ANSYS Magnetostatic and Structural Analyses of the sPHENIX Magnet at Full Current

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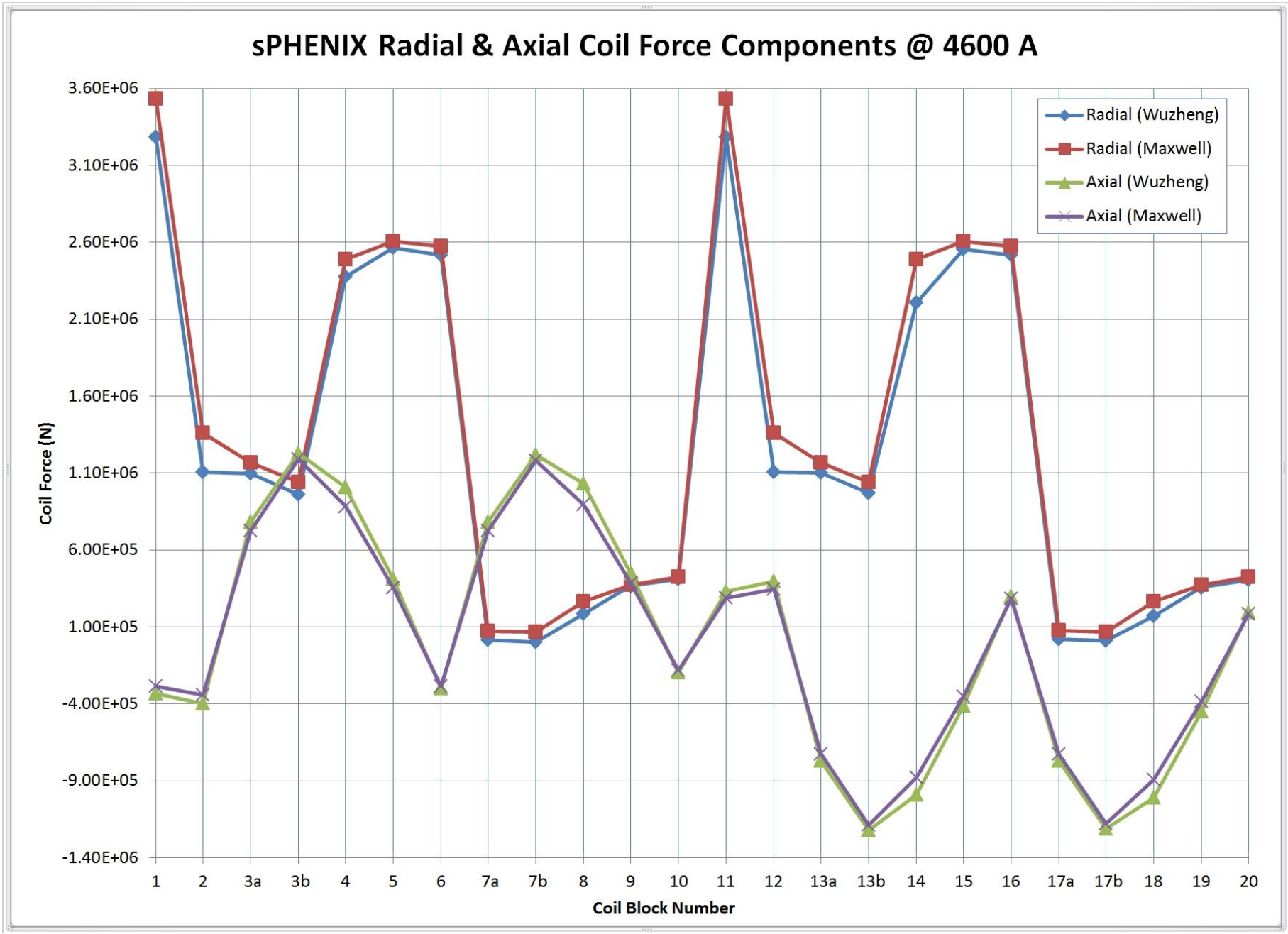
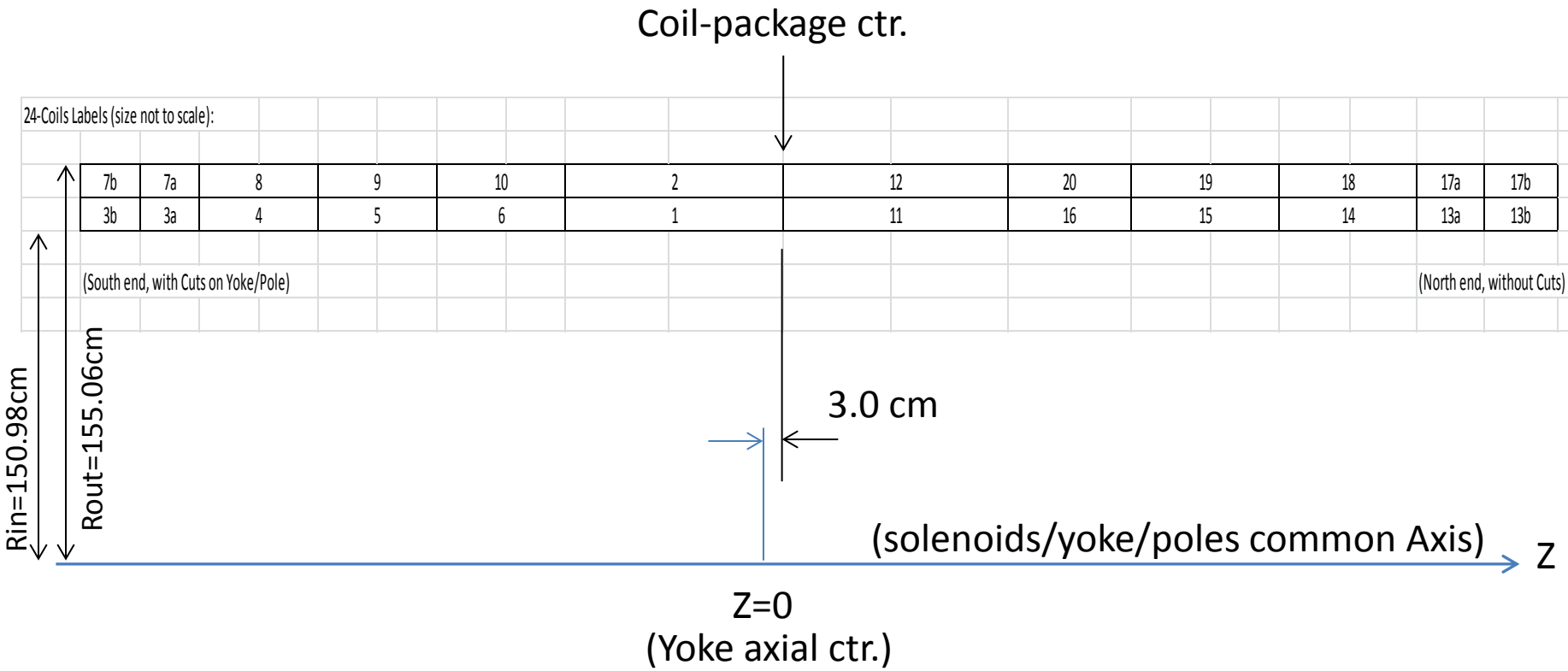
- ***ANSYS Maxwell Analysis of sPHENIX Magnet***
  - Final comparison of Maxwell axial and radial coil forces (7/28/16) to Wuzheng Meng's 2D results from 6/17/15
    - Forces track acceptably (see following chart).
    - The 2D Maxwell axisymmetric simulation has functioned properly and generates valid results.


