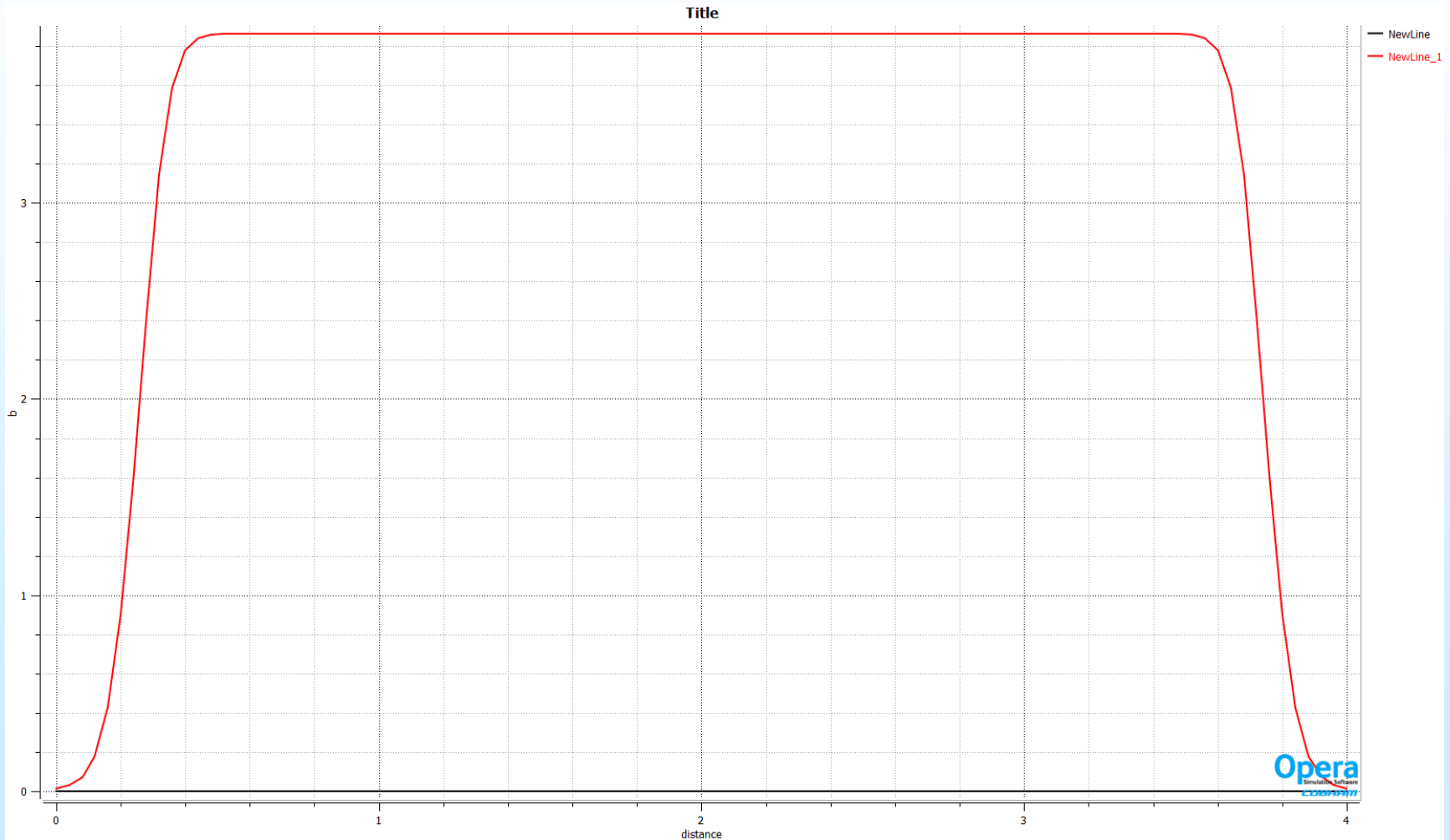
Field Point Local Coordinates	
Local	= Global

