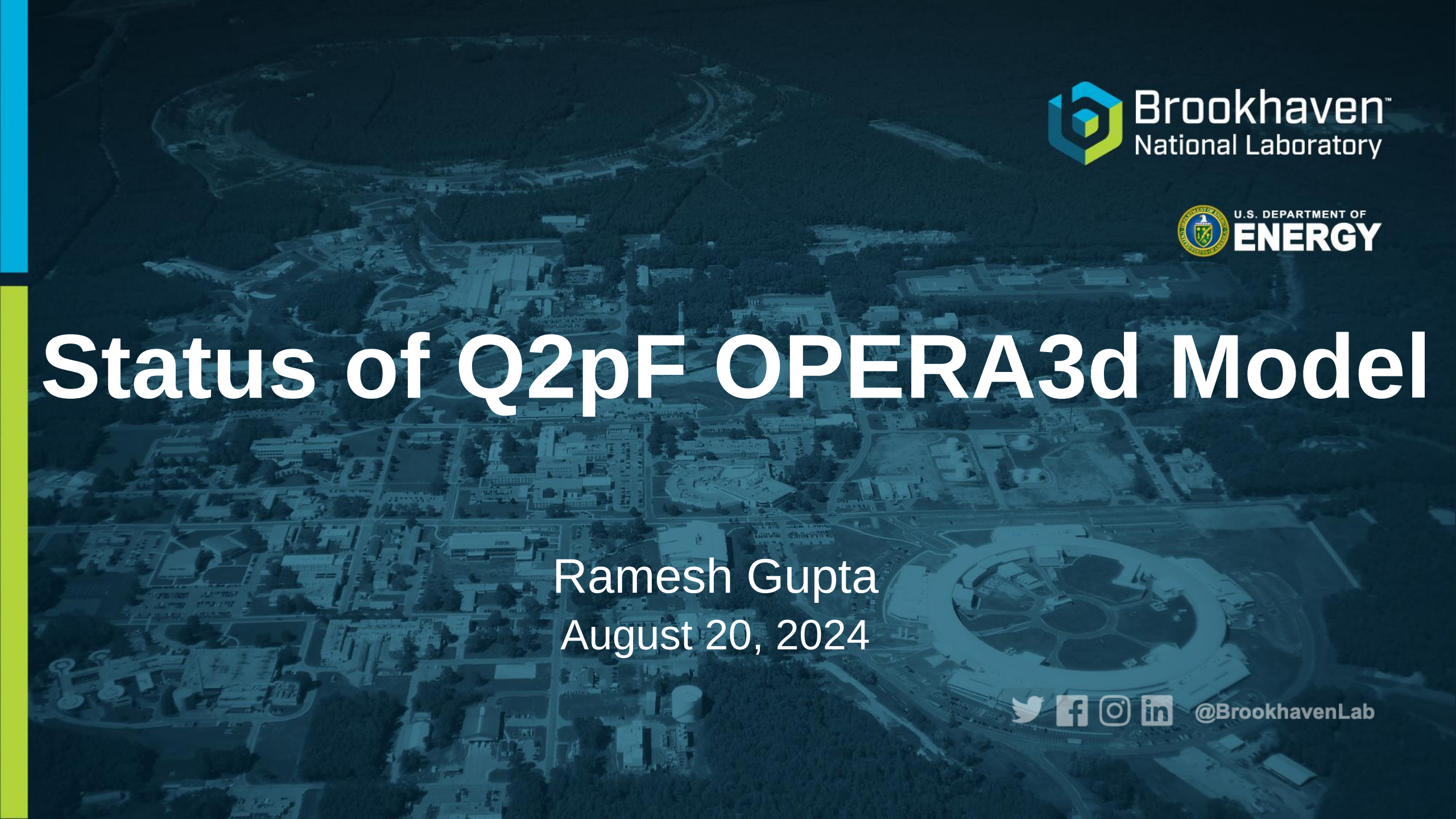


Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

Status of Q2pF OPERA3d Model

Ramesh Gupta

August 20, 2024

@BrookhavenLab

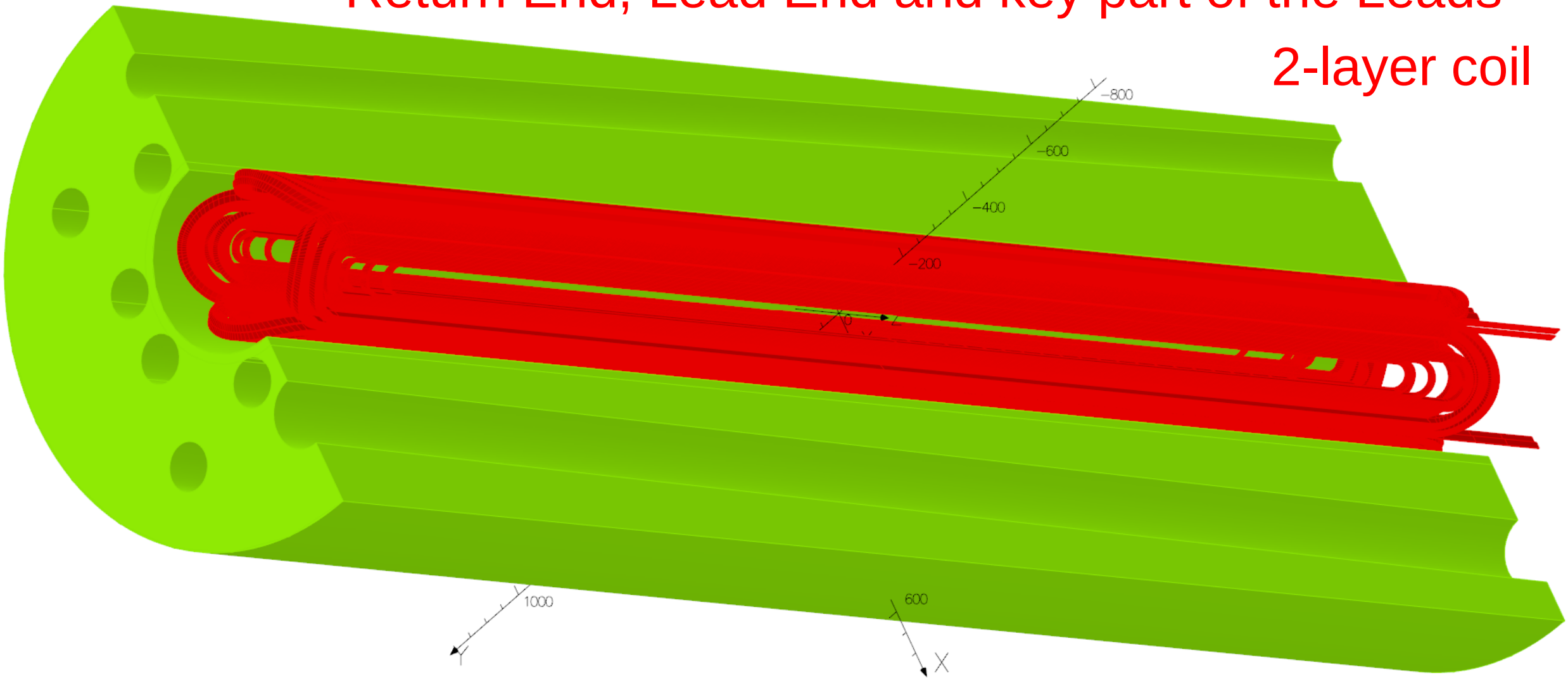
Content

- OPERA3d model for the whole coil (including return and lead ends and key part of the leads) for the updated turn-to-turn spacing.
- Updated yoke cross-section in the current model.
- OPERA3d solver (TOSCA) run with a denser mesh (gives higher accuracy, but it takes longer) at the design current.
- Post processing continues. Some results will be shown; other takes significant time depending on the method of calculations)
- More results to be presented in future, including current dependence and field harmonics in electron hole

