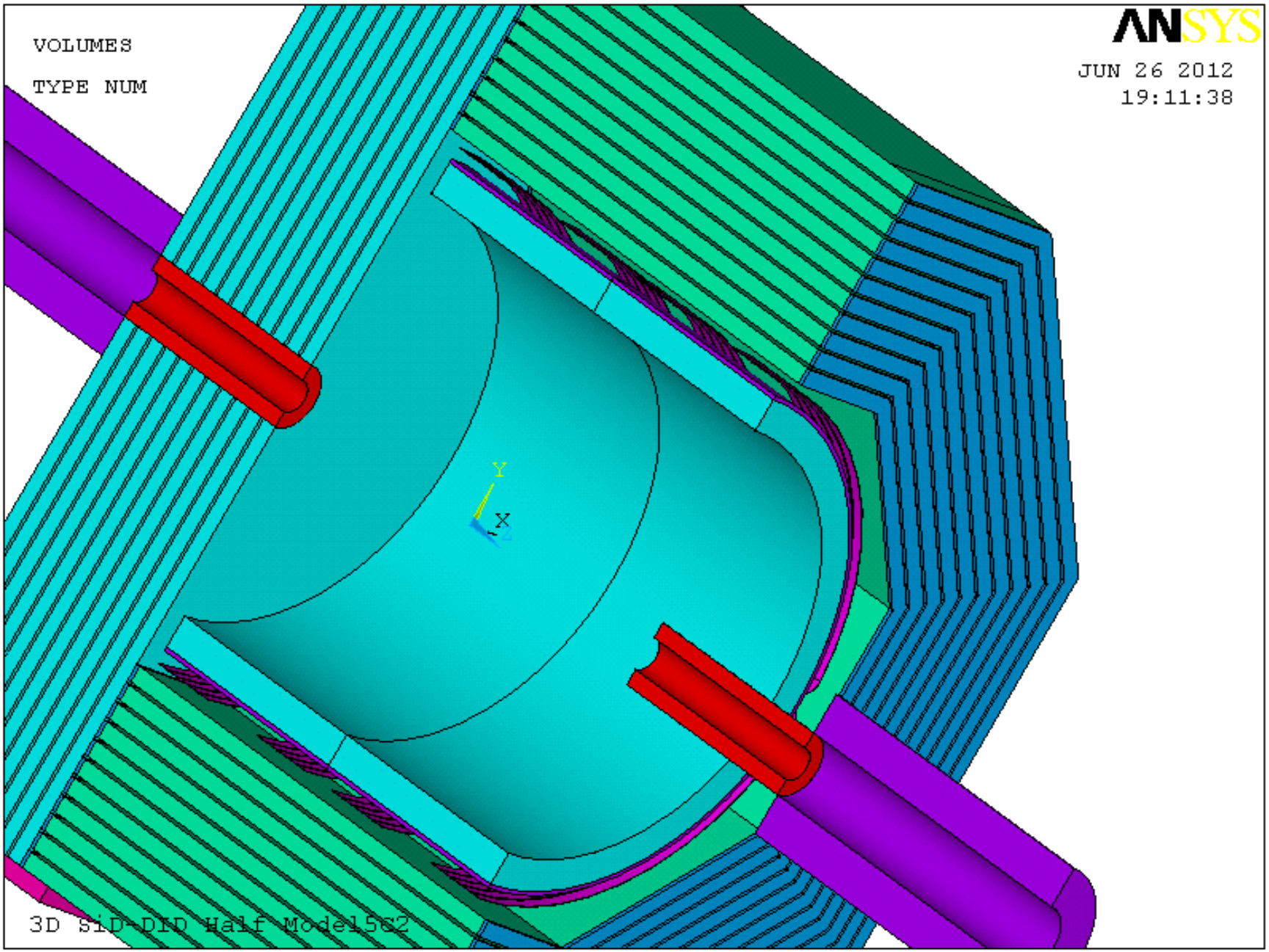
SiD Workshop
Magnet DBD STATUS
SLAC

January 17, 2013

Wes Craddock



Cross Section Showing Volumes

RECENT CHANGES

- A 3D MAGNETIC FIELD MODEL WAS COMPLETELY REVISED AND NOW HAS SUFFICIENT CONVERGENCE
- 3D ANALYSIS PICTURES AND RESULTS PRESENTED IN THE DBD ARE REASONABLE
- PREVIOUS DBD RESULTS FOR PHYSICS ANALYSIS WOULD NOT BE ADEQUATE. NEW RESULTS WOULD BE ADEQUATE
- THE NEW MODELING INCLUDE BARREL/DOOR SPACER PLATES BUT NOT THE CRYOSTAT AND CHIMNEY PENETRATIONS
- AXIAL AND VERTICAL DECENTERING FORCES ARE NOW CALCULATED

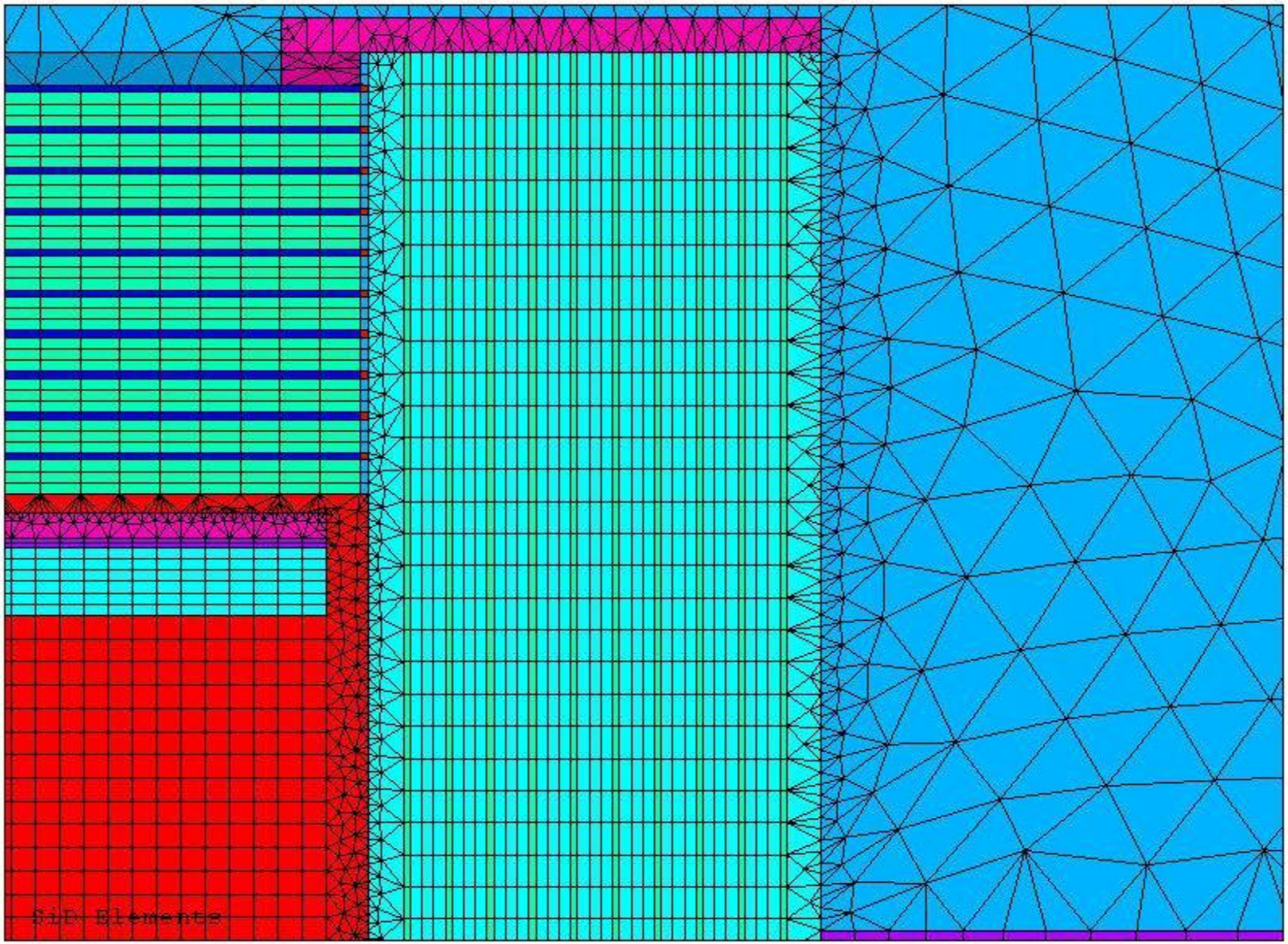
3D ANSYS MAGNETIC ANALYSIS DEVELOPMENT

- ALL 3D ANALYSIS USE EDGE ELEMENT FORMULATION. THIS REDUCES THE VECTOR POTENTIAL DOF FROM 3 TO 1.
- ANALYIS STARTED (DBD RESULTS) WITH 1 MILLION, MOSTLY HEXAHEDRA (Brick) ELEMENTS using a 8 GB memory PC.
- REFINEMENT CONTINUED WITH A 64 GB memory PC UP TO A MODEL SIZE OF 4.5 MILLION HEXAHEDRA ELEMENTS
- (12 million nodes) WITHOUT SUFFICIENT CONVERGENCE.
- PROBLEM APPEARS TO BE CREATION OF PYRAMID (degenerate hexahedra) ELEMENTS in high field and gradient volumes that transition from hexahedra to tetrahedra.
- THE 167 VOLUMES WERE REMESHED WITH PRIMARILY TETRAHEDRA ELEMENTS (6.4 M elements and 9 M nodes) WITH SATISFACTORY RESULTS. Solution time = 24 hours (still out of core).

3D ANSYS MAGNETIC RESULTS cont.

- 3D MAGNETIC AXIAL SPRING CONSTANT = 1870 kN/cm
  2D MAGNETIC AXIAL SPRING CONSTANT = 1830 kN/cm

- 3D MAGNETIC VERTICAL SPRING CONSTANT = 278 kN/cm
  2D MAGNETIC VERTICAL SPRING CONSTANT = 380 kN/cm

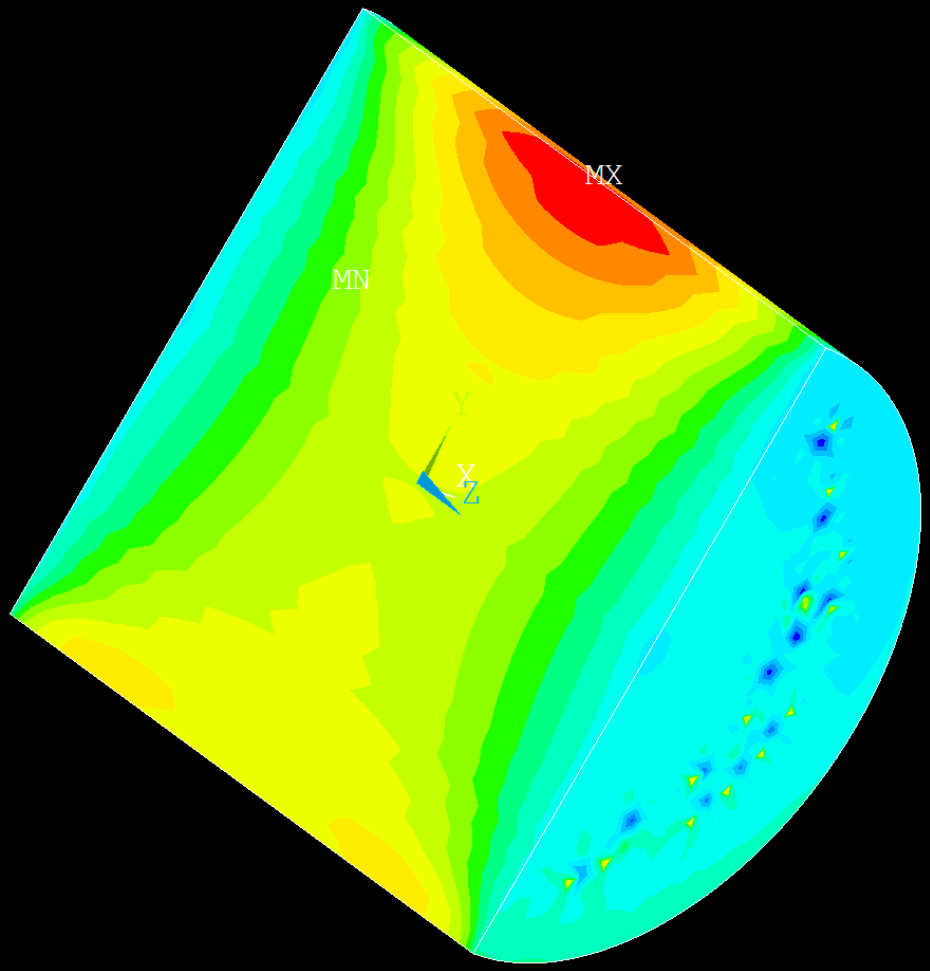


Previous 1 million hexahedra mesh model

ANSYS
R14.5

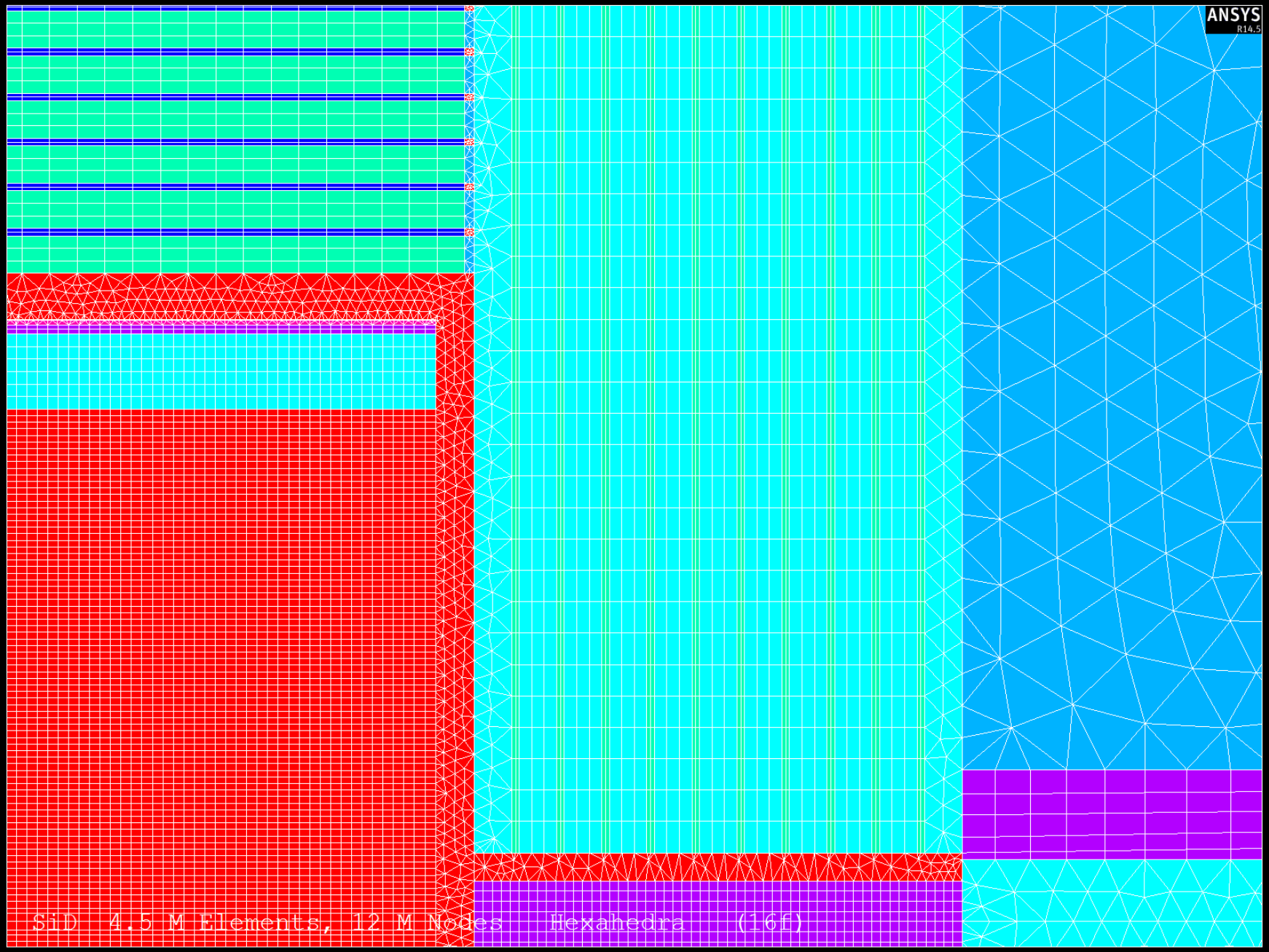
NODAL SOLUTION

STEP=1
SUB =1
TIME=1
BSUM (AVG)
RSYS=0
SMN =3.2009
SMX =5.87527

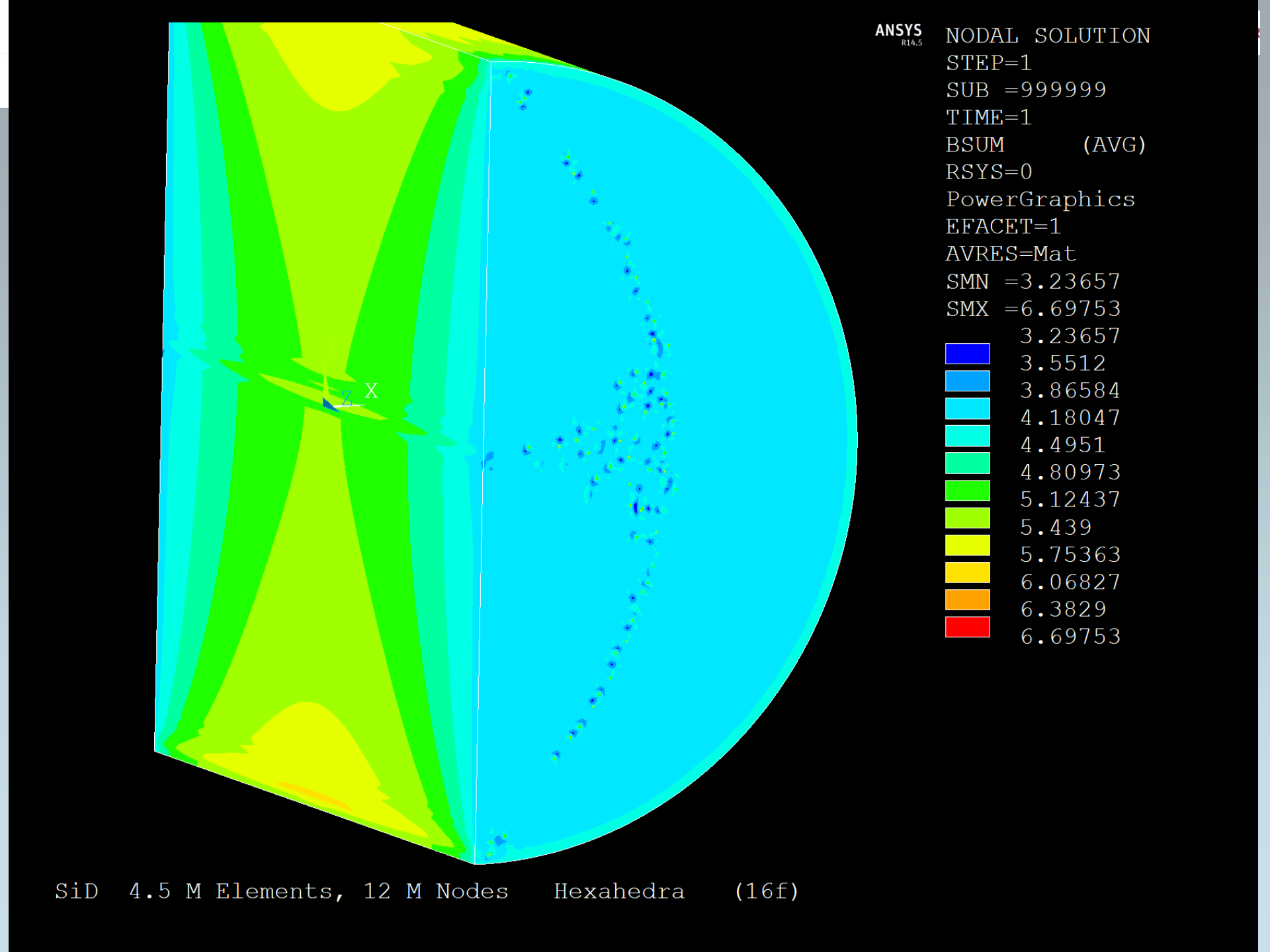


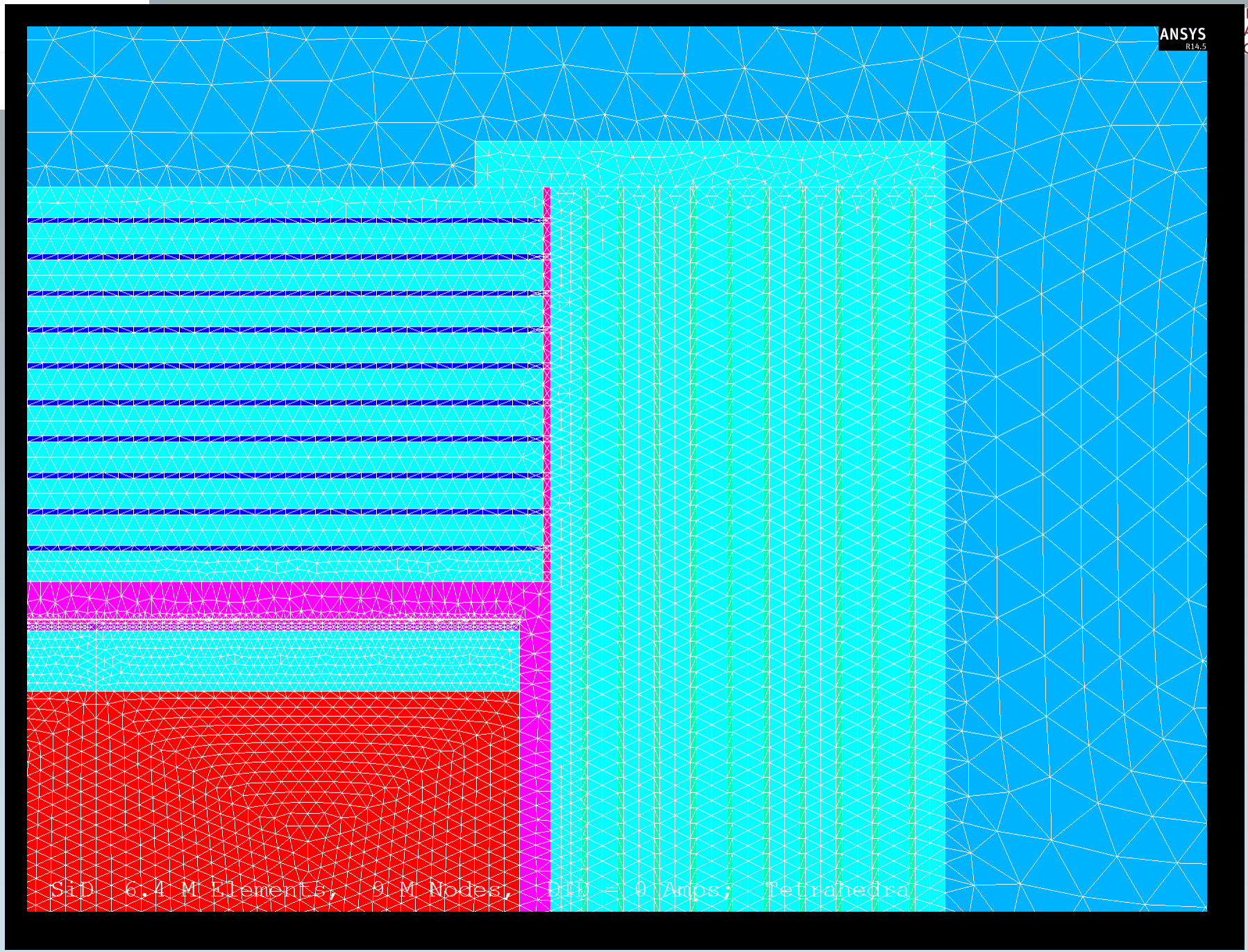
3.2009
3.55749
3.91407
4.27065
4.62723
4.98382
5.3404
5.69698
5.87527

SiD 1.1 M Elements / 2.9 M Nodes Hexahedra

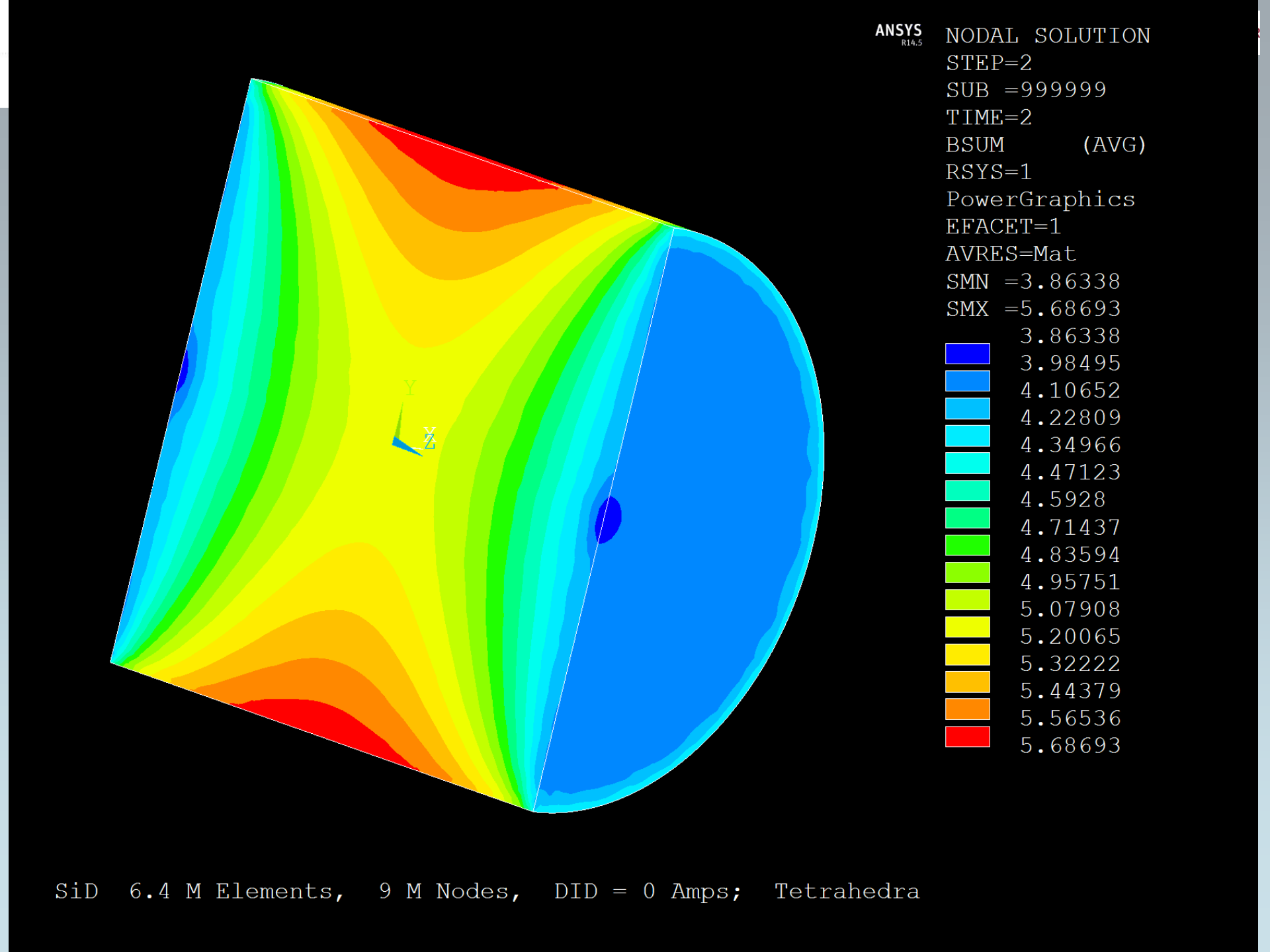


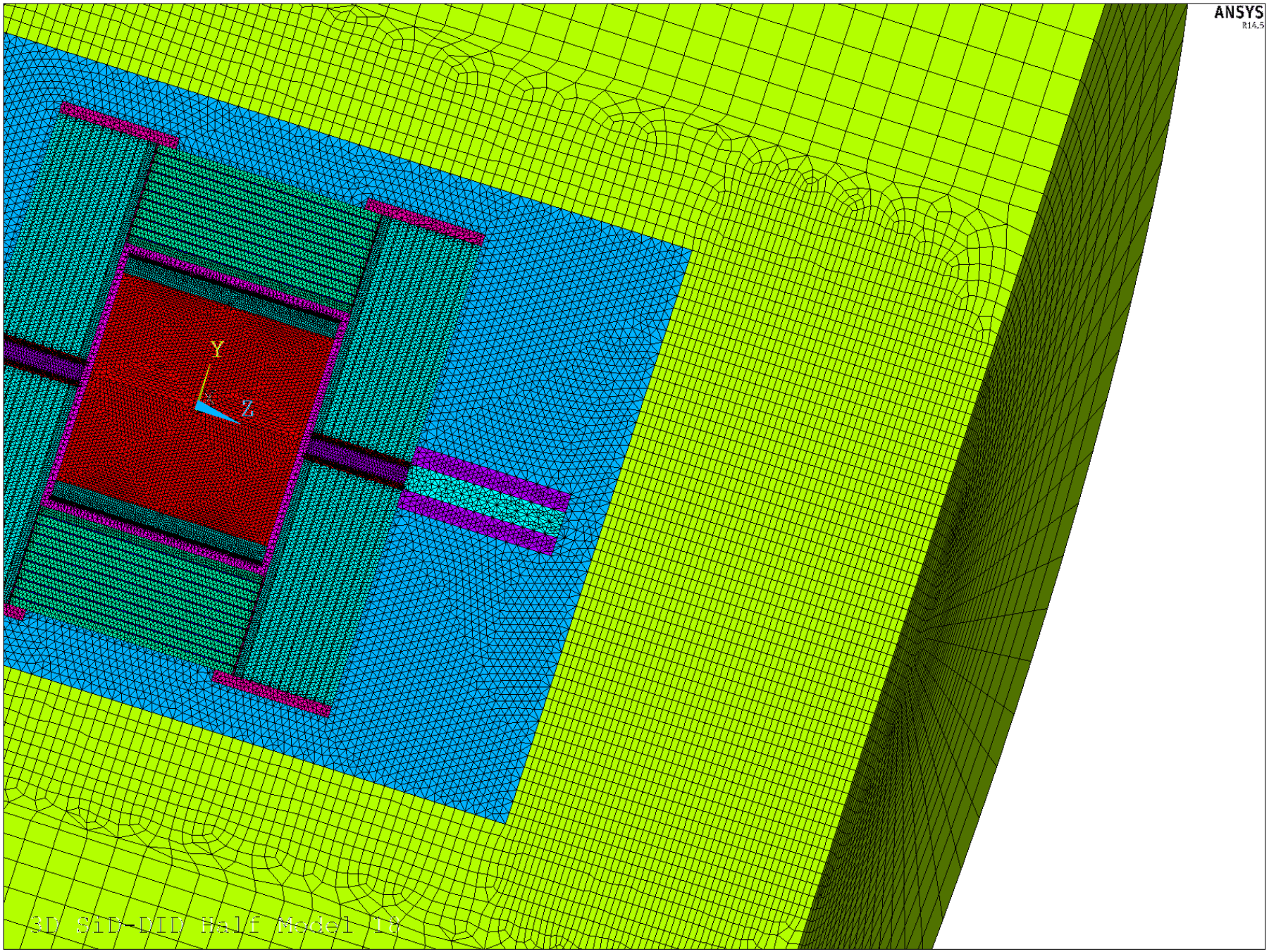
4.5 Million Elements & 12 Million Nodes (Hexahedra Mesh)


ANSYS
R14.5
NODAL SOLUTION
STEP=1
SUB =999999
TIME=1
BSUM (AVG)
RSYS=0
PowerGraphics
EFACET=1
AVRES=Mat
SMN =3.23657
SMX =6.69753
3.23657
3.5512
3.86584
4.18047
4.4951
4.80973
5.12437
5.439
5.75363
6.06827
6.3829
6.69753
Y
Z
X
SiD 4.5 M Elements, 12 M Nodes Hexahedra (16f)

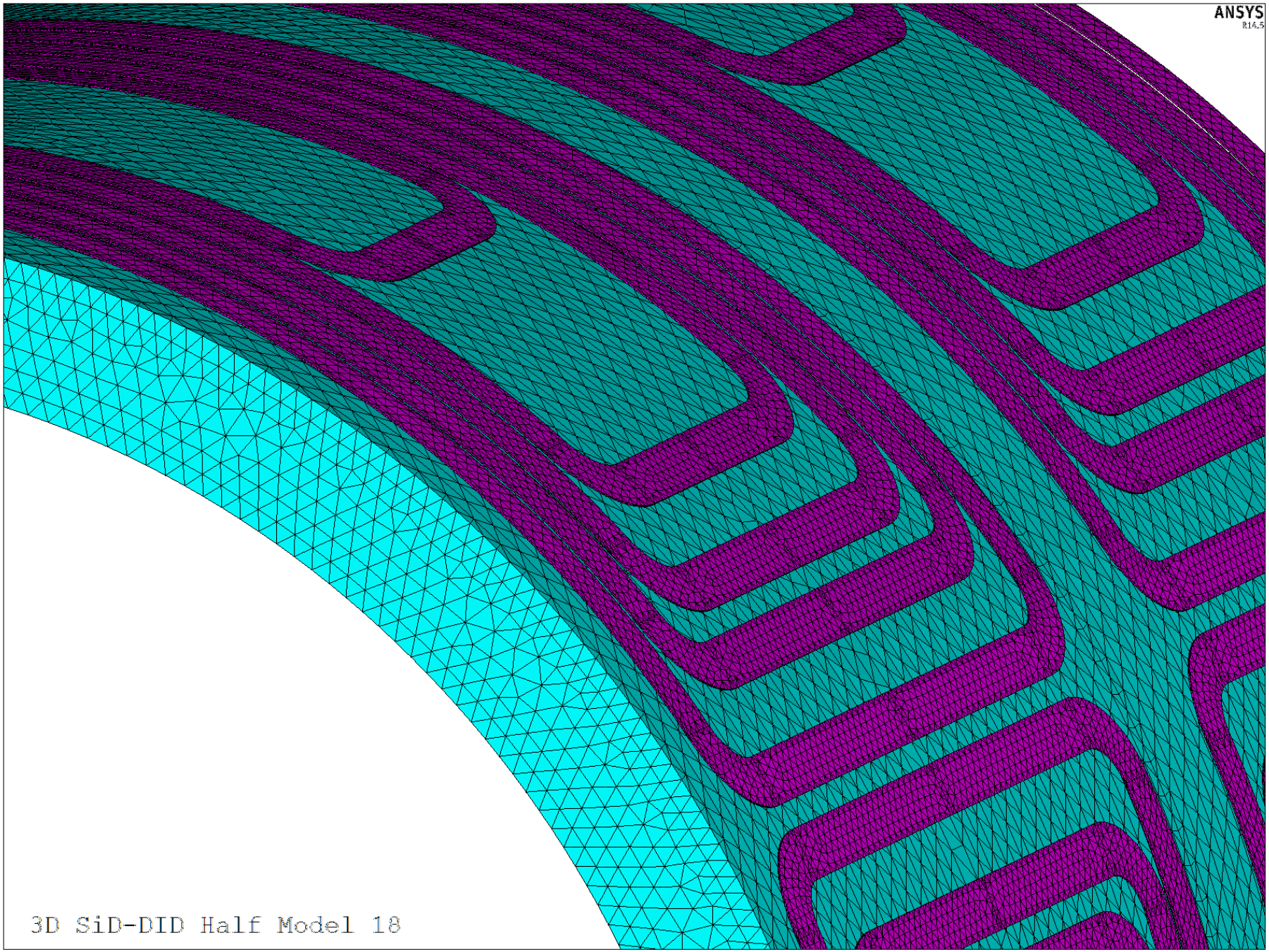


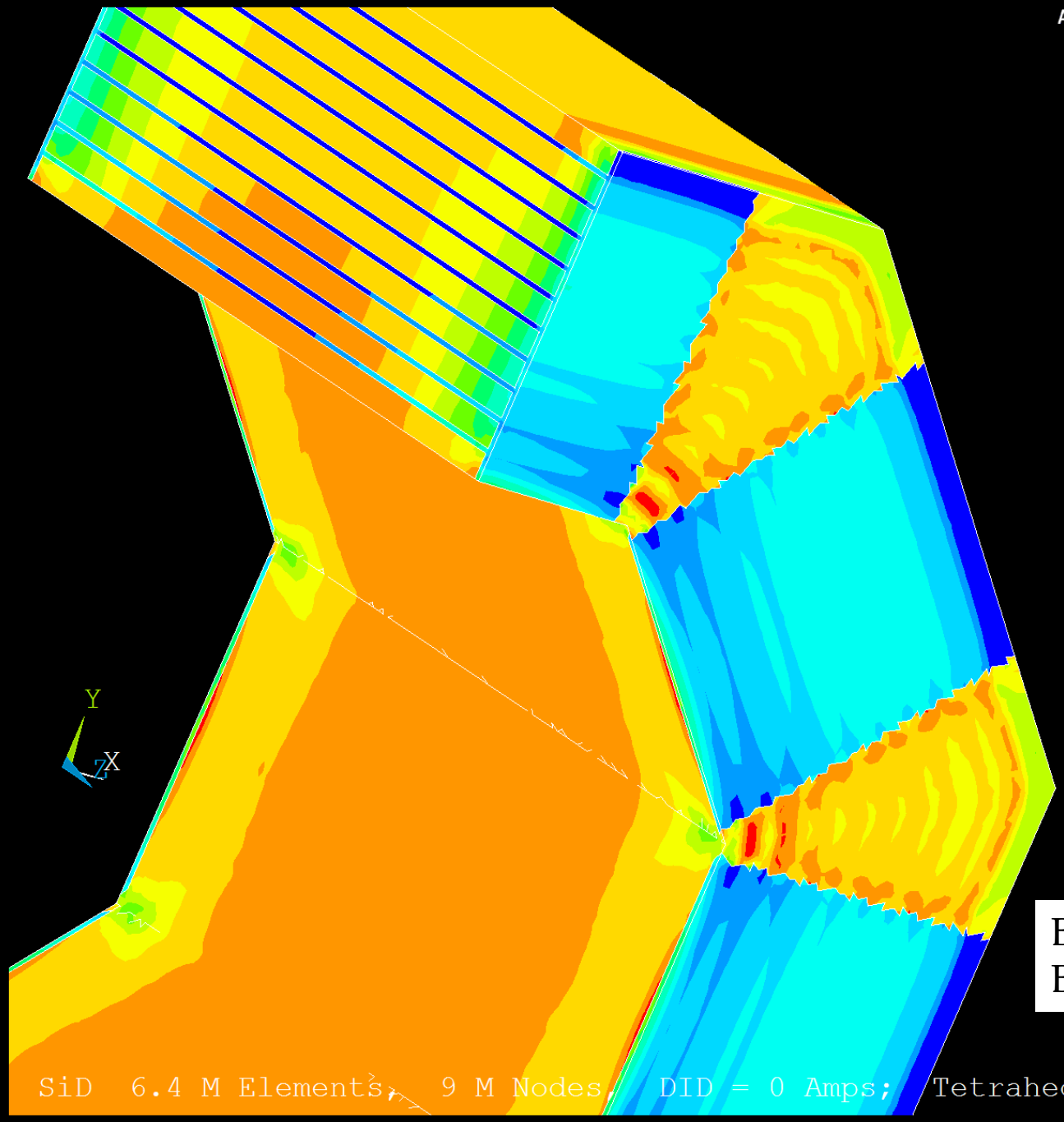
6.4 Million Elements & 9 Million Nodes (Tetrahedra Mesh)


ANSYS
R14.5
NODAL SOLUTION
STEP=2
SUB =999999
TIME=2
BSUM (AVG)
RSYS=1
PowerGraphics
EFACET=1
AVRES=Mat
SMN =3.86338
SMX =5.68693
3.86338
3.98495
4.10652
4.22809
4.34966
4.47123
4.5928
4.71437
4.83594
4.95751
5.07908
5.20065
5.32222
5.44379
5.56536
5.68693
Y
Z
X
SiD 6.4 M Elements, 9 M Nodes, DID = 0 Amps; Tetrahedra



6.4 Million Elements & 9 Million Nodes (Tetrahedra Mesh)


ANSYS
R14.5
3D SiD-DID Half Model 18



B Field Showing
Barrel/Door Gap Plates

CONCLUSIONS

- **A PARAMETERIZED 3D MAGNETIC FIELD MODEL WAS CREATED THAT SHOULD BE SUFFICIENT FOR ENGINEERING DESIGN. This model could be easily adapted for any SiD/DID type of magnet.**

- **WOULD HAVE BEEN NICE FOR DBD:**
- **BH Curves for actual iron.**
- **Additional iron plates for required fringe field reduction.**
- **Refinement in the DID region for peak field on the DID conductor.**
- **Chimney penetrations for localized fringe fields.**
- **Input magnet force results into solenoid, DID and iron plate stress and deflection ANSYS analysis.**
- **Magnetic energy calculation. Will be available with ANSYS 15 (towards end of 2013).**

- **FUTURE ANALYSIS WAY BEYOND THE DBD:**
  A full 3D model for horizontal decentering forces.

  Transient analysis to predict DID quenching of solenoid.