Design of Q1BpF with Q1eF for 4K Operation

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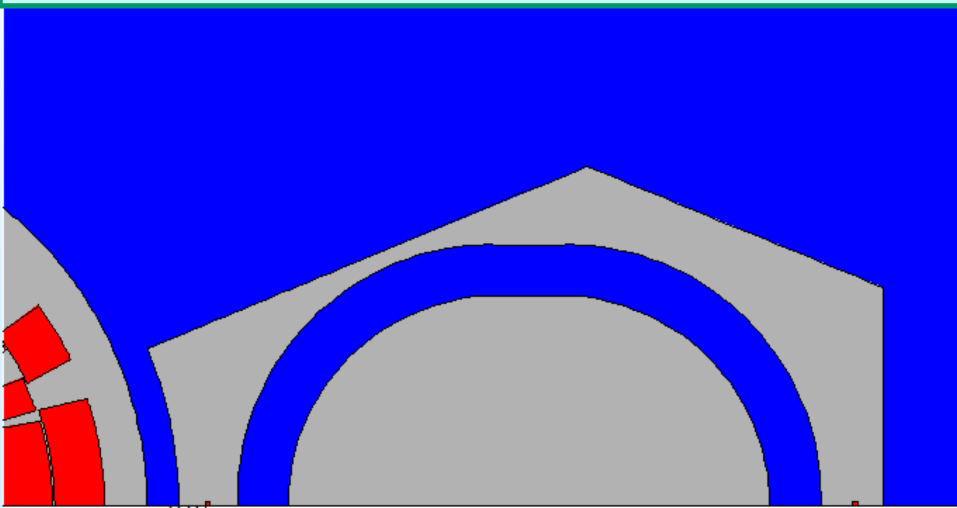
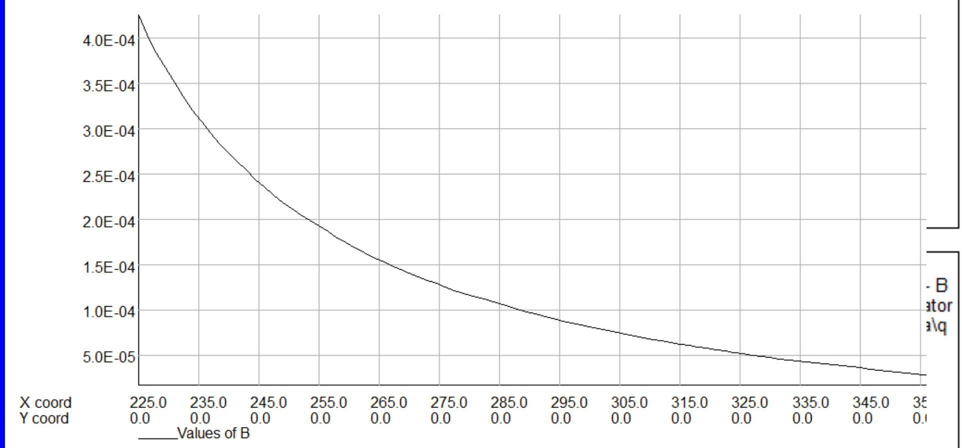
Overview

- Goal: Check and optimize the design of Q1BpF with Q1eF to allow 4K operation
- Earlier we found a solution for Q2BpF 4 K operation without the introduction of Q1eF
- The addition of Q1eF may force yoke at the critical place more into saturation, possibly generating cross-talk induced errors between Q2BpF and Q1eF
- Several cases examined; only one each of above will be presented
- Next task?

Shielding Solution that Worked in Q1BpF (in the absence of Q1eF)

Path of flux lines navigated with cutout in yoke and small coils on the two side of yoke over e-beam region added to further navigate flux lines (and reduce saturation) to significantly reduce field in the e-beam region

