LINEAR COLLIDER WORKSHOP

SiD Magnetic Field Studies

Wes Craddock

SLAC

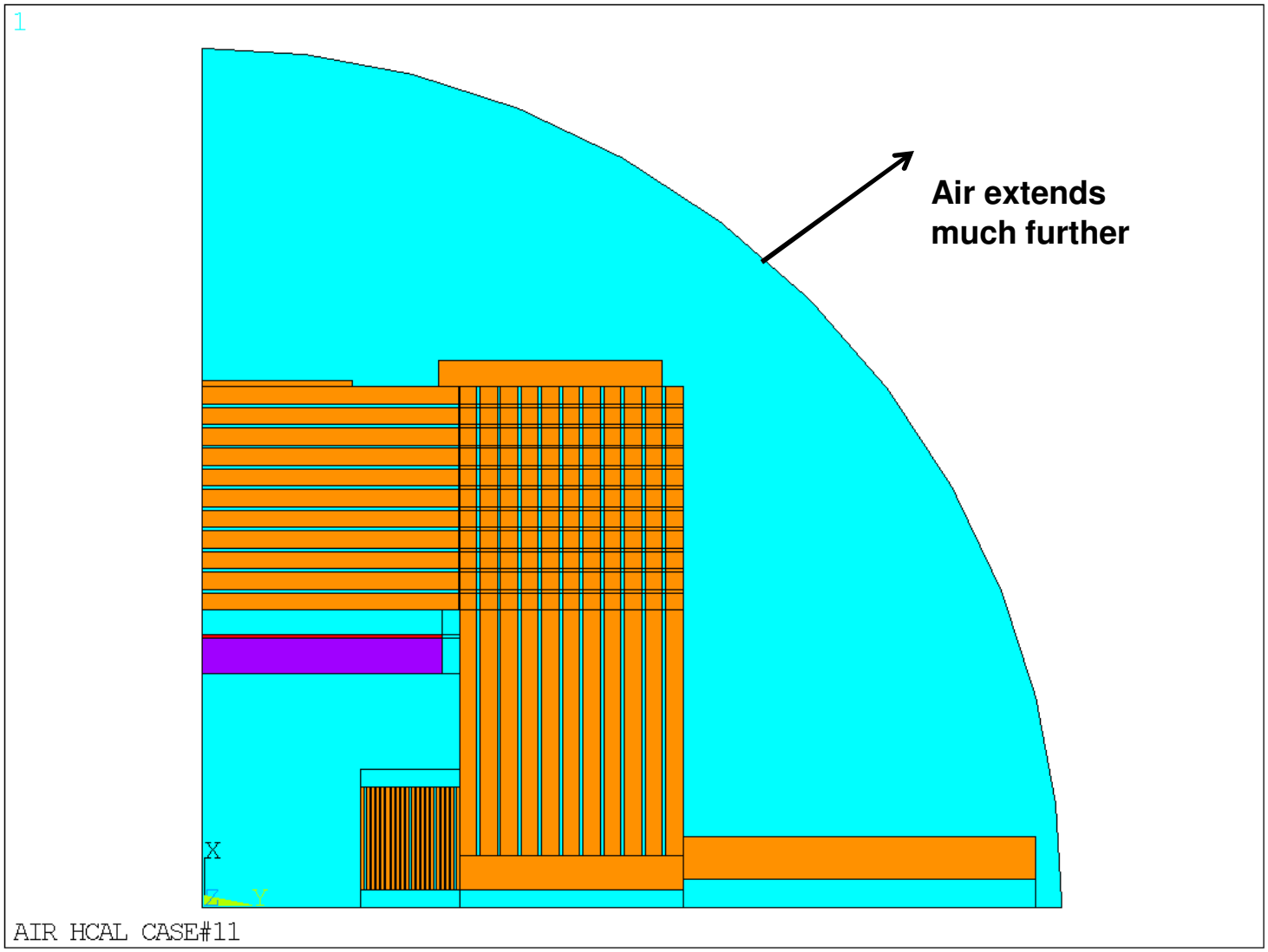
March 29, 2010

SiD MAGNETIC FIELD ANALYSIS STATUS

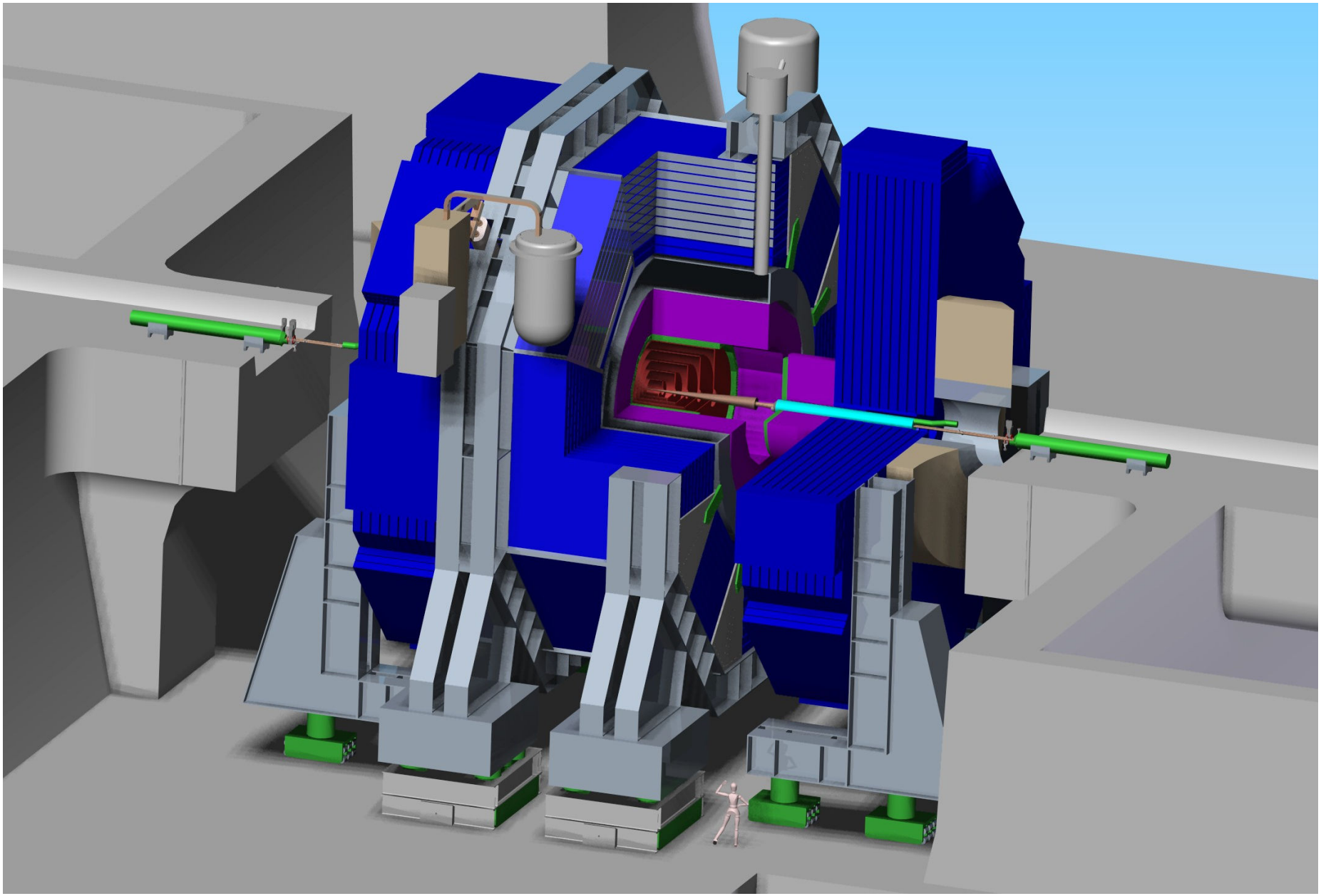
- **IRON END CAP HCAL --- DONE**
- **FRINGE FIELD REDUCTION --- Struggling for better results**
- **3D ANALYSIS WITH DID COILS --- Starting**
- **POWER SUPPLY ---- Concept Done**
  DUMP BREAKERS
  DUMP RESISTOR

SiD ANSYS 2D FEM MODEL

(showing Iron EndCap HCAL)