OPERA3d Model (only ½ yoke displayed for clarity)

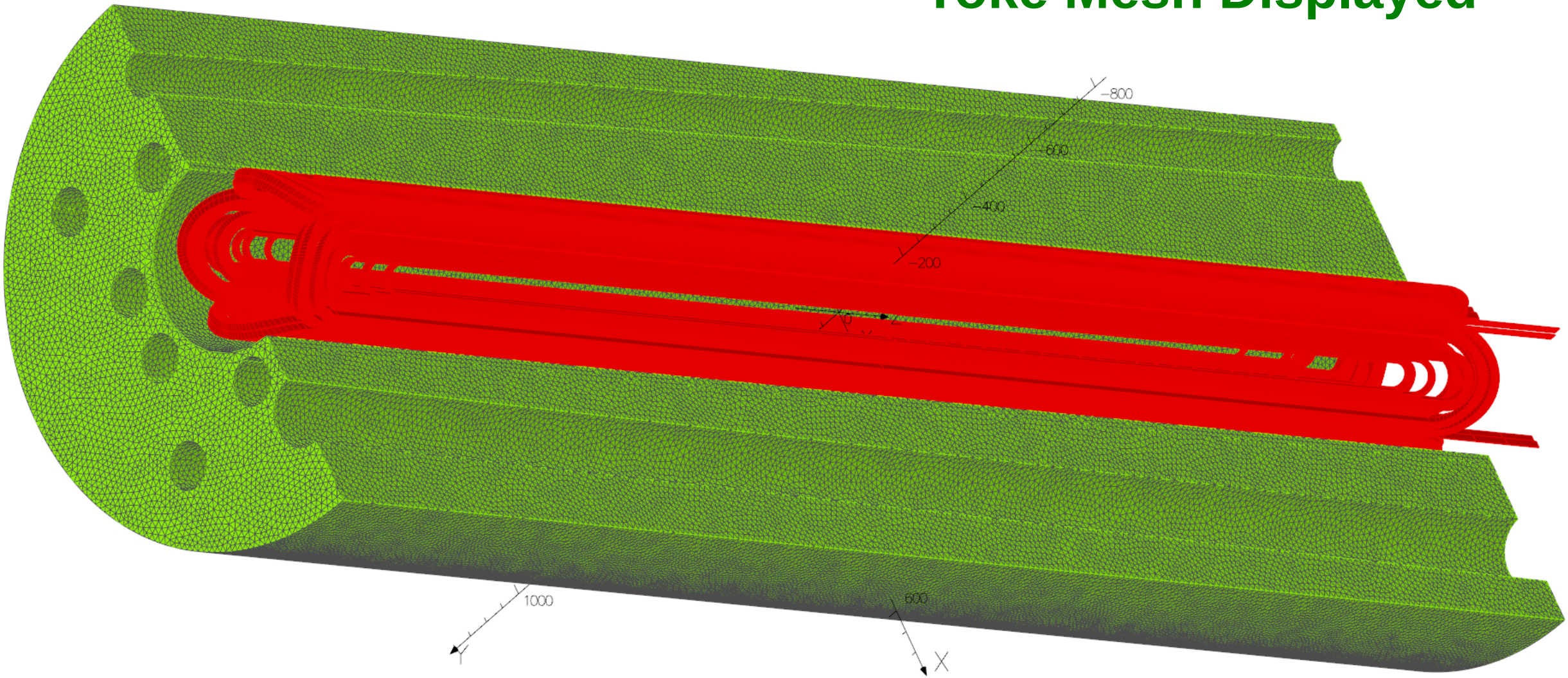
Return End, Lead End and key part of the Leads

2-layer coil



OPERA3d Model (only ½ yoke displayed for clarity)