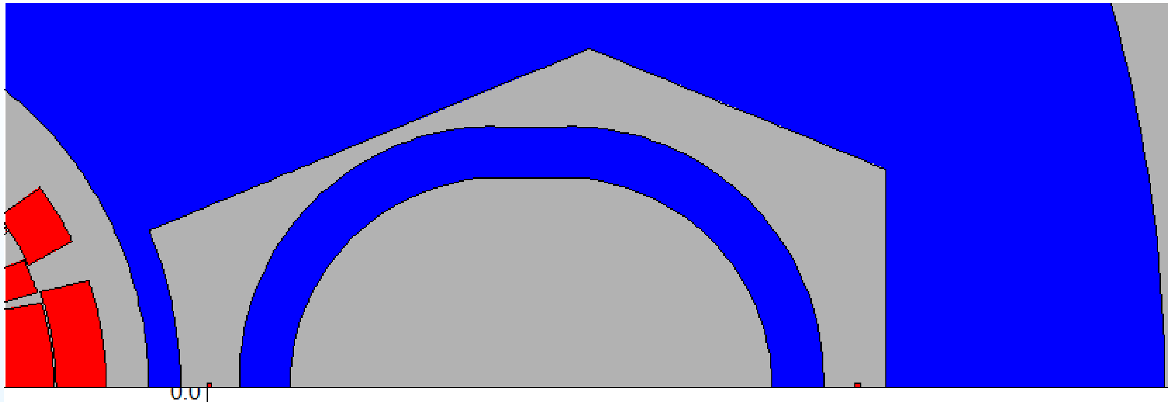




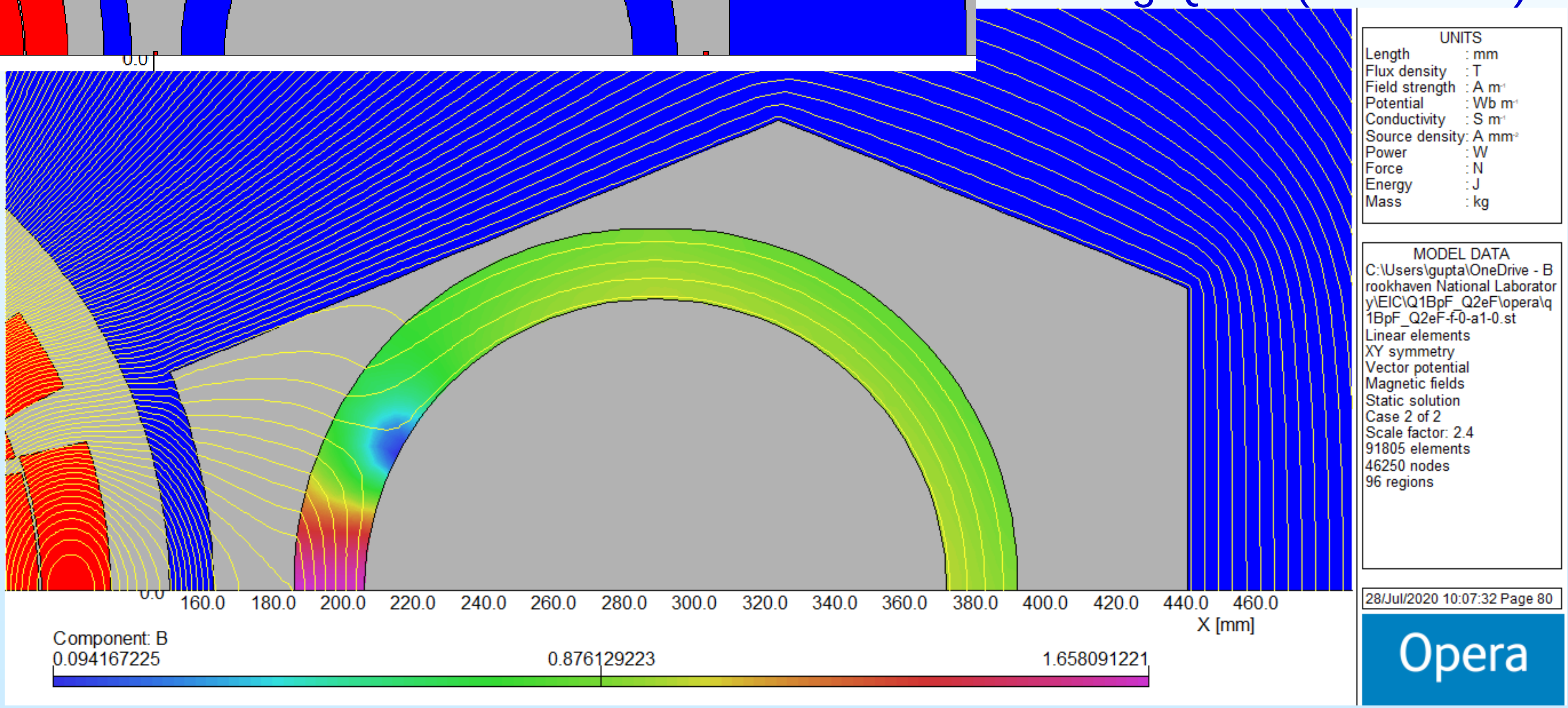
Hole@ x = 288.3 mm to 312.5 mm (with flat-top)

Radius of hole = 83 mm (63 mm for electron beam)

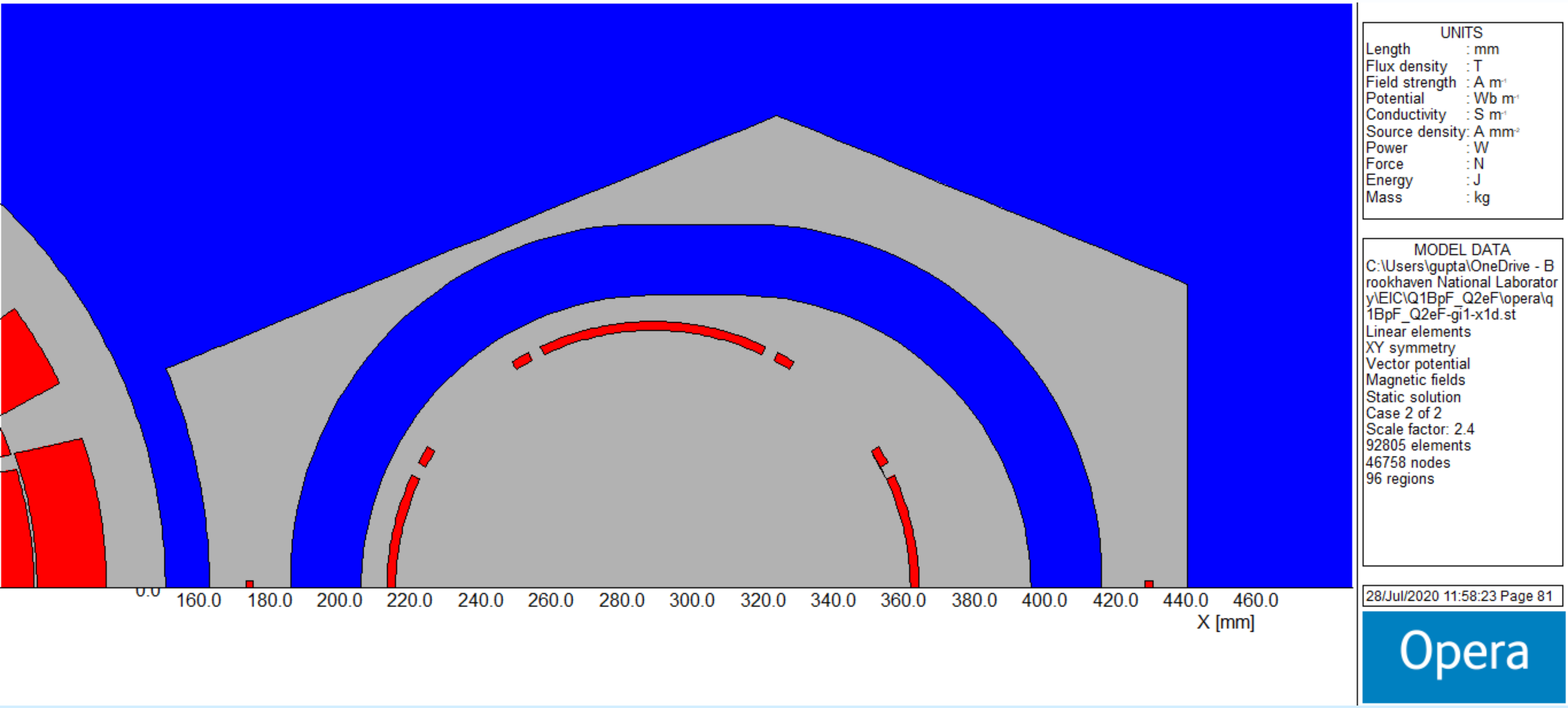
Q1BpF with Q1eF (need to remove flat-top)



