Optimization of Dipole Ends and Three Pole Wiggler Position

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Topics Covered

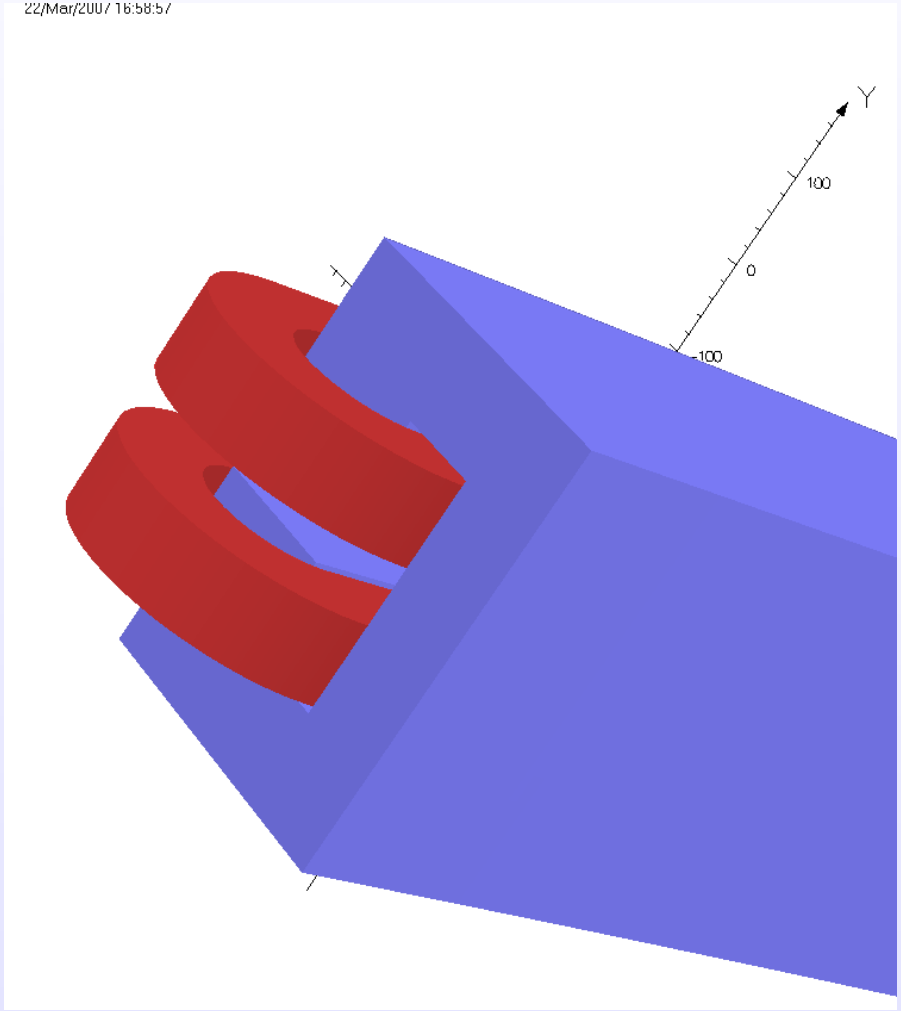
- **Development of efficient dipole ends**
  - **Make ends disappear**
    - **at least in terms of the coil ends consuming the valuable real estate**
- **Combined 3-d modeling of dipole and three pole wiggler**
- **Reduce space between magnetic elements**
  - **Bring 3-pole wiggler as close to dipole as possible**

Most real estate deductions are beneficial – ask your tax advisor.

Development of Efficient Dipole Ends

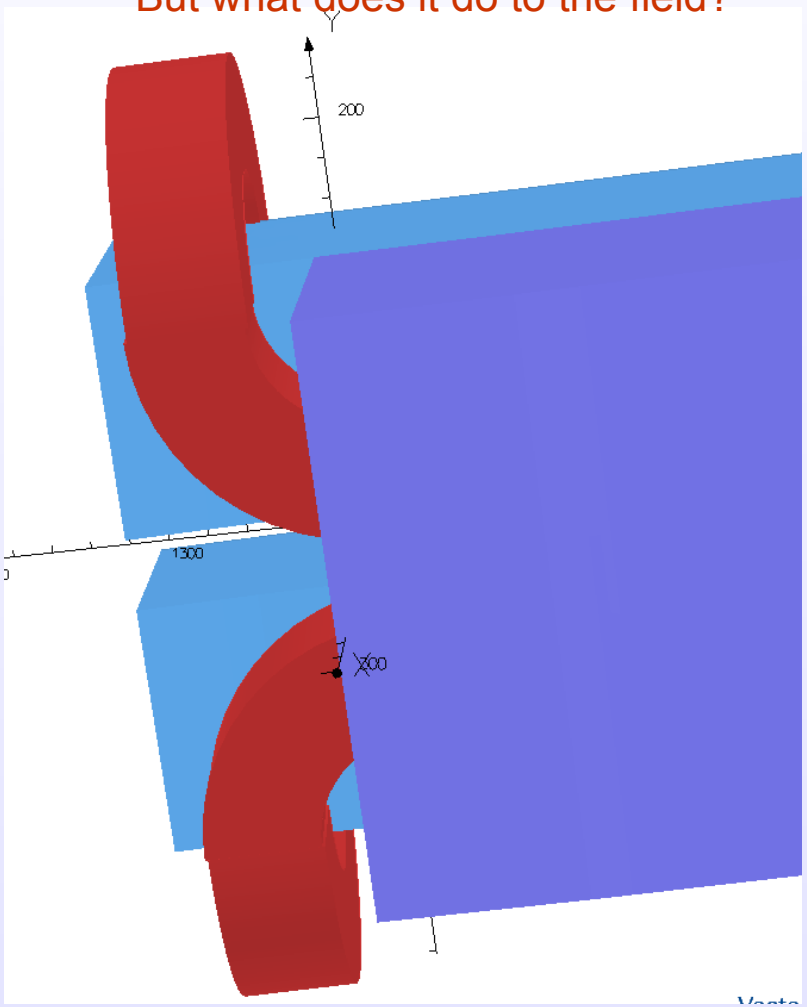
In iron dominated magnet, the field is defined by yoke.