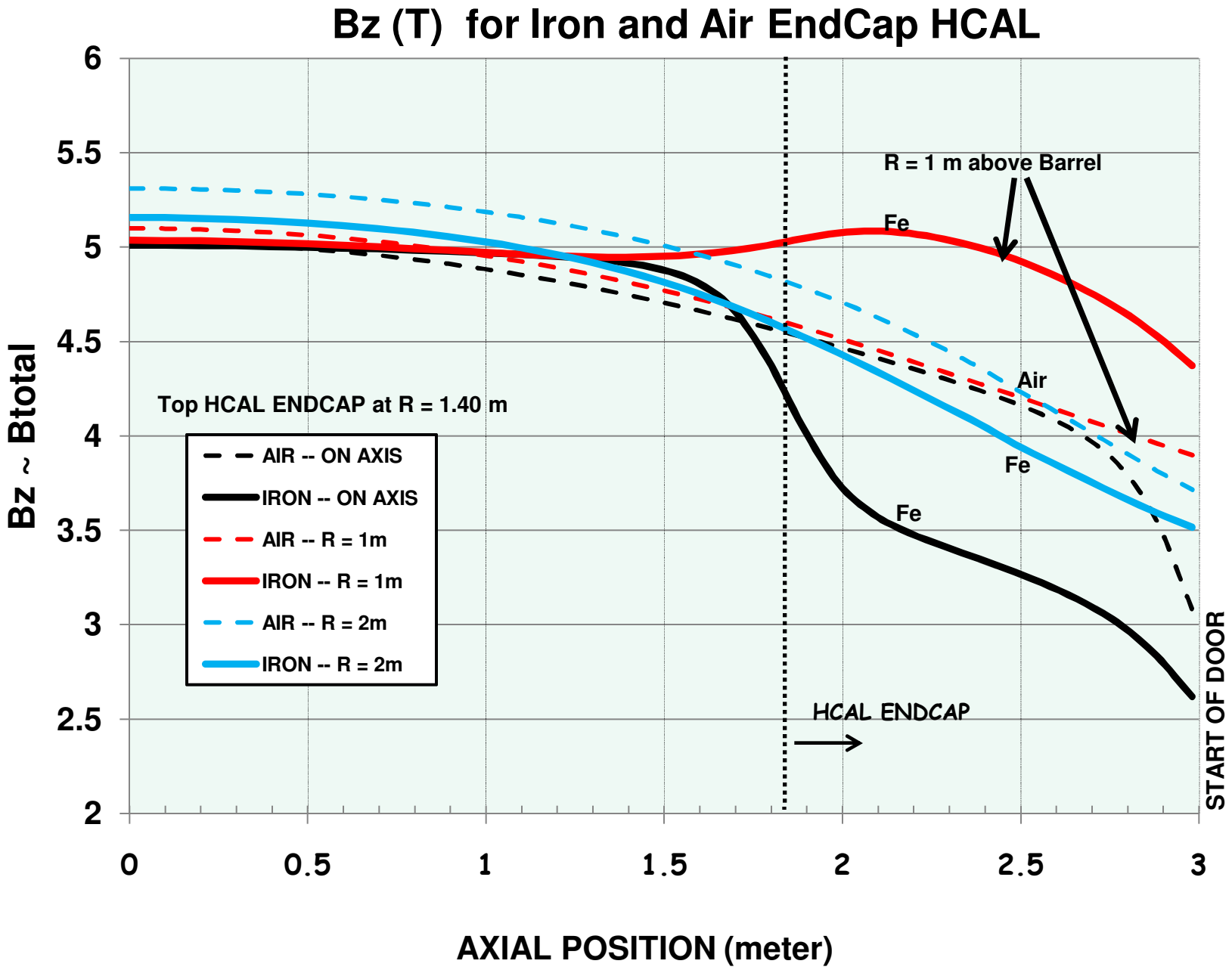


IRON
AIR
COIL
AL

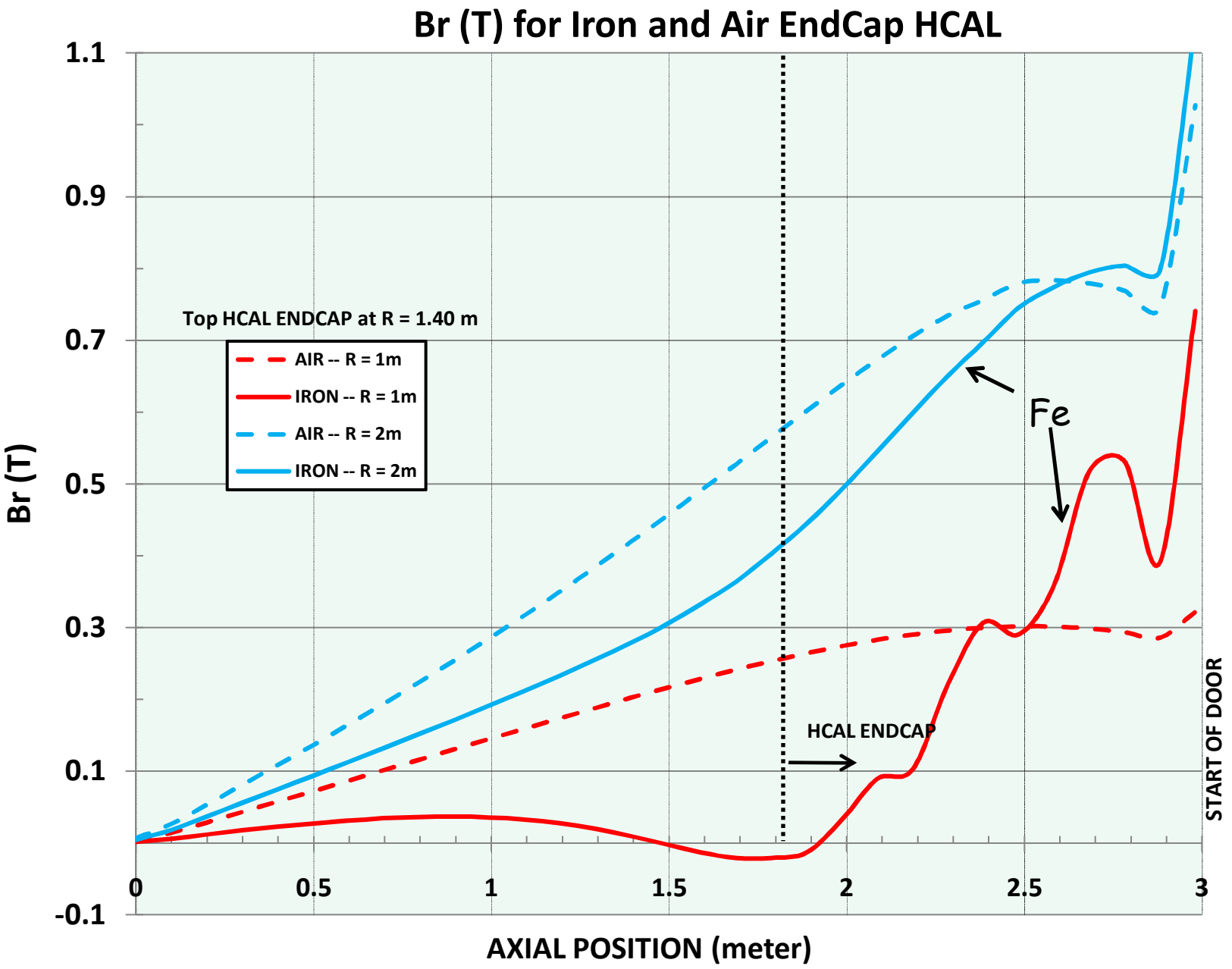


March 29, 2010 LCWS 2010

SiD Solenoid
Wes Craddock /SLAC

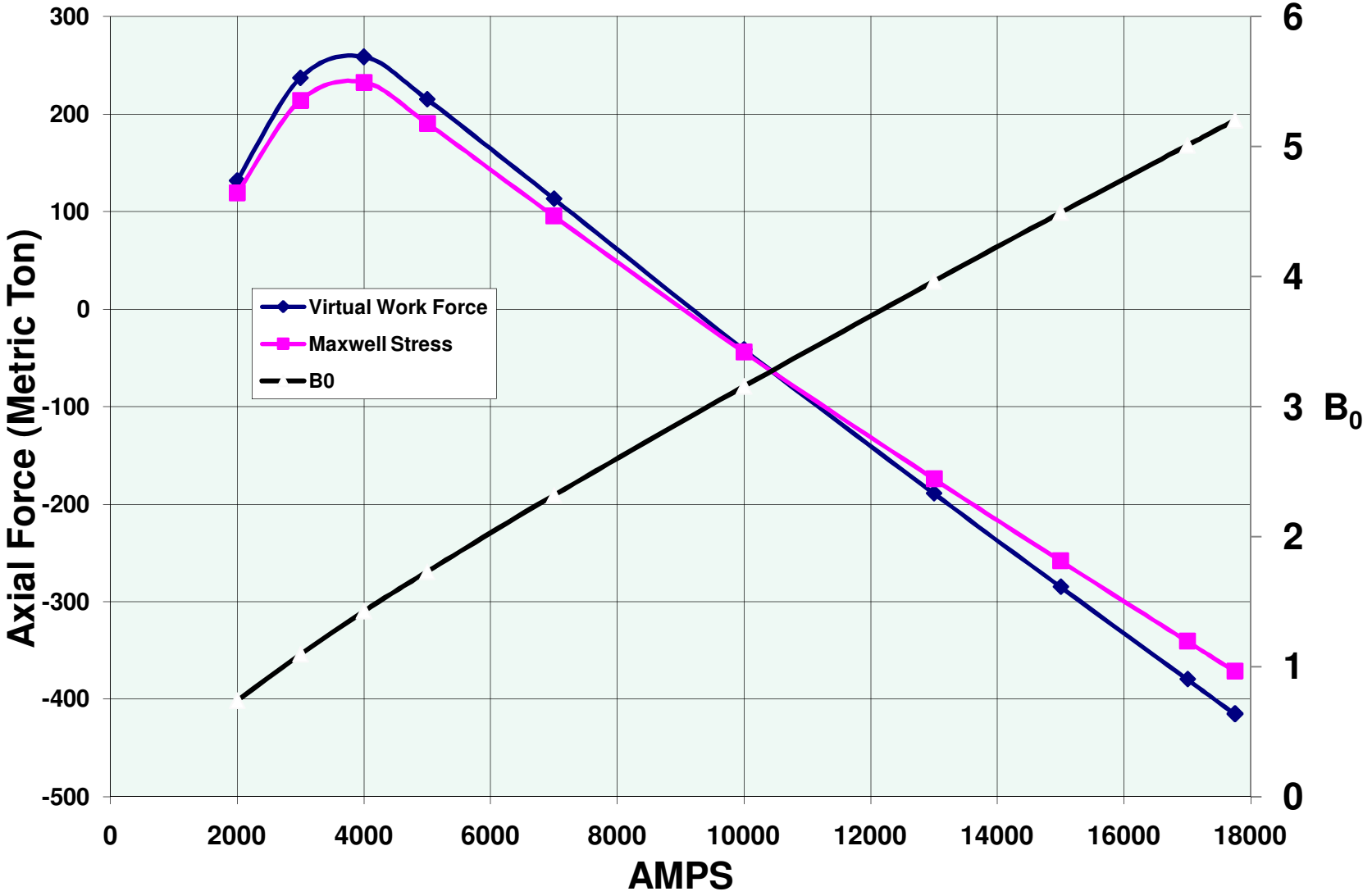


SiD Solenoid
Wes Craddock / SLAC

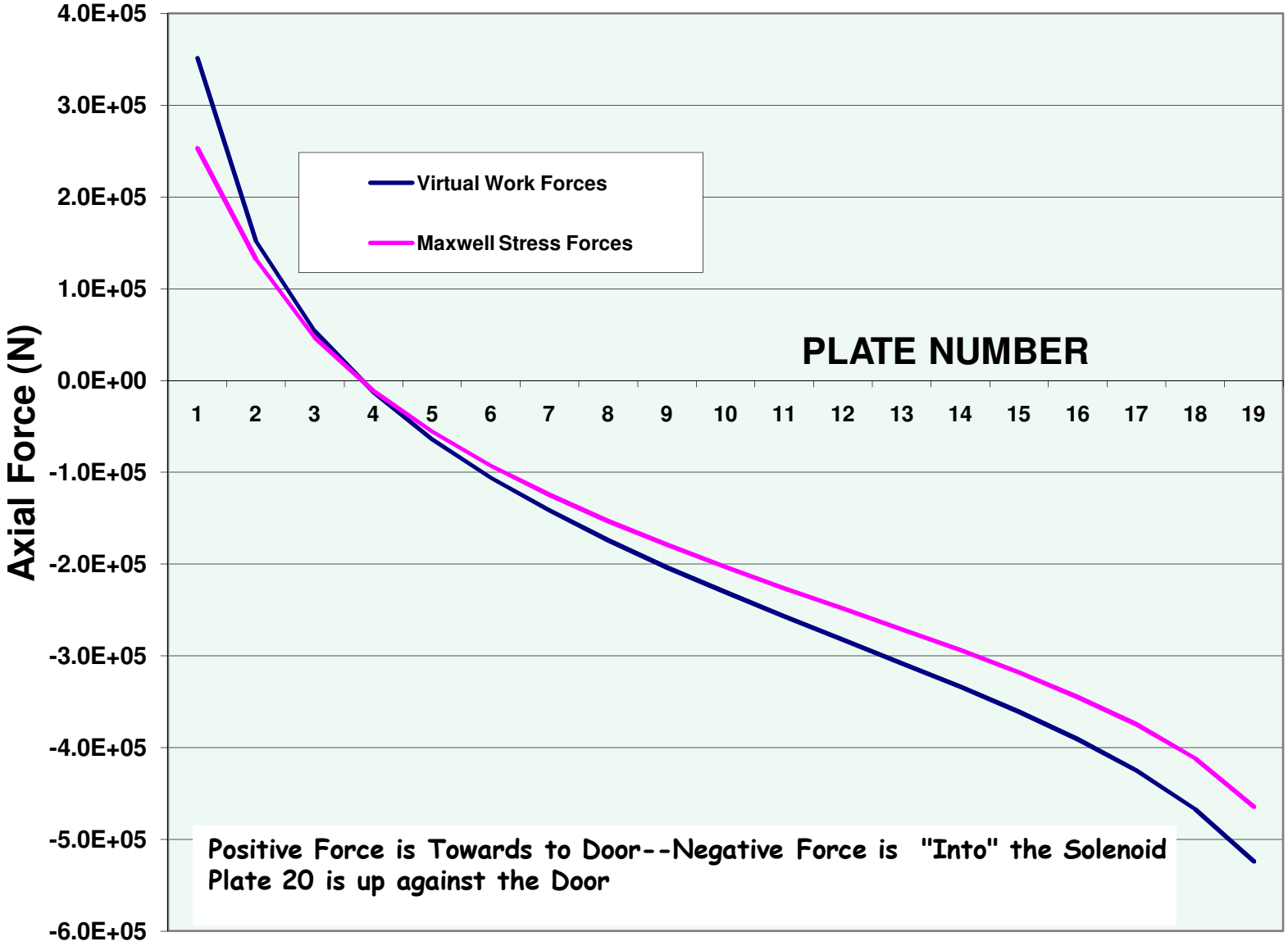

Br (T) for Iron and Air EndCap HCAL
Top HCAL ENDCAP at R = 1.40 m
AIR -- R = 1m
IRON -- R = 1m
AIR -- R = 2m
IRON -- R = 2m
Fe
HCAL ENDCAP
START OF DOOR
Br (T)
AXIAL POSITION (meter)
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