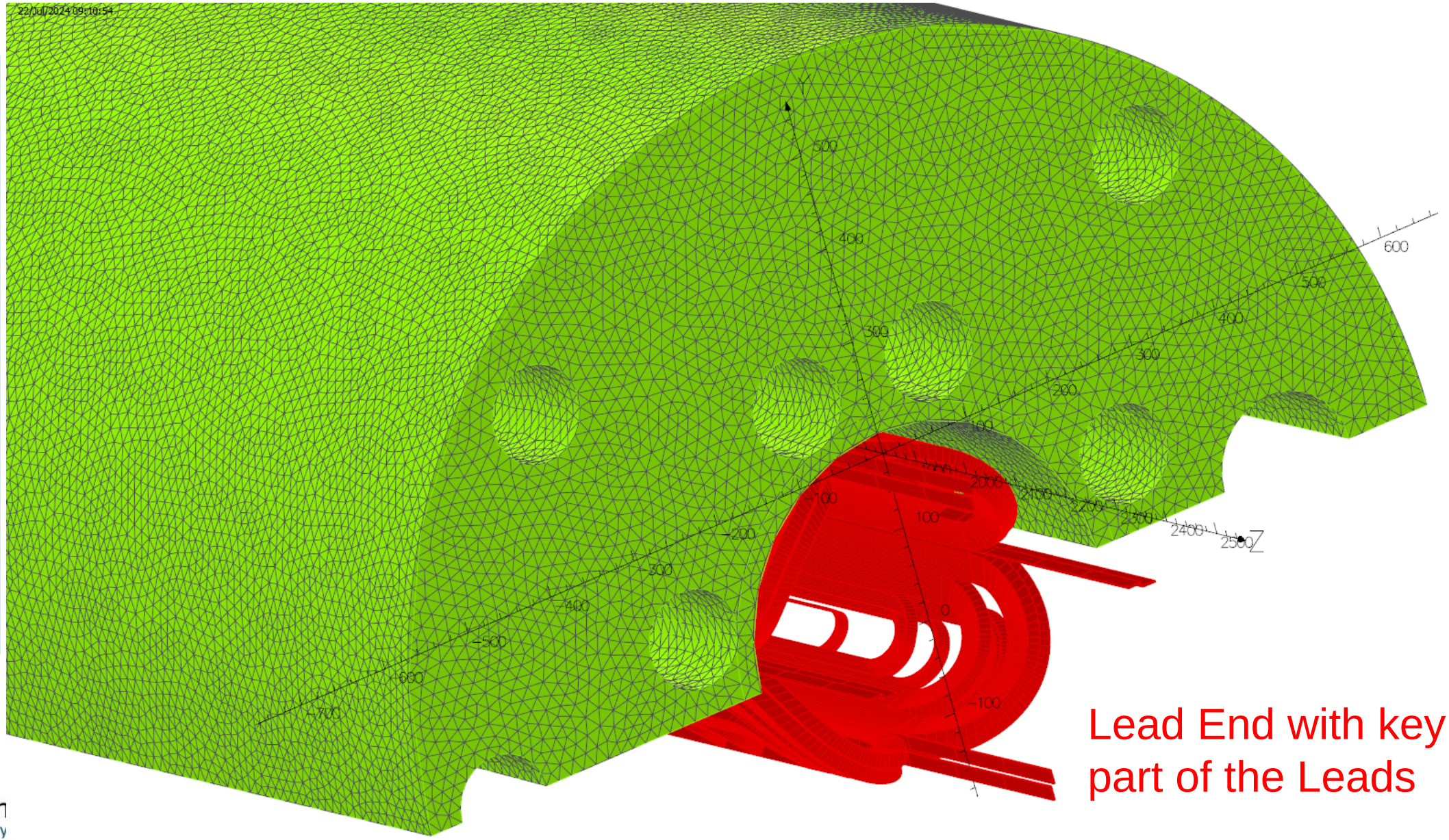
Yoke Mesh Displayed



OPERA3d Model (only ½ yoke displayed for clarity)

Updated yoke with higher mesh density for better accuracy

(takes longer to run)



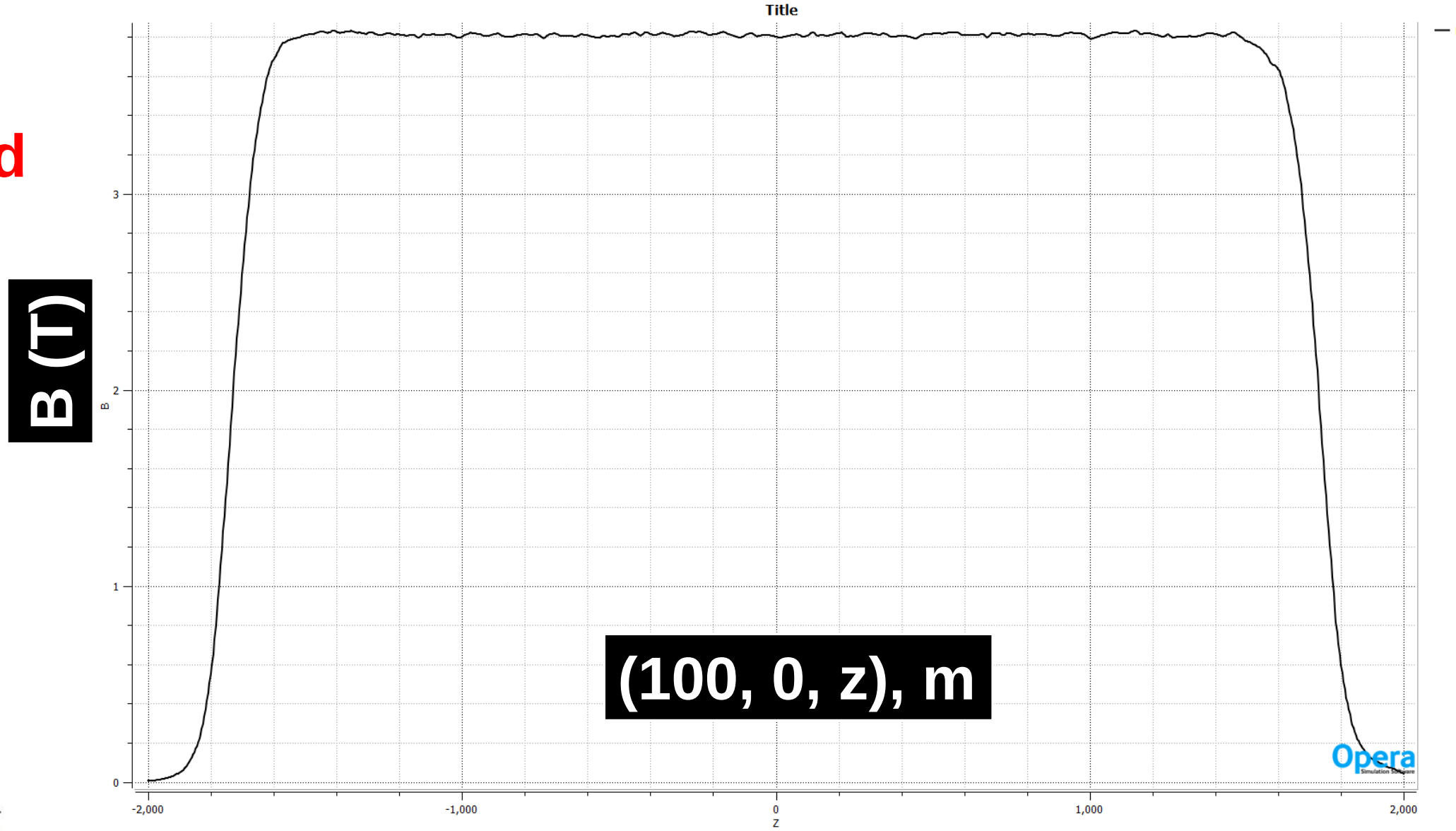
Lead End with key part of the Leads

OPERA3d Model Calculations (Energy & Forces)

- **Gradient at the center at 8.5 kA: ~38 T/m**
- **Stored Energy at 8.5 kA: ~2:6 MJ**
- **Total end forces (axial), per end: 0.8 MN**
- **Total horizontal forces/quadrant: 0.85 MN**