But, these coil ends still take space.

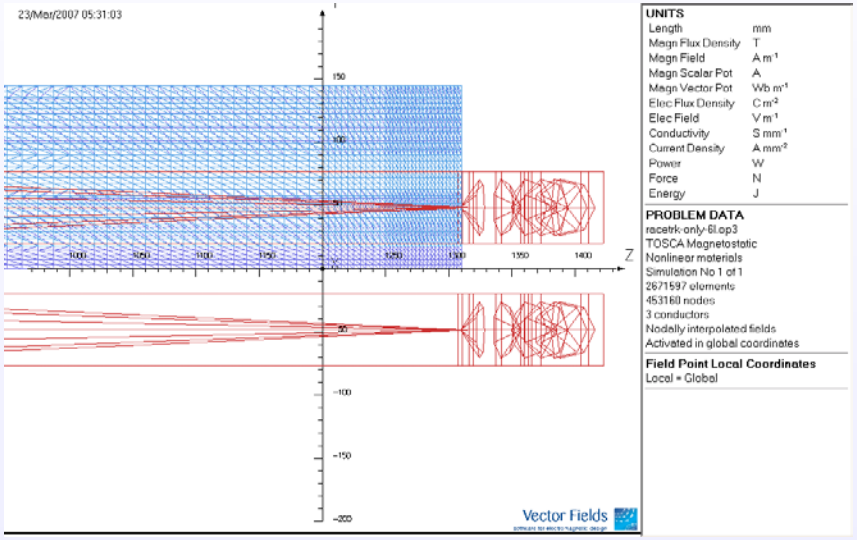


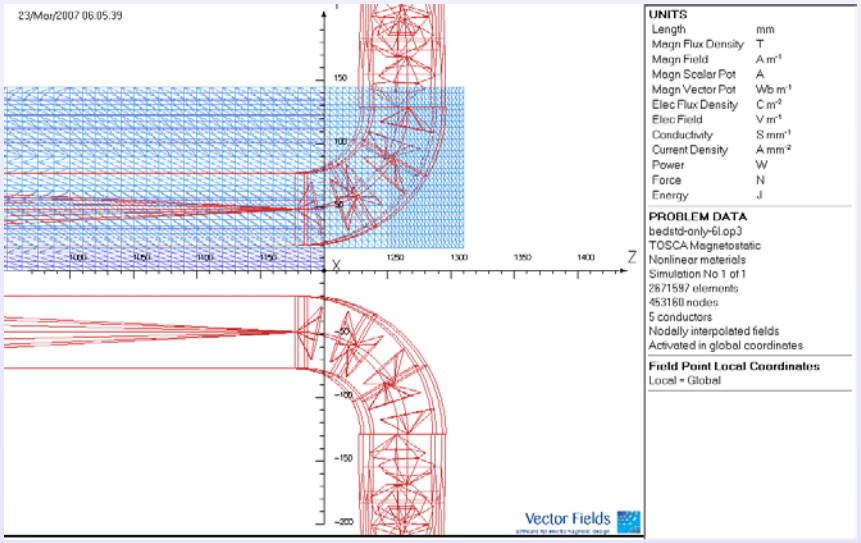
So release space by moving coil ends out of the way.

