Structure, Pre-stress and Training

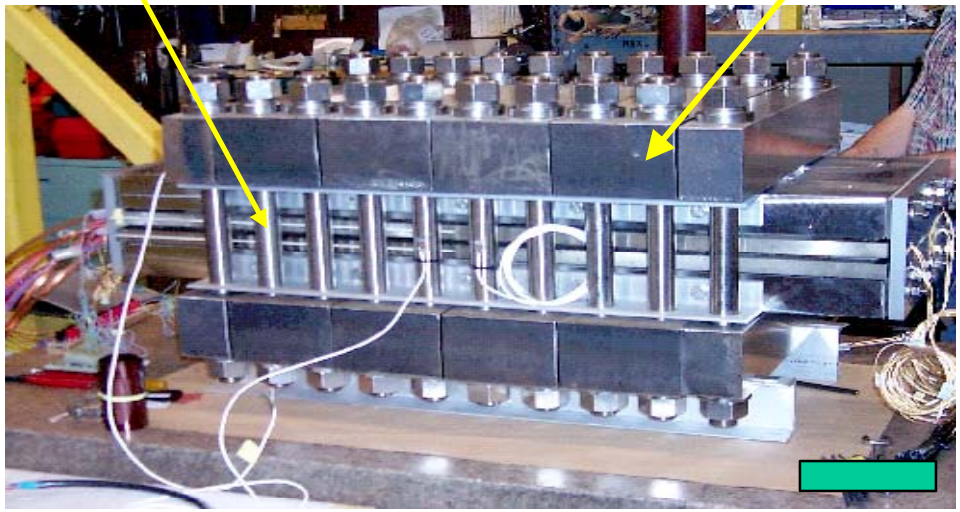
Erice October , 2003

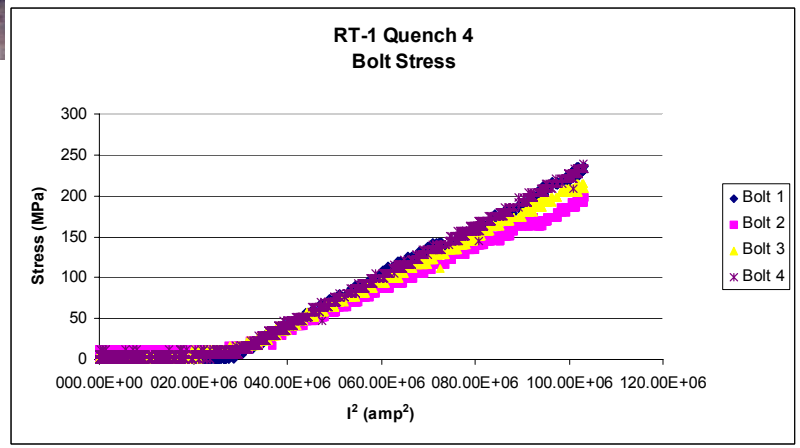
Shlomo Caspi

Measured RT1 Stress History

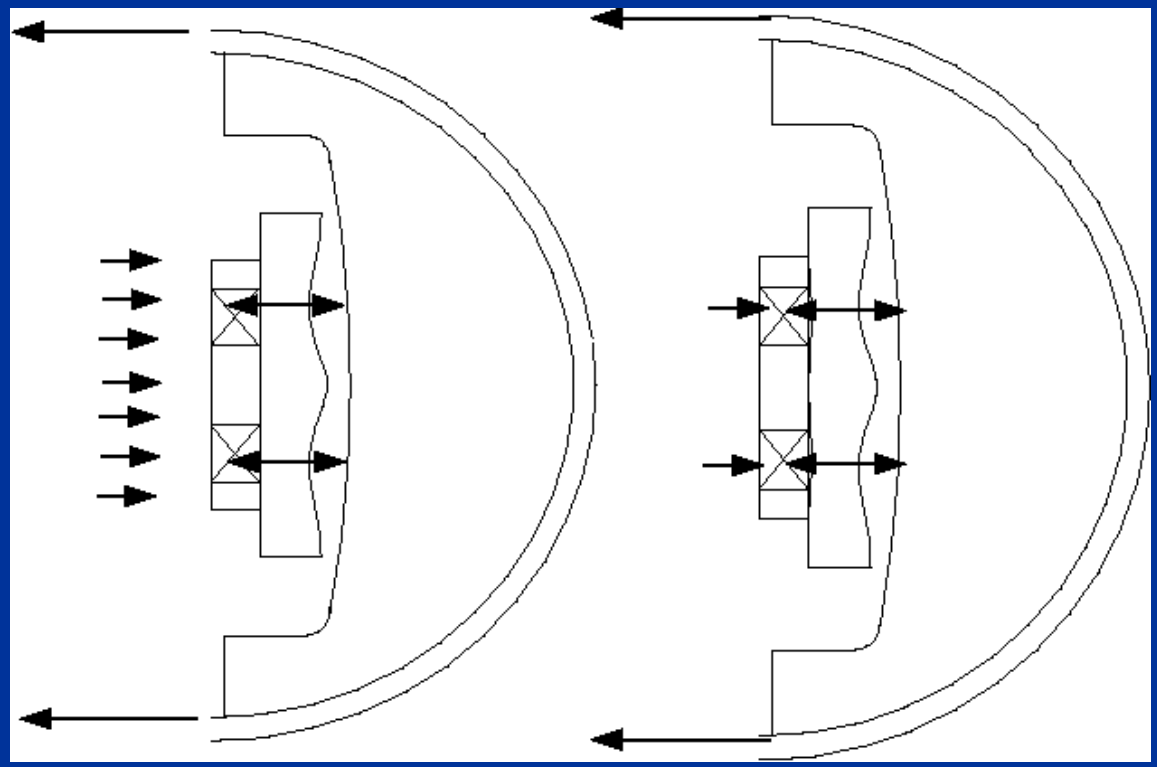
115 mm SS structural beams

38 mm SS tie rods





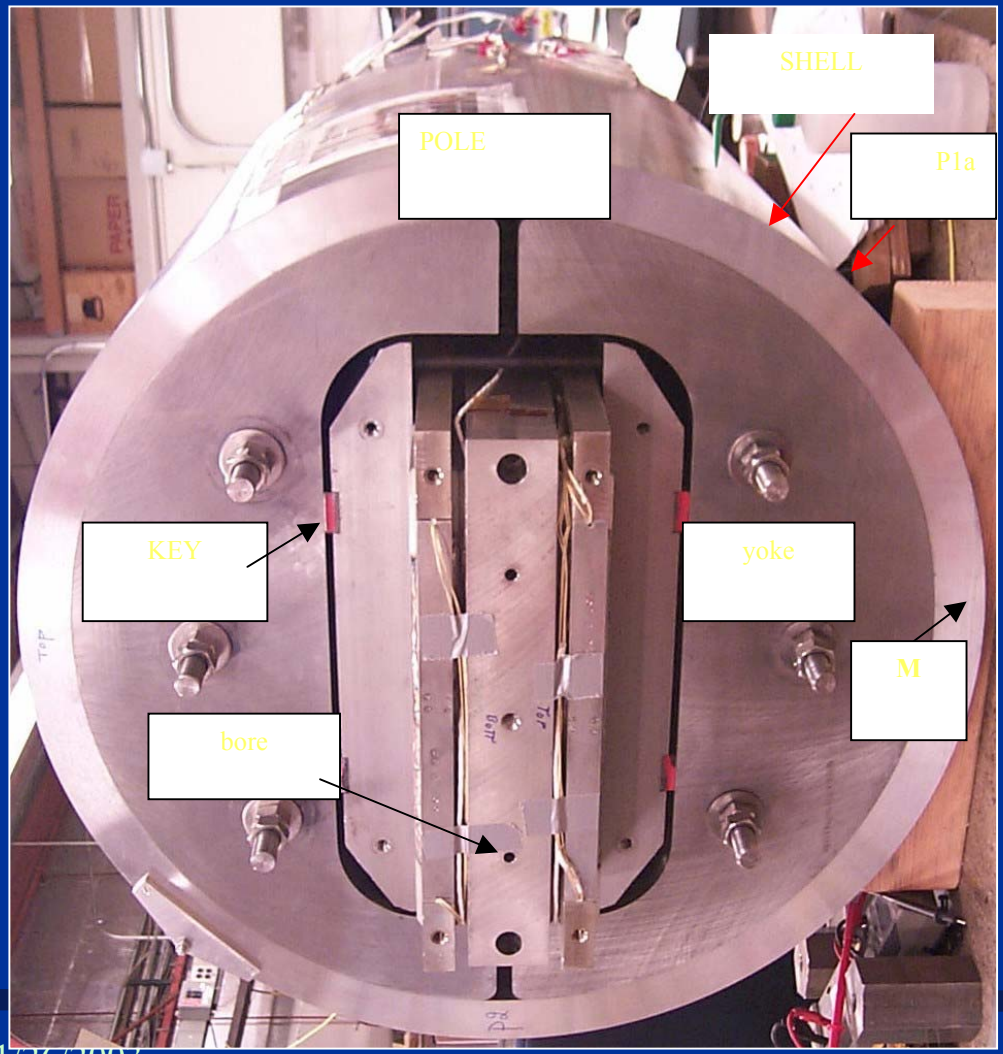
Shell, Keys, and Bladders – Principal of operation