0
0.5
1
1.5
2
2.5
3

TOTAL AXIAL FORCE ON SiD IRON HCAL END PLATES

Negative Force is "into" the Solenoid



AXIAL FORCE ON HCAL IRON END PLATES



SiD Solenoid
Wes Craddock /SLAC

SiD Iron HCAL ENDCAP STUDY

- ANSYS was used to see if it was worthwhile to use iron in the EndCap HCAL.

- POSSIBLE ADVANTAGES:
  1) Improved field uniformity
  2) Reduced number of solenoid amp-turns or greater superconductor stability.
  3) Slight reduction in material cost

- DISADVANTAGES:
  1) Magnetic forces on the HCAL with increased construction and engineering costs
  2) Substantially greater difficulty in magnetic field mapping

SiD Iron HCAL ENDCAP CONCLUSIONS

- **SUMMARY OF RESULTS:**
  1) Magnetic forces are a large but manageable 250 T (towards the Door) to -400 T (into the solenoid) during solenoid ramping to full field.

  2) An iron HCAL EndCap reduces the operating current from 17750 A to 17000 A (only a 4% reduction).

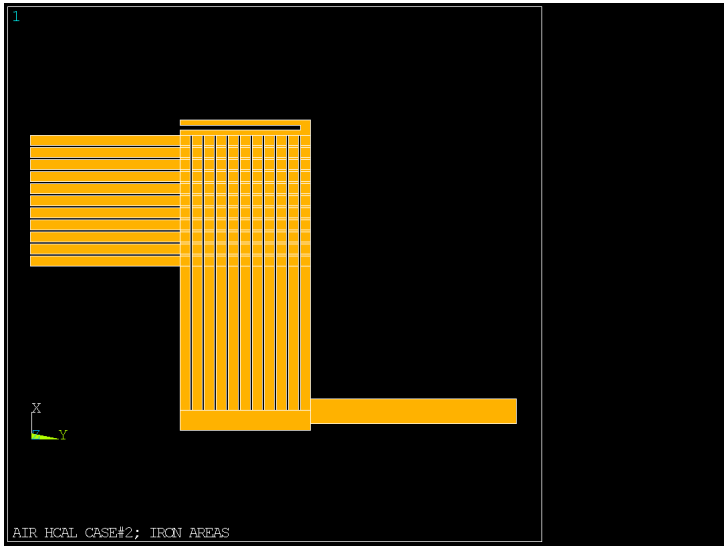
  3) Field uniformity is improved.