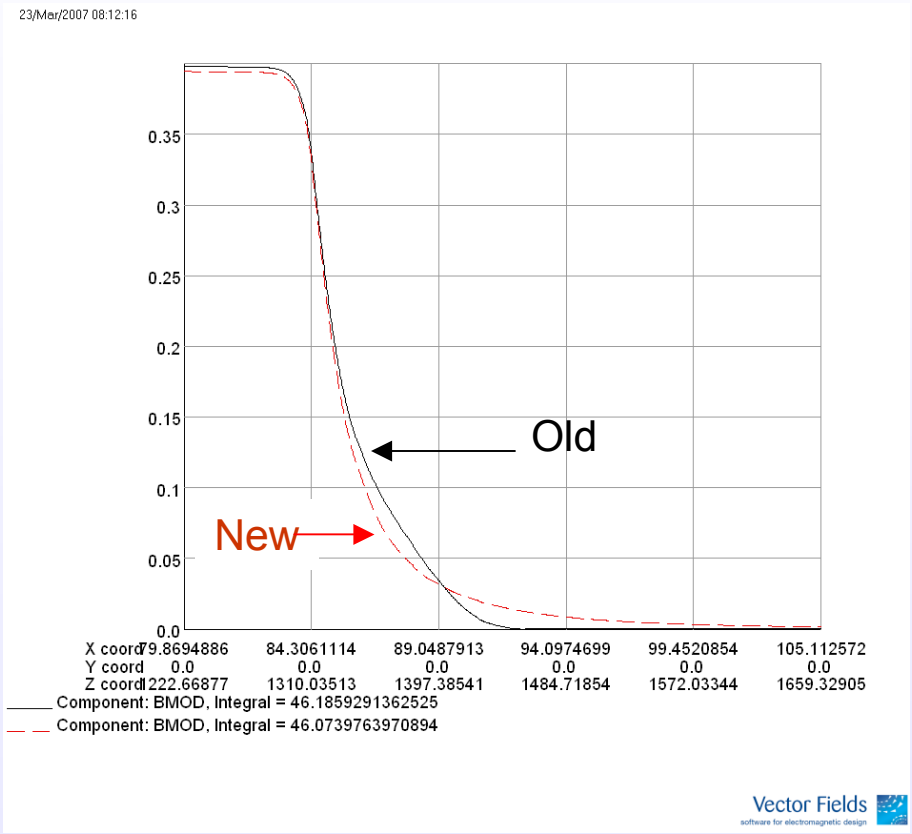
But what does it do to the field?



Comparison of End fields in Convention and Space Saving Ends

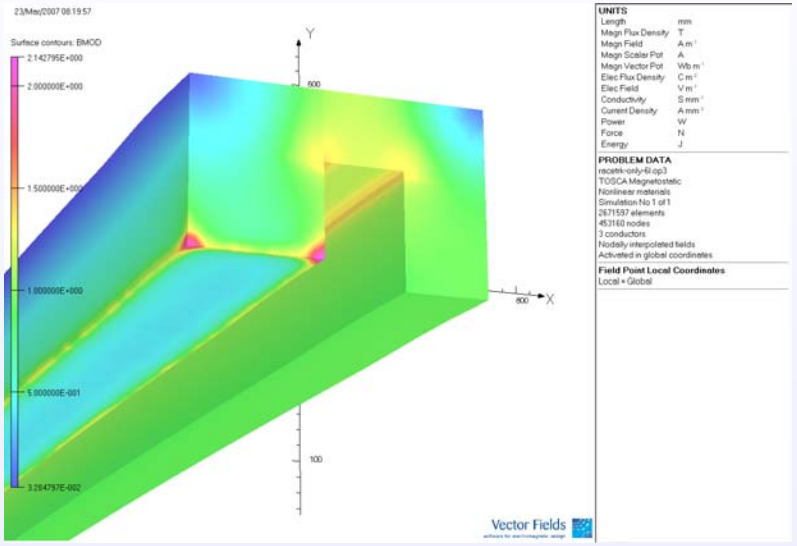


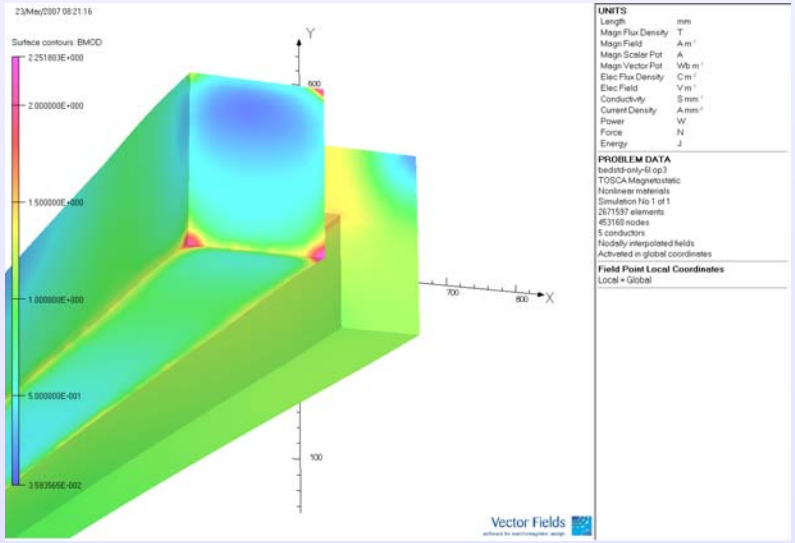




- There is no loss in magnetic length in releasing the space occupied by coil ends.
- End fields are similar in both cases.
- **Are we ready to accept this deduction in real estate as valid now (or we wait till April 15th)?**