- Three main components:
  - ✓ Outer **Shell** - Tension
  - ✓ Intermediate **Yoke and Key**- Transmitters
  - ✓ Inner **Coil** - Compression

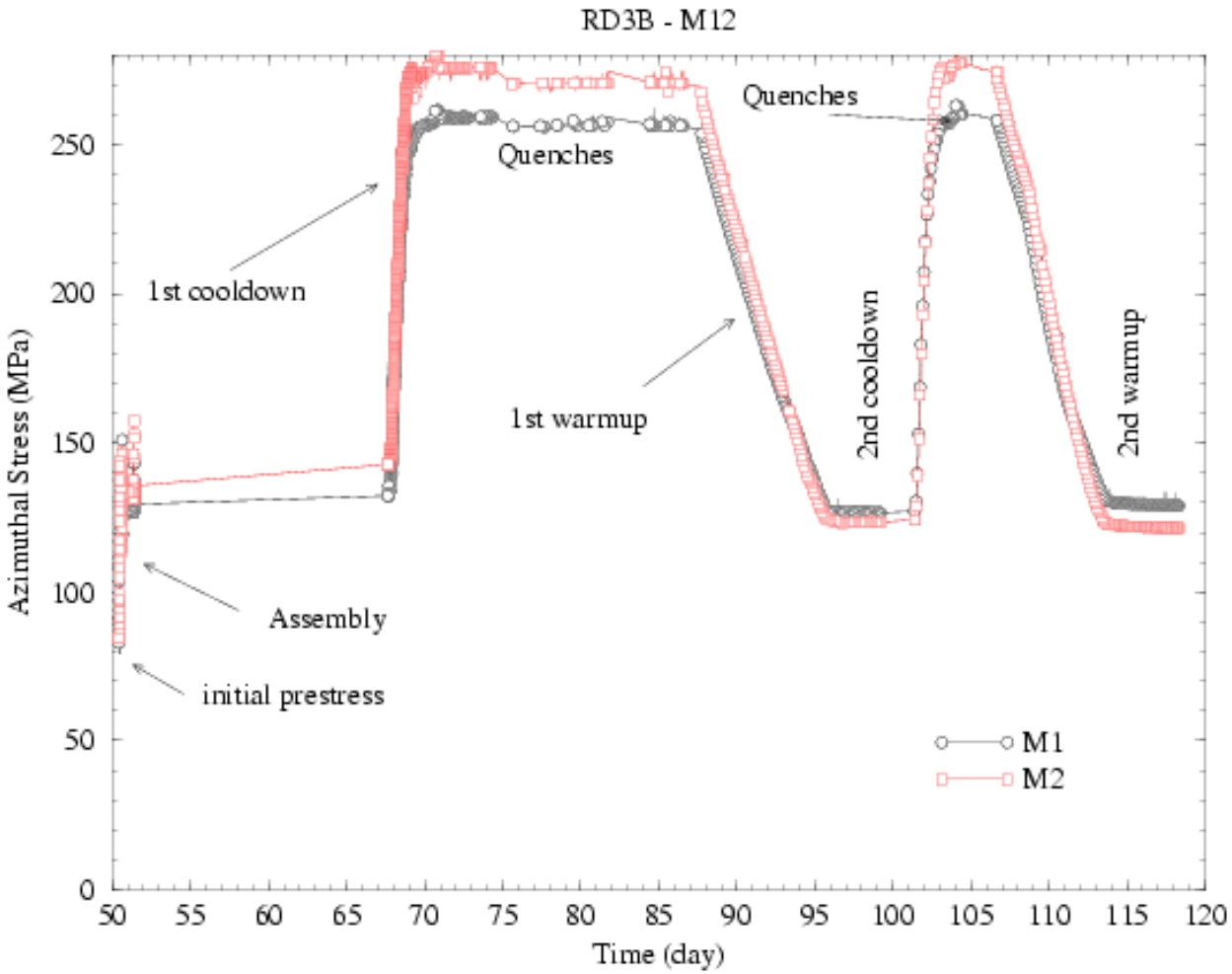
As Lorentz forces increase, reaction forces decrease leaving the stress in the shell unchanged..

RD3 End View



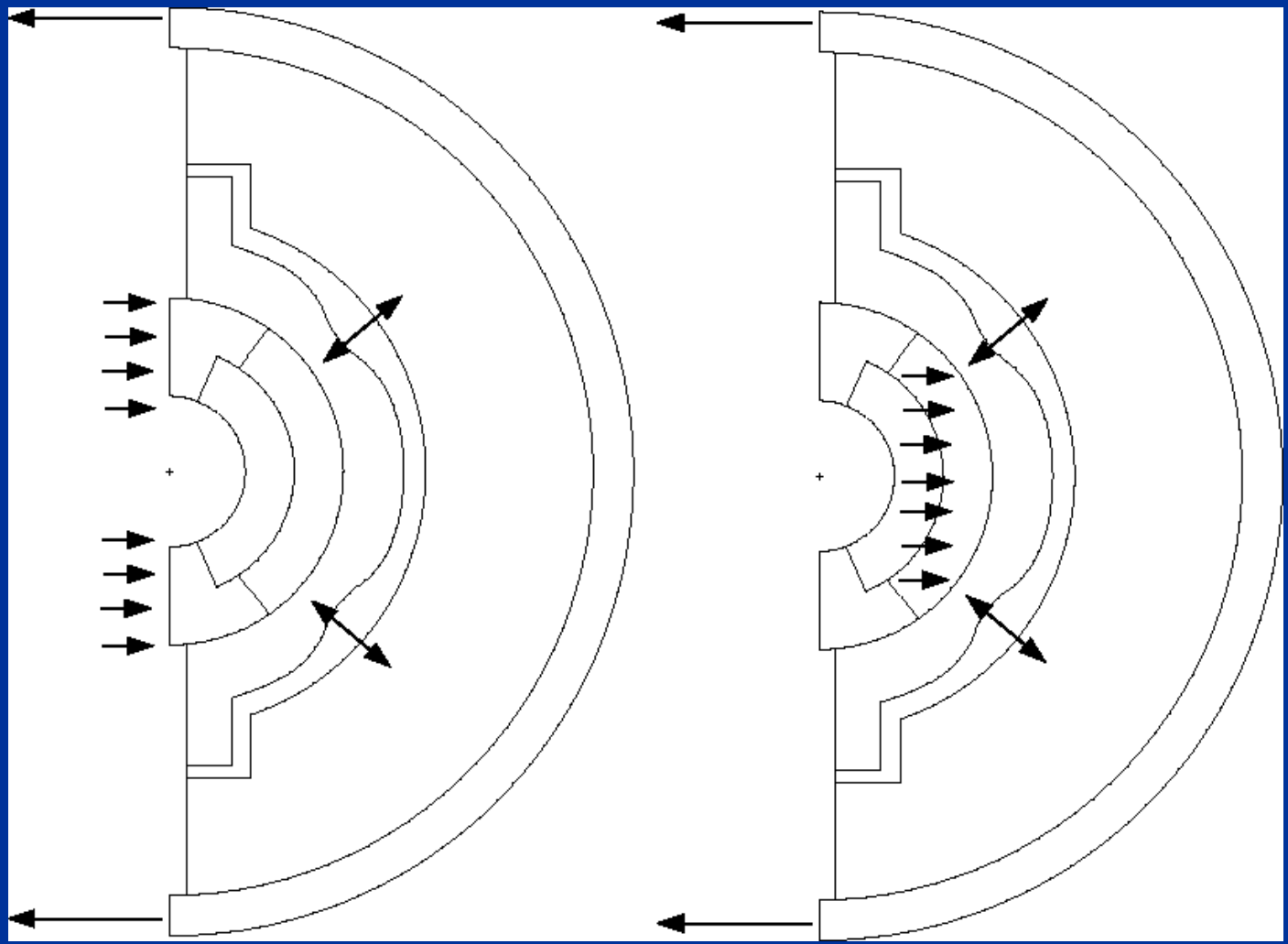
- End view showing the Aluminum shell, iron yoke,iron pads, 3 coil modules and keys.