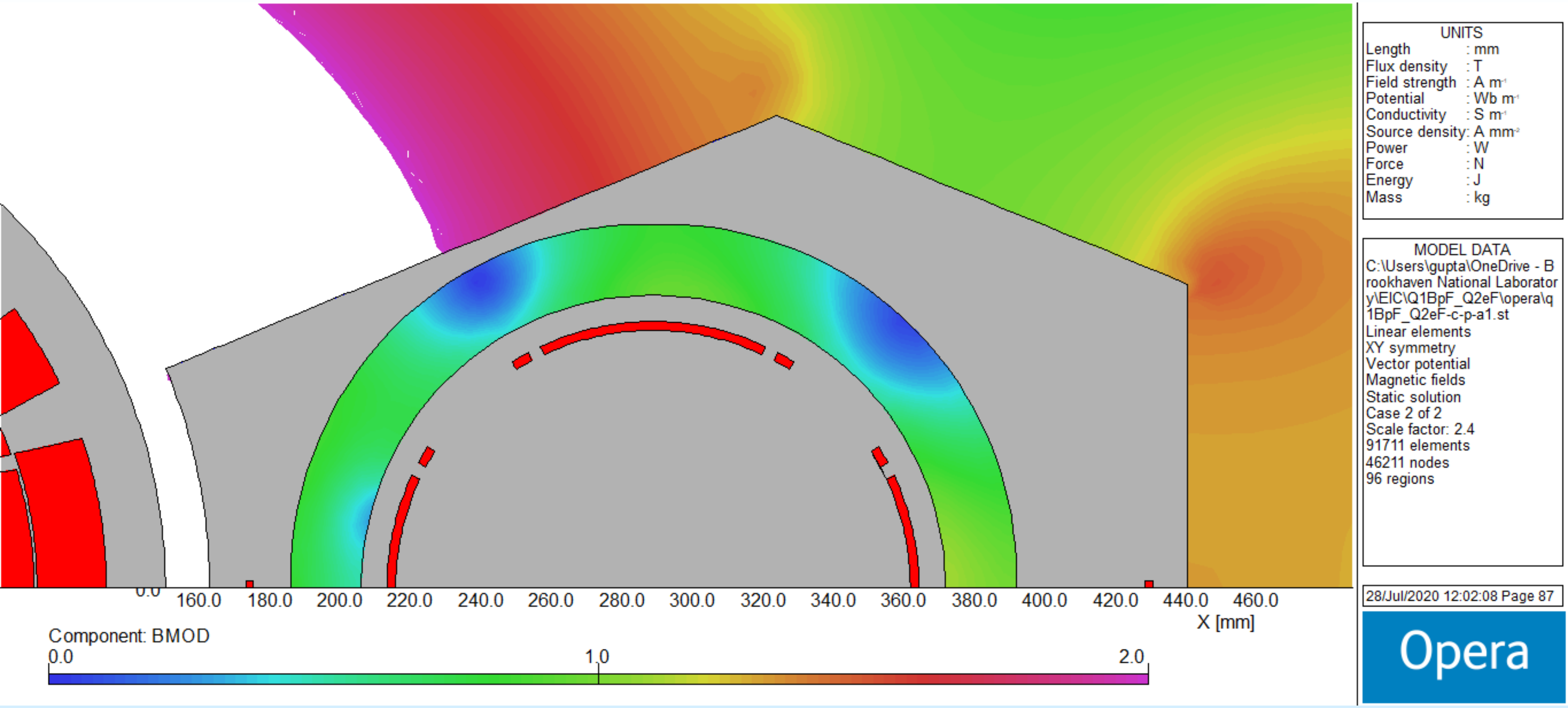
Flat-top creates non-allowed harmonics and takes away iron from the return yoke. therefore, it is removed for inserting Q1eF (see below)



Q1BpF (Q1eF in flat-top yoke NOT GOOD)

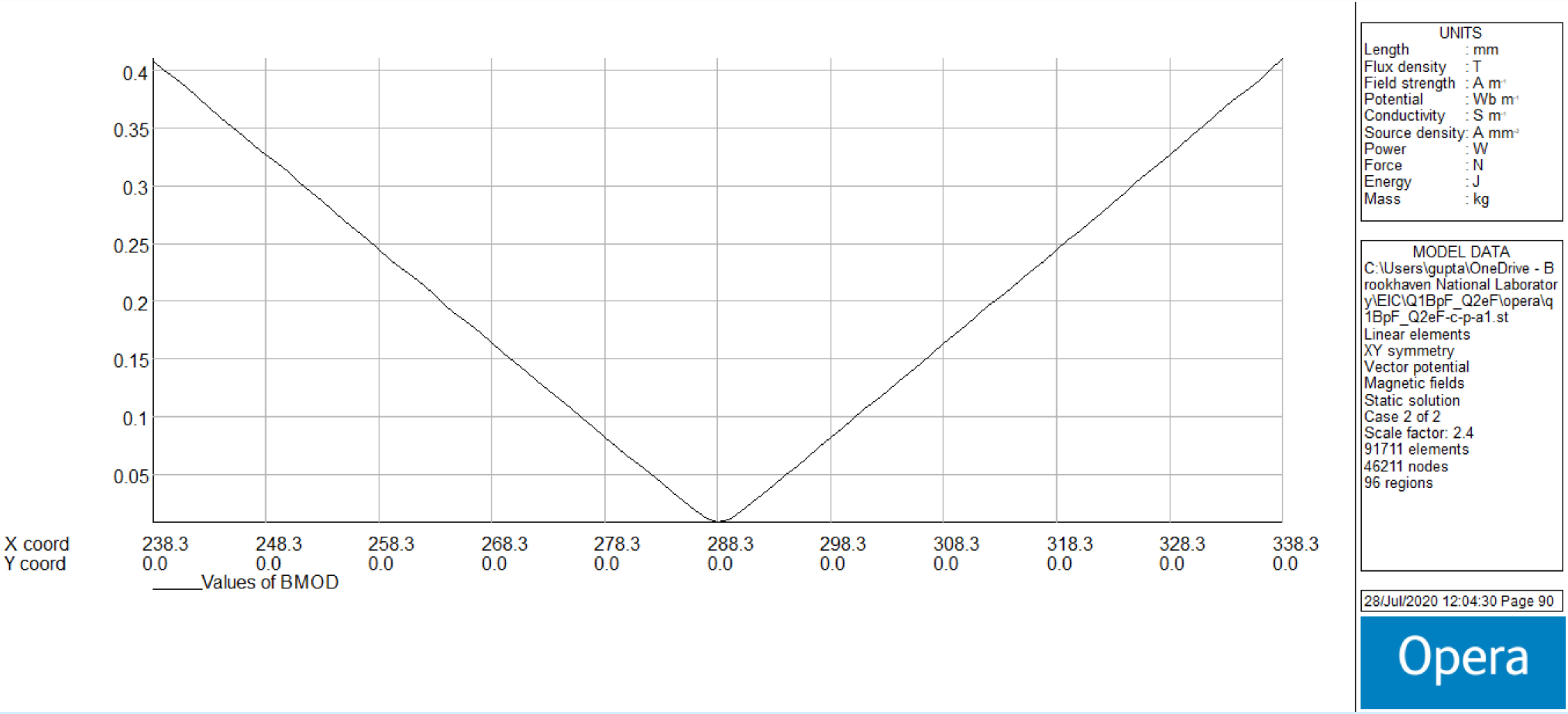


Q1BpF (Q1eF with one polarity)