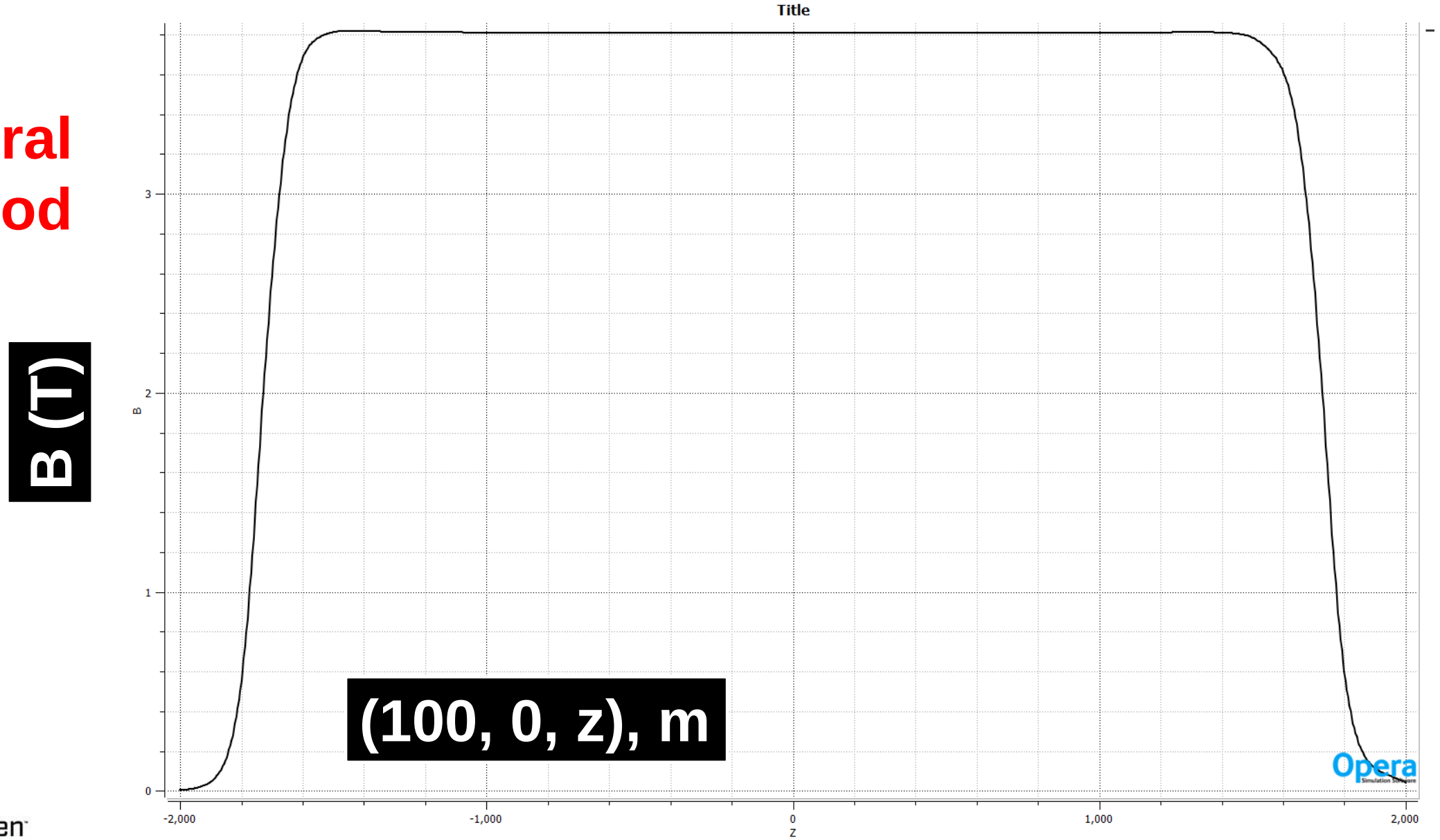
Field along the z-axis (length of the magnet)

Nodal method

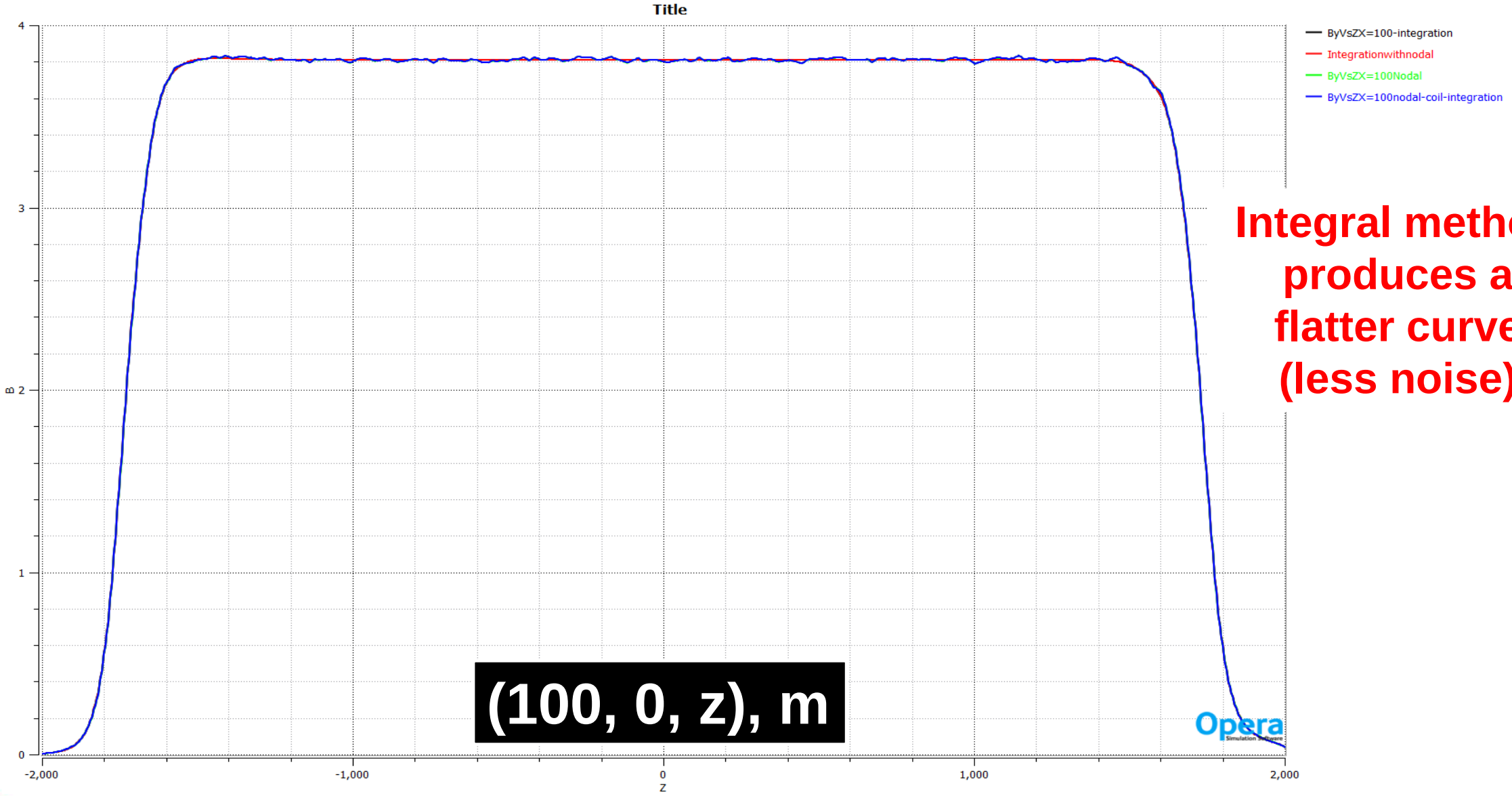


Field along the z-axis (length of the magnet)