Shell Stress History – 14.7 T (RD3)

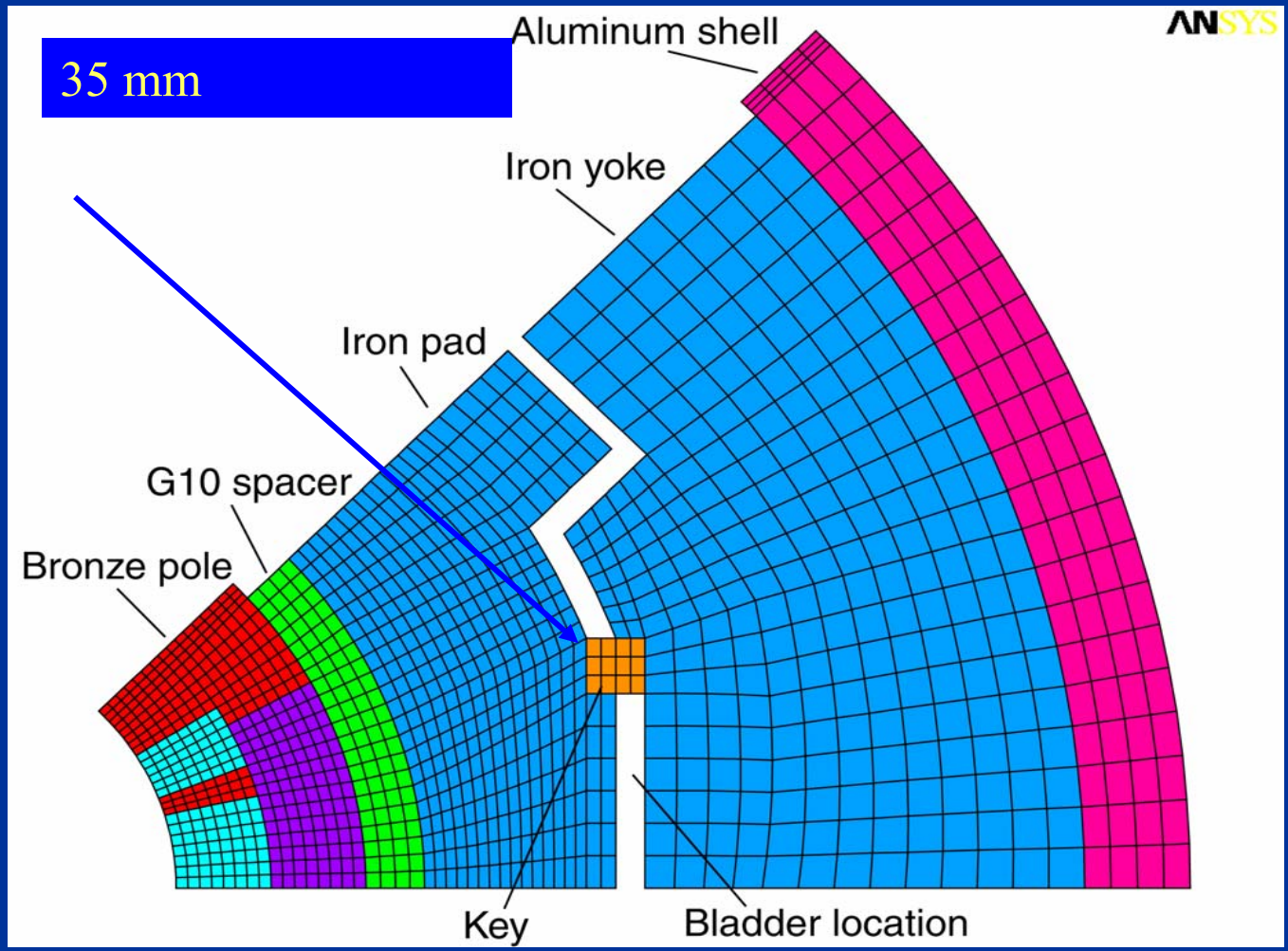


- Initial stress 130 MPa
- No creep
- Gain of 120 MPa during cool-down
- No increase in stress up to 14.7 T
- Reversible stress upon warm-up
- Reversible stress upon 2'nd cool-down

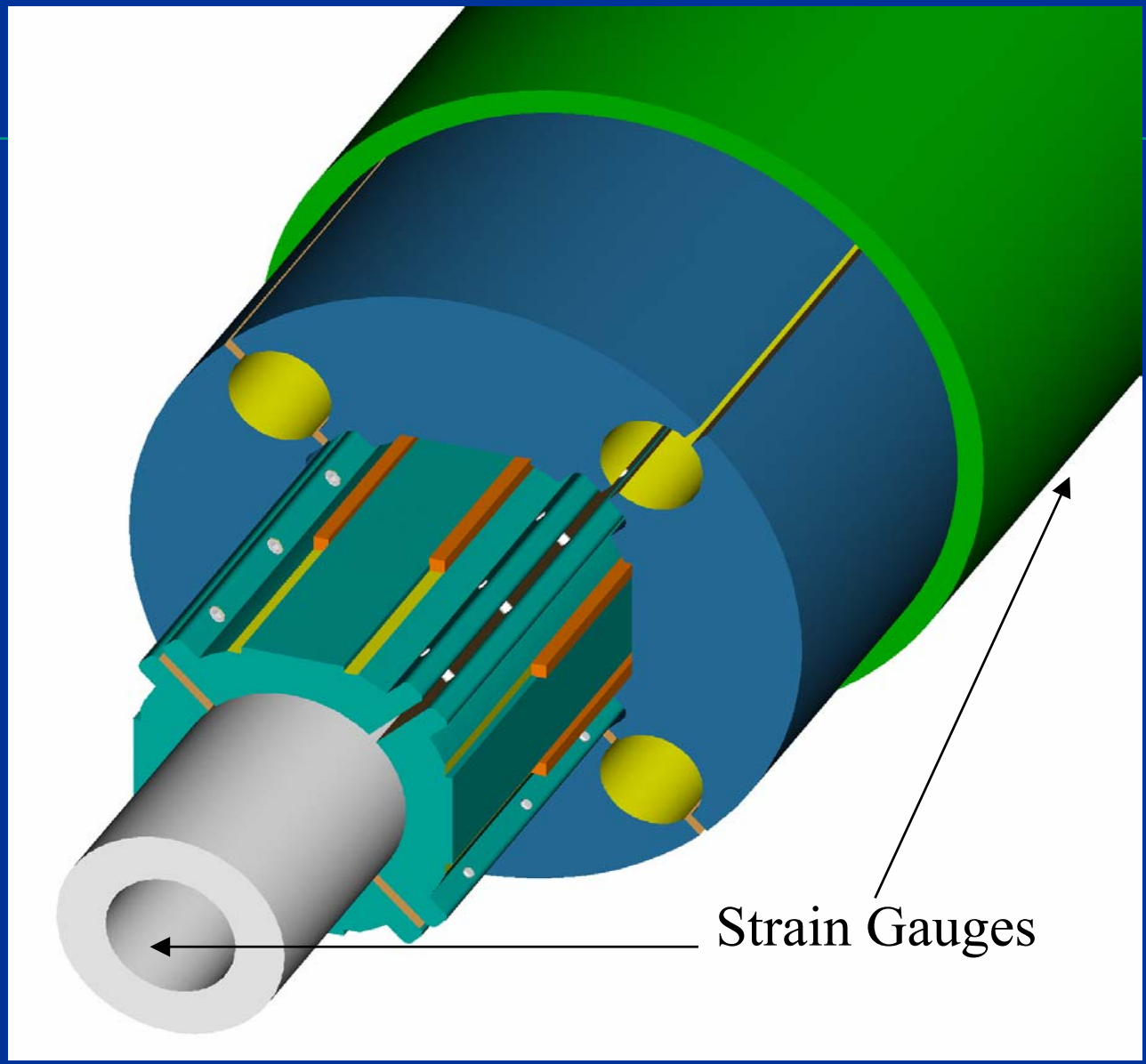
Shell, Keys, and Bladders – Principal of operation