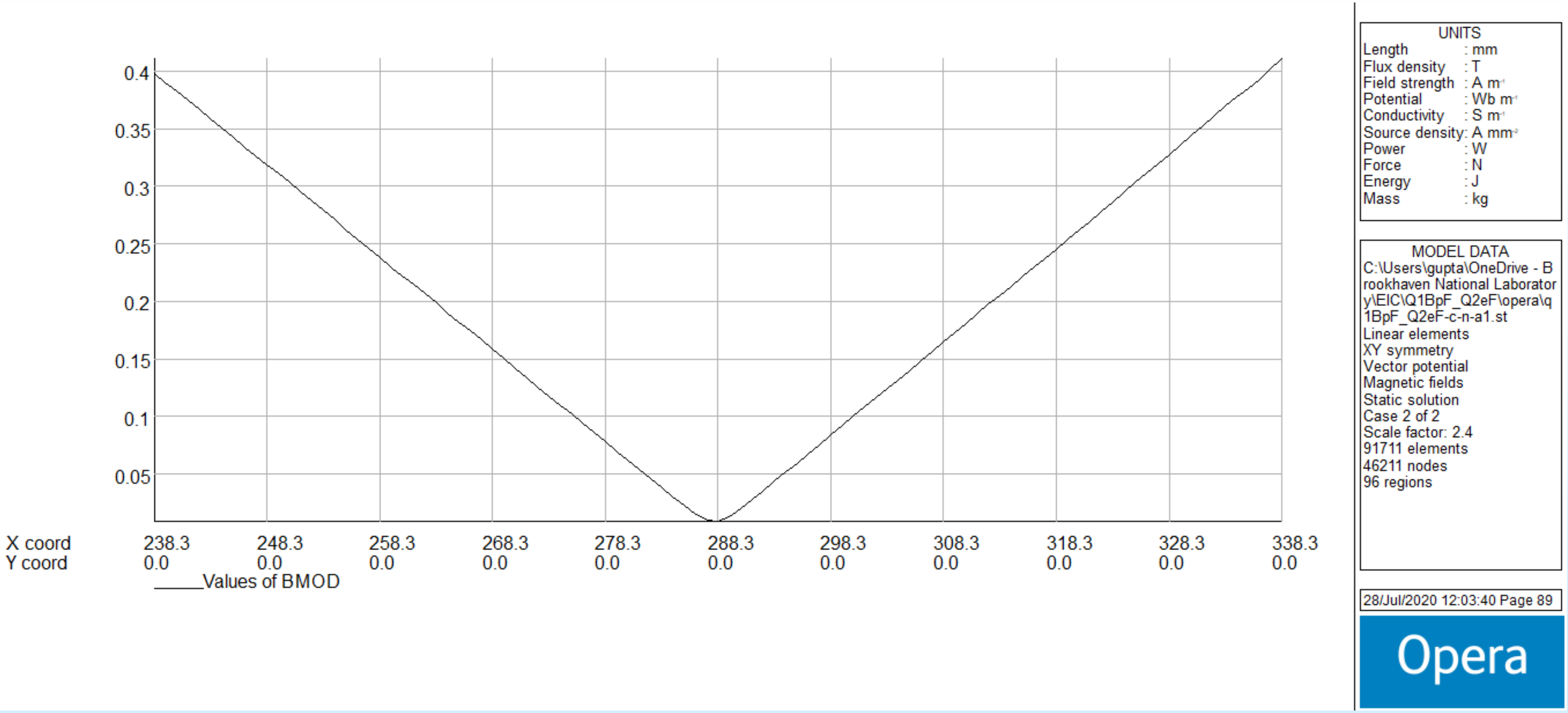
Looks good as iron providing the shielding is not saturated

Q1BpF (Q1eF with one polarity)



Looks good as gradient is symmetric around the center of Q1eF (x=288.3)

Q1BpF (Q1eF with opposite polarity)



Does NOT looks good as gradient is not symmetric around the center of Q1eF

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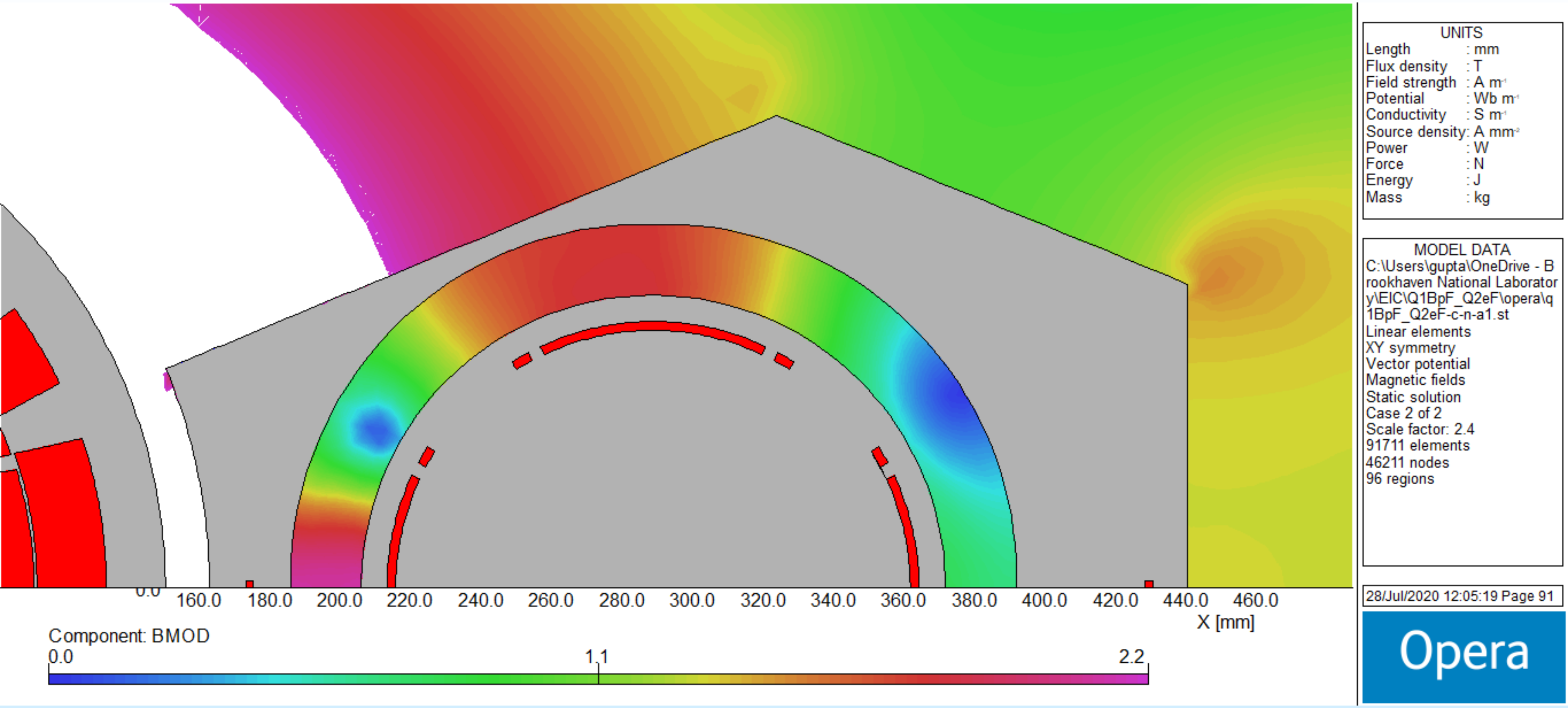
Q1BpF (Q1eF with opposite polarity)