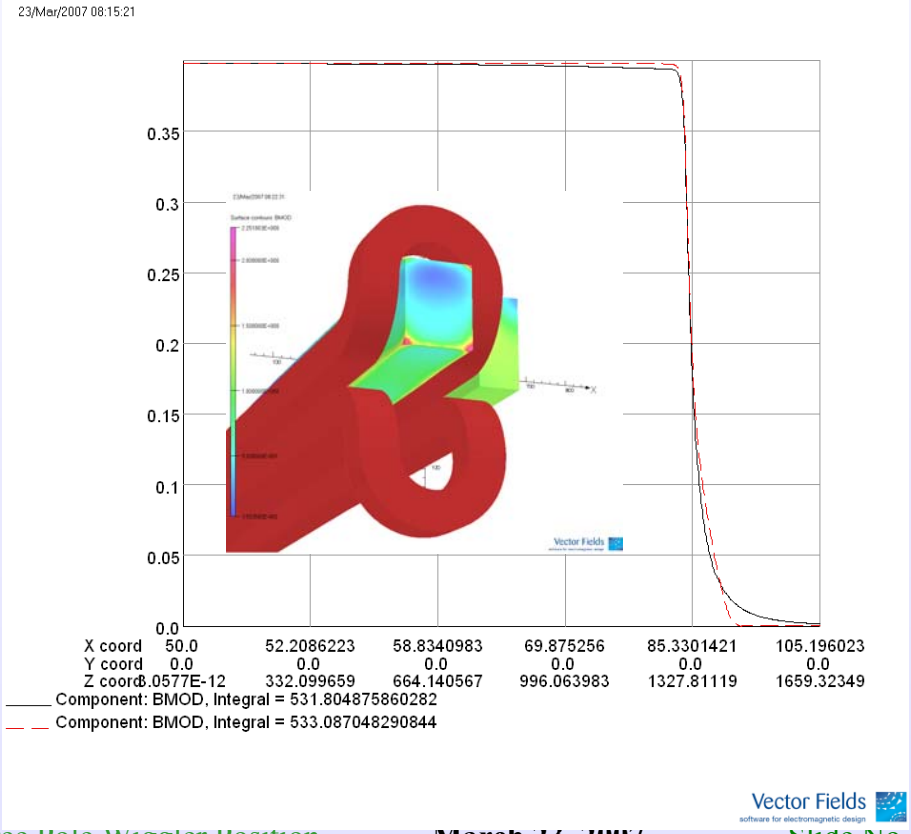
More on Comparison in Two Ends



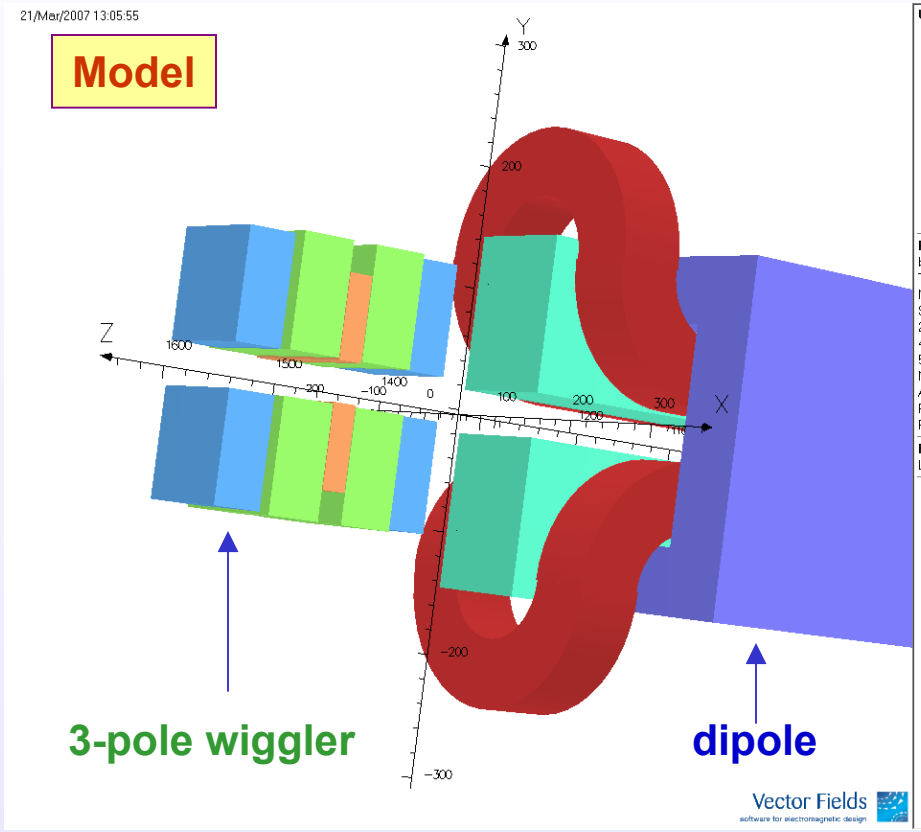


Note that the saturation in iron is not significant in either case (which makes life simpler).

A very small difference in the end may be due to a minor saturation, or it may disappear on improved modeling. In any case, we seem to be in good situation.