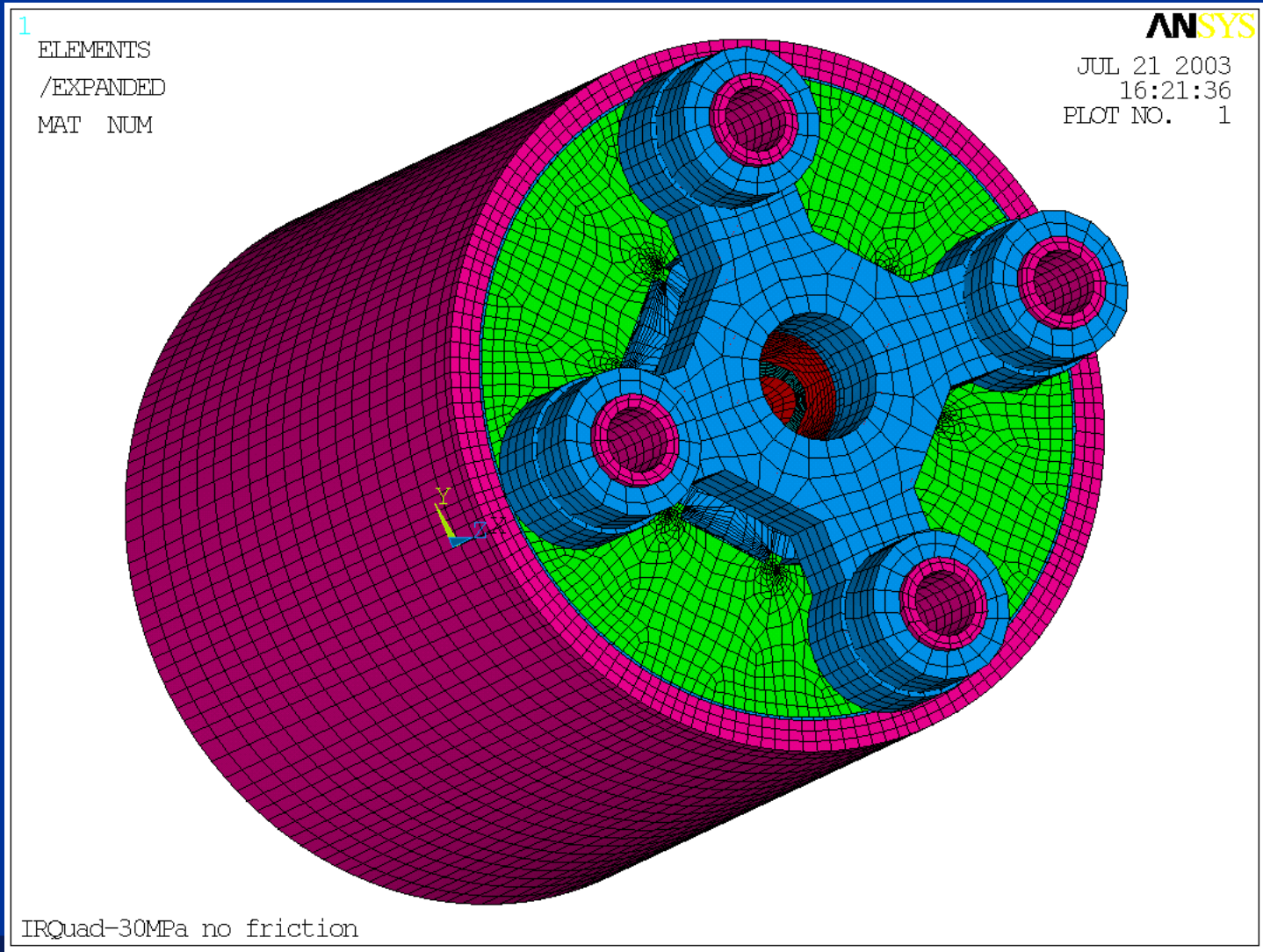
Coil Stress and key position



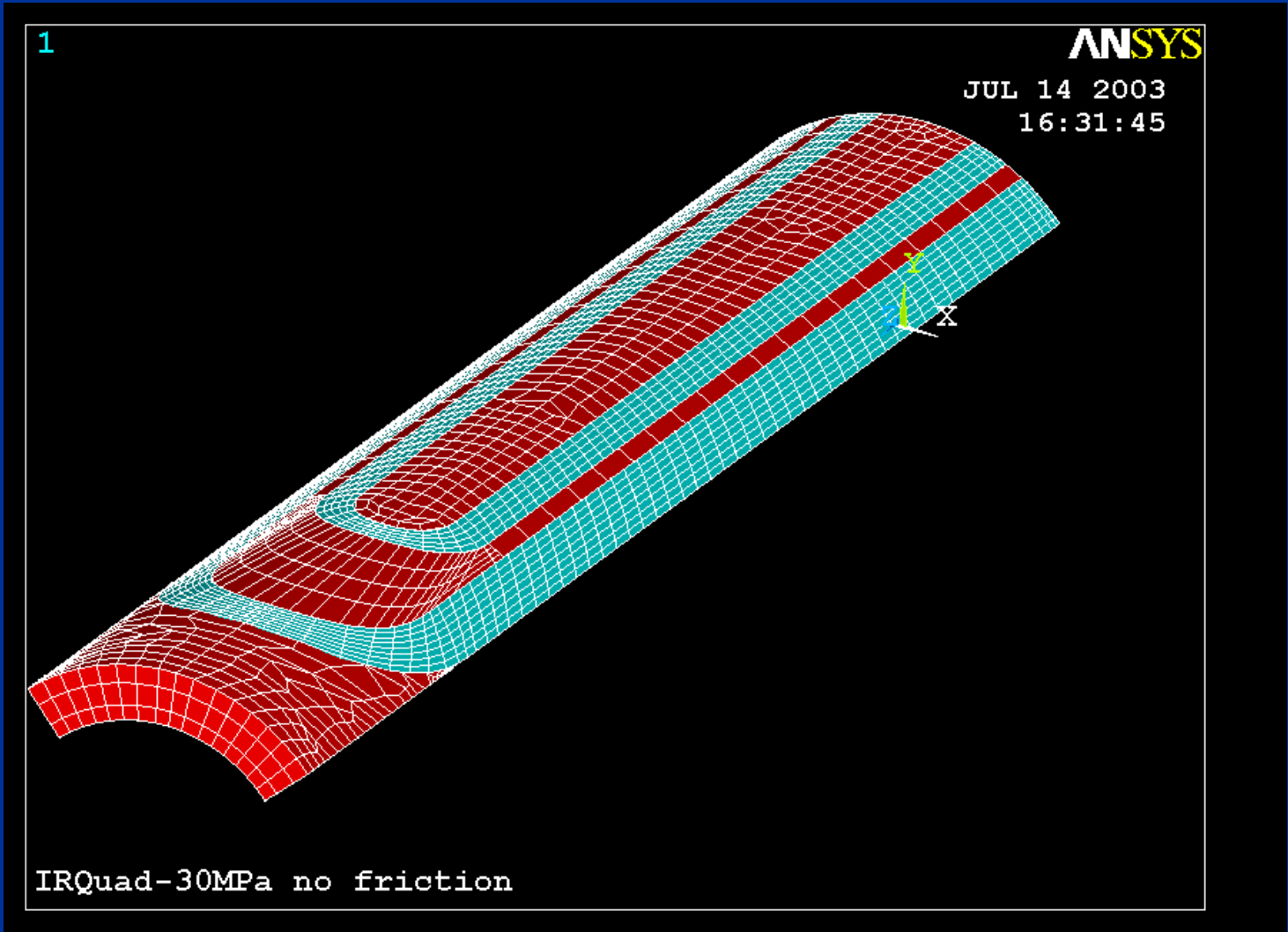
s_caspi@lbl.gov


Strain Gauges

Magnet Assembly - ANSYS

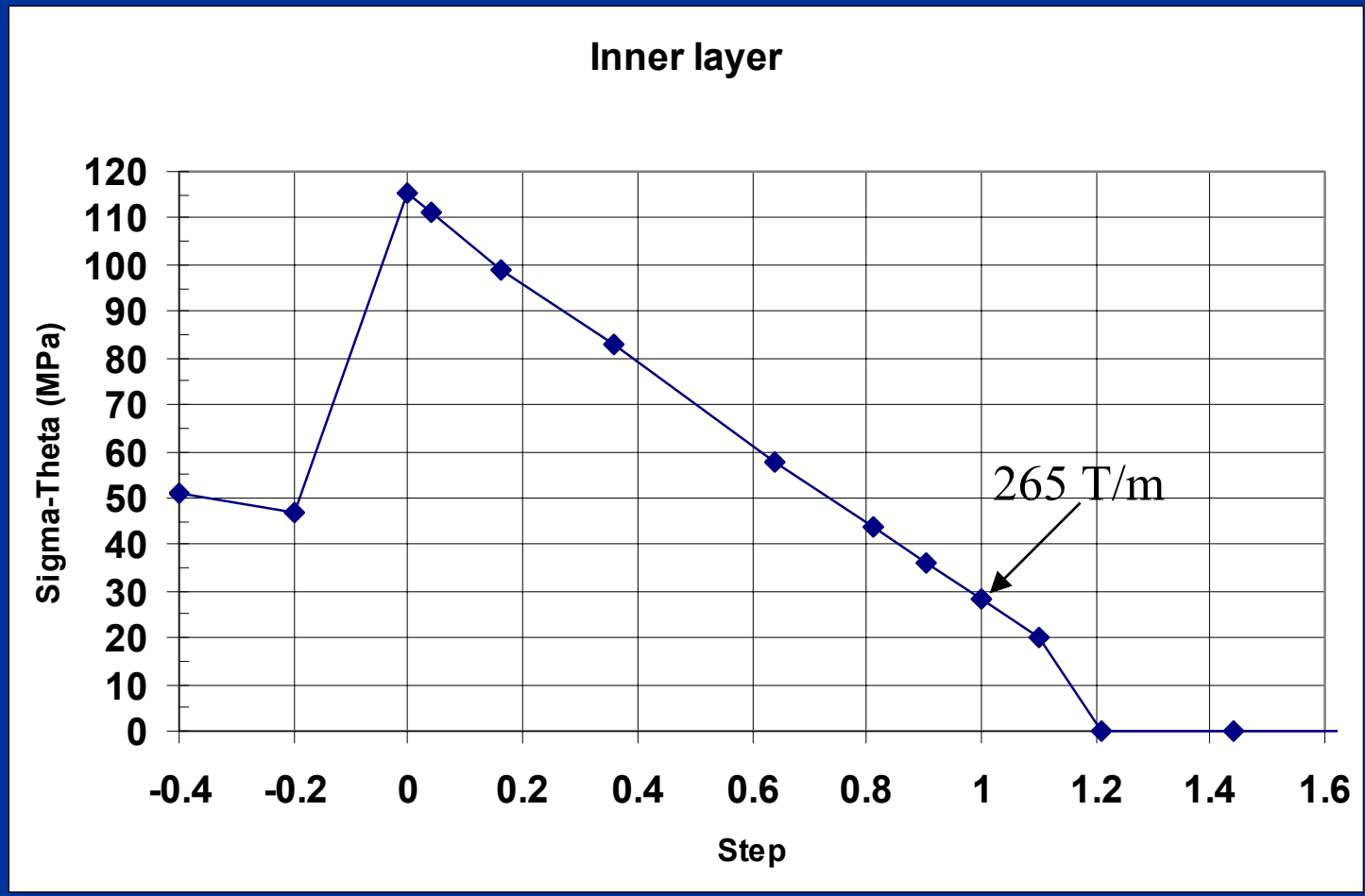


Layer 1



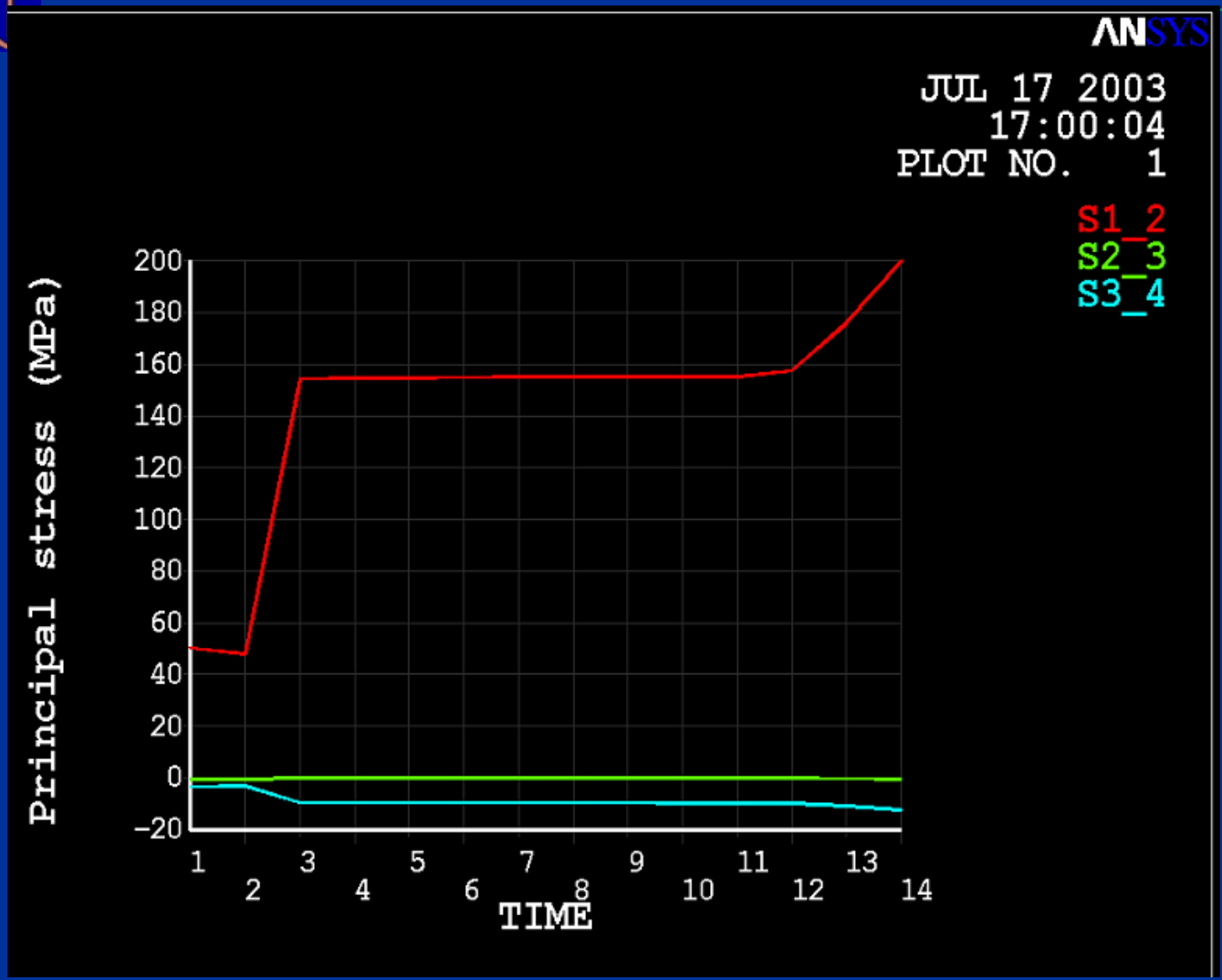
1. **Bladder pressure 30 MPa**
2. **Keys on bladders removed**
3. **Cool-down to 4.2K**
4. I=14000A (0.7Imax, I^2=0.49)
5. I=16000A (0.8Imax, I^2=0.64)
6. I=18000A (0.9Imax, I^2=0.81)
7. I=19000A (0.95Imax, I^2=0.9025)
8. I=19500A (0.975Imax, I^2=0.9506)
9. **I=20000A (1.0 Imax, I^2=1.0)**
10. I=21000A (1.05Imax, I^2=1.1025)
11. I=22000A (1.1 Imax, I^2=1.21)
12. I=24000A (1.2Imax, I^2=1.44)