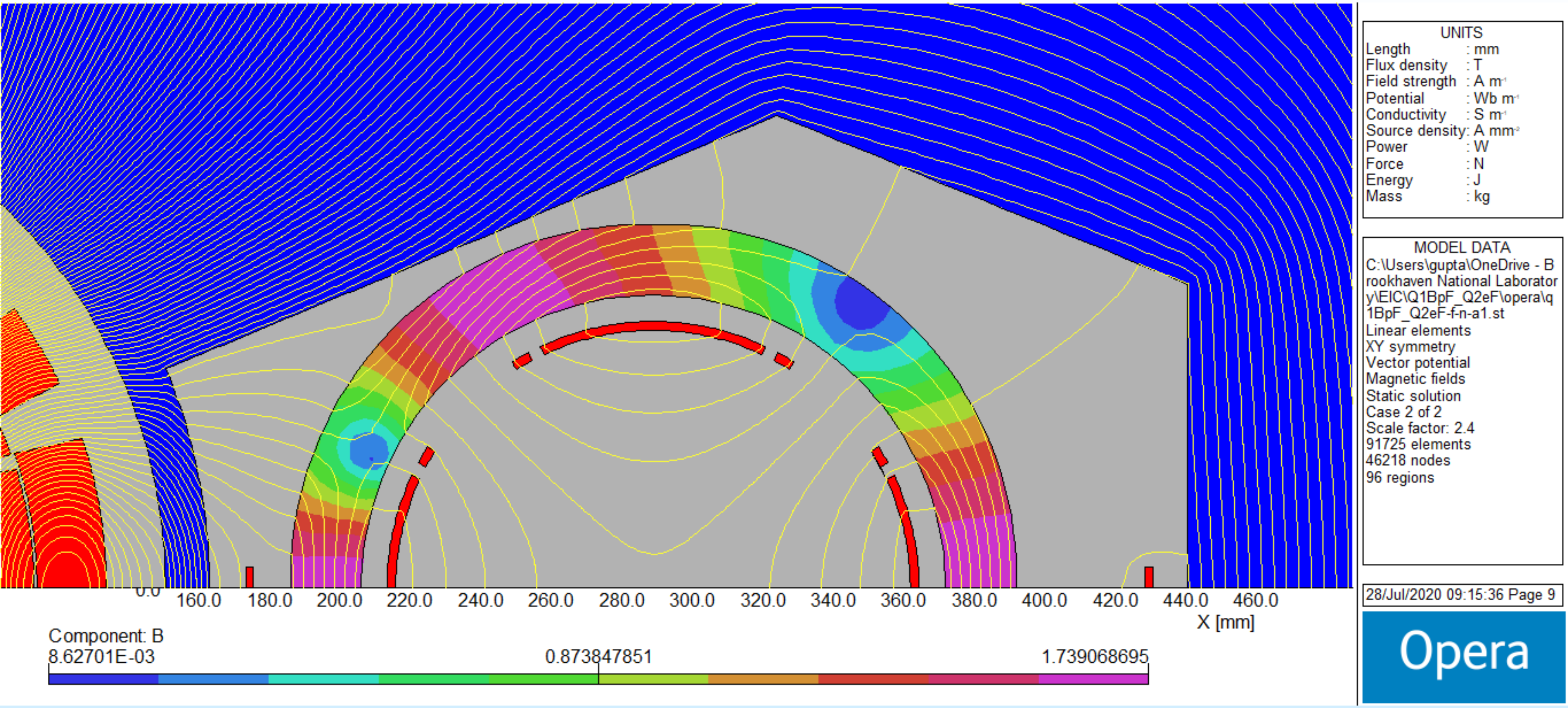


Does not look good as the iron providing the shielding is highly saturated on one side (>2T)

Solution

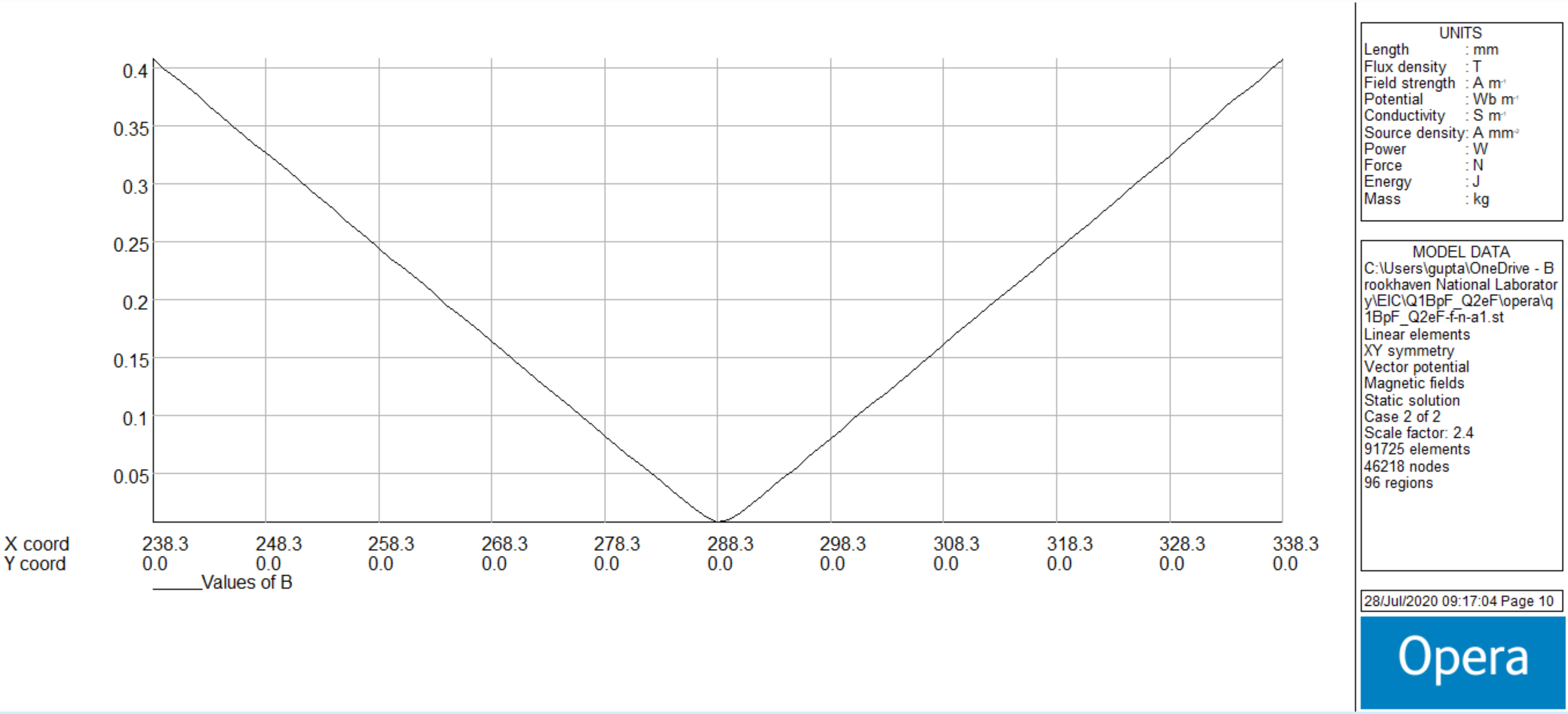
Use the technique that we recently invented (strengthen the coils around the iron to reduce saturation)