Combined Modeling of Dipole and 3-pole Wiggler



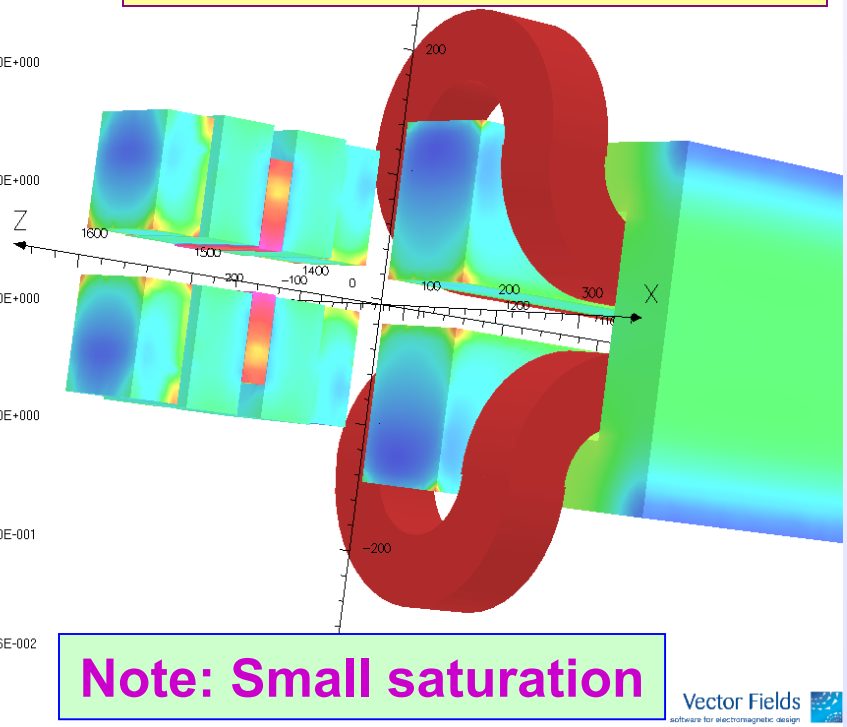
UNITS

Length	mm
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 mm^{-1}
Current Density	A mm^{-2}
Power	W
Force	N
Energy	J

PROBLEM DATA
bedstd-3pole-6h.op3
TOSCA Magnetostatic
Nonlinear materials
21/Mar/2007 13:05:19
Surface contours: BMOD
2.904657E+000
2.500000E+000
2.000000E+000
1.500000E+000
1.000000E+000
5.000000E-001
3.577926E-002

We made several models to understand the interaction of the dipole and 3-pole wiggler field

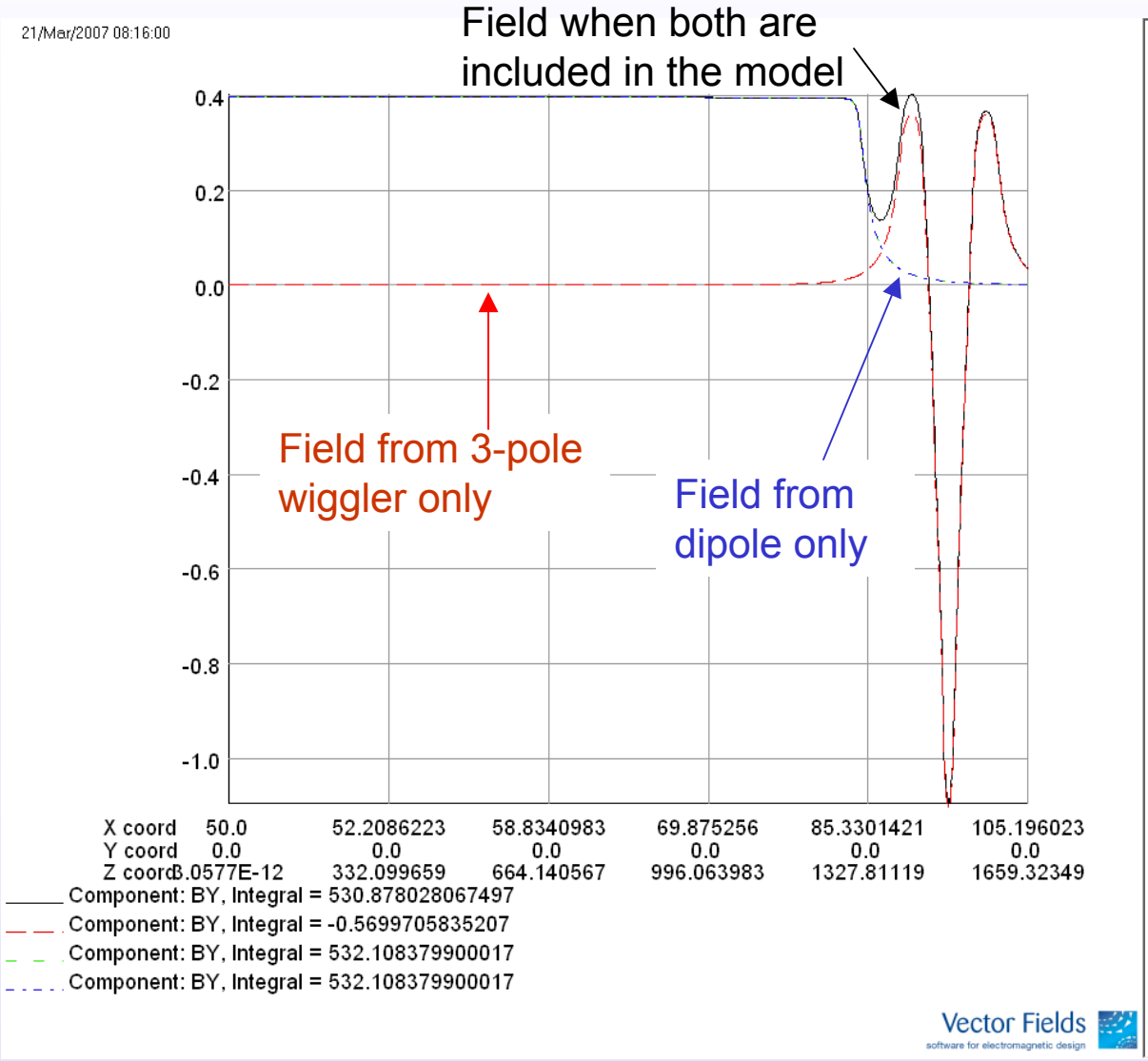
Field Super-imposed on surface to help investigate saturation



Note: Small saturation

The attempt is to see how little space (between the two magnets) we can get away with?

