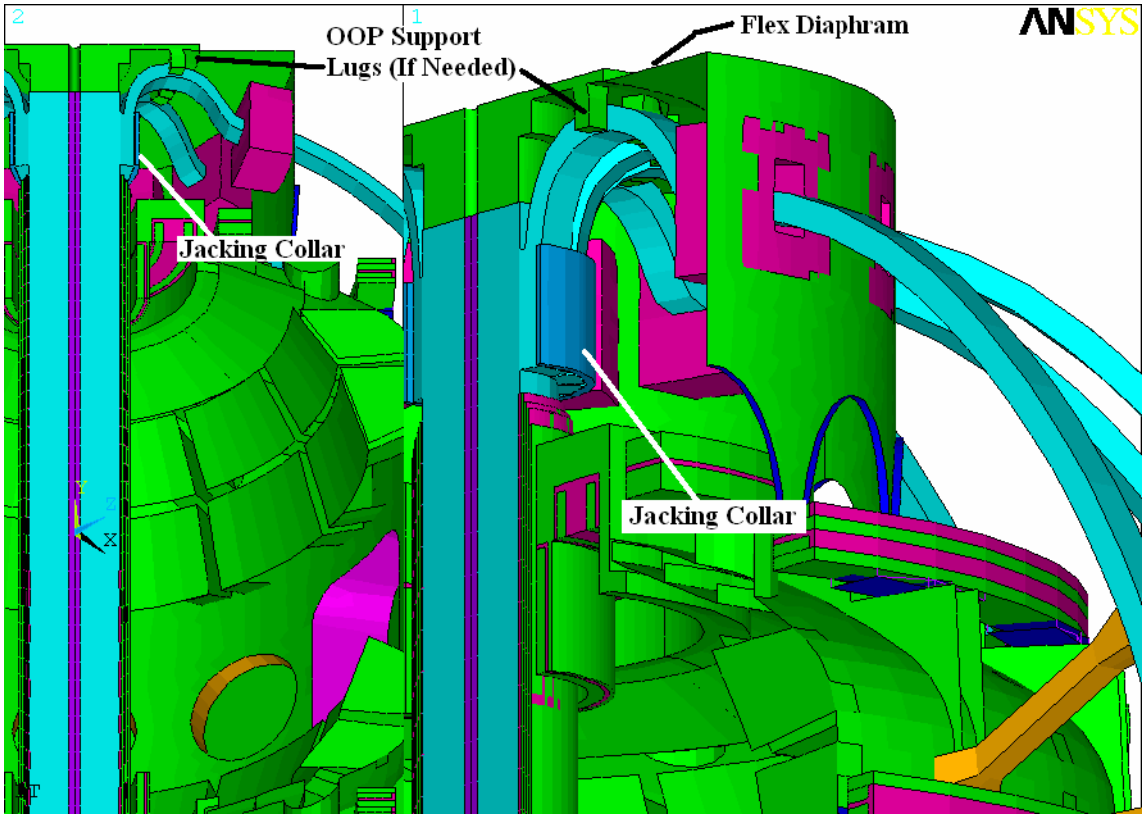
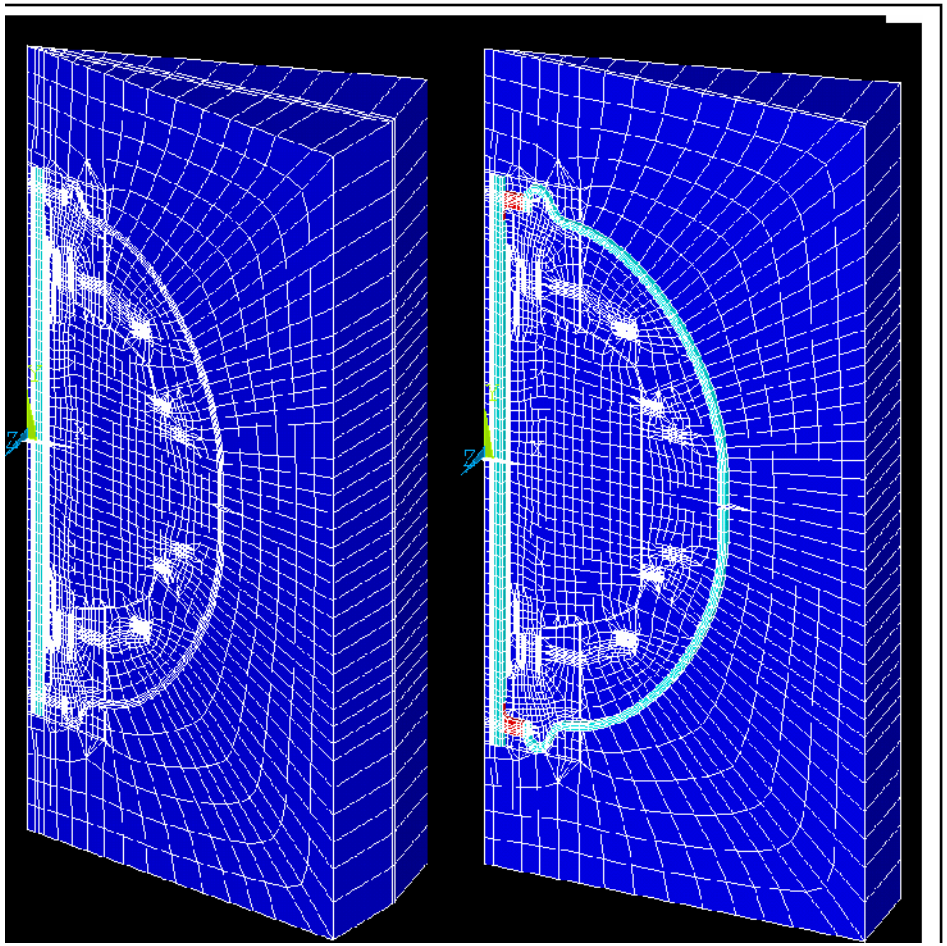
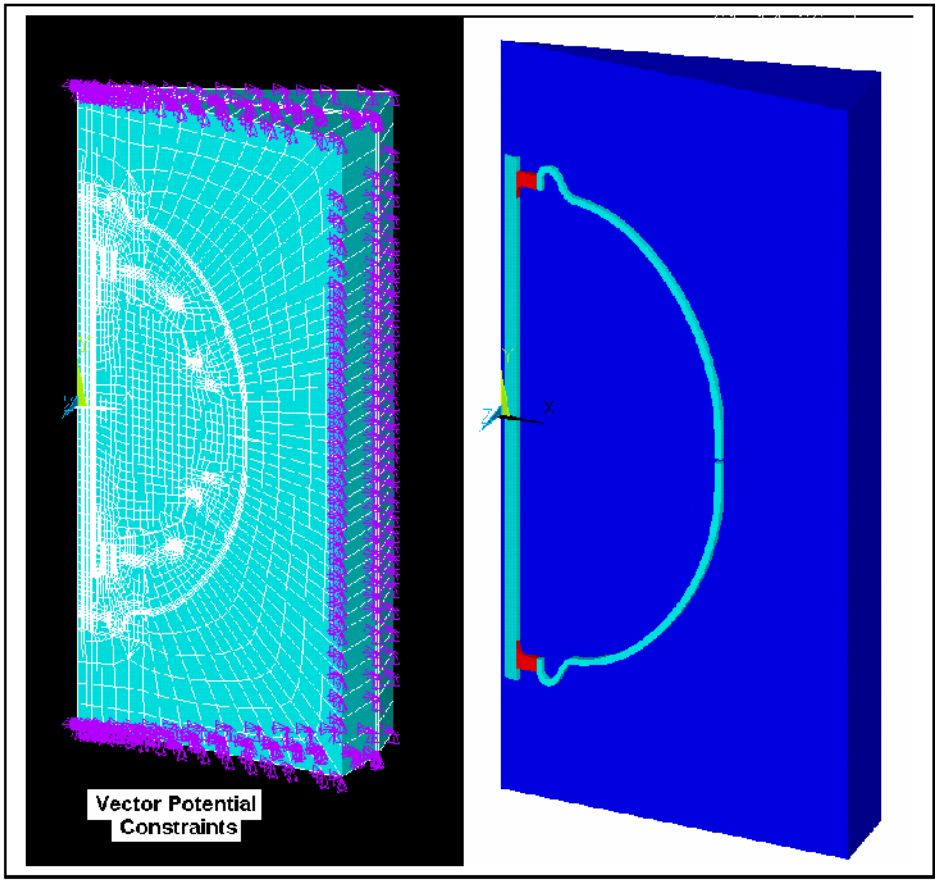
NSTX Joint Conference Call
Peter H. Titus, Thursday February 26 2009