# Other differences

- **Comparison made at the different field (field gradient)**

# Design A: B vs z at x= 0.1 m

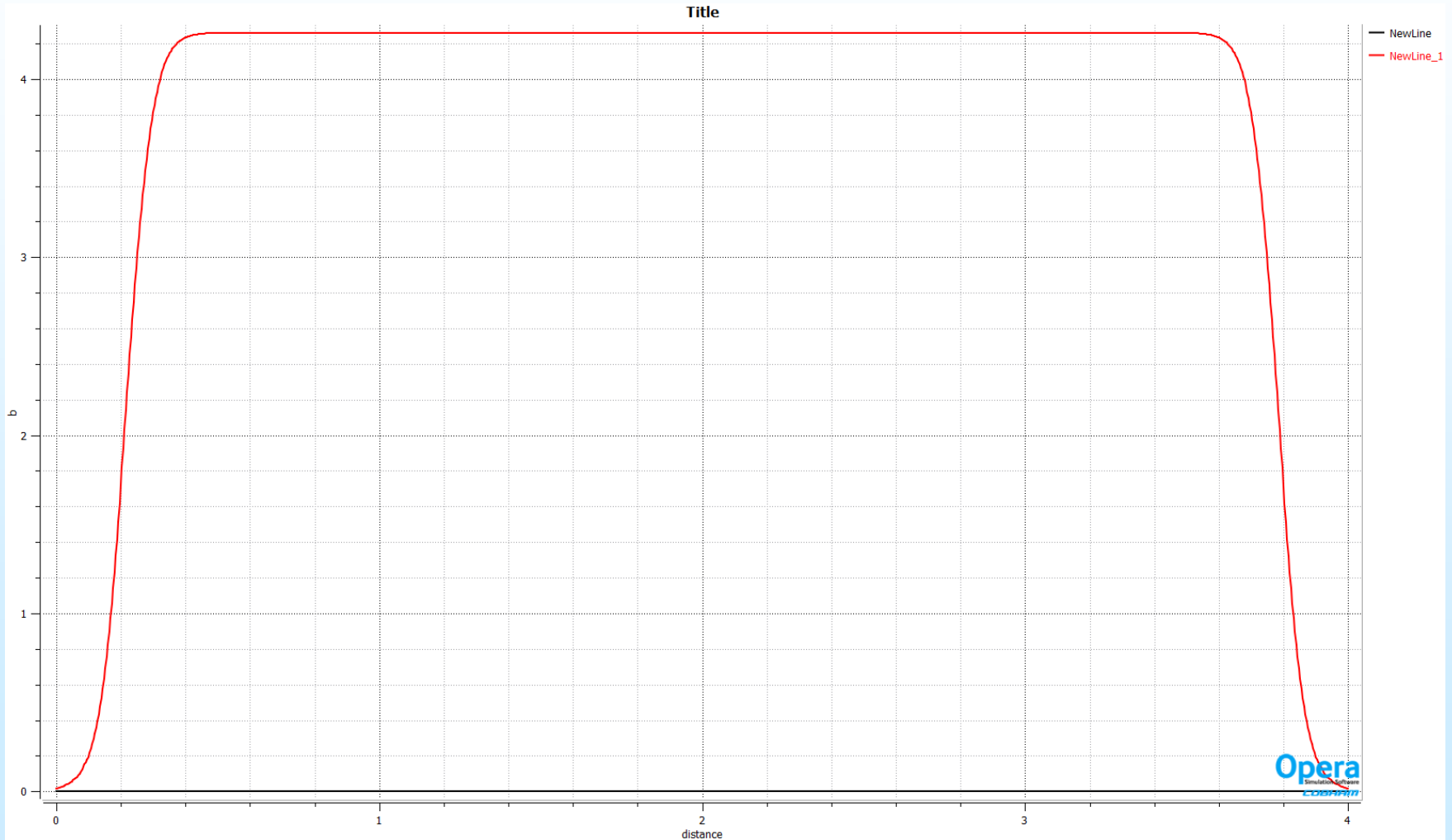
➤ ~3.8 T





# Design B: B vs z at x= 0.1 m

➤ ~4.3 T (much higher than that in Design A)