Dipole and 3-pole Wiggler Field



UNITS	
Length	mm
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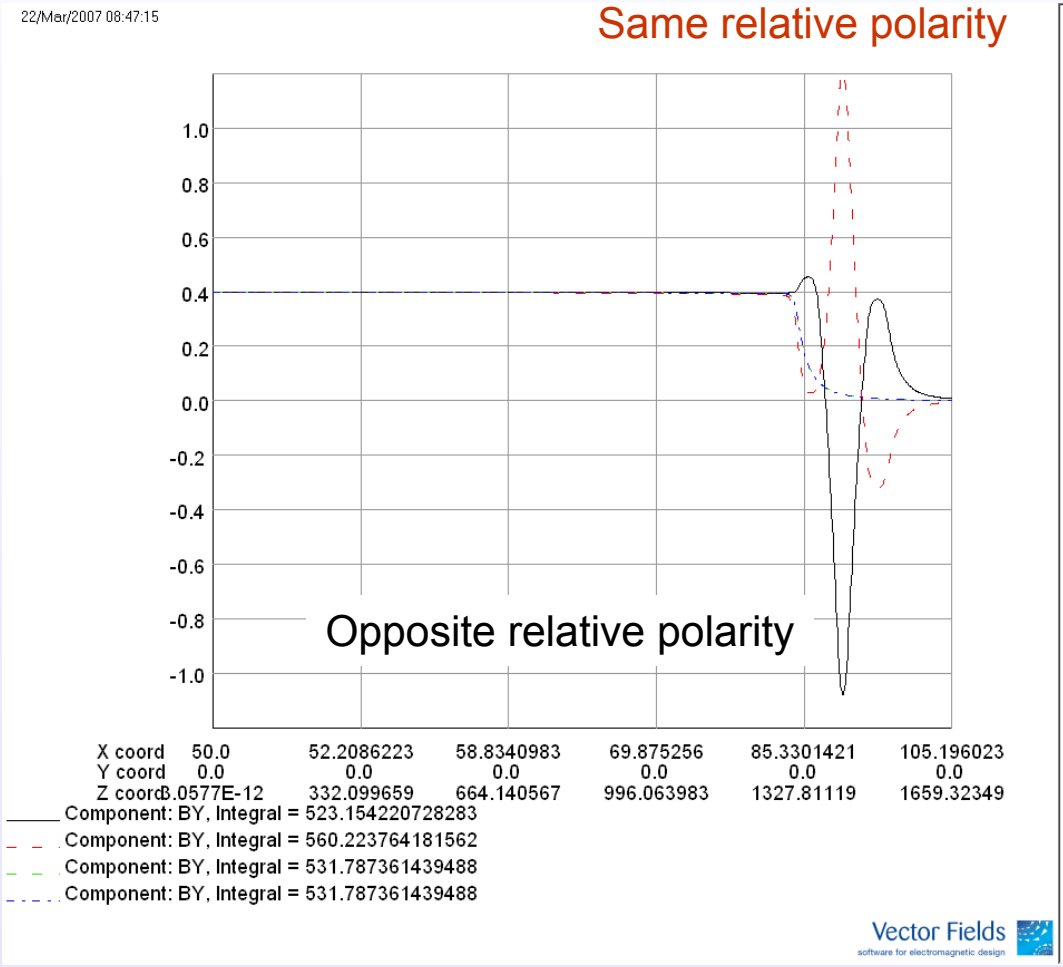
Magn Field	A m^{-1}
Magn Scalar Pot	A
Magn Vector Pot	Wb m^{-1}
Elec Flux Density	C m^{-2}
Elec Field	V m^{-1}
Conductivity	S mm^{-1}
Current Density	A mm^{-2}
Power	W
Force	N
Energy	J

PROBLEM DATA
ls2-bedstead-2.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
1703155 elements
290087 nodes
5 conductors
Nodally interpolated fields
Activated in global coordinates

Field Point Local Coordinates
Local = Global

- Note: There seems to be a linear superimposition of the field of two magnets.
- This is good and is reflection of negligible saturation.
- This means that the two magnets can be brought still closer.