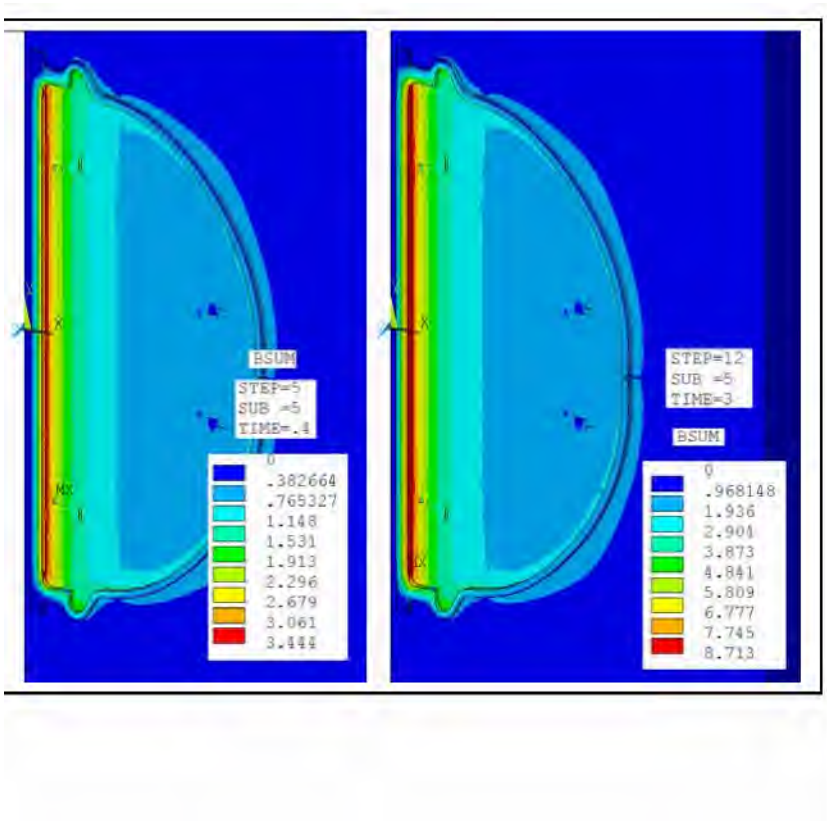


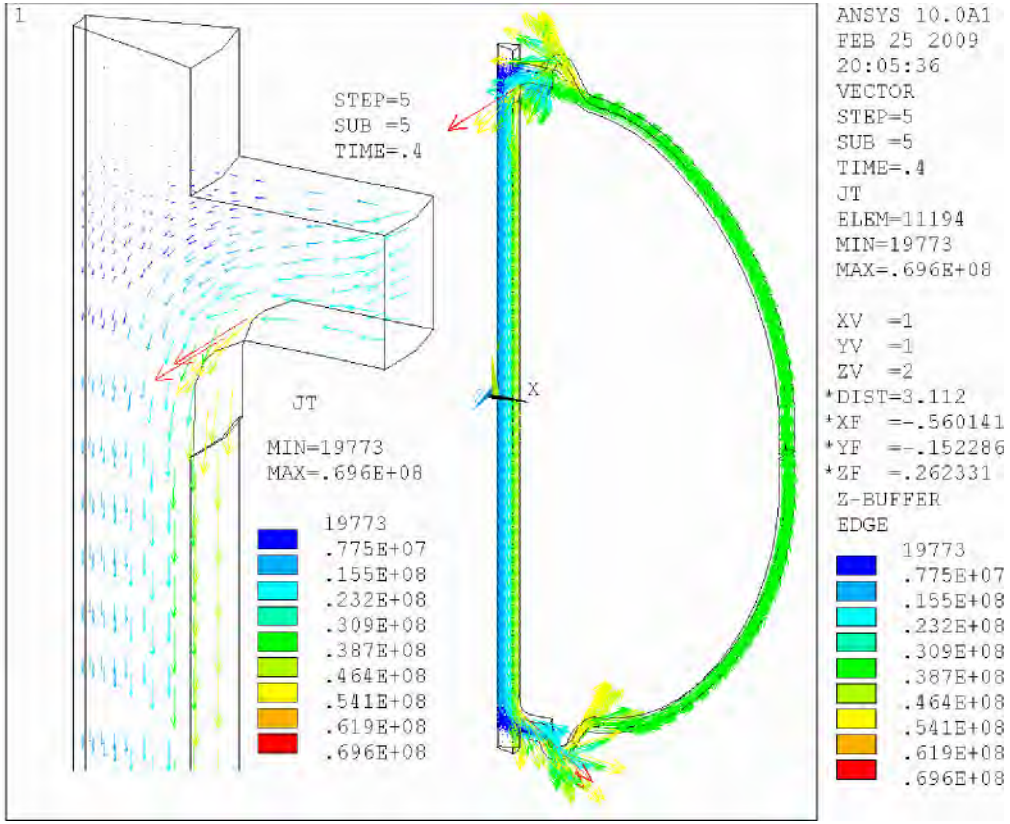
First Phil's Joint:
Coupled Electromagnic-Thermal Analysis Then a Stress Pass with an LDREAD of Lorentz Forces and Temperatures