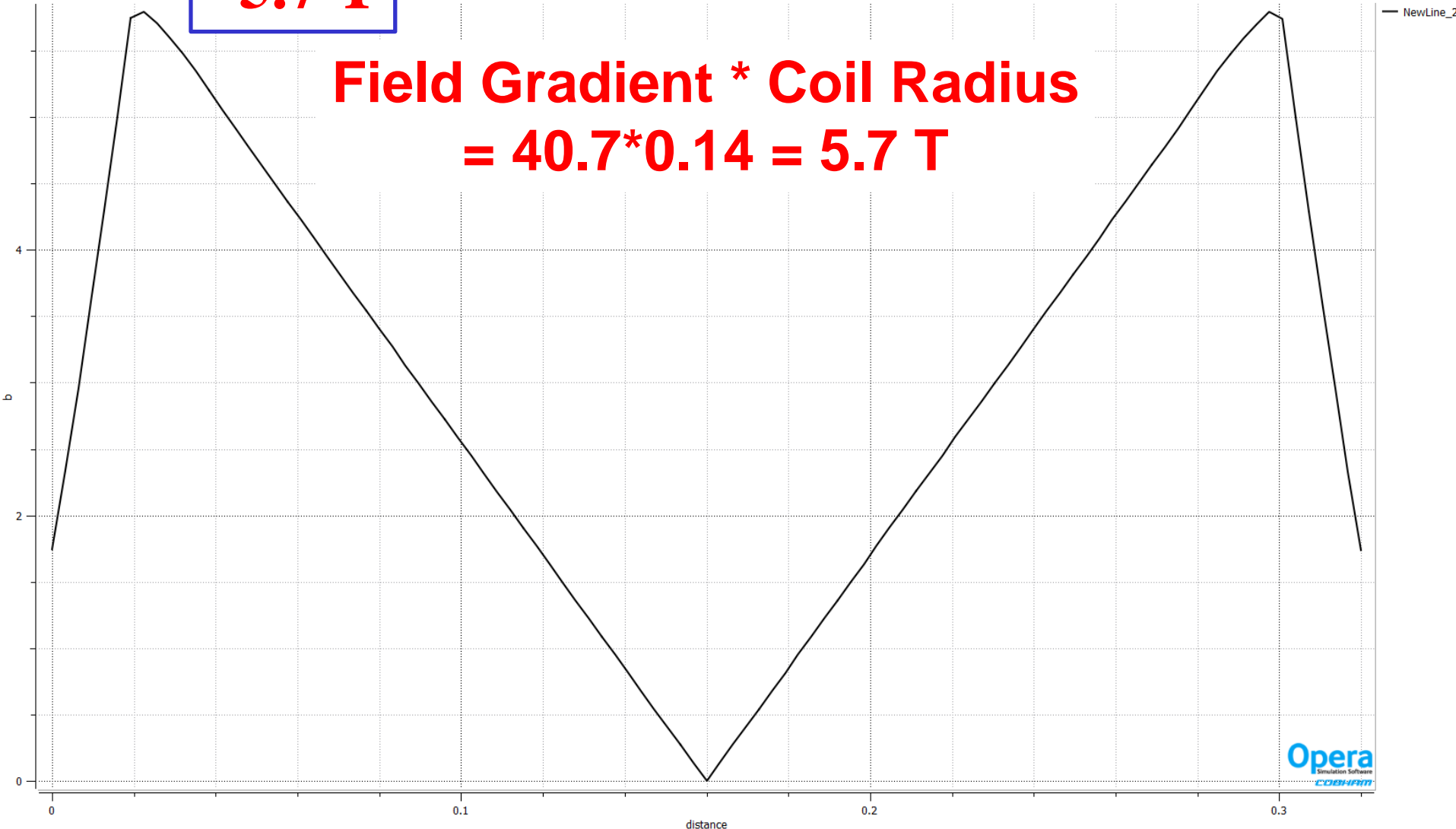


# Design B: Field at midplane

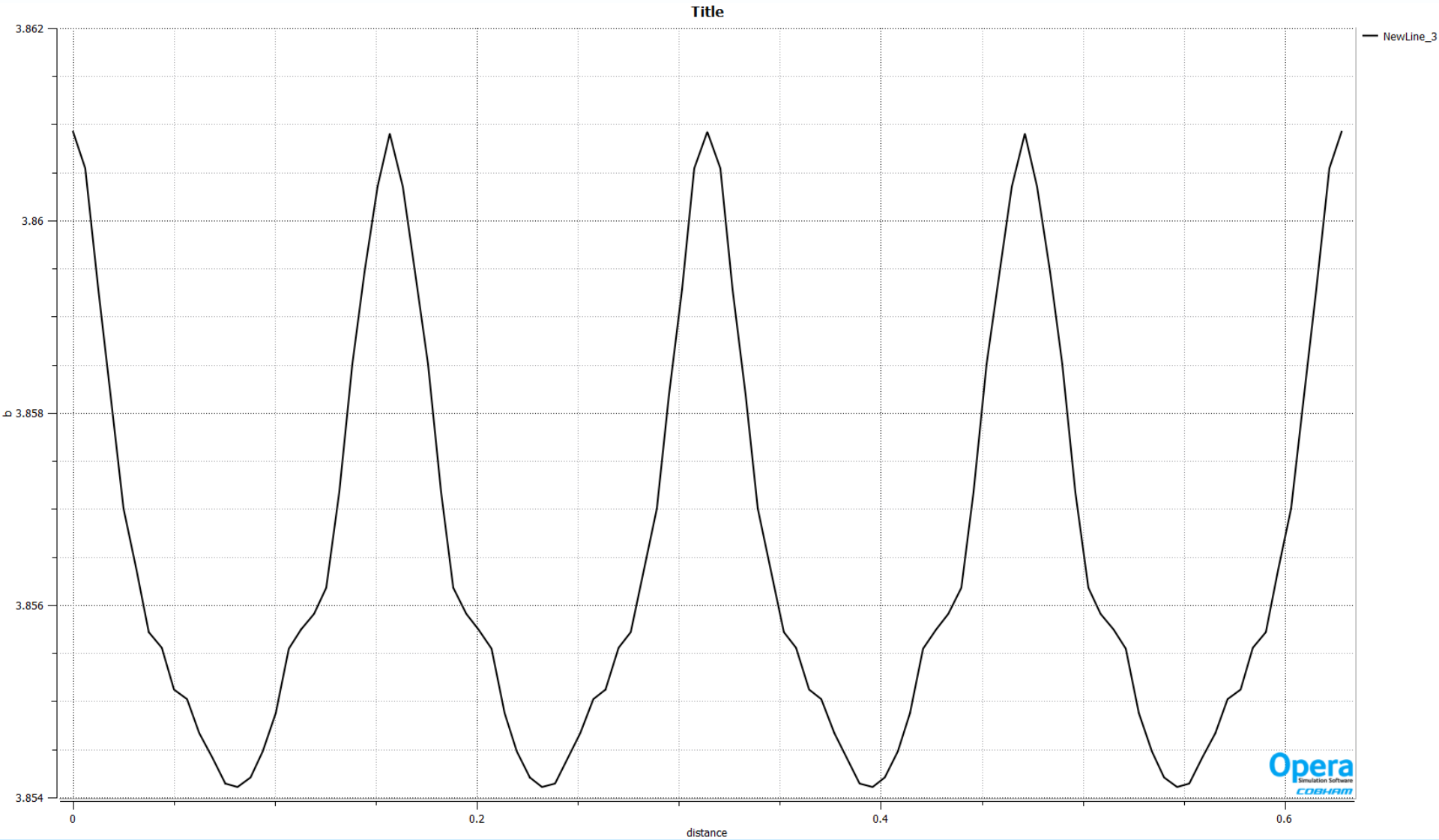