Relative Polarity of Dipole and 3-pole Wiggler Fields



UNITS	
Length	mm
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 mm^{-1}
Current Density	A mm^{-2}
Power	W
Force	N
Energy	J

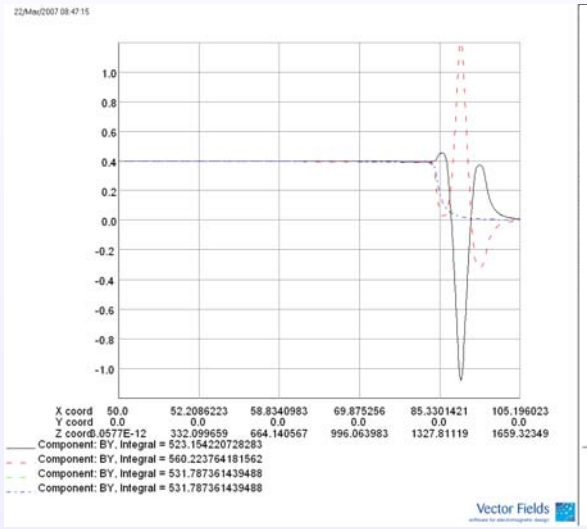
PROBLEM DATA
bedstd-only-6h.op3
TOSCA Magnetostatic
Nonlinear materials
Simulation No 1 of 1
2628527 elements
445743 nodes
5 conductors
Nodally interpolated fields
Activated in global coordinates

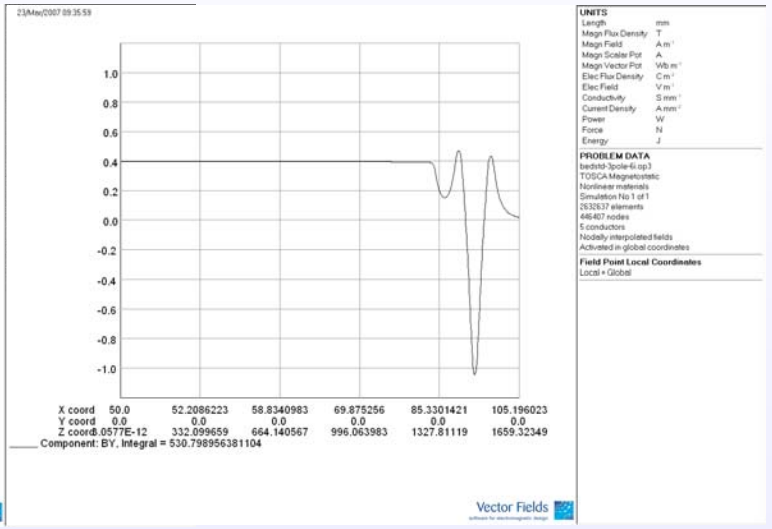
Field Point Local Coordinates
Local = Global

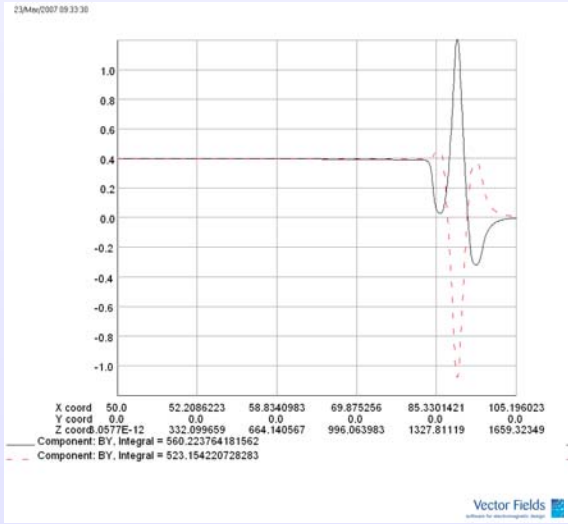
- Does Any One Care About the Relative Polarity of 3-pole Wiggler?
- It may have some impact on net field profile?

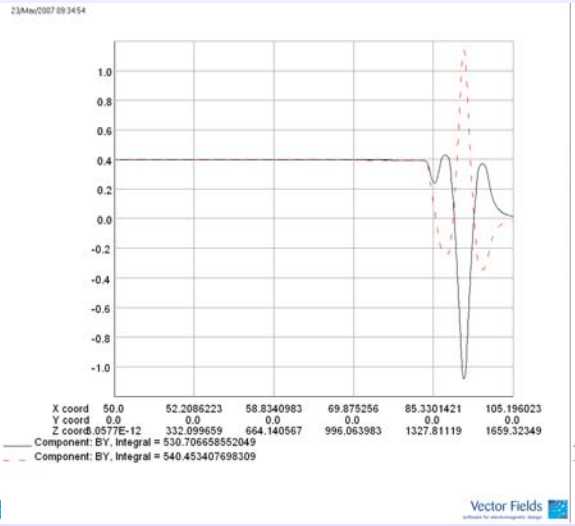
How close 3-pole wiggler can be?

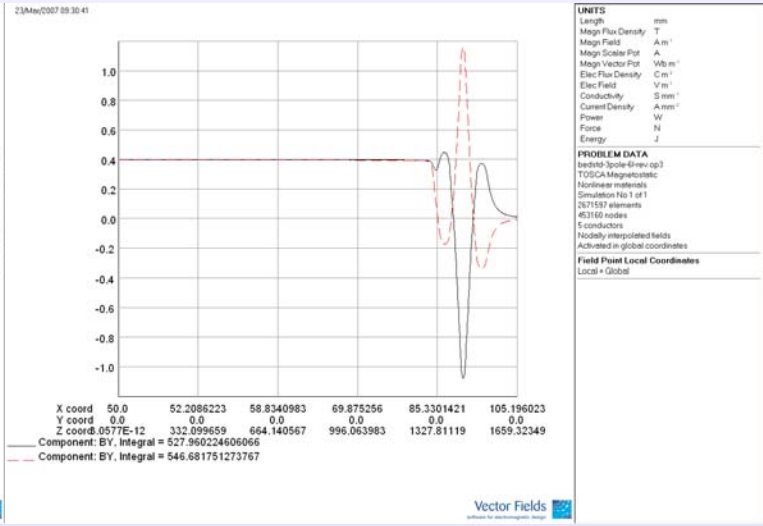
- Here is the analysis to help you determine.
- Iron to iron separation between dipole and 3-pole wiggler ranges from 2 cm to 9 cm.
- Detailed discussion can be done off line?