Q1BpF (Q1eF with opposite polarity AND stronger control coils)



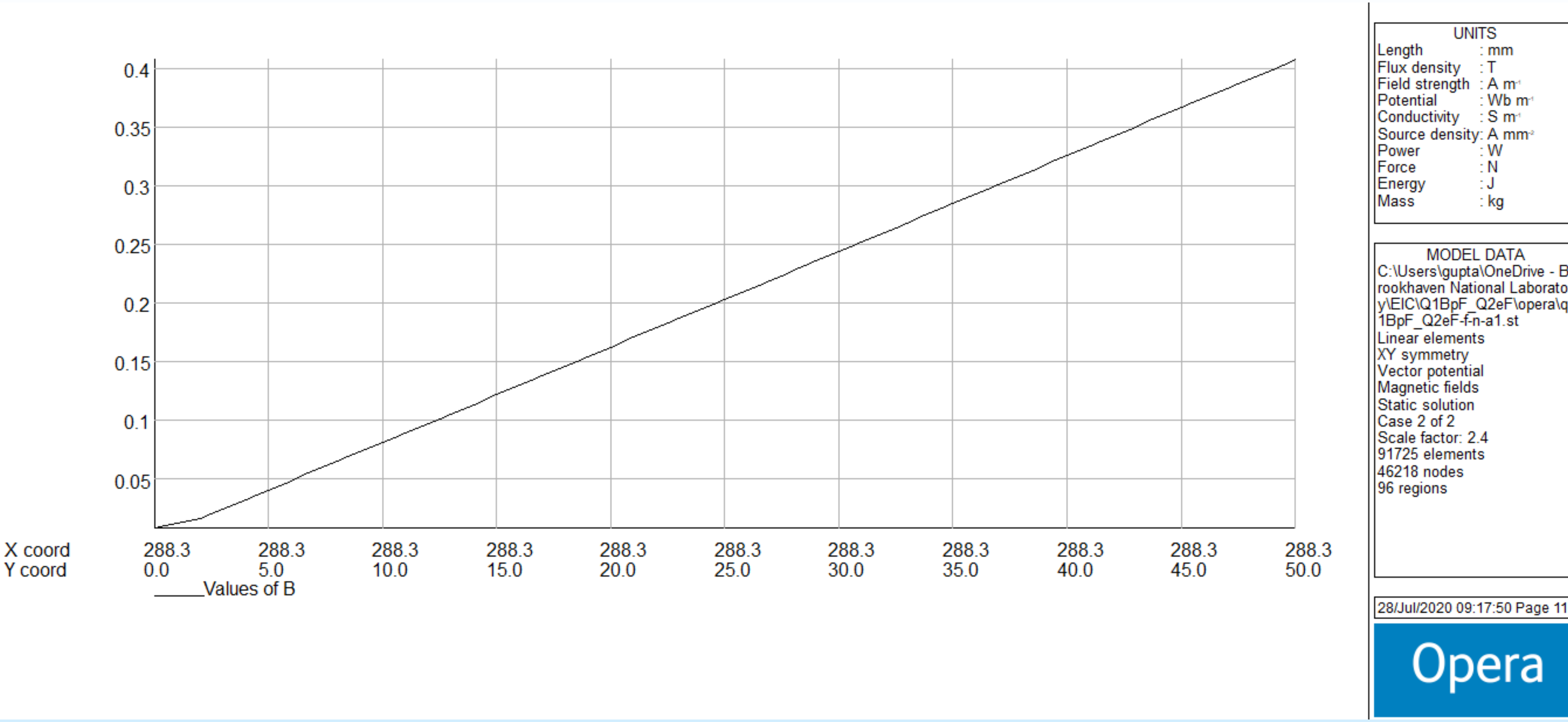
Looks better as the iron providing the shielding is less saturated (1.7 T rather than over 2 T)

Q1BpF (Q1eF with opposite polarity AND stronger control coils)