Integral method

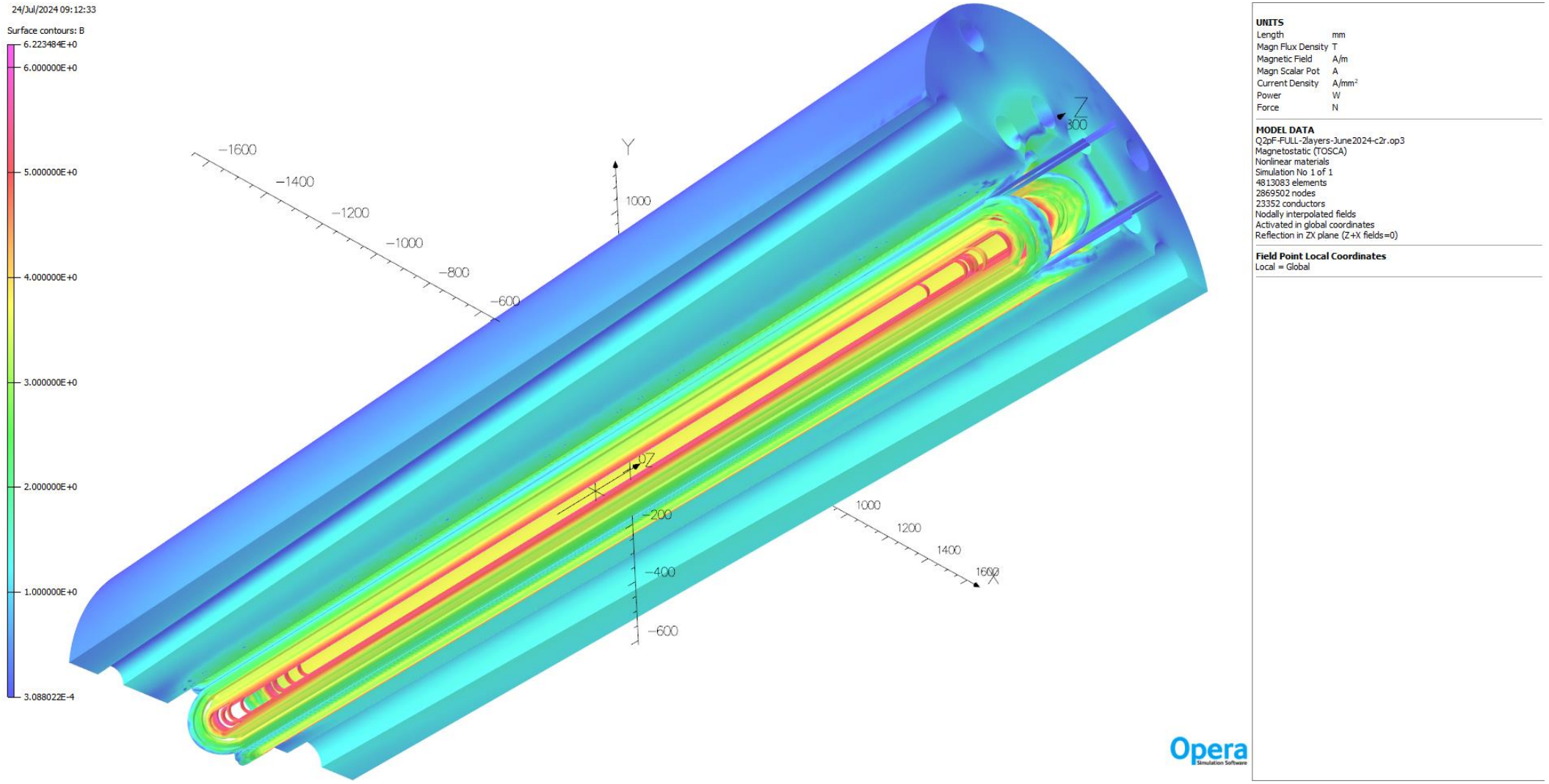


Field along the z-axis (length of the magnet)