sPHENIX Radial & Axial Coil Force Components @ 4600 A
Radial (Wuzheng)
Radial (Maxwell)
Axial (Wuzheng)
Axial (Maxwell)
Coil Force (N)
3.60E+06
3.10E+06
2.60E+06
2.10E+06
1.60E+06
1.10E+06
6.00E+05
1.00E+05
-4.00E+05
-9.00E+05
-1.40E+06
1
2
3a
3b
4
5
6
7a
7b
8
9
10
11
12
13a
13b
14
15
16
17a
17b
18
19
20
Coil Block Number

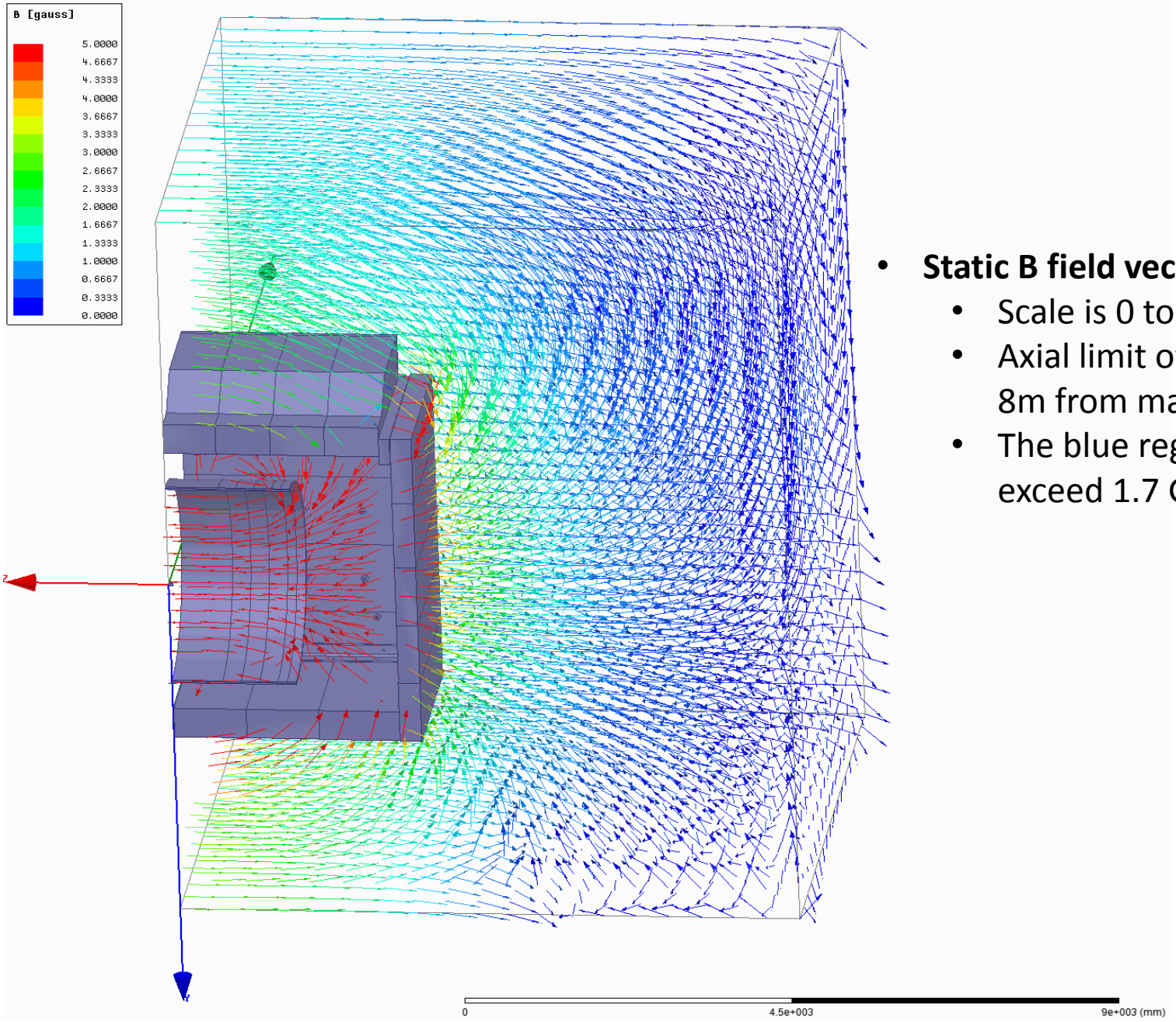
Labels on 24 Solenoid Coils

(Not to Scale)