Inner layer Stress



s_caspi@lbl.gov

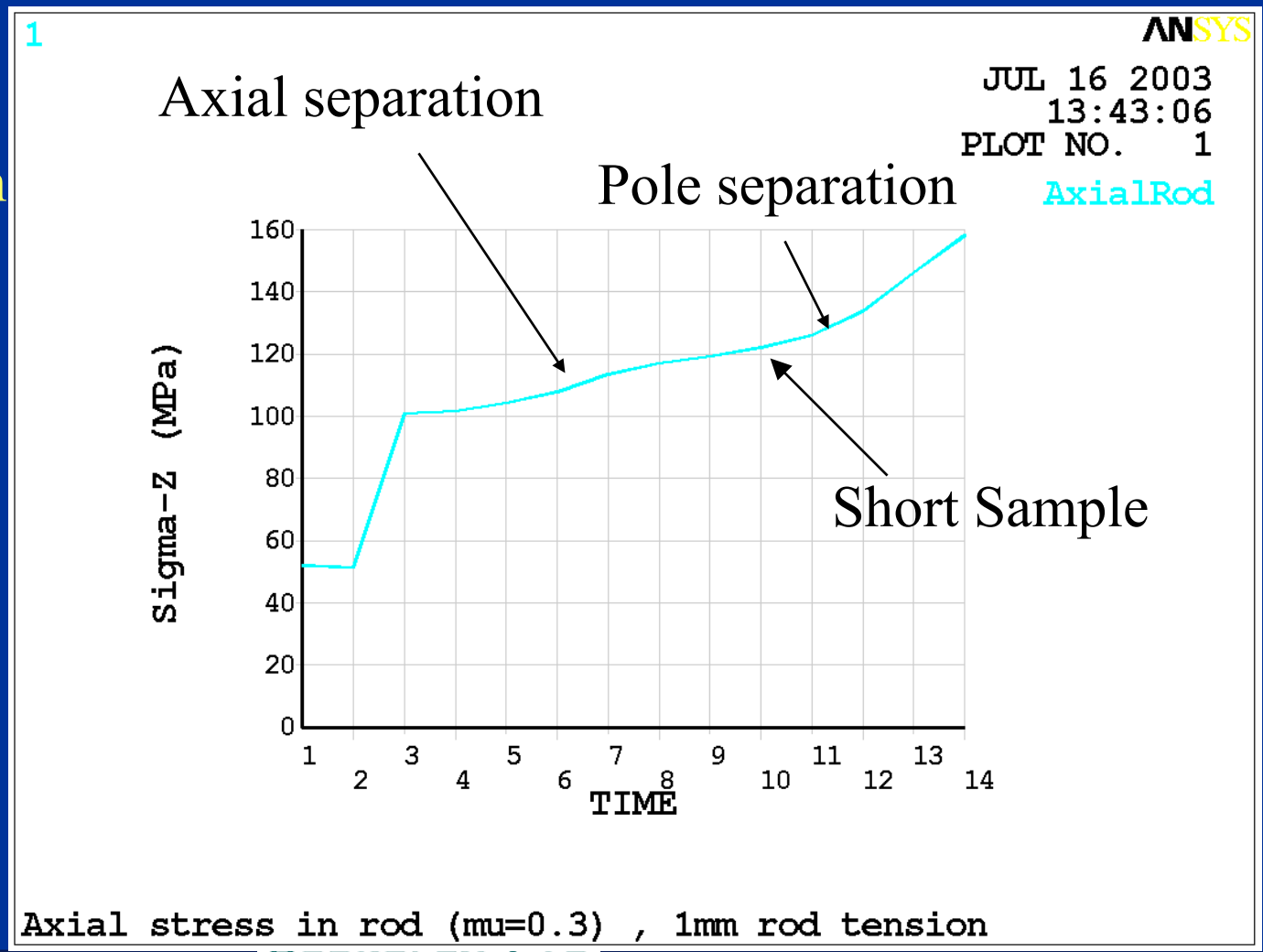
Azimuthal Stress in Shell, mu=0

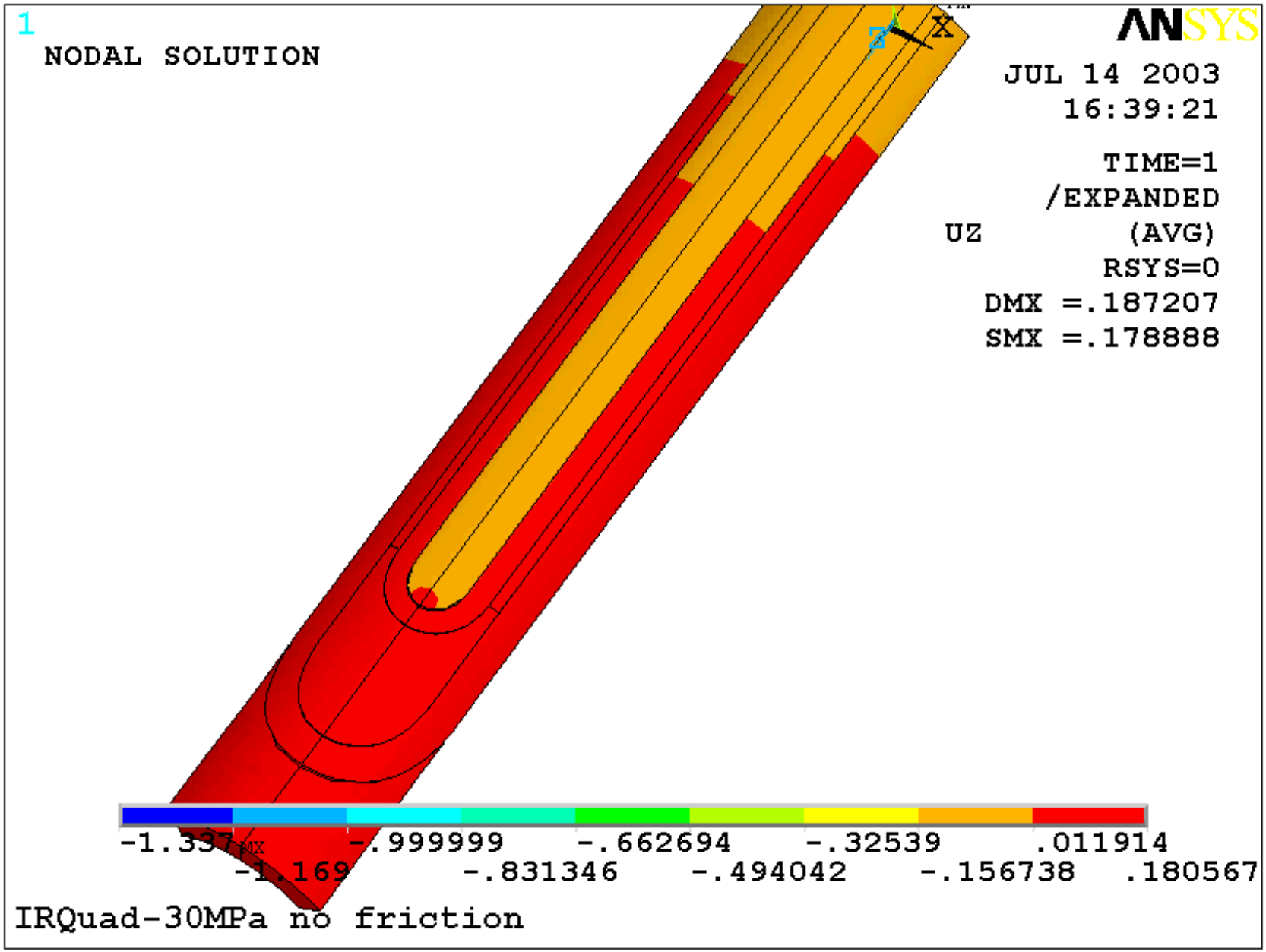


s_caspi@lbl.gov

Axial Stress in Rod

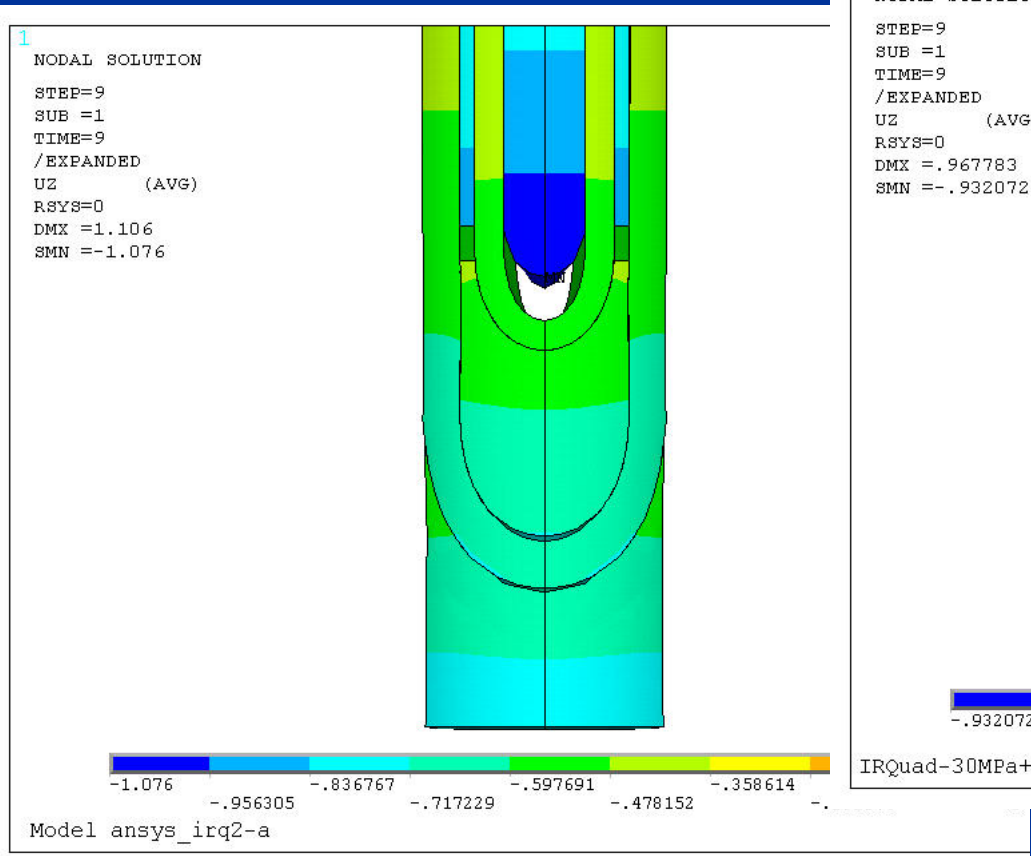
Axial rods pre-tension at 1mm = 55 MPa