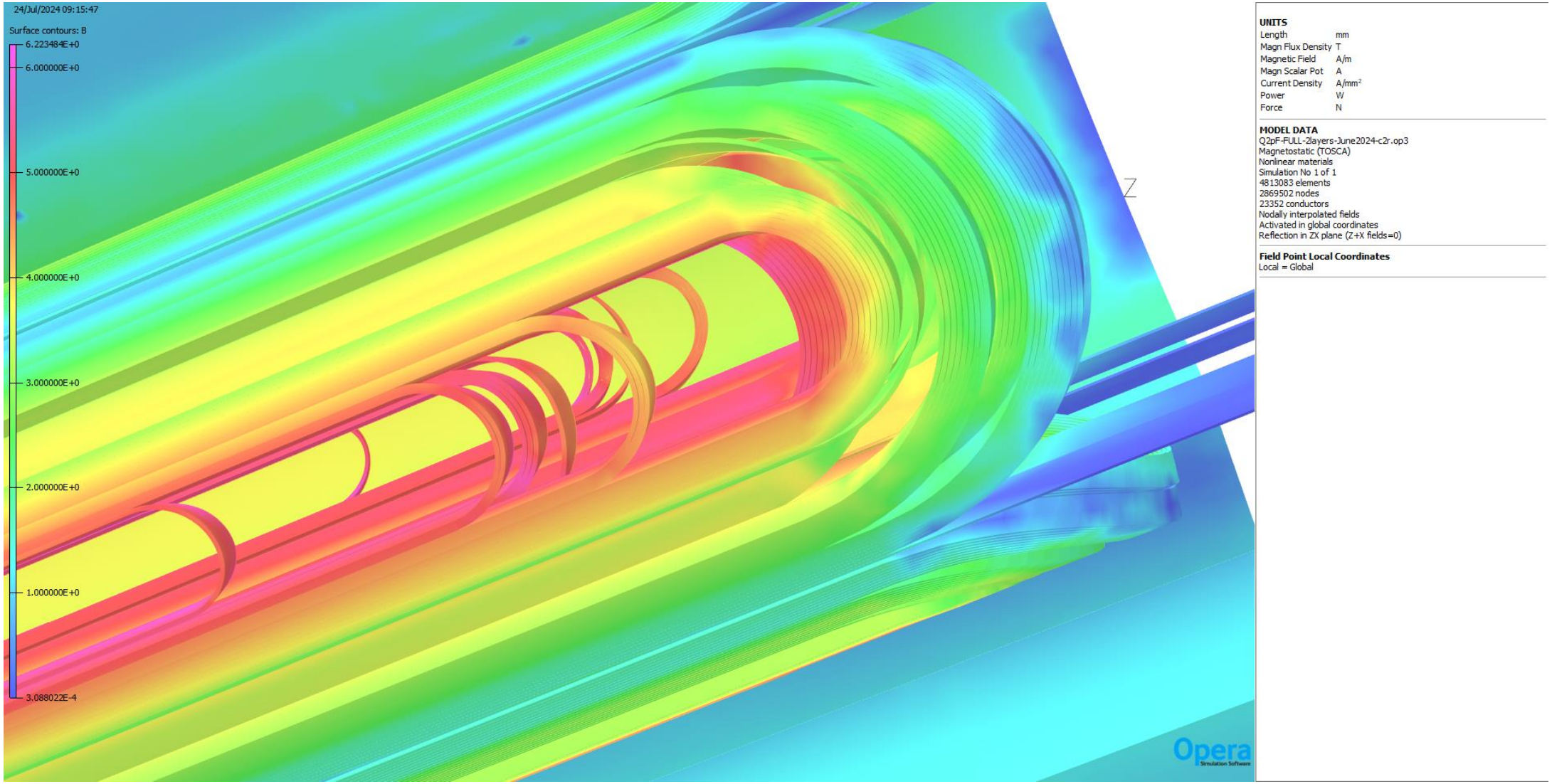


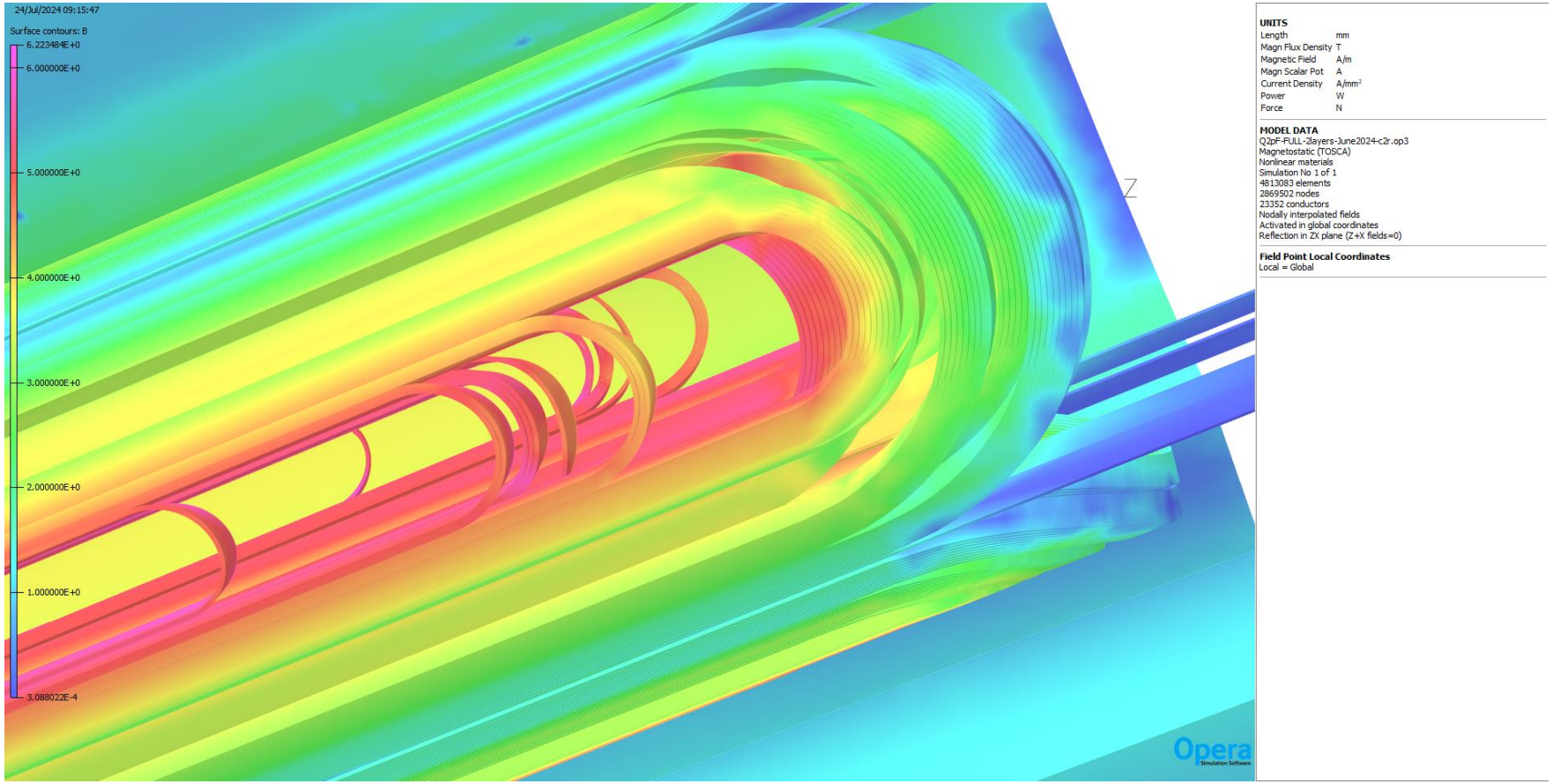
Integral method produces a flatter curve (less noise)