**~5.7 T**

Title

**Field Gradient \* Coil Radius  
= 40.7\*0.14 = 5.7 T**

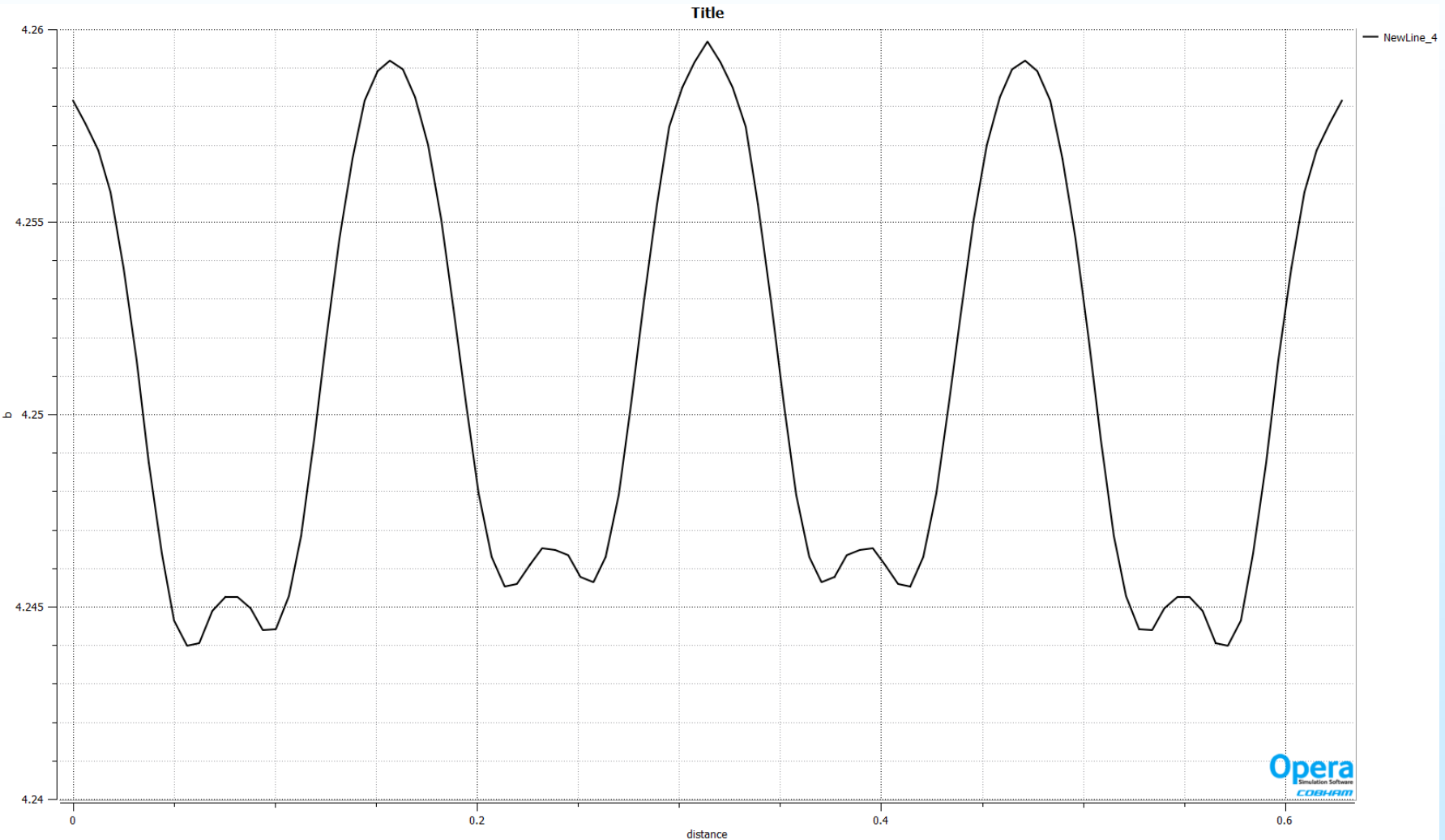