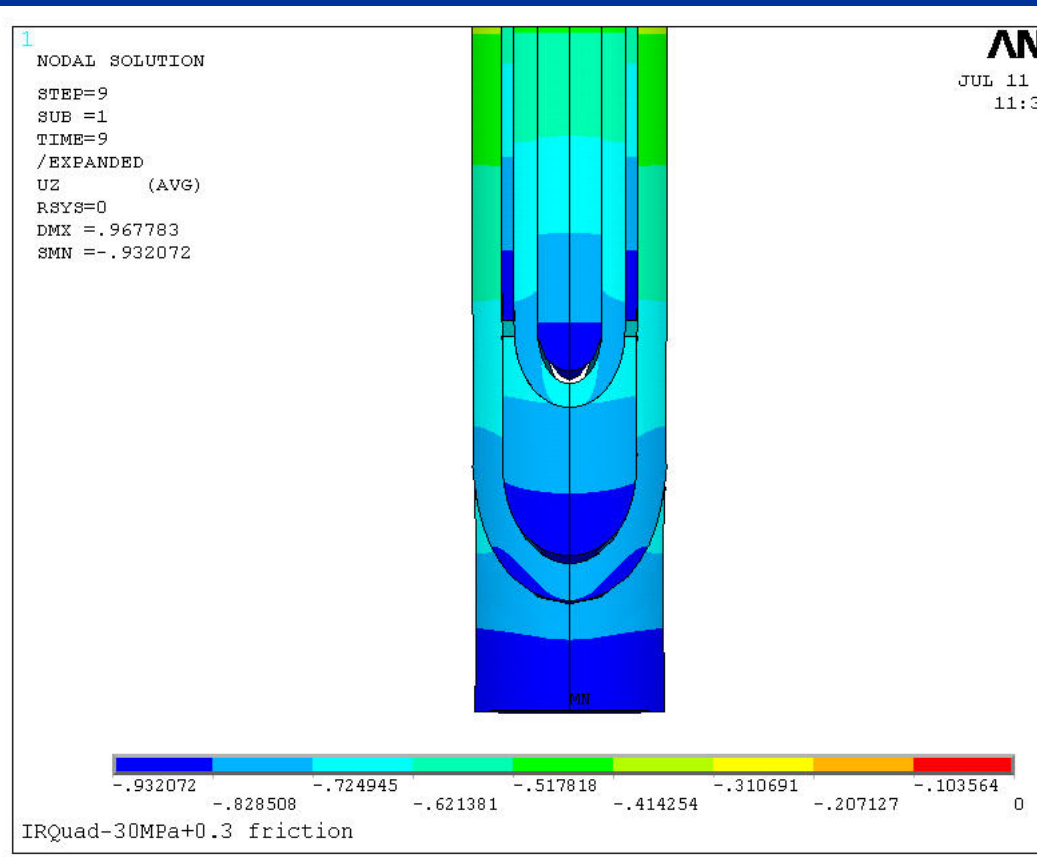

1
NODAL SOLUTION
ANSYS
JUL 14 2003
16:39:21
TIME=1
/EXPANDED
UZ (AVG)
RSYS=0
DMX =.187207
SMX =.178888
-1.337
-1.169
-.999999
-.831346
-.662694
-.494042
-.32539
-.156738
.011914
.180567
IRQuad-30MPa no friction