B superimposed over yoke and coil at 8500 A



B superimposed over yoke and coil at 8500 A




24/Jul/2024 09:15:47
Surface contours: B
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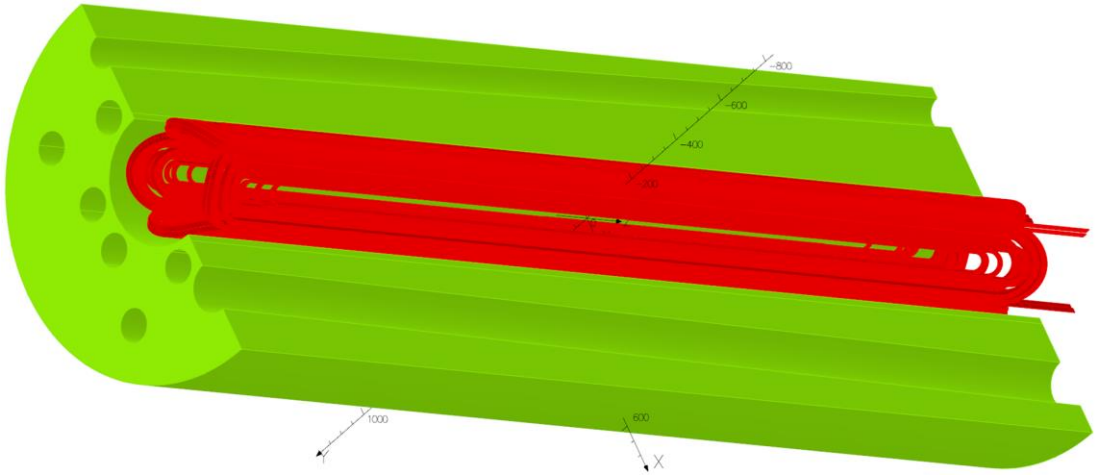
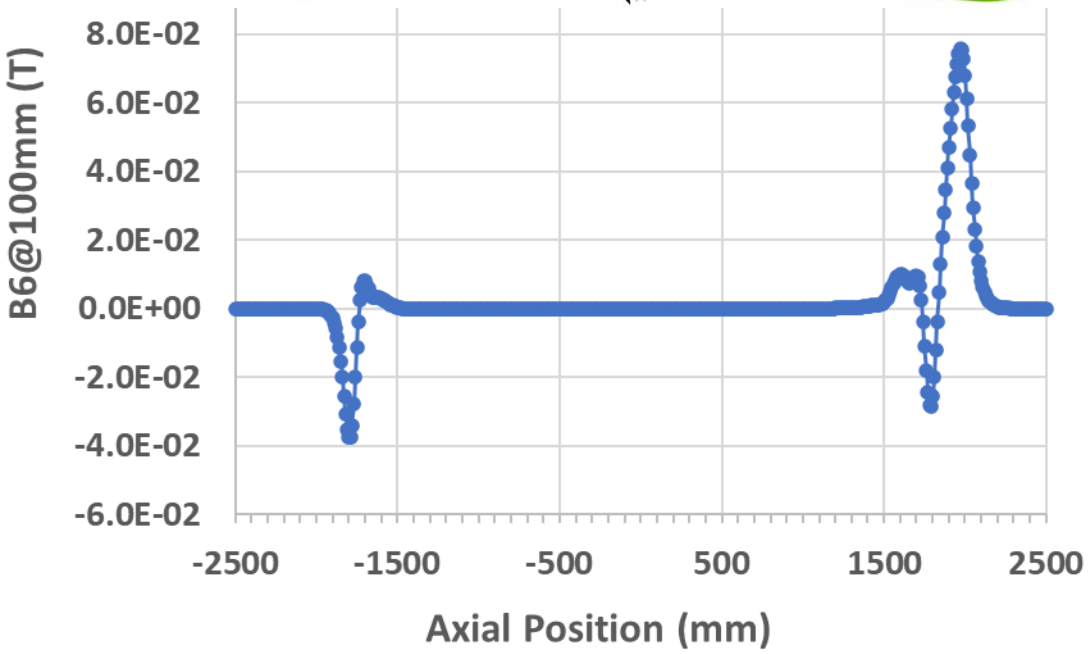
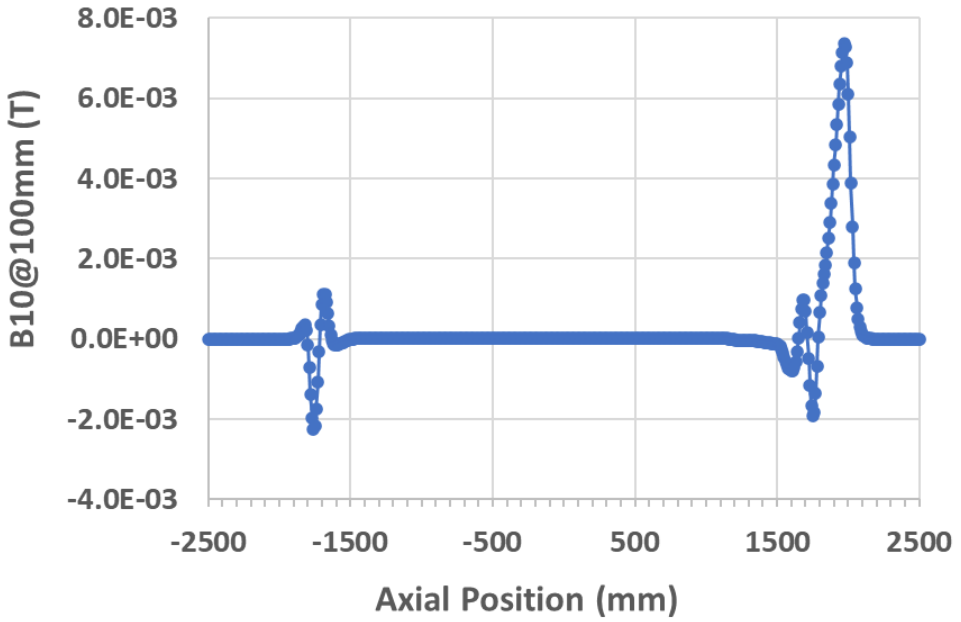
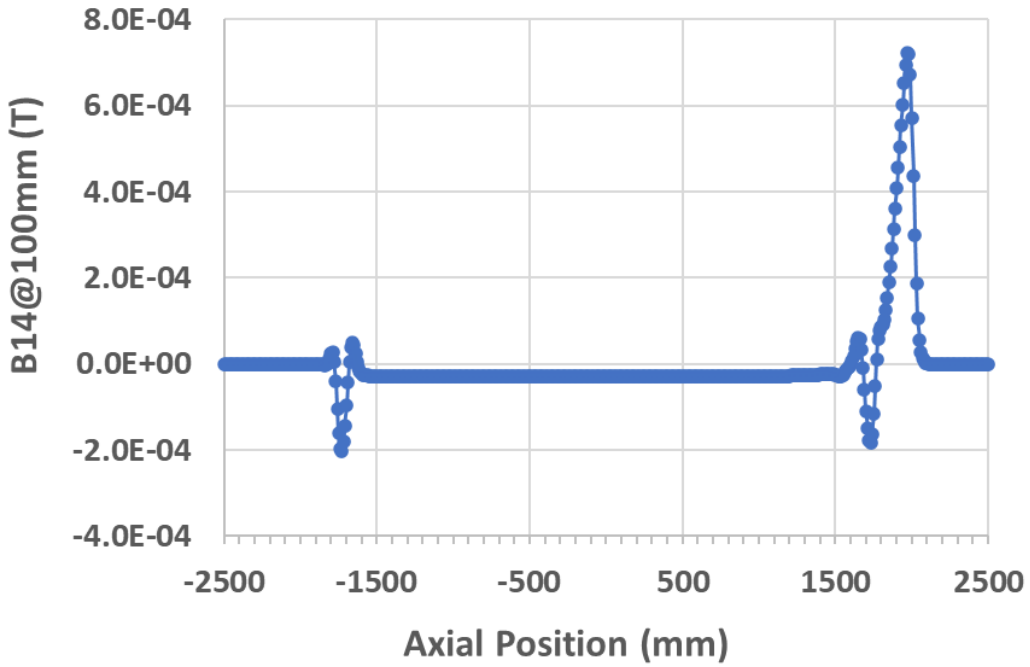
6.000000E+0
5.000000E+0
4.000000E+0
3.000000E+0
2.000000E+0
1.000000E+0
3.088022E-4
Z
UNITS
Length mm
Magn Flux Density T
Magnetic Field A/m
Magn Scalar Pot A
Current Density A/mm²
Power W
Force N
MODEL DATA
Q2pF-FULL-2layers-June2024-c2r.op3
Magnetostatic (TOSCA)
Nonlinear materials
Simulation No 1 of 1
4813083 elements
2869502 nodes
23352 conductors
Nodally interpolated fields
Activated in global coordinates
Reflection in ZX plane (Z+X fields=0)
Field Point Local Coordinates
Local = Global
Opera

Axial Variation of Harmonics (1)