# Design A: B vs theta at R = 0.1 m

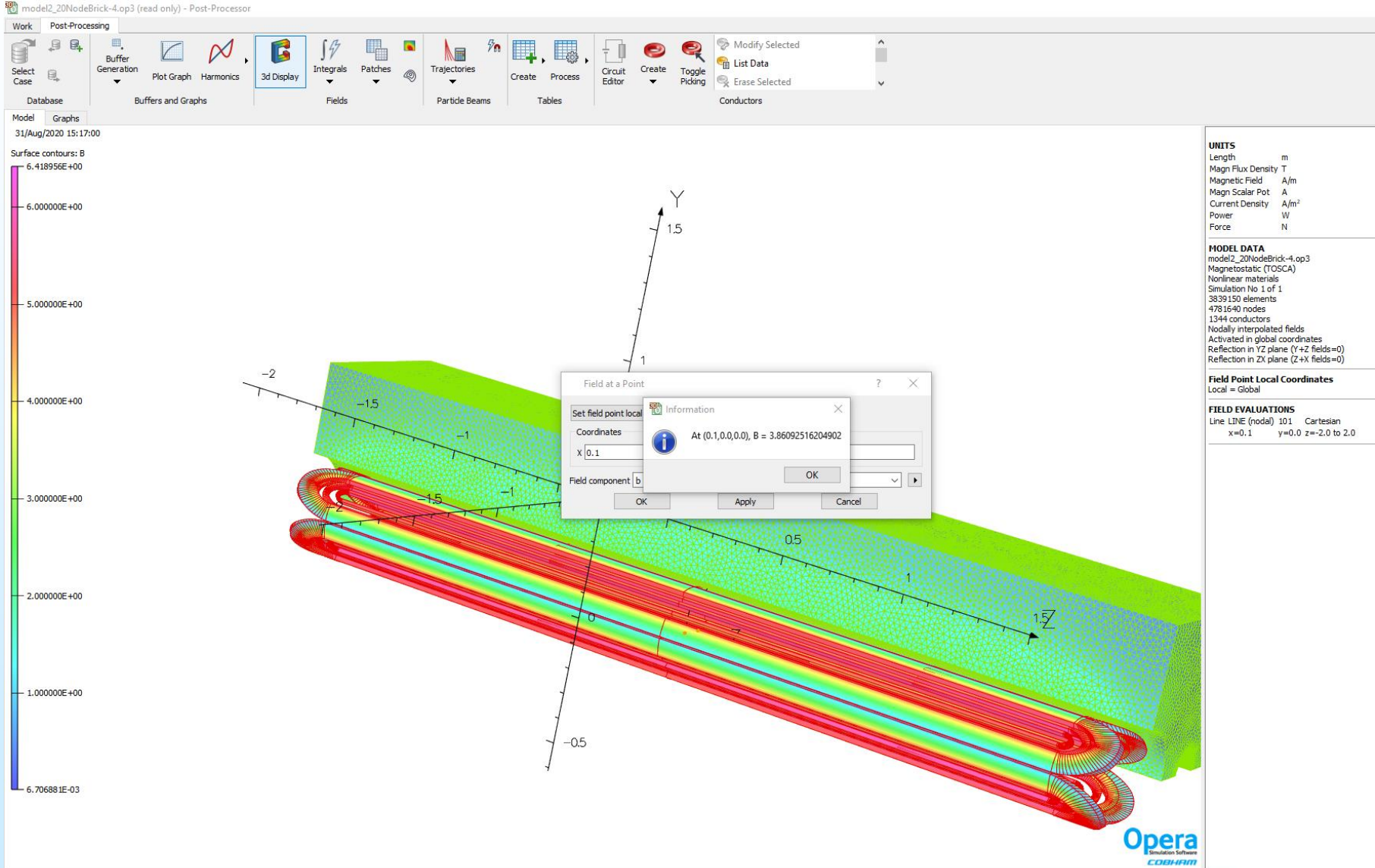


# Design B: B vs theta at R = 0.1 m

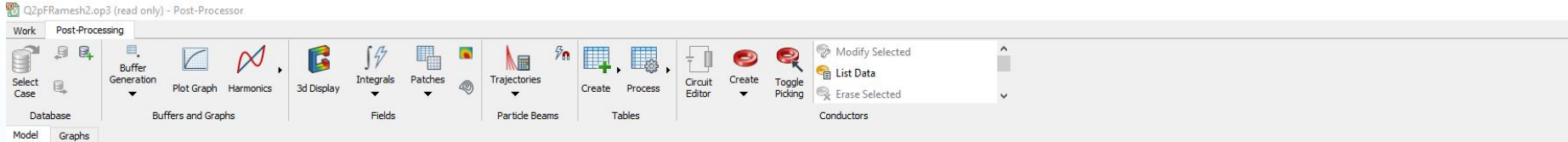
(much higher than that in Design A)