W. Meng, 6/17/15

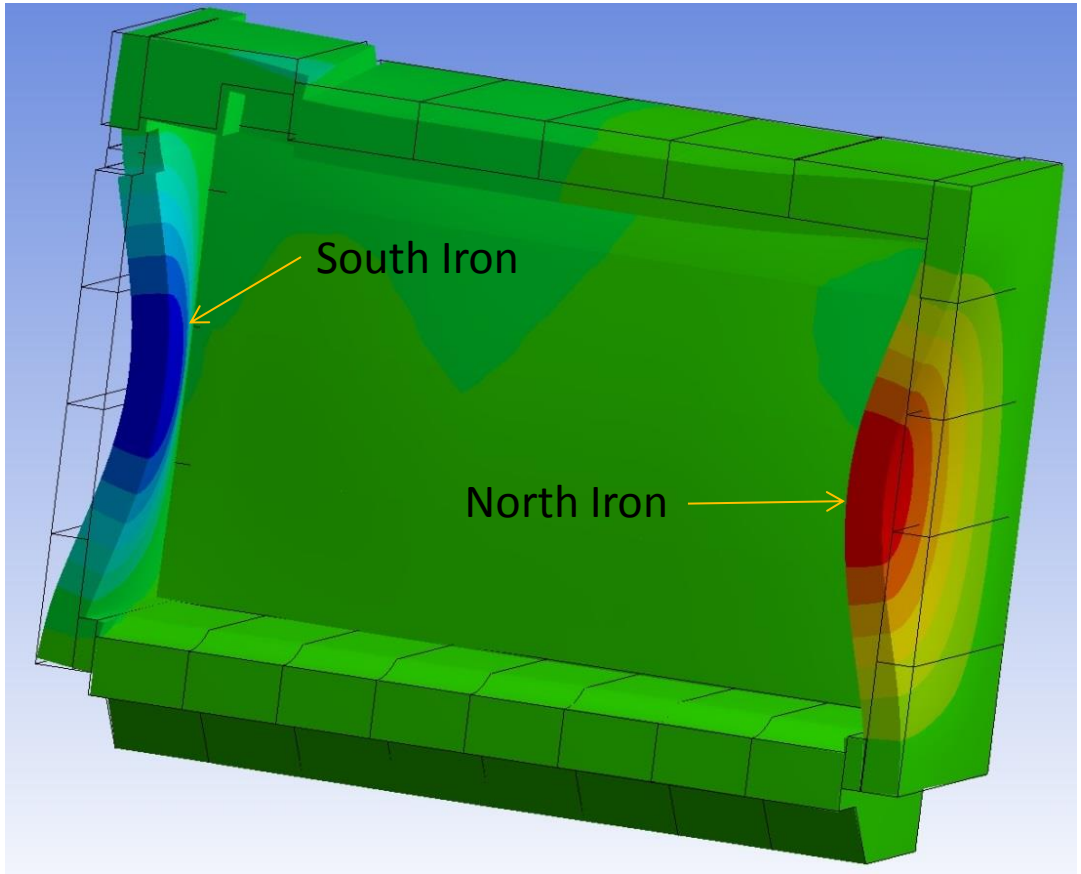


- ***ANSYS Maxwell Analysis of sPHENIX Magnet***
  - 3D magnetostatic FE analysis of the coil in the iron
    - Geometry is taken from the simplified Creo solid model.
      - The coil center is shifted 3cm north relative to the iron.
        - » The iron weight is approximately 1,320,000 lb.
        - » The fringe B field outside the iron is observed at 4600 A.
        - » The simplified 3D FE model is used to compare end forces on the iron to Wuzheng's calculations from 6/17/2015.



- **Static B field vector plot at 4600 A**
  - Scale is 0 to ≥4.3 Gauss (red)
  - Axial limit of region is about 8m from magnet center.
  - The blue region does not exceed 1.7 Gauss.