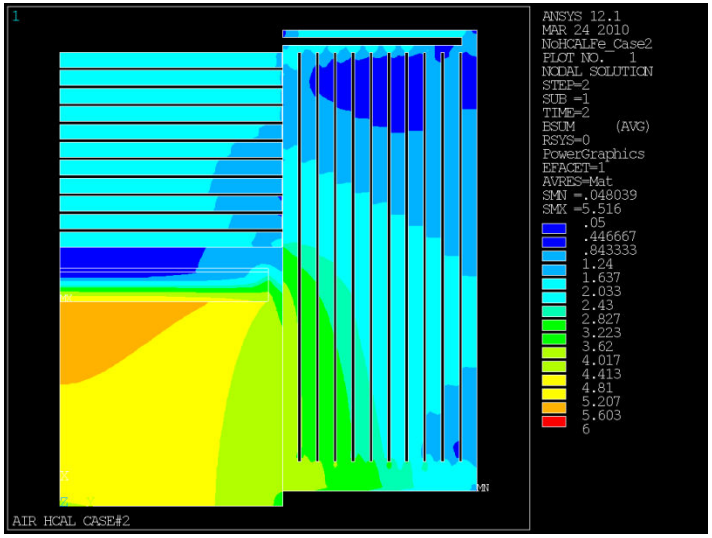
- **DISADVANTAGES:**
  1) Magnetic forces on the HCAL with increased construction and engineering costs.
  2) Substantially greater difficulty in magnetic field mapping.

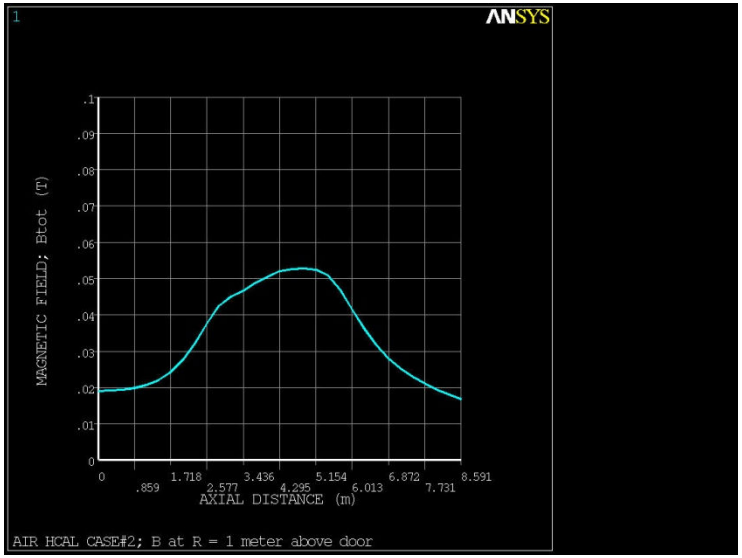
- **CONCLUSIONS:**
  1) It is doubtful whether the improved field uniformity is enough to offset, the very substantial increased difficulty in field mapping and to a lesser extent the forces.
  2) However, this option exists if it is considered to be absolutely essential.

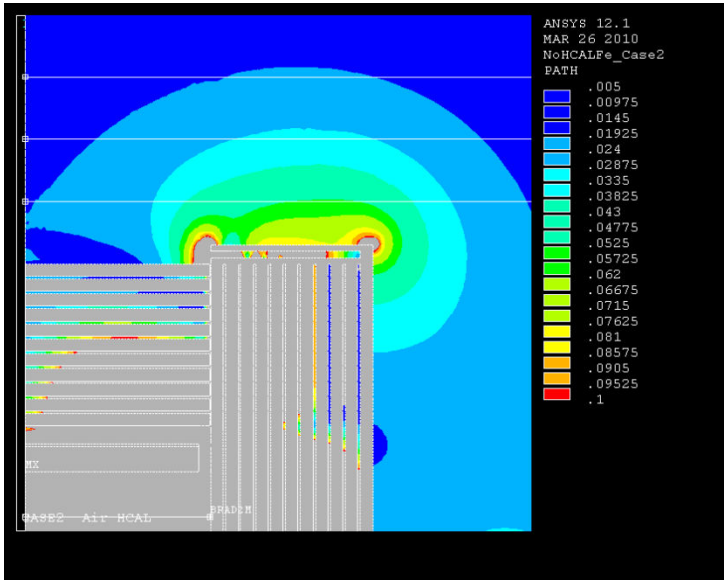
SiD FRINGE FIELD REDUCTION

- Trying for 100 G at 1 m (LOI)
- More typical values are 300 to 500 G at 1 m above the Door