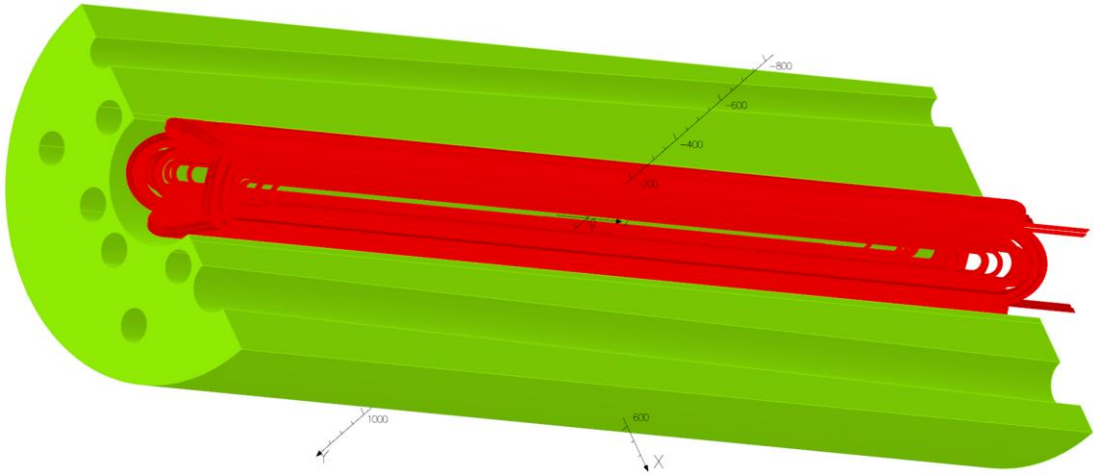


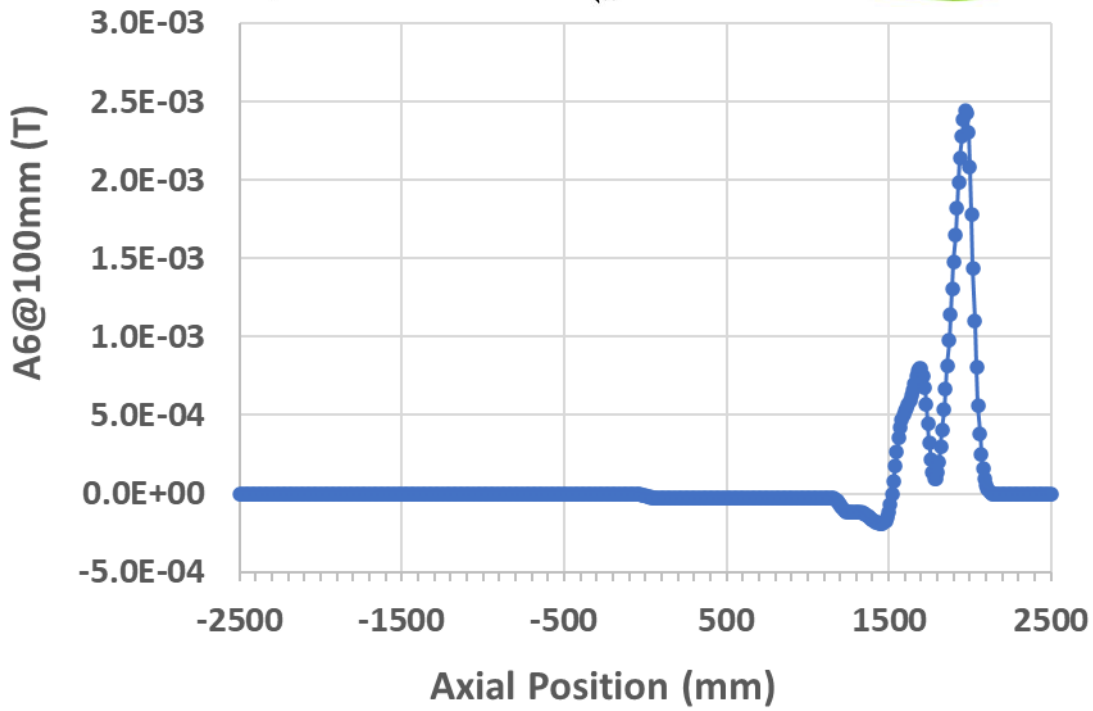


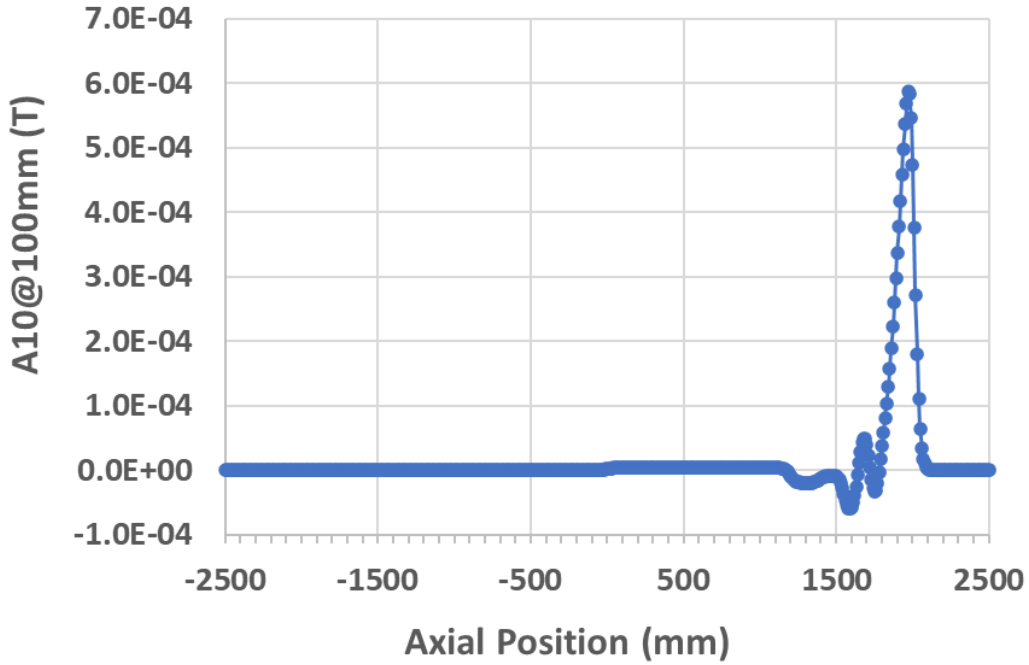


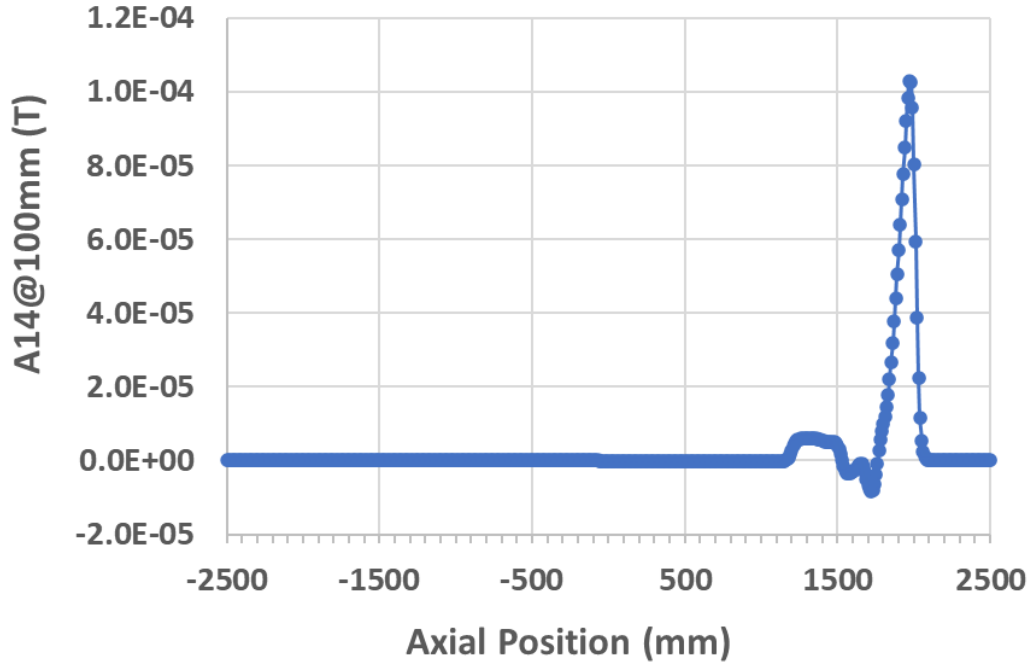
Extra harmonics due to leads (needs to be corrected)

Axial Variation of Harmonics (2)









Skew harmonics in Lead ends