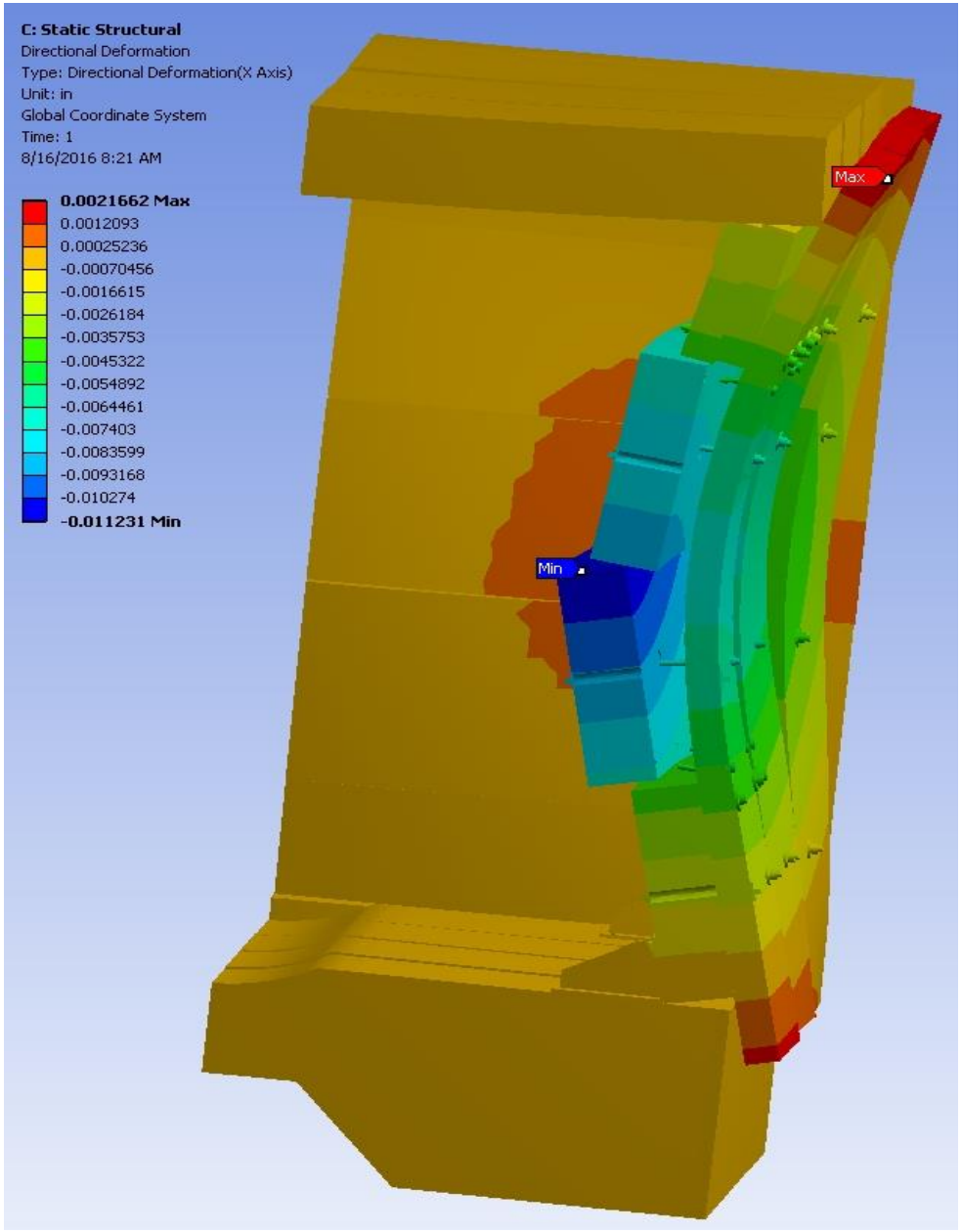
- Axial Forces on sPHENIX Iron End Caps at 4600 A with 3 & 4 cm Coil Offsets North



		S Iron (lbf)	N Iron (lbf)	Delta (lbf)
3cm Offset	Wuzheng	154267	181716	27449
3cm Offset	Maxwell	162000	193000	31000
4cm Offset	Maxwell	137000	199000	62000