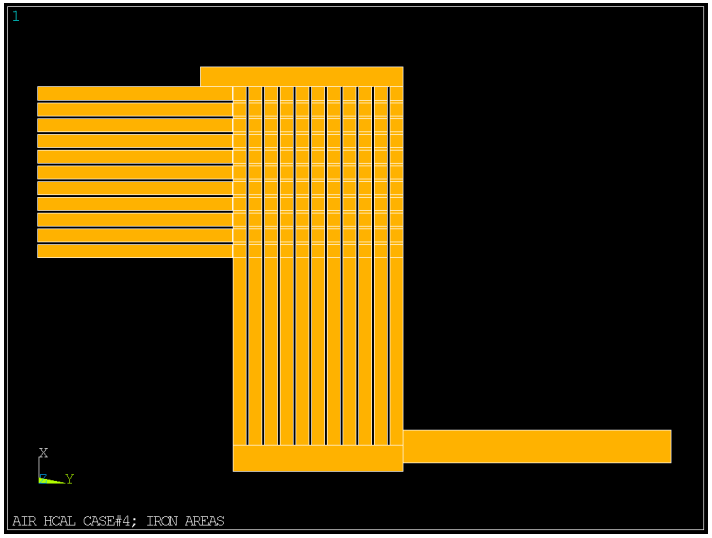


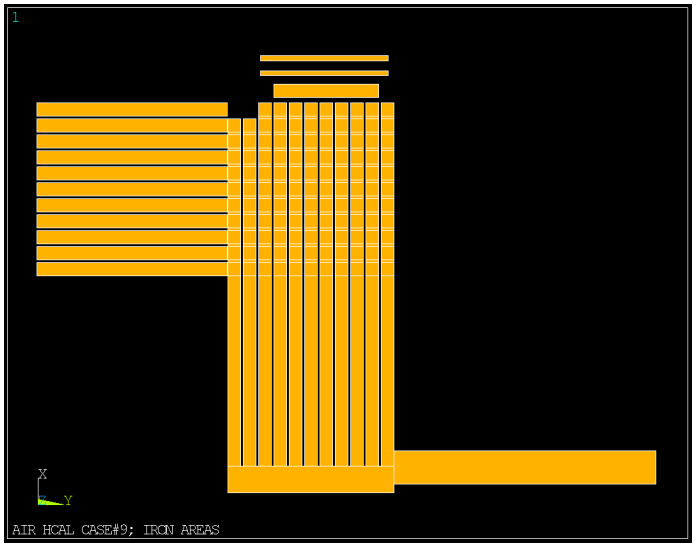


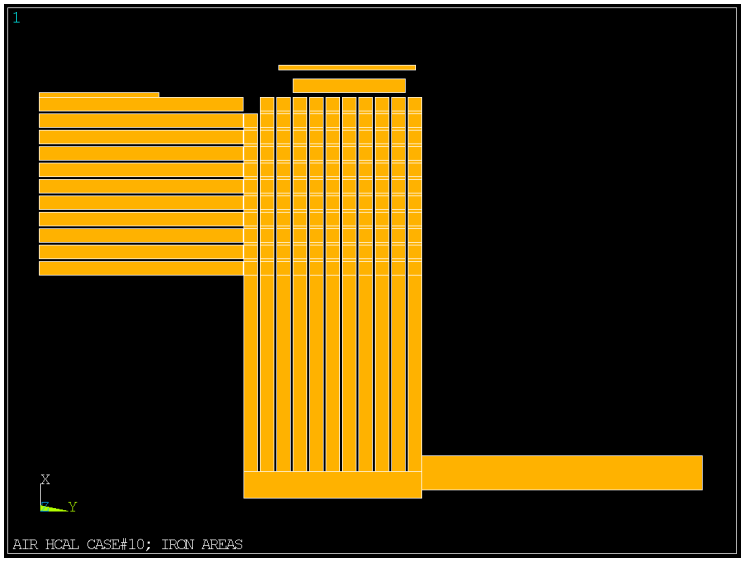


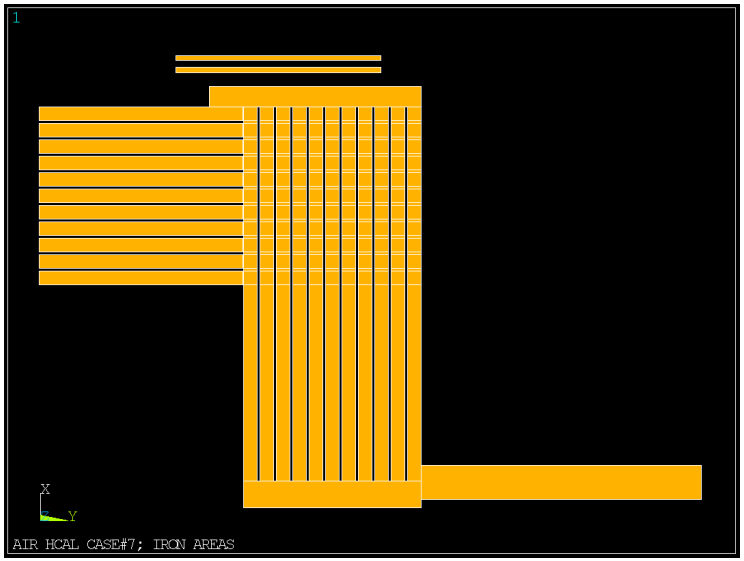
SiD FRINGE FIELD REDUCTION

- A few of the many iron profiles tried for fringe field reduction





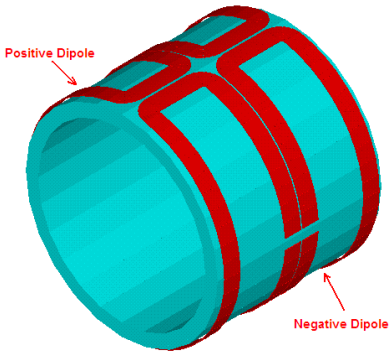




SiD FRINGE FIELD SUMMARY

- Have not found a really good design yet. Still have many more options to try. The ANSYS model is segmented in many different areas so this is easy and fast to solve (35,000 elements.
- If lower fields are really needed everywhere, adding enough iron (cost) will always work.
- Still fairly optimistic that a good design is still possible.
- Good News: Most iron configurations have fringe fields above the door/barrel with minimum values at the mid-plane where most all the electronics would be or could be located.
- There is little difference in fringe fields between Iron End Cap HCAL or "Air" End Cap HCAL geometries.