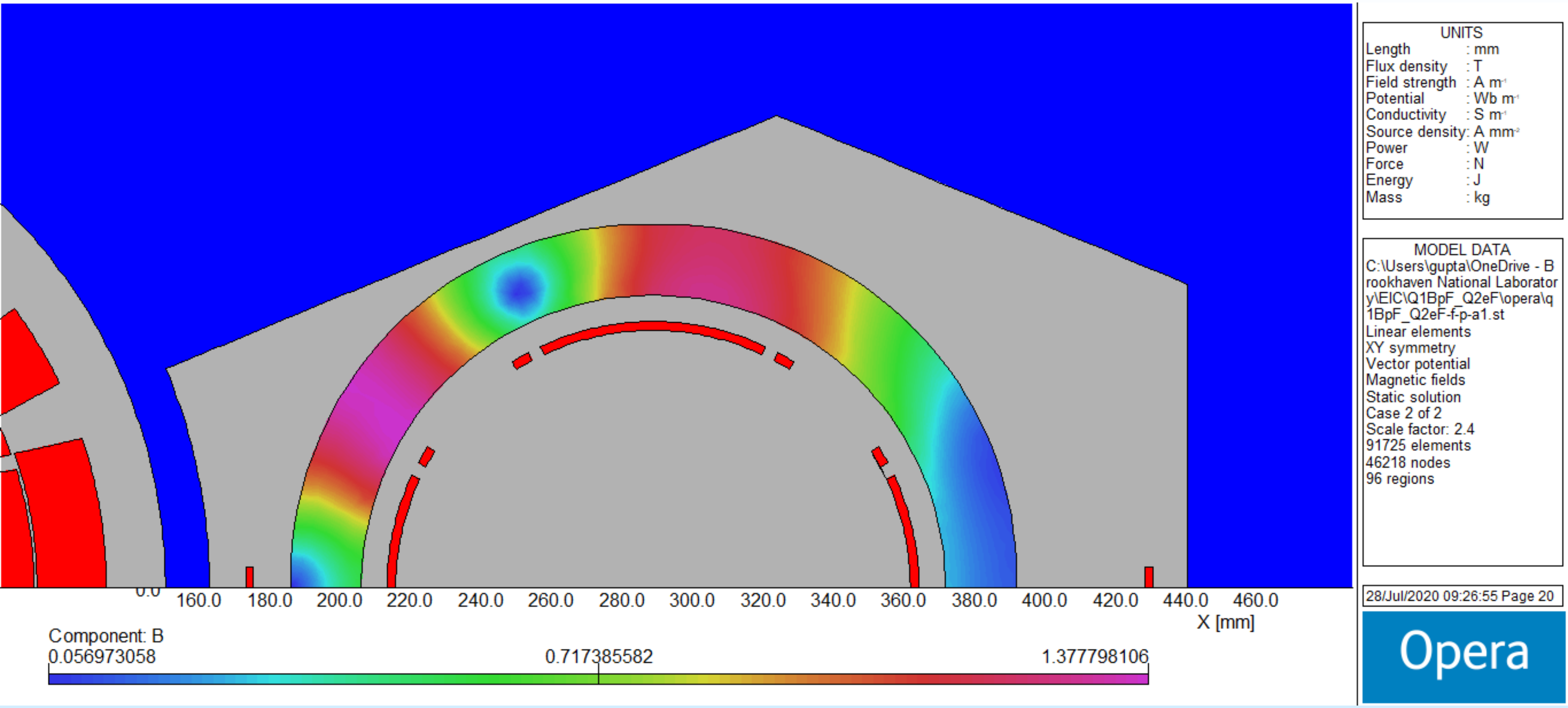
Still looks good as gradient is symmetric around the center of Q1eF (x=288.3)

Q1BpF (Q1eF with opposite polarity AND stronger control coils)



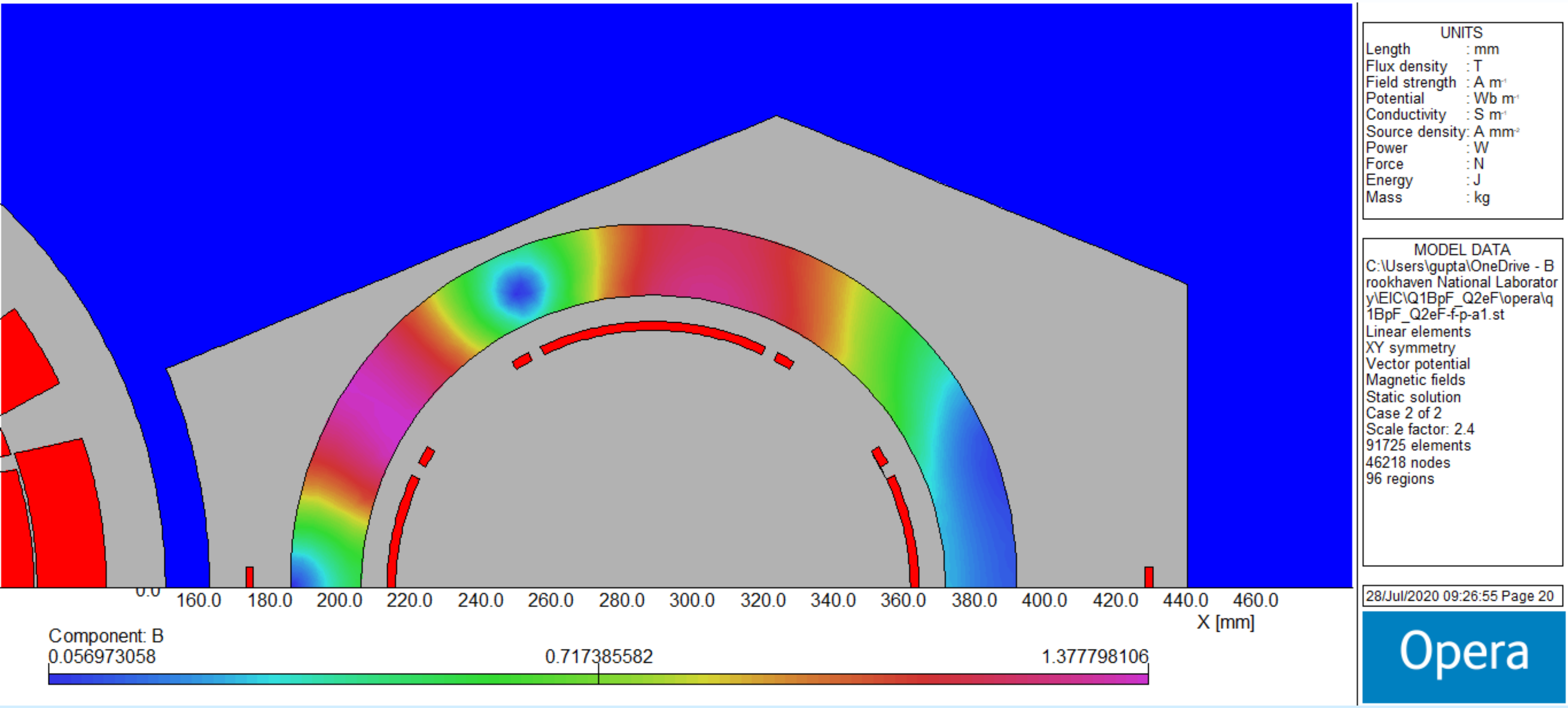
Field (gradient) on vertical axis looks good as well around the center of Q1eF (x=288.3)

Q1BpF (Q1eF with good polarity AND stronger control coils)