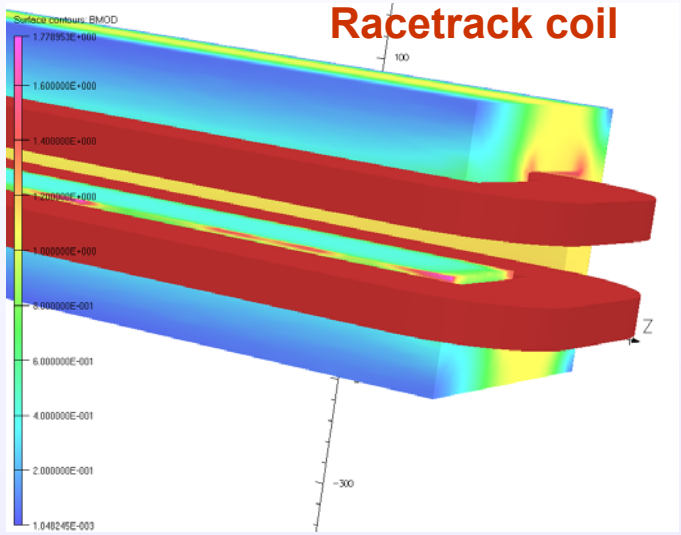


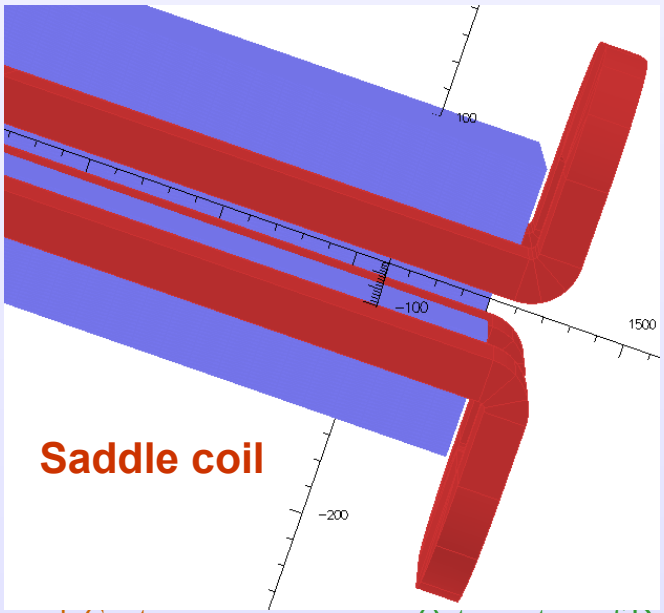
Summary

- Significant space from coil ends can be released.
- Detailed 3-d magnetic modeling and analysis has been made to examine beam dynamics issues related to further reducing space between 3-pole wiggler and dipole.
- The total saving in space can be 20 to 30 cm per dipole.
- More investigations and thoughts should help improve situation further.

Recap on Last Presentation

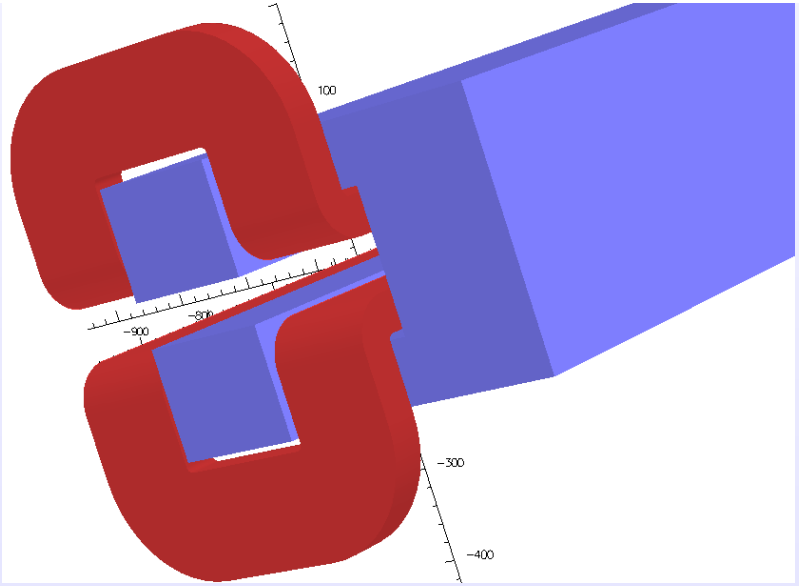
Extended Pole Piece to Eliminate Loss in Magnetic Length Due to Coil Ends





An investigation to see if magnetic length can be determined by pole only and loss in length due to coil ends can be freed-up for other purpose.

Likely to be more beneficial in low field magnet (such as this) where iron defines the field shape.



Saddle coil with extended pole