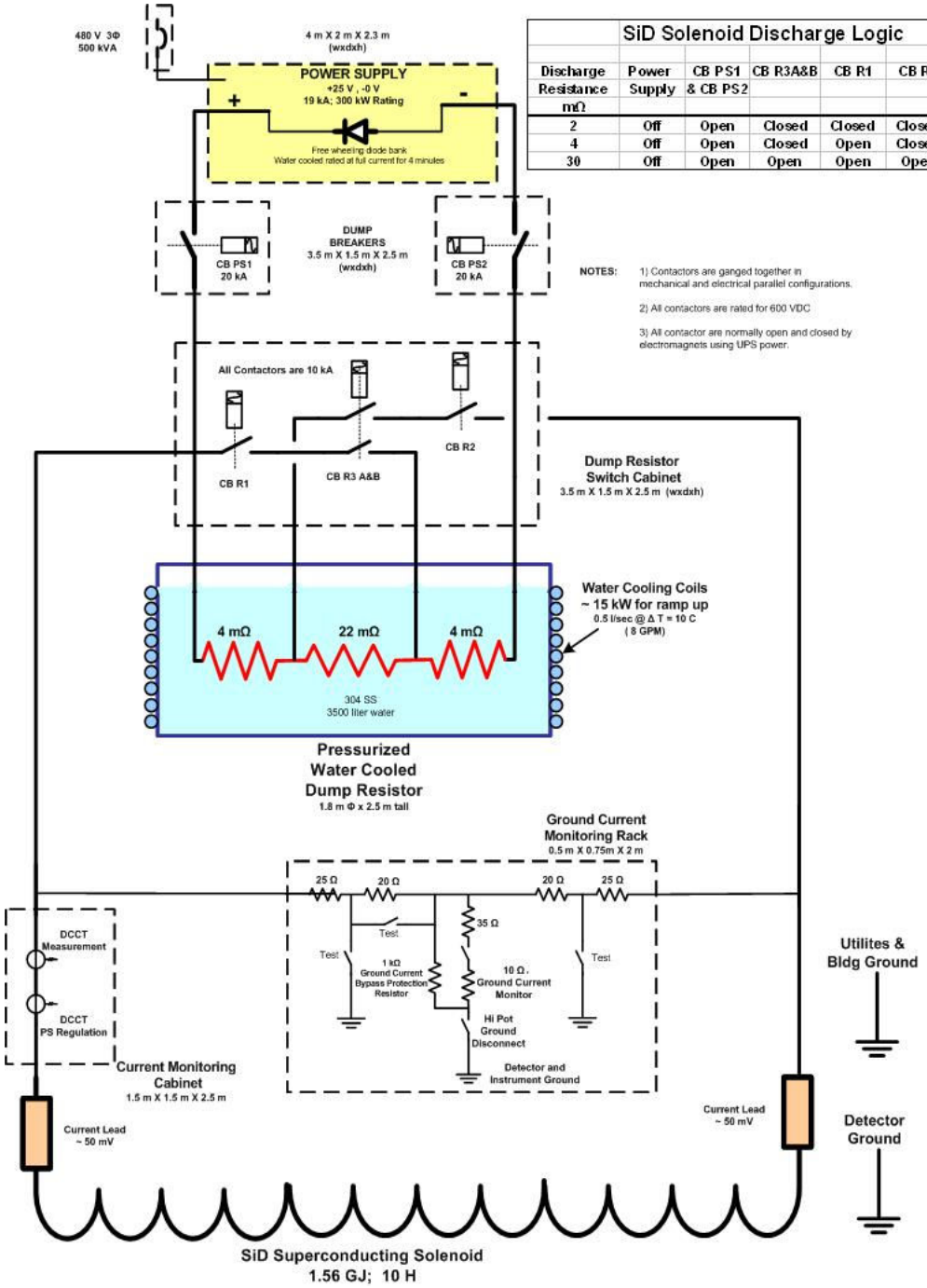
3D ANALYSIS FOR DID COILS



Simplified DID Model

- An ANSYS 3D model that includes the DID coils has begun.
- This model will be used to compare the OPERA 3D that Brett Parker (BNL) has created and solved.
- This ANSYS model will permit direct / easy coupling of DID forces into structural analysis. It can eventually be used for transient analysis and coupling of the solenoid to the DID
- The ANSYS model uses the very new and improved SOLID 236/237 edge-flux formulation elements.
- Race track coils with rounded ends have been created.

SiD SOLENOID POWER CIRCUIT



SiD Solenoid Discharge Logic					
Discharge Resistance mΩ	Power Supply	CB PS1 & CB PS2	CB R3A&B	CB R1	CB R2
2	Off	Open	Closed	Closed	Closed
4	Off	Open	Closed	Open	Closed
30	Off	Open	Open	Open	Open

SiD SOLENOID POWER CIRCUIT

SiD Power Circuit Based on the CMS Design

Differences Between SiD and CMS

• Power supply operates in only 1 quadrant, positive voltage & positive current. The CMS supply is two quadrant, positive and negative voltage with pos. current. This means CMS must use more complex thyristors but can voltage control ramp down.

•SiD uses simpler and more reliable free wheeling diodes.

•SiD uses a water cooled resistor.

•SiD has no changeable buswork for current reversal.

Fermilab is looking at the grounding /ground monitoring scheme.