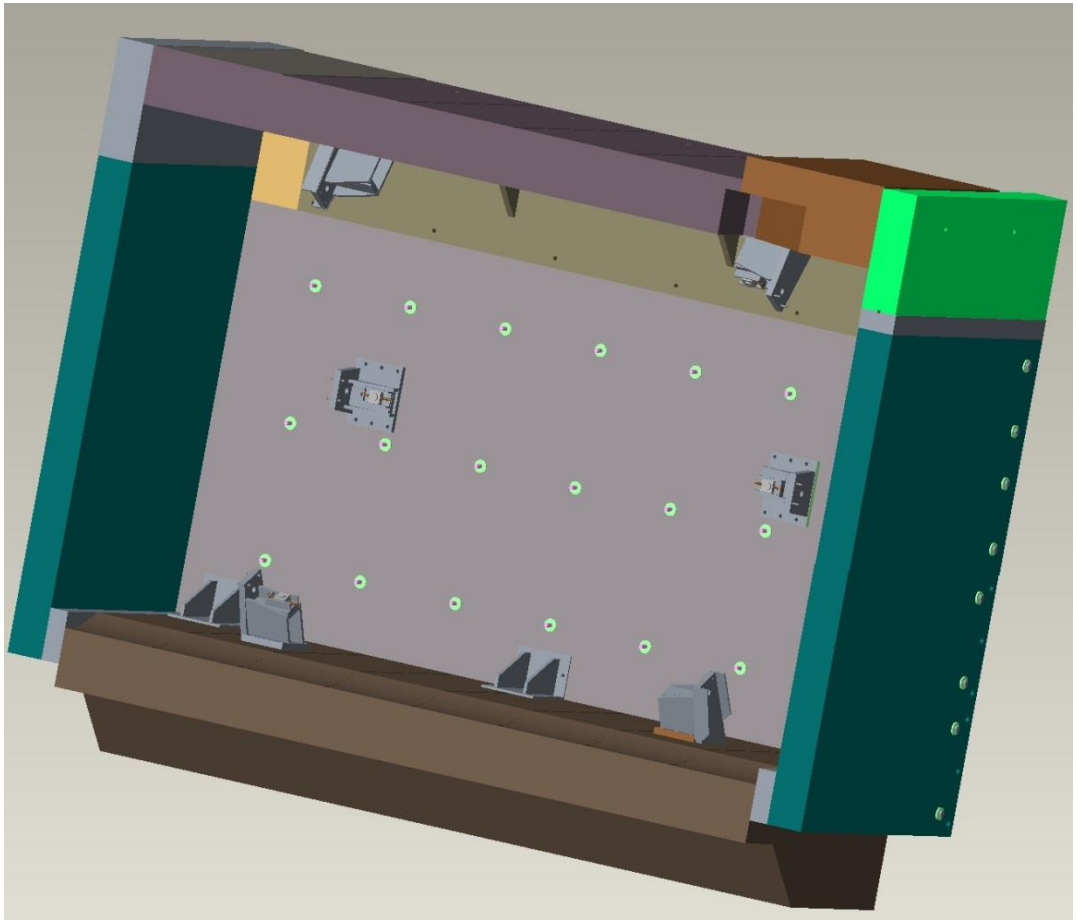
- ***ANSYS Maxwell Analysis of sPHENIX Magnet***
  - 3D magnetostatic and static structural FE analysis of the iron at 4600 A
    - Geometry is taken from the latest Creo solid model.
      - One side wall includes actual physical features and realistic contact conditions.
        - » Therefore, deflections should better represent actual behavior.

• *ANSYS Maxwell Analysis of sPHENIX Magnet*



- **One side wall is modeled in detail.**
  - Frictionless contact is applied where appropriate.
  - Bolts are in place but are not preloaded in the model.
  - Max inward deflection is .011 inch (blue).
    - Note: This model lacks some of the latest features such as heavy angle braces and additional fasteners.
    - The effect of such iron deflections on the cryostat via its support struts has not yet been studied.

- ***ANSYS Maxwell Analysis of sPHENIX Magnet***



- **Structural FE analysis of the cryostat support system is the logical next step.**
  - The yoke assembly should include all newly added relevant features including steel gussets, additional bracing, and doublers.
  - Effects of the 30,000 lbf axial load imbalance should be considered as well.
  - Consider verifying the axial location of the solenoid relative to the iron.