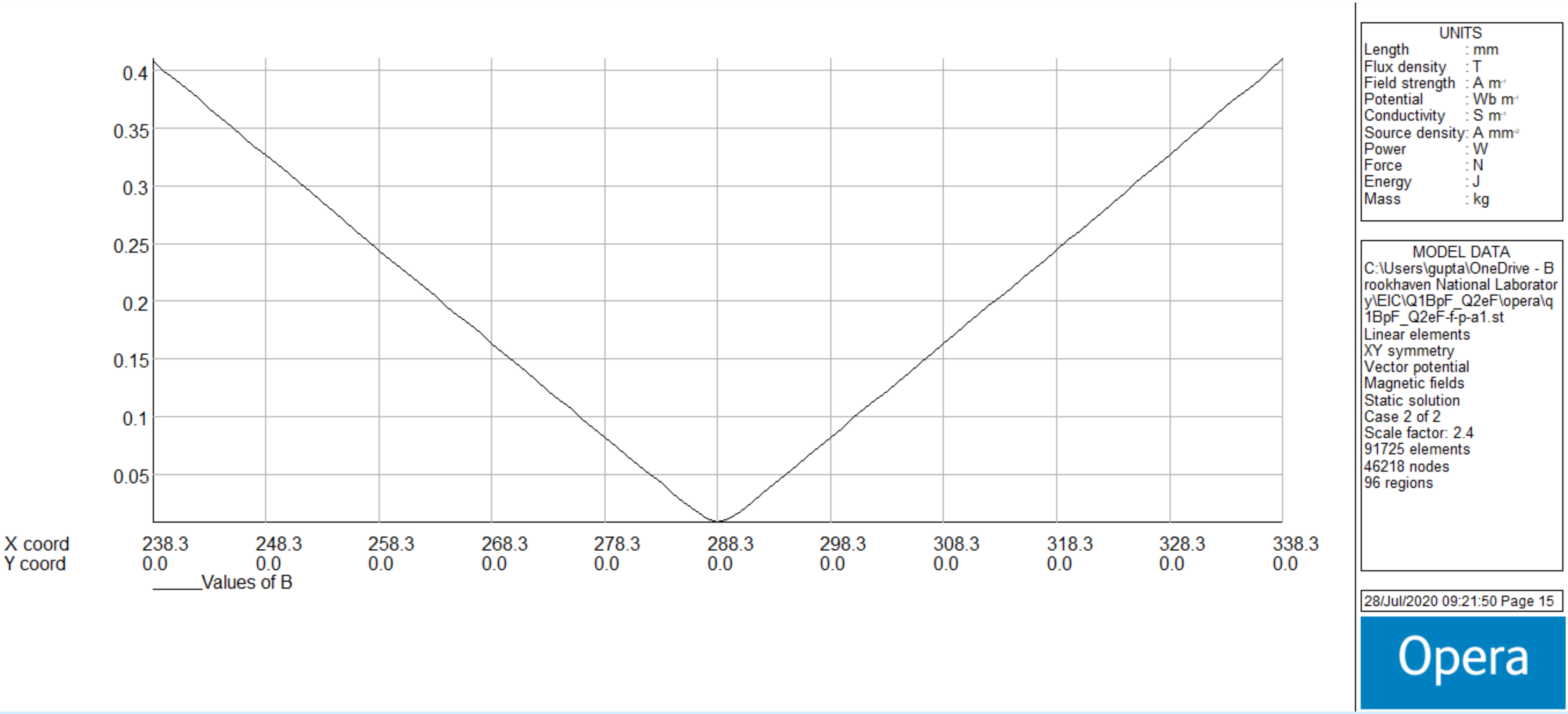


Looks good as the iron providing the shielding is less saturated (1.3 T)

Q1BpF (Q1eF with good polarity AND stronger control coils)

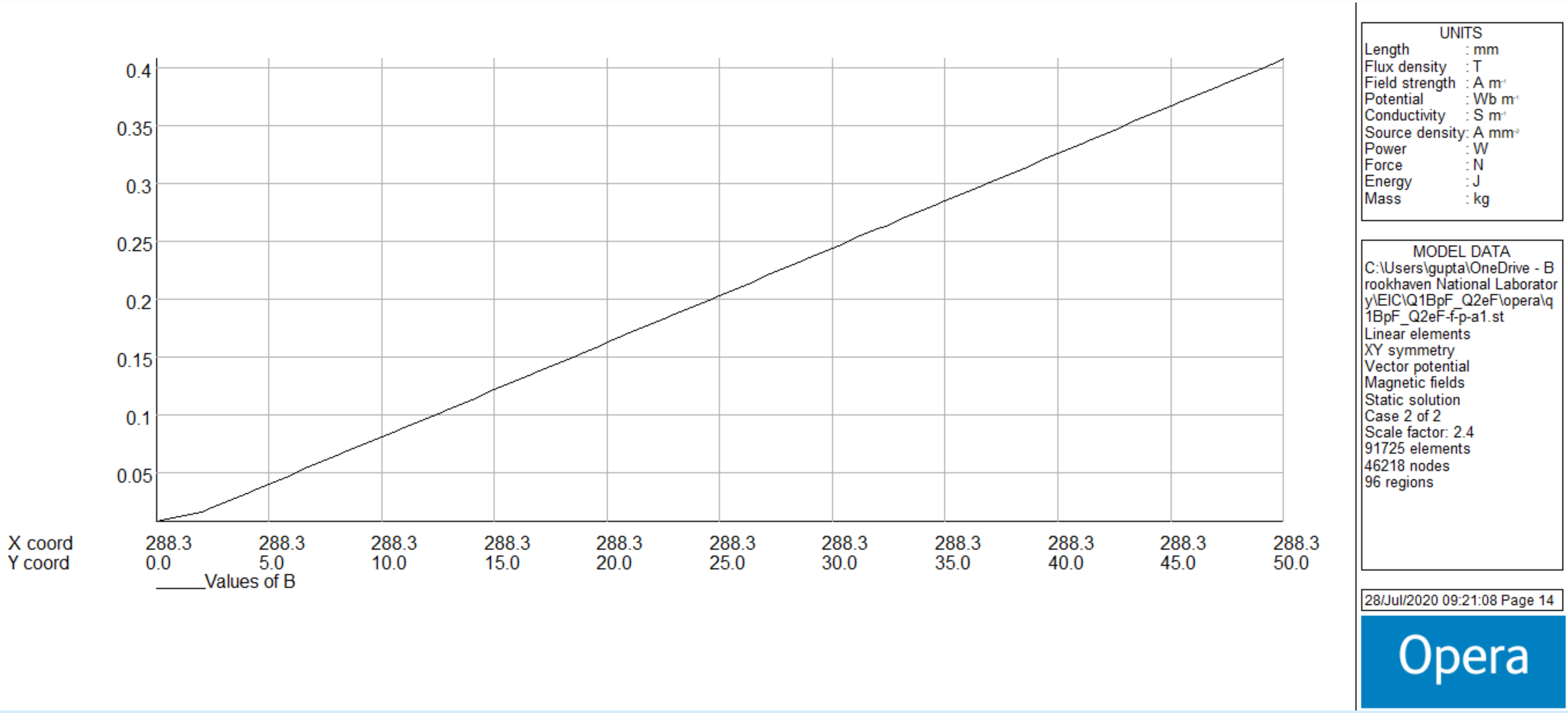


Q1BpF (Q1eF with good polarity AND stronger control coils)



Field (gradient) on vertical axis looks good as well around the center of Q1eF (x=288.3)

Q1BpF (Q1eF with good polarity AND stronger control coils)



Field (gradient) on vertical axis looks good as well around the center of Q1eF (x=288.3)

Discussion and Conclusions

- More detail analysis and further optimization needs to be performed; however, it appears that we have a solution.
- We are still good for 4 K operation
- Next task?
  - 3d-design of above magnets?
  - Examine other magnets?