Layer 1 - 1.0Imax

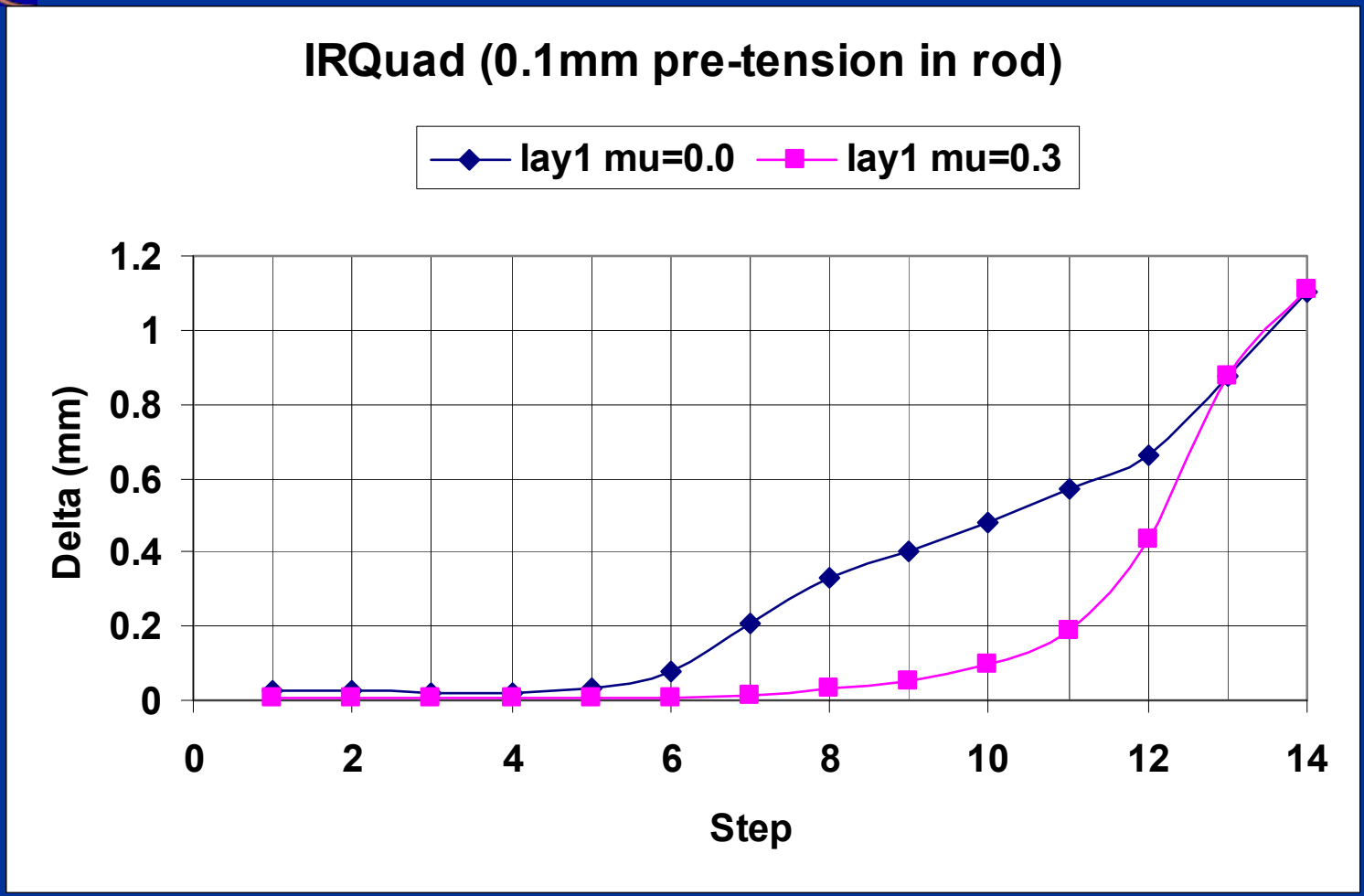
0 friction



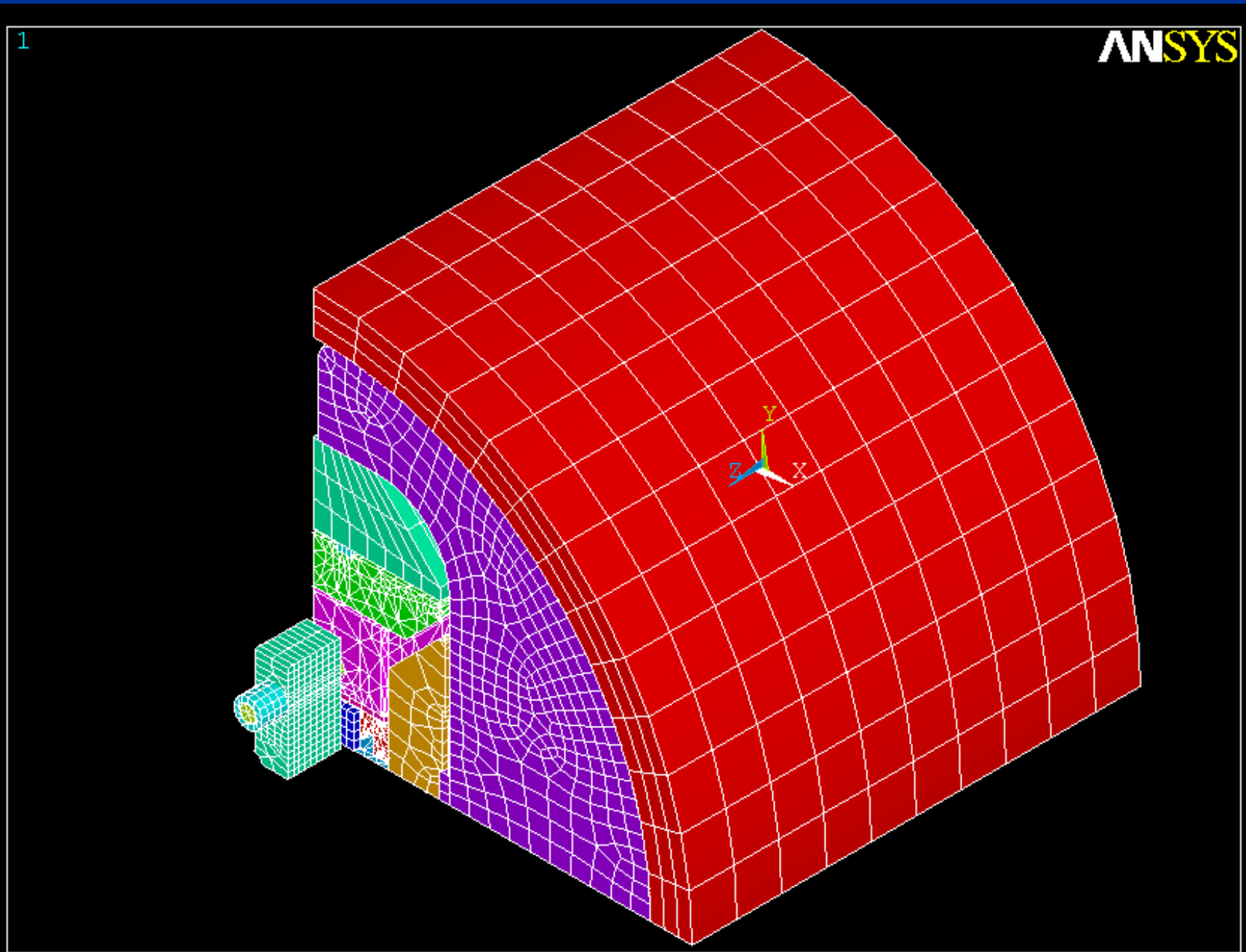
0.3 friction