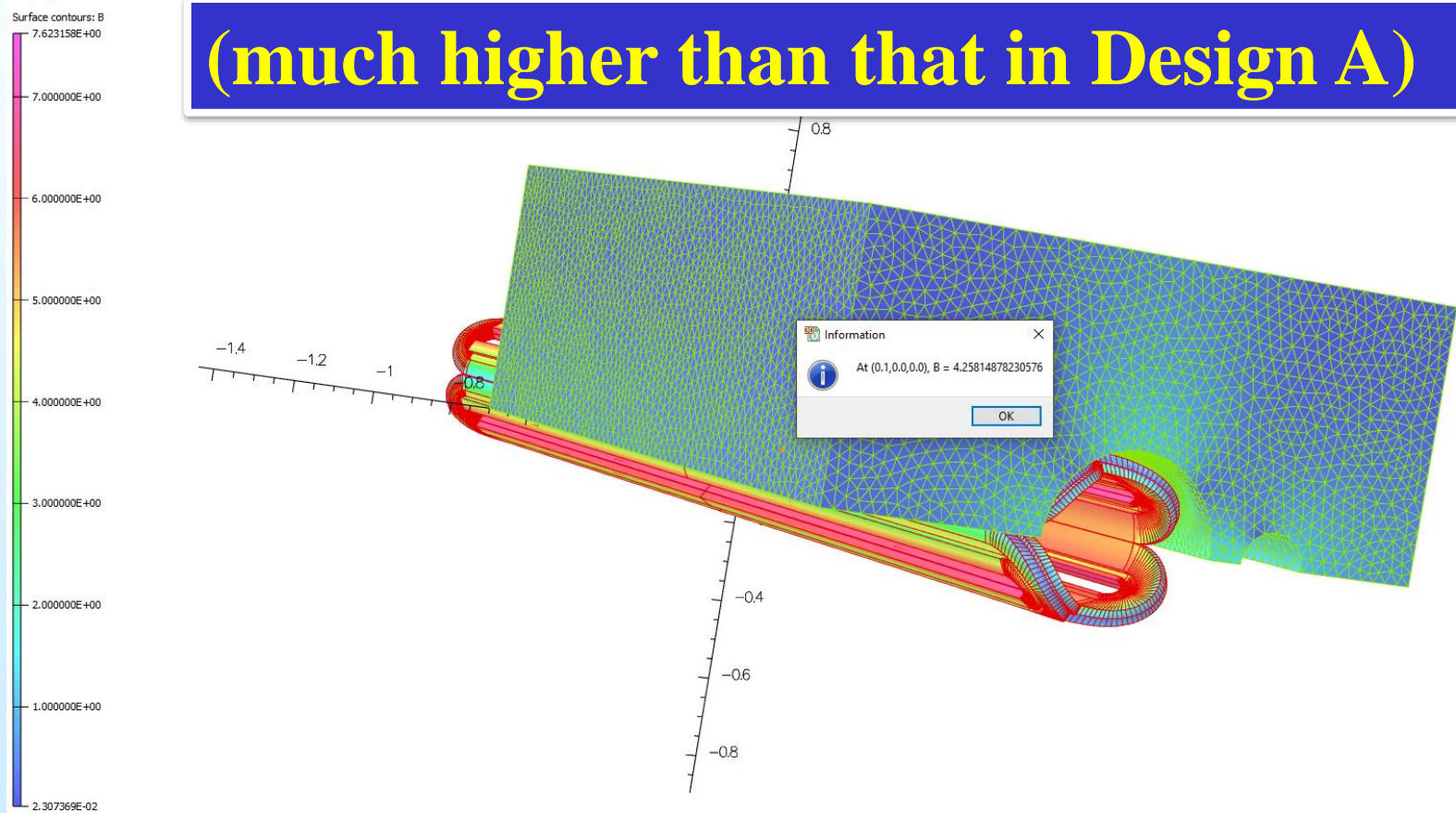
# Design A: $B(0.1,0,0)=3.86 \text{ T}$



**Design A:  $B(0.1,0,0) = 4.25 \text{ T}$**



**(much higher than that in Design A)**



**UNITS**

Length	m
Magn Flux Density	T
Magnetic Field	A/m
Magn Scalar Pot	A
Current Density	A/m <sup>2</sup>
Power	W
Force	N

**MODEL DATA**

Q2pFRamesh2.op3  
 Magnetostatic (TOSCA)  
 Nonlinear materials  
 Simulation No 1 of 1  
 619018 elements  
 333934 nodes  
 1344 conductors  
 Nodally interpolated fields  
 Activated in global coordinates  
 Reflection in XY plane (Z field=0)  
 Reflection in ZX plane (Z+X fields=0)

**Field Point Local Coordinates**  
 Local = Global



# Summary

- **Large peak fields in the ends must be avoided**
- **Since ends generally have a more complex and less robust structure, the peak field in the ends should be lower than the peak field in the body of the magnets**
- **Design A and Design B are compared at different field gradient**
- **Next step: optimize end designs**