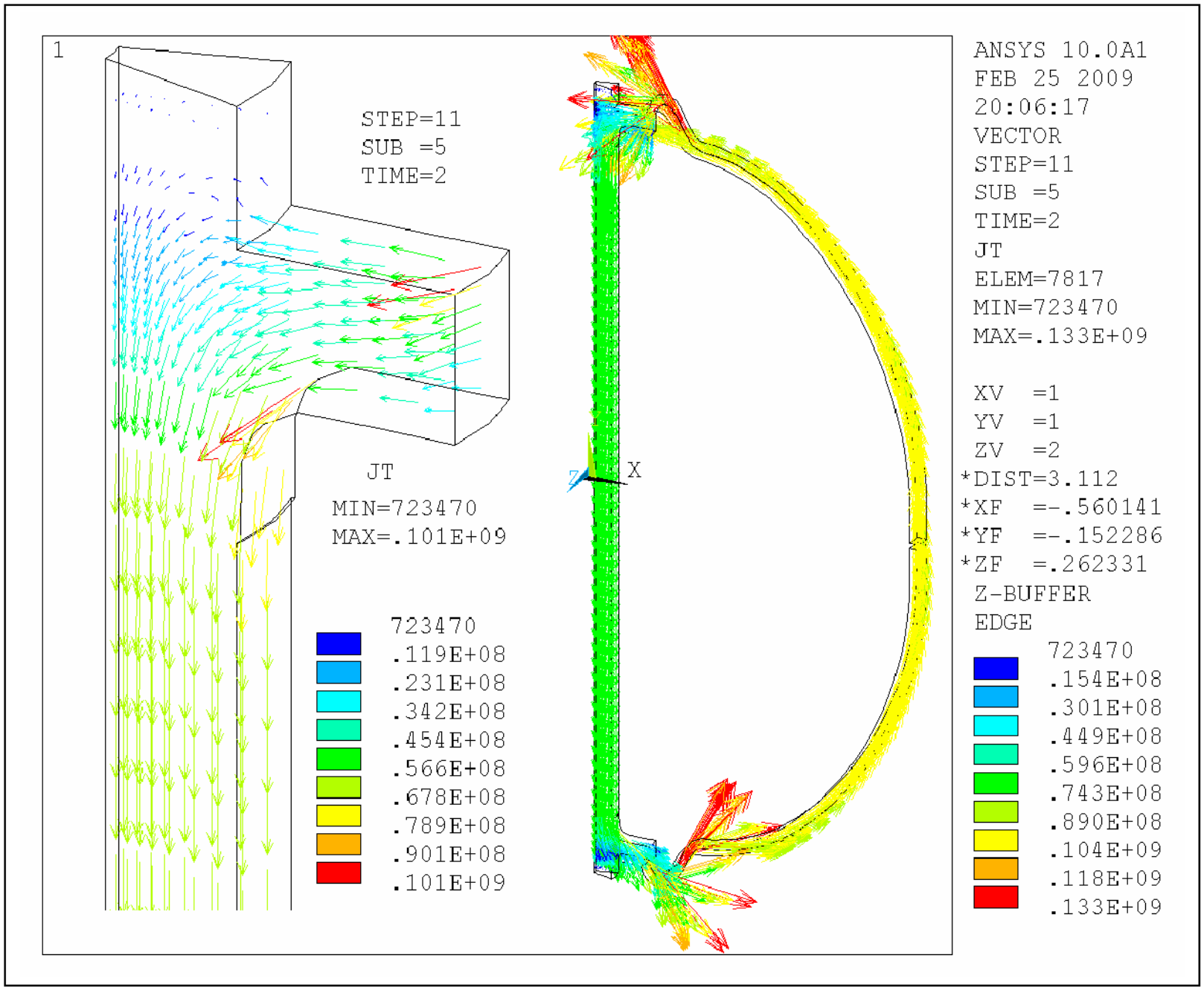




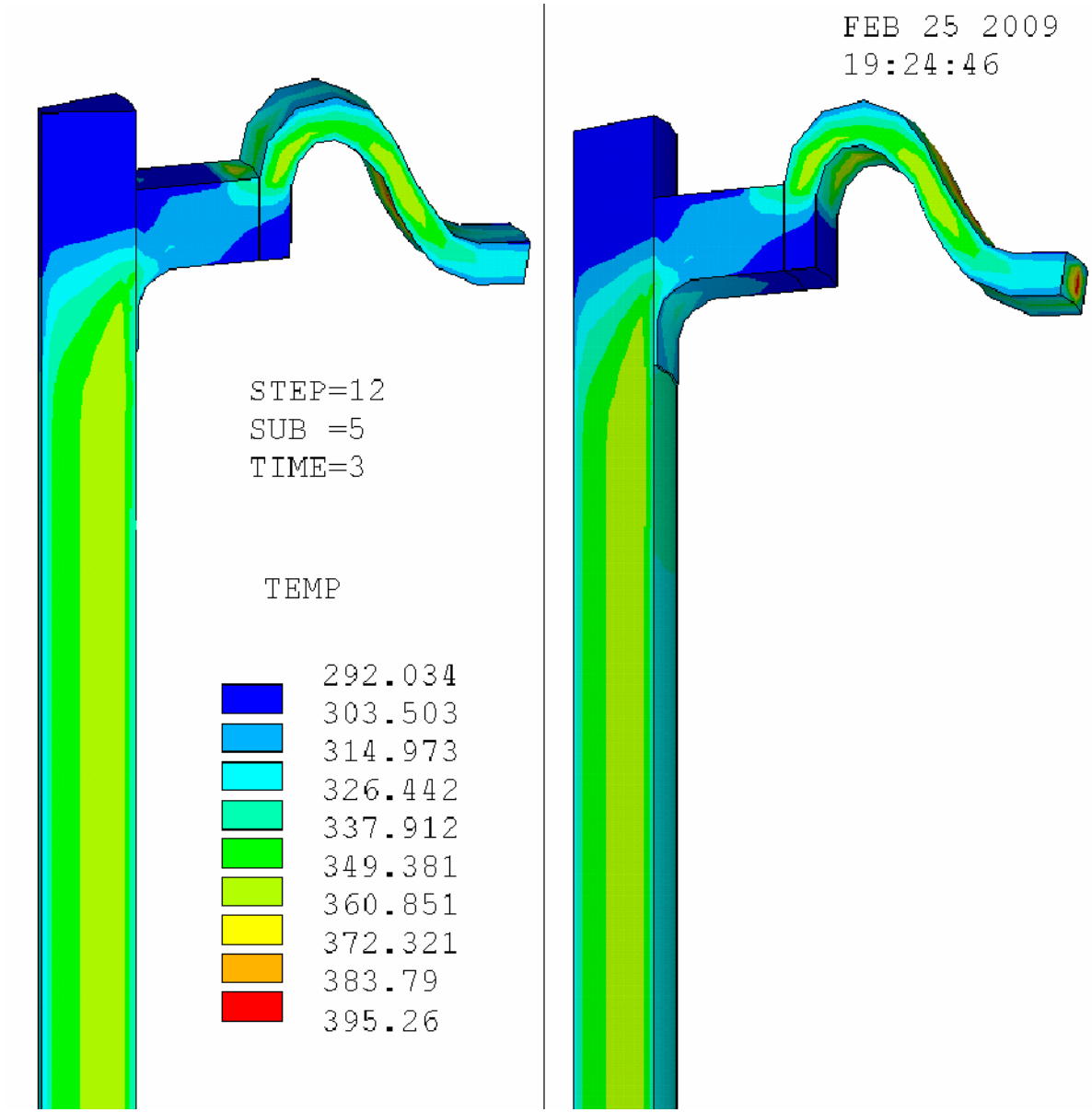
B Field and Current Density Results



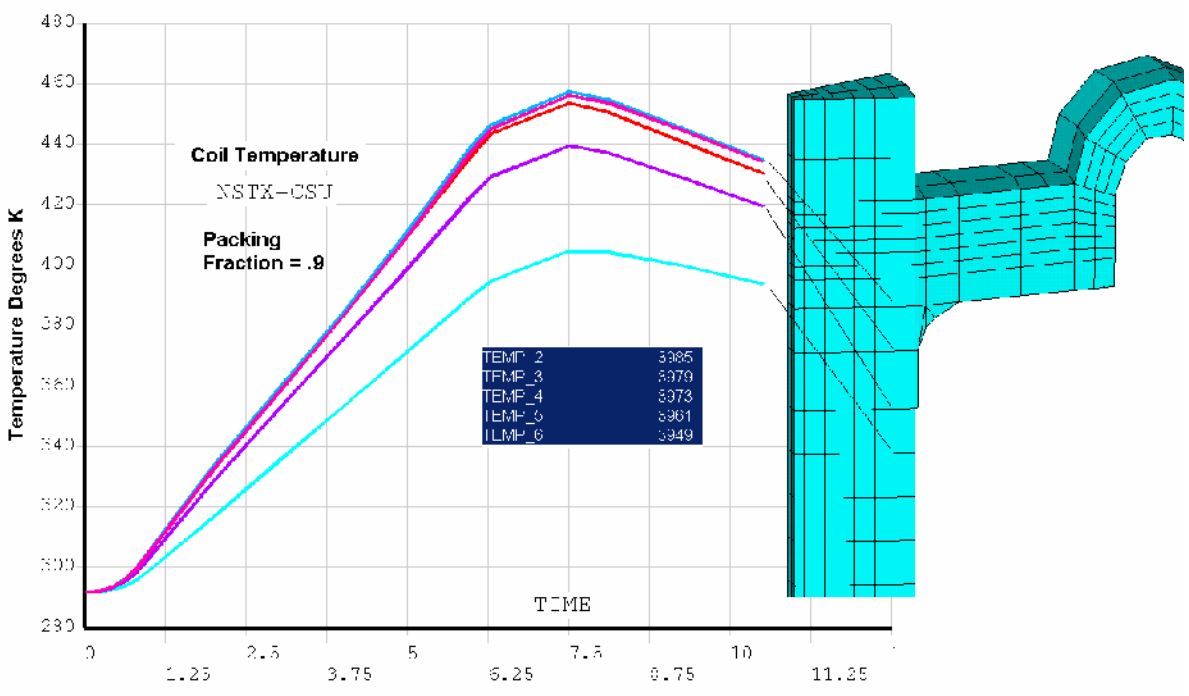


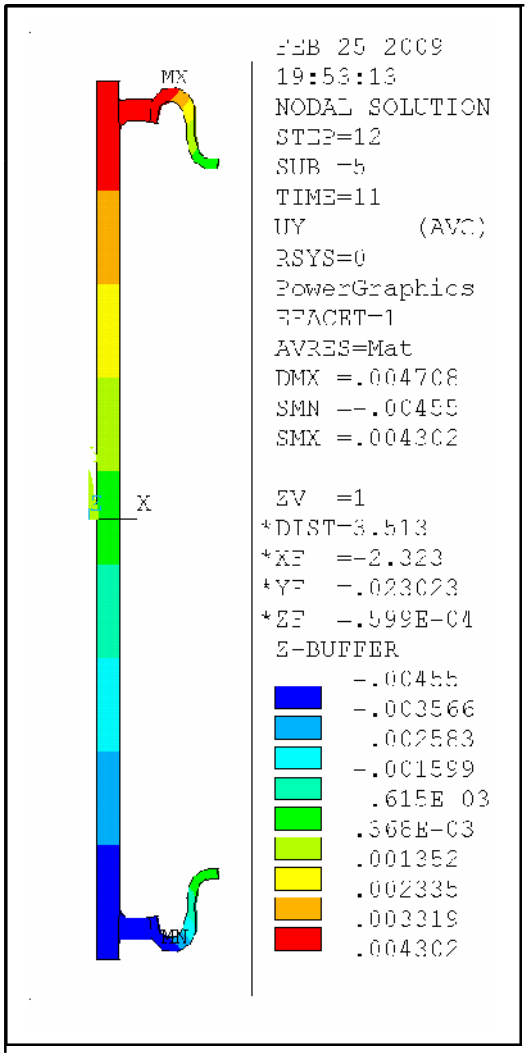

1
STEP=11
SUB =5
TIME=2
JT
MIN=723470
MAX=.101E+09
723470
.119E+08
.231E+08
.342E+08
.454E+08
.566E+08
.678E+08
.789E+08
.901E+08
.101E+09
Z
X
ANSYS 10.0A1
FEB 25 2009
20:06:17
VECTOR
STEP=11
SUB =5
TIME=2
JT
ELEM=7817
MIN=723470
MAX=.133E+09
XV =1
YV =1
ZV =2
*DIST=3.112
*XF =-.560141
*YF =-.152286
*ZF =.262331
Z-BUFFER
EDGE
723470
.154E+08
.301E+08
.449E+08
.596E+08
.743E+08
.890E+08
.104E+09
.118E+09
.133E+09

Thermal Results

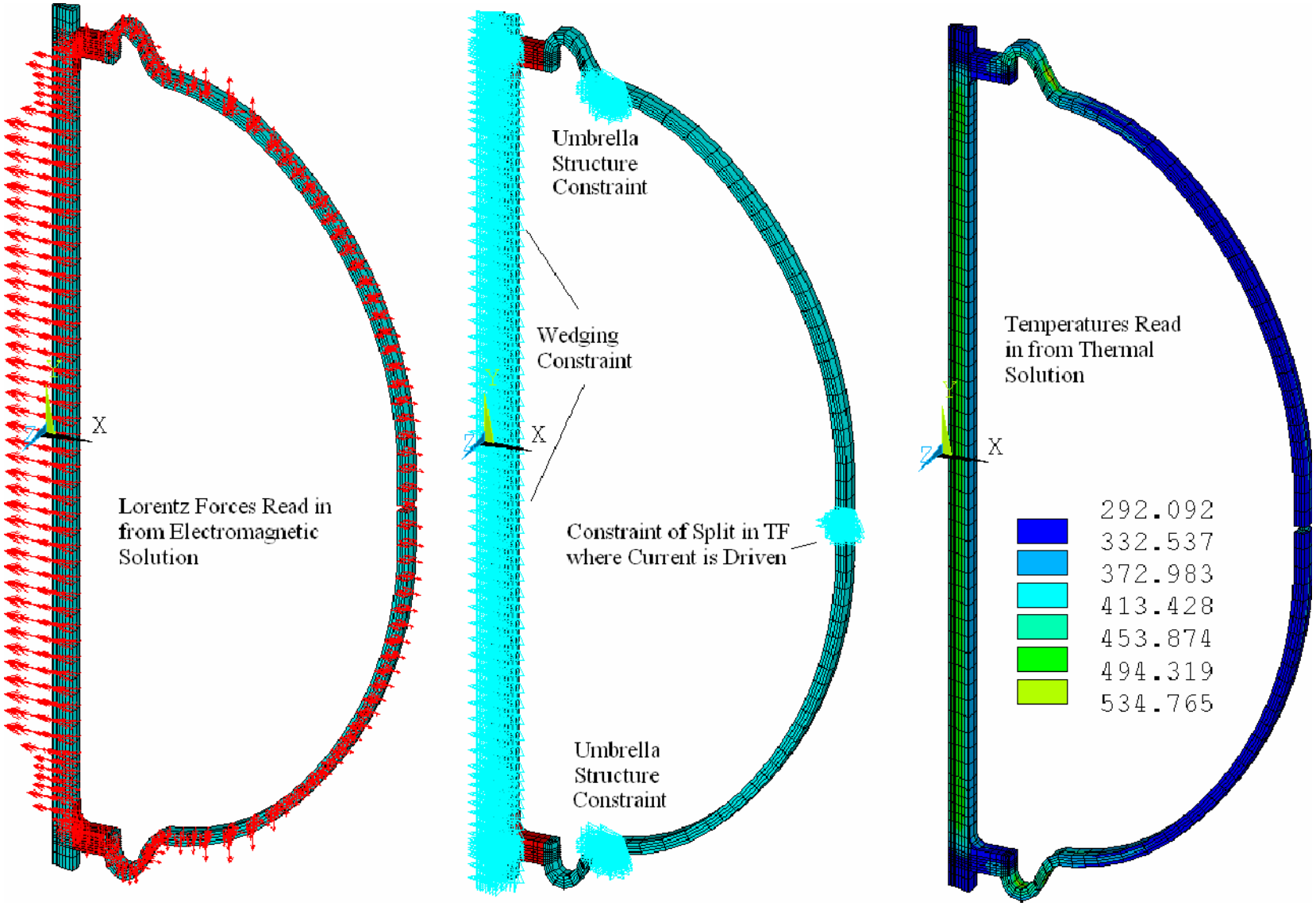


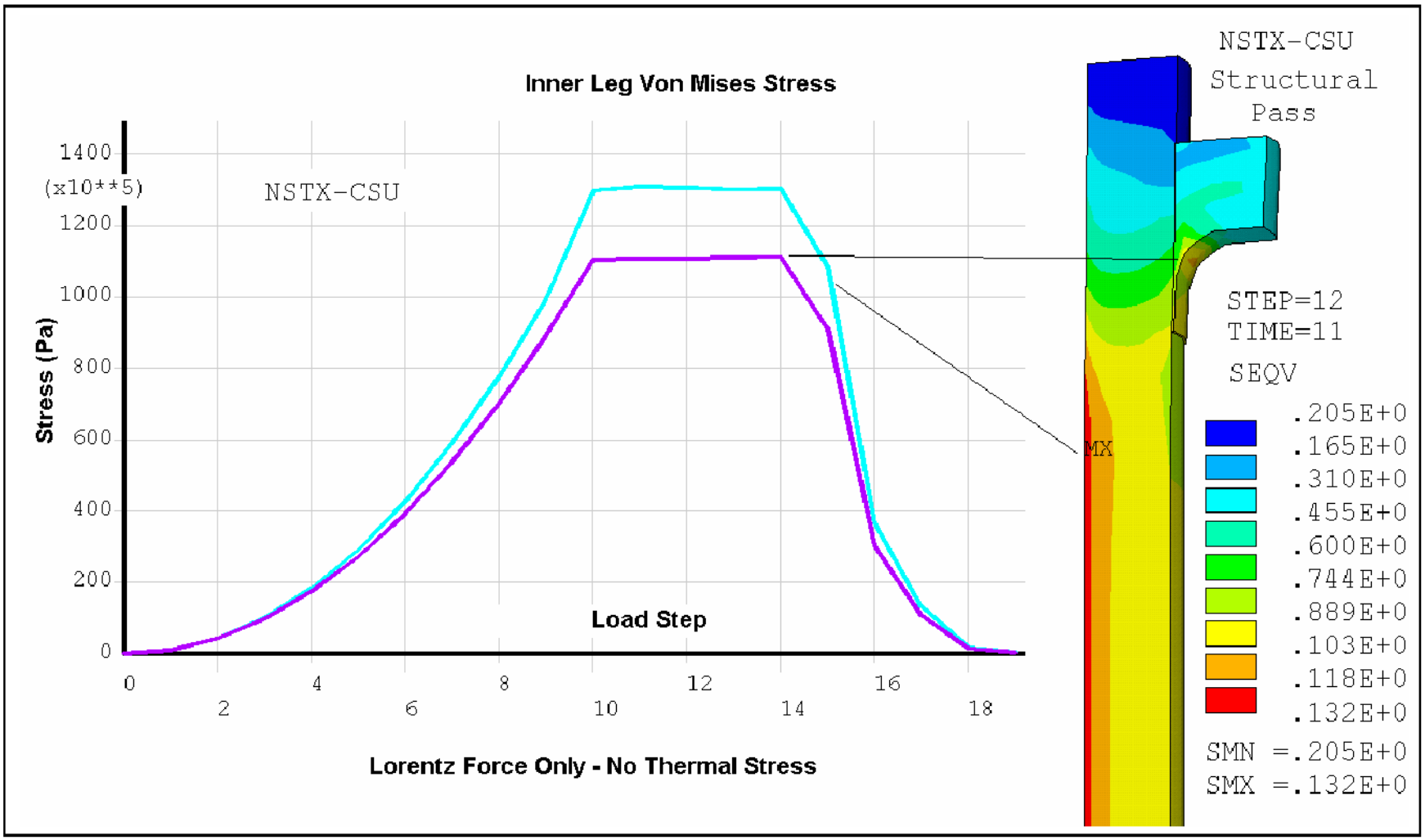
Average Inner Leg Temp is Supposed to be 100C or 373 K

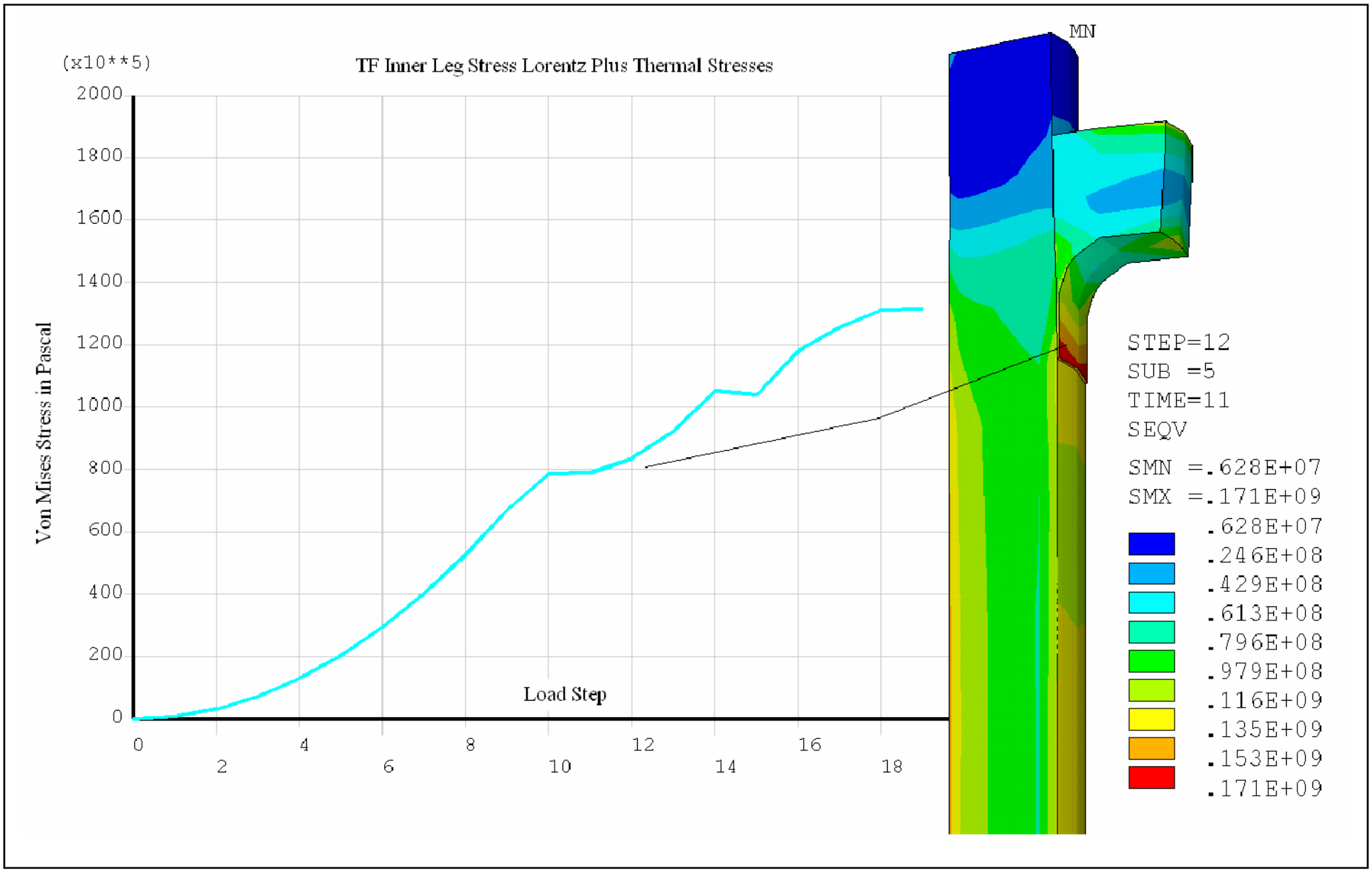




Structural Pass

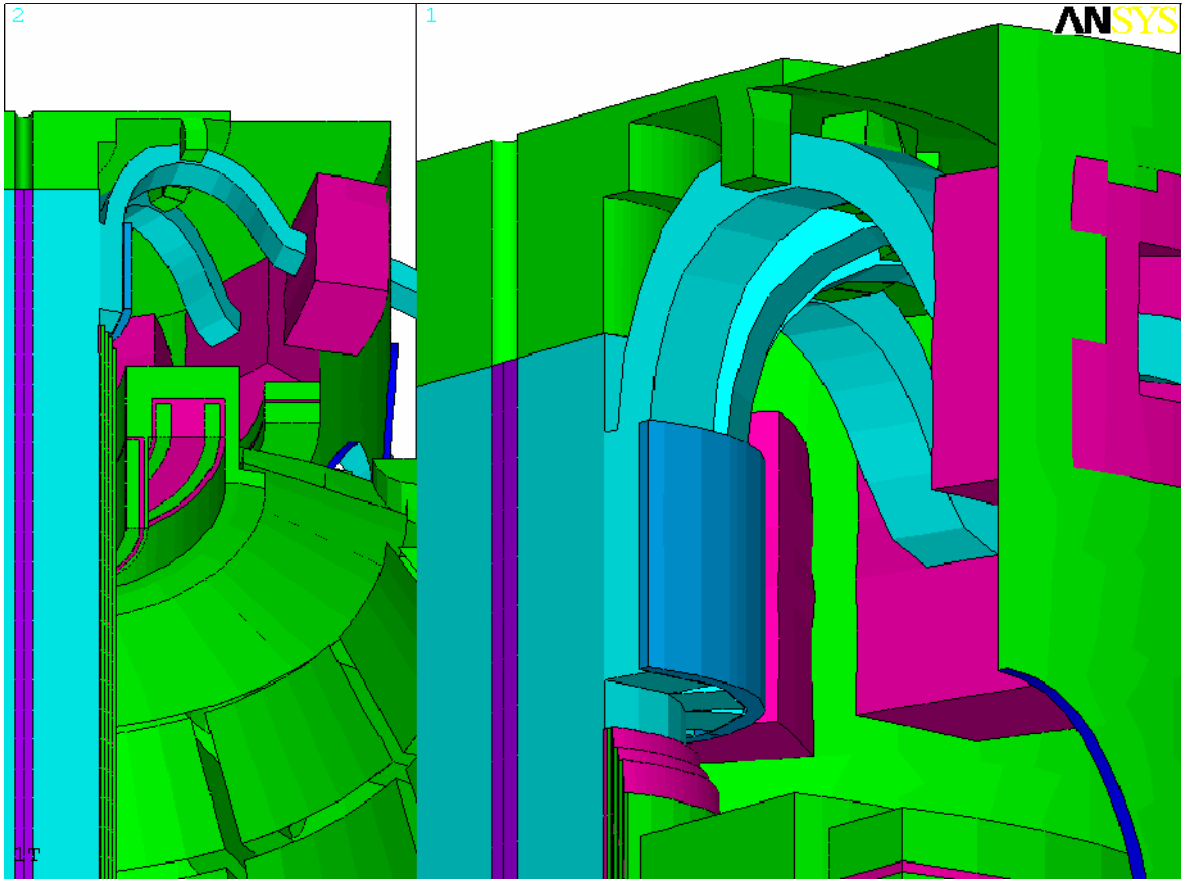



Inner Leg Von Mises Stress
NSTX-CSU
(x10**5)
1400
1200
1000
800
600
400
200
0
Stress (Pa)
0
2
4
6
8
10
12
14
16
18
Load Step
Lorentz Force Only - No Thermal Stress
NSTX-CSU
Structural
Pass
STEP=12
TIME=11
SEQV
.205E+0
.165E+0
.310E+0
.455E+0
.600E+0
.744E+0
.889E+0
.103E+0
.118E+0
.132E+0
SMN =.205E+0
SMX =.132E+0
MX

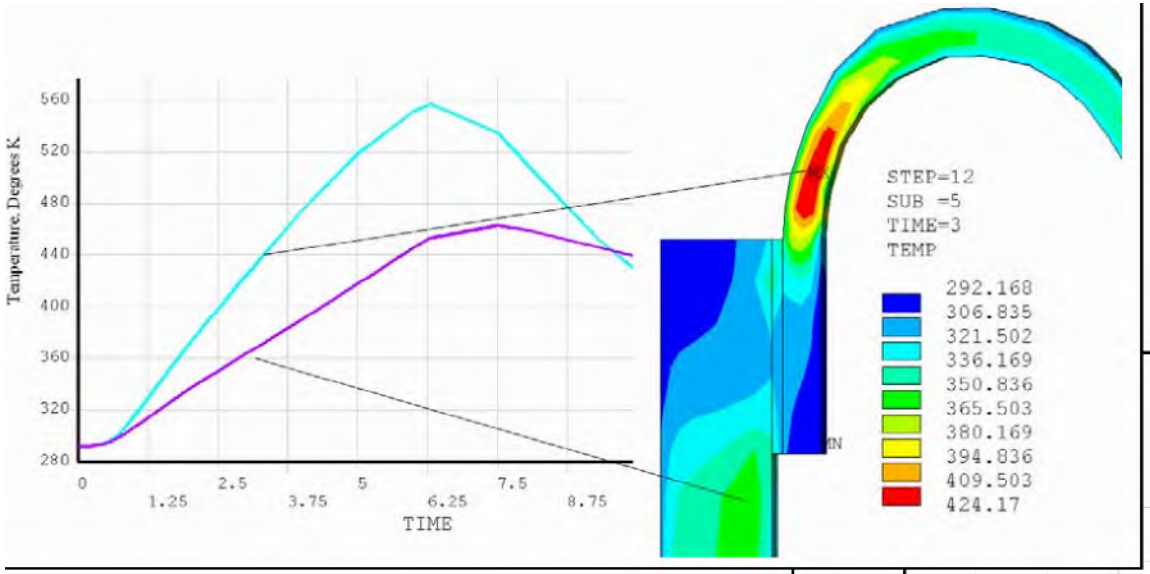

TF Inner Leg Stress Lorentz Plus Thermal Stresses
(x10**5)
Von Mises Stress in Pascal
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
2
4
6
8
10
12
14
16
18
Load Step
MN
STEP=12
SUB =5
TIME=11
SEQV
SMN =.628E+07
SMX =.171E+09
.628E+07
.246E+08
.429E+08
.613E+08
.796E+08
.979E+08
.116E+09
.135E+09
.153E+09
.171E+09

Next, the Titus-Woolley-? Joint

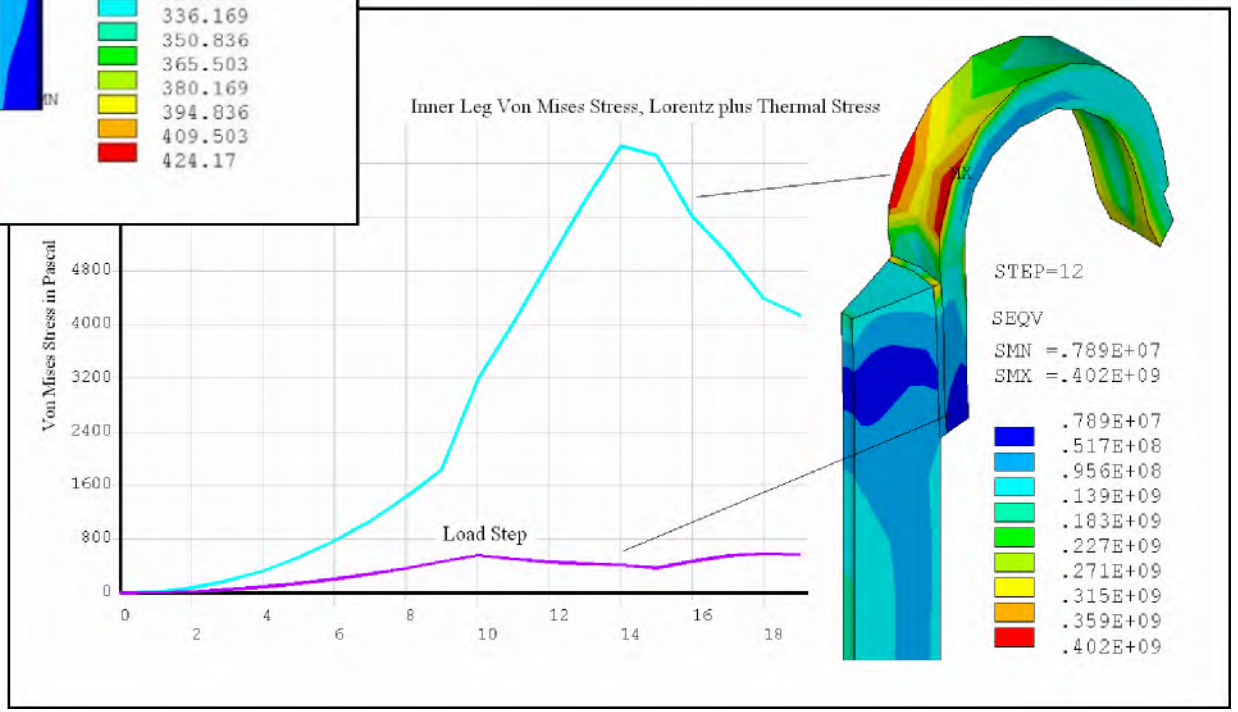
- **Jacking Ring**
- **Big Constant Tesion (Sort-of) Expansion Loop**



Titus-Woolley-? Joint Electromagnetic-Thermal Analysis

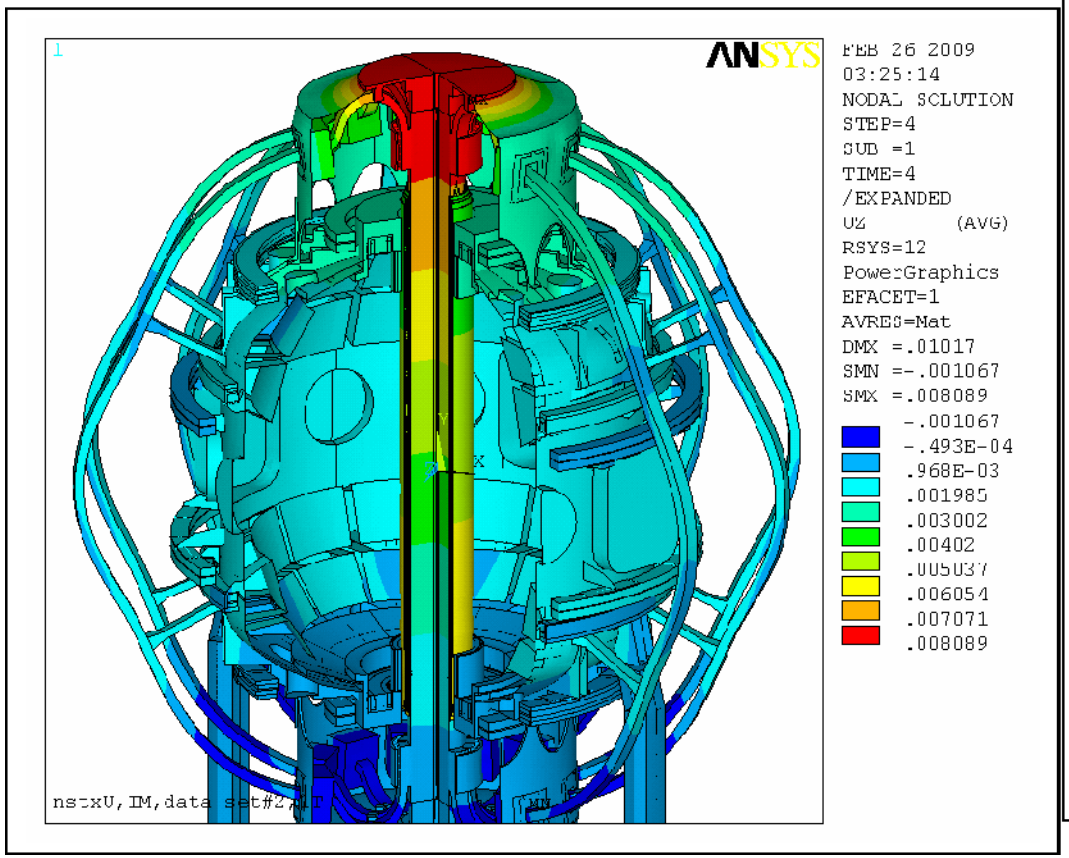


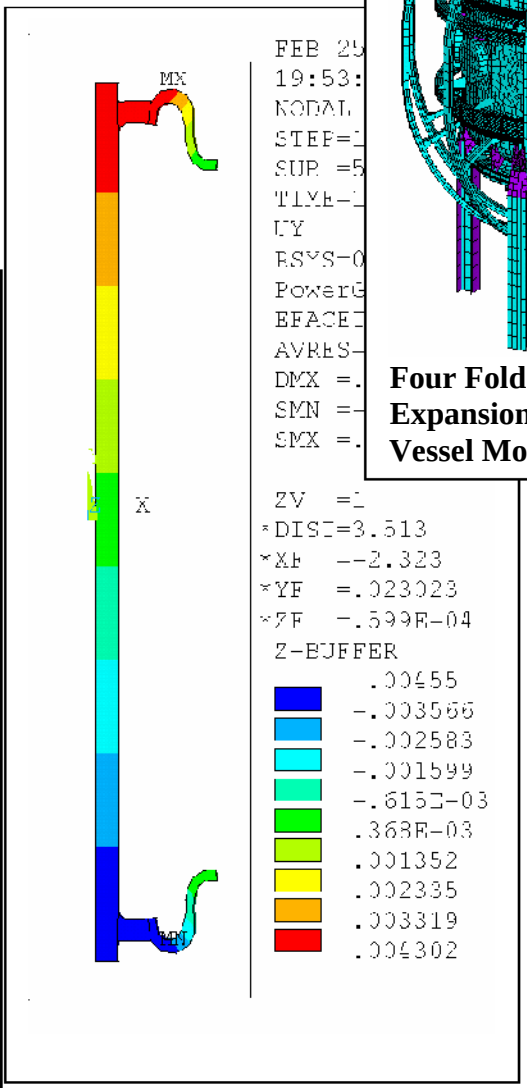
Much of the stress in the loop appears to be a result of the thermal gradient.

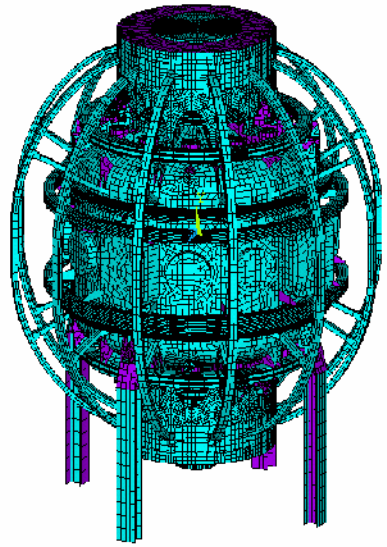


Global Structural Modeling of the Titus-Woolley-? Joint

- **This time the inner leg is at 100C temp and the outer leg is at 50C**
- **Integrated central column expansion is close to the electromagnetic thermal diffusion model**

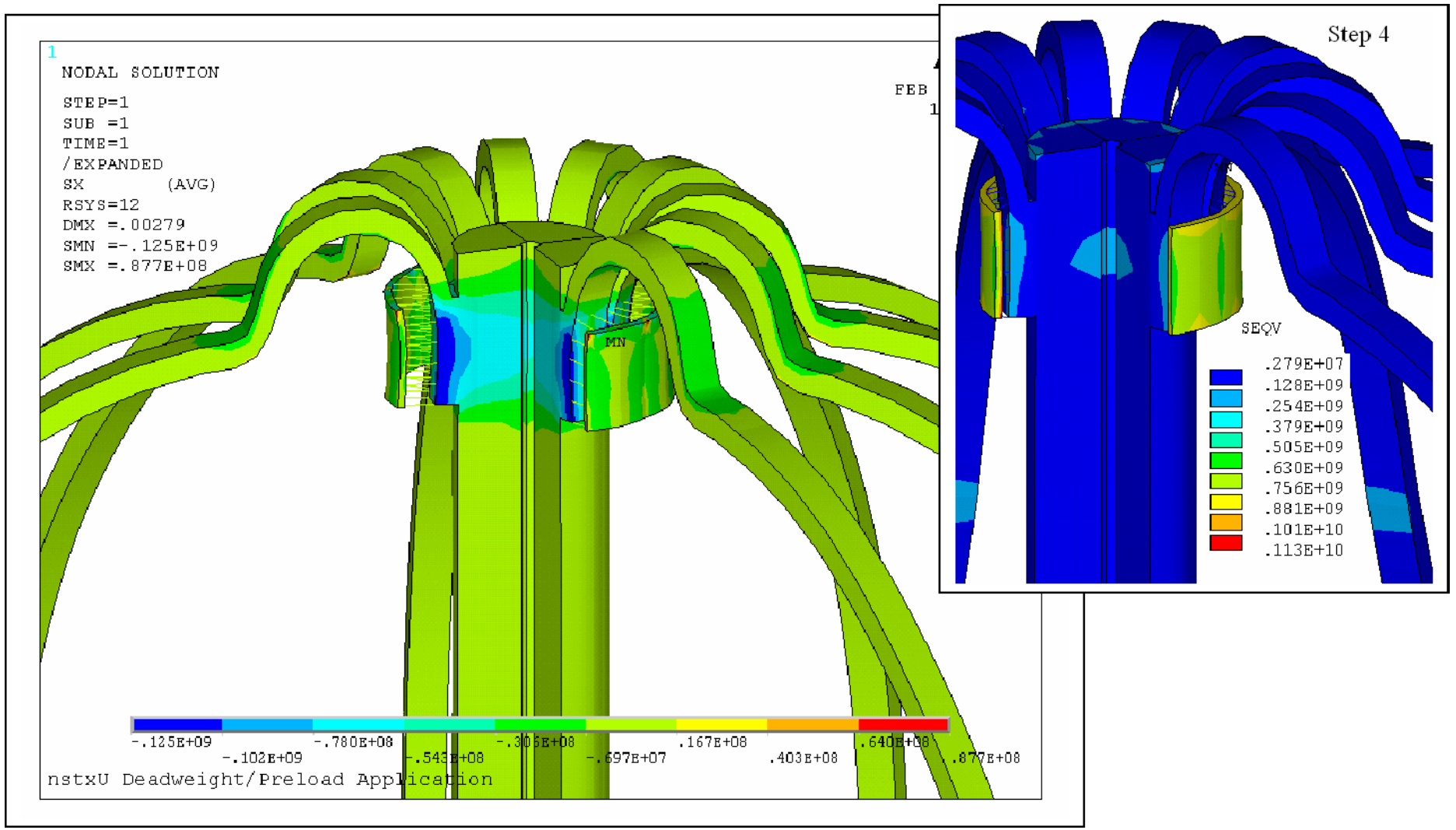




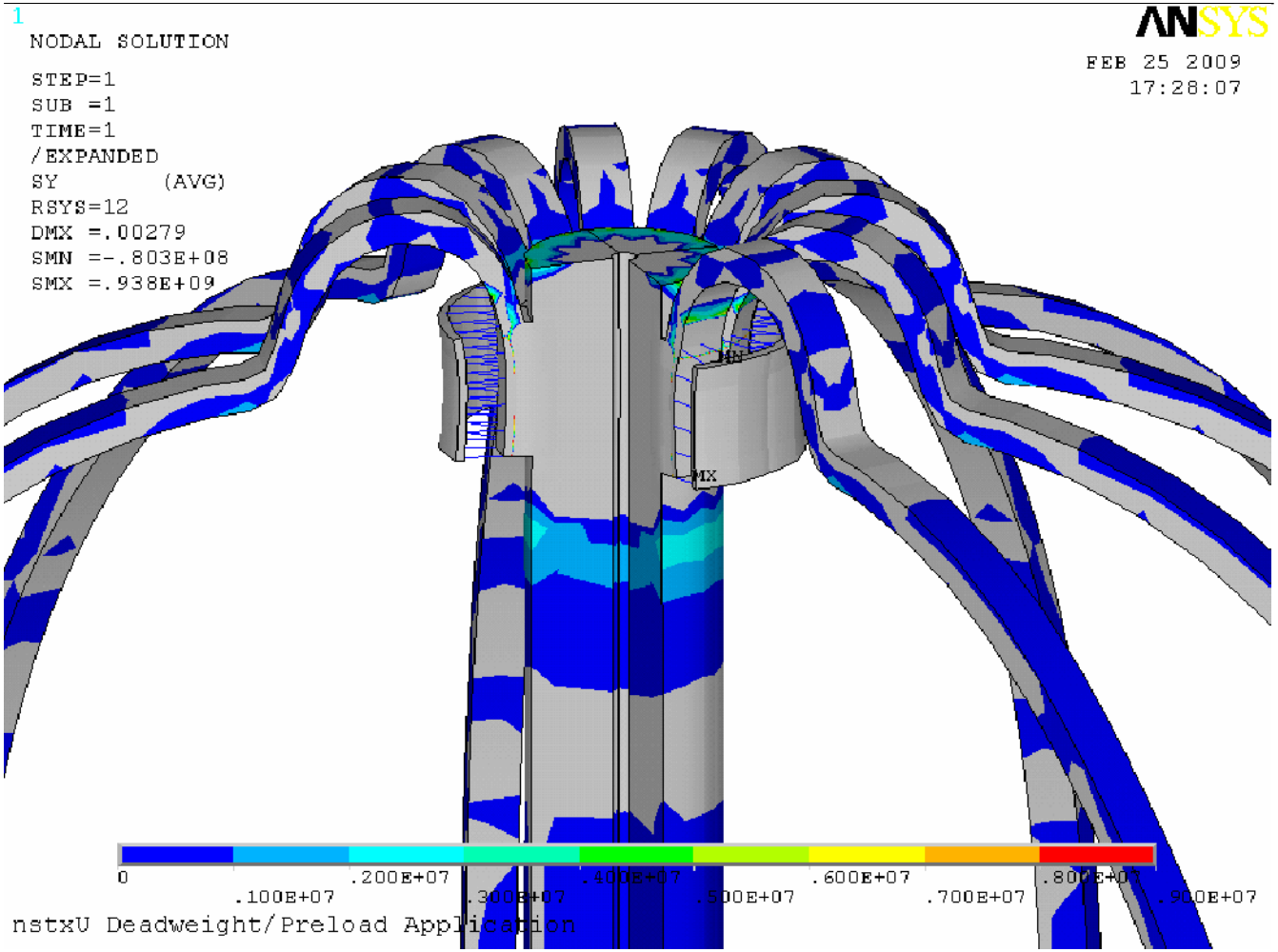


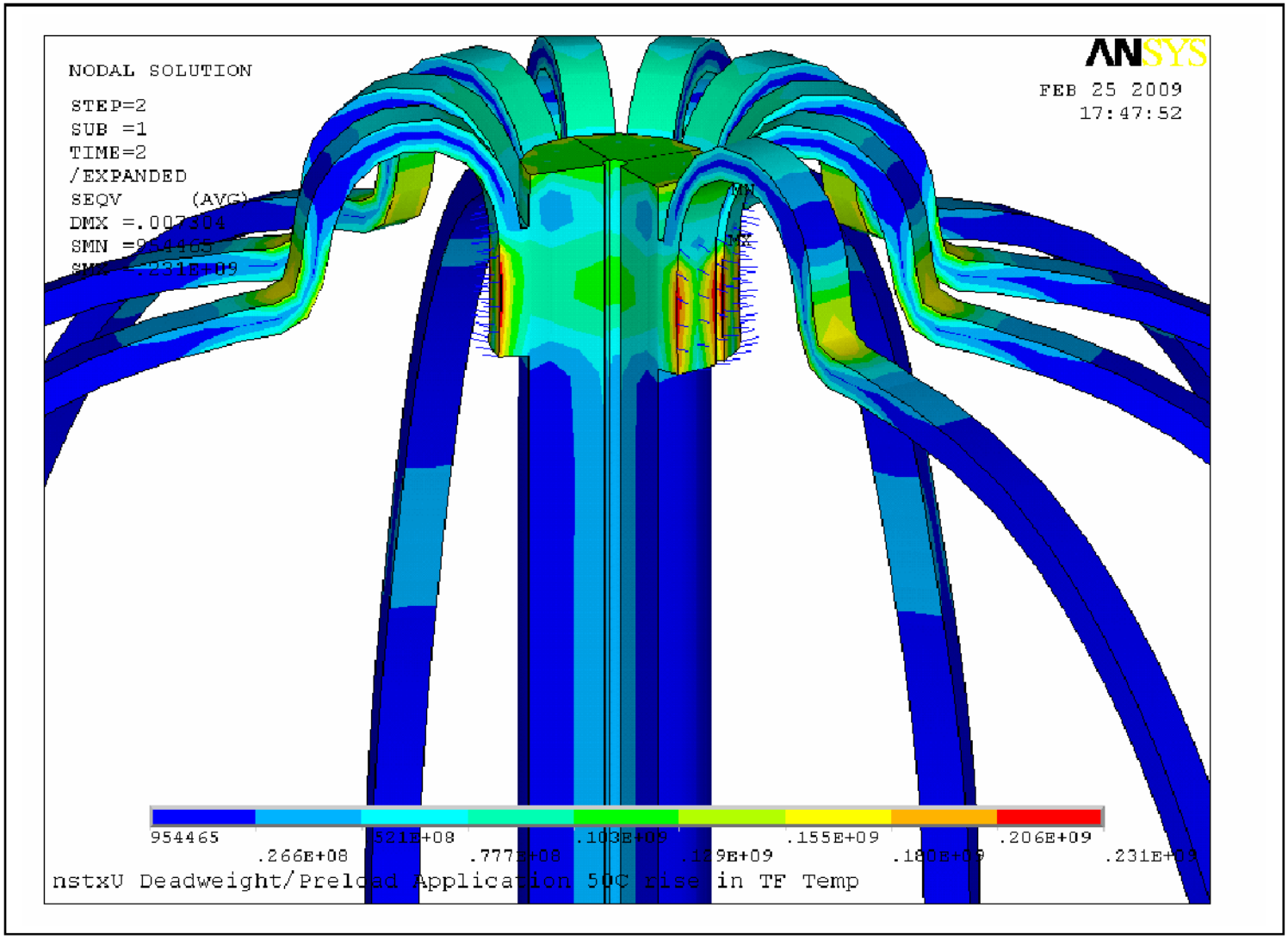
Four Fold Symmetry Expansion. HM Provided the Vessel Model

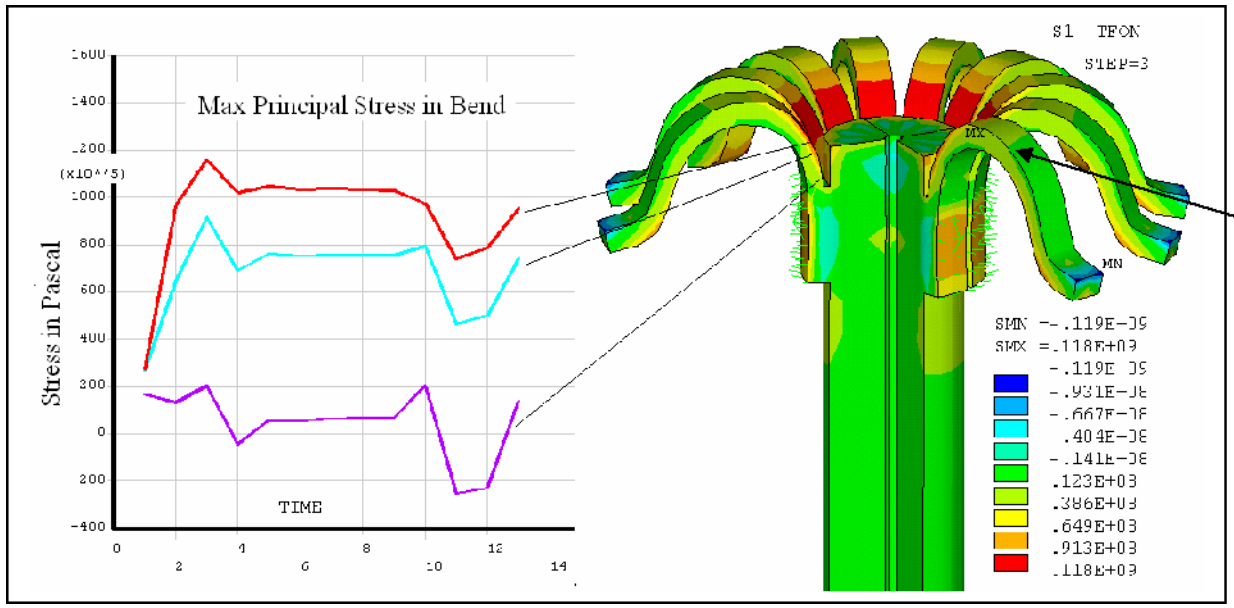
Radial Compression from the Jacking Ring
In this run I used 1 mm interference. Ring stress and compression are too large
I have run .5mm but have not post-processed it.



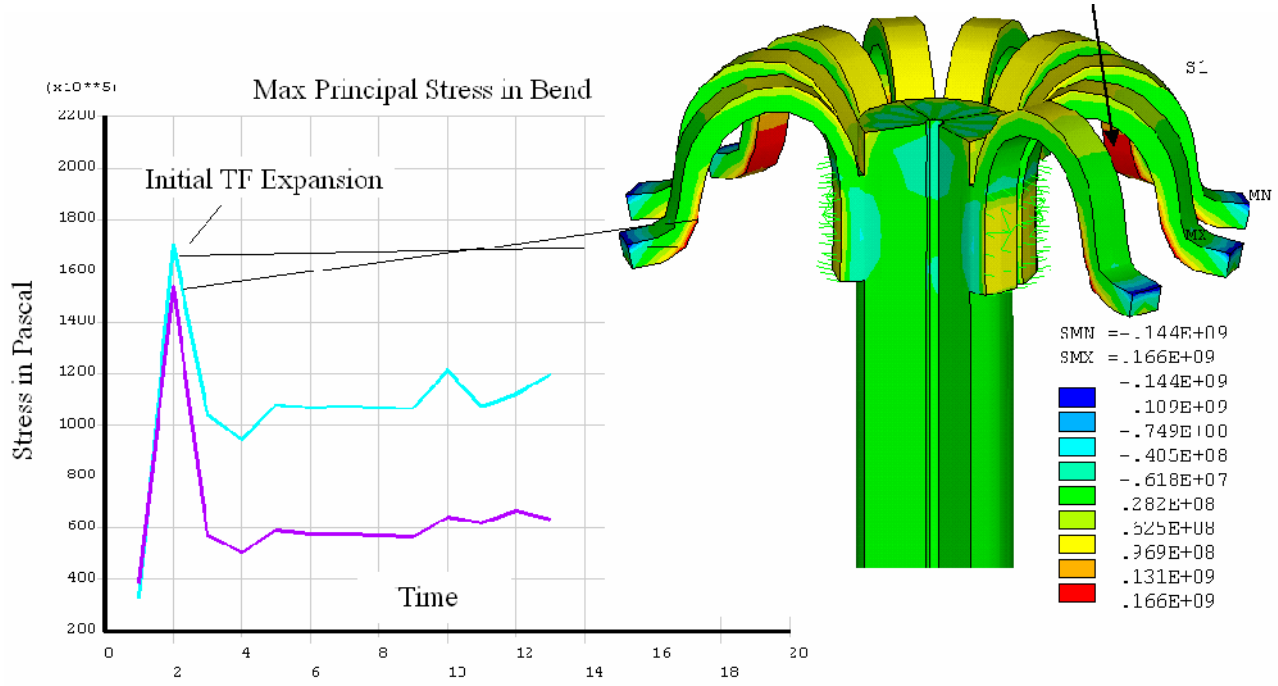
D-Wedging Effect is Minimal




NODAL SOLUTION
STEP=2
SUB =1
TIME=2
/EXPANDED
SEQV (AVG)
DMX =.007304
SMN =954465
SMX =.231E+09
ANSYS
FEB 25 2009
17:47:52
954465
.266E+08
.521E+08
.777E+08
.103E+09
.129E+09
.155E+09
.180E+09
.206E+09
.231E+09
nstxU Deadweight/Preload Application 50C rise in TF Temp

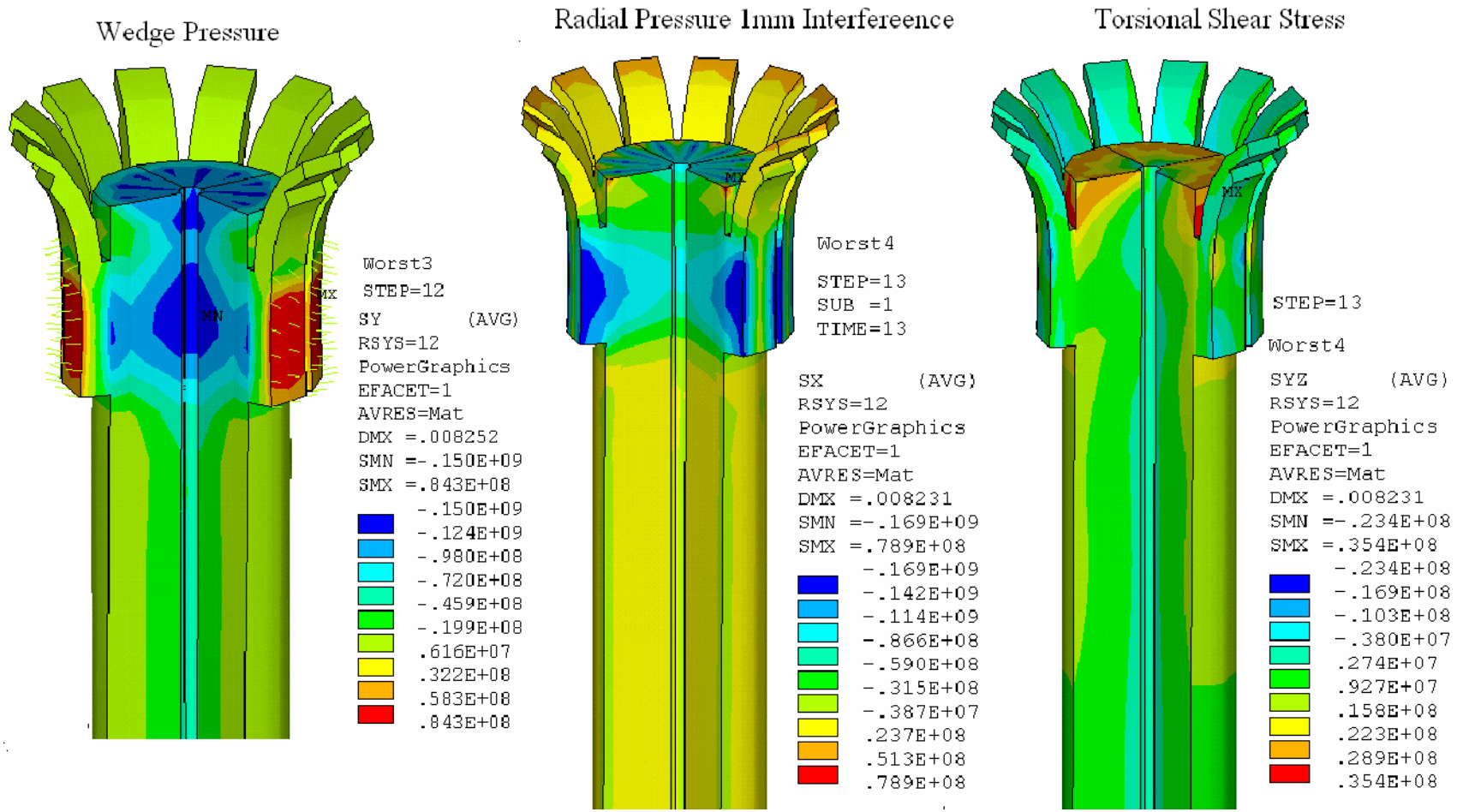


Max Principal Stress In Bend. –No Internal Thermal Gradient
Max is 118 MPa
Max is 166 MPa

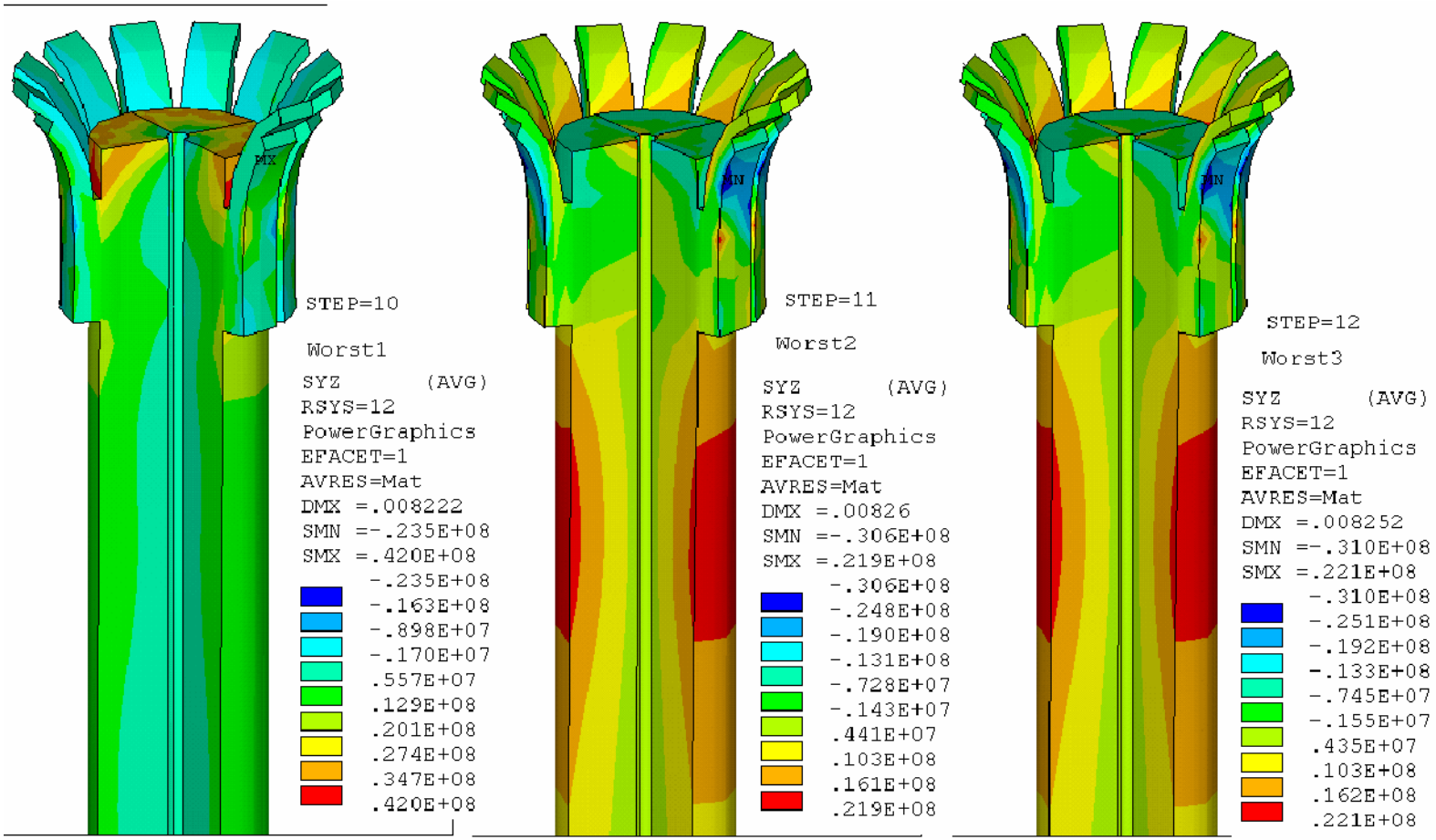


Jacking Ring Compression Helps Support Torsion

Ring height might be increased to improve torsional carrying capacity of the extension that connects with the umbrella structure hub



More “Worst” Torsional Shear Stresses



Conclusions:

Titus-Woolley-? Joint :

- **Can Develop Needed Contact Pressures**
- **Expansion Loop Can Absorb Central Column Vertical Motion With Acceptable Stress**
- **Jacking Ring Compression Aids Torsional Shear Carrying Capacity**
- **No Mechanical Connections Penetrating the TF Inner Leg**
- **Jacking Ring Compression Supports in-Plane Shear Carrying Capacity**
- **OOP Support Lugs D Not Appear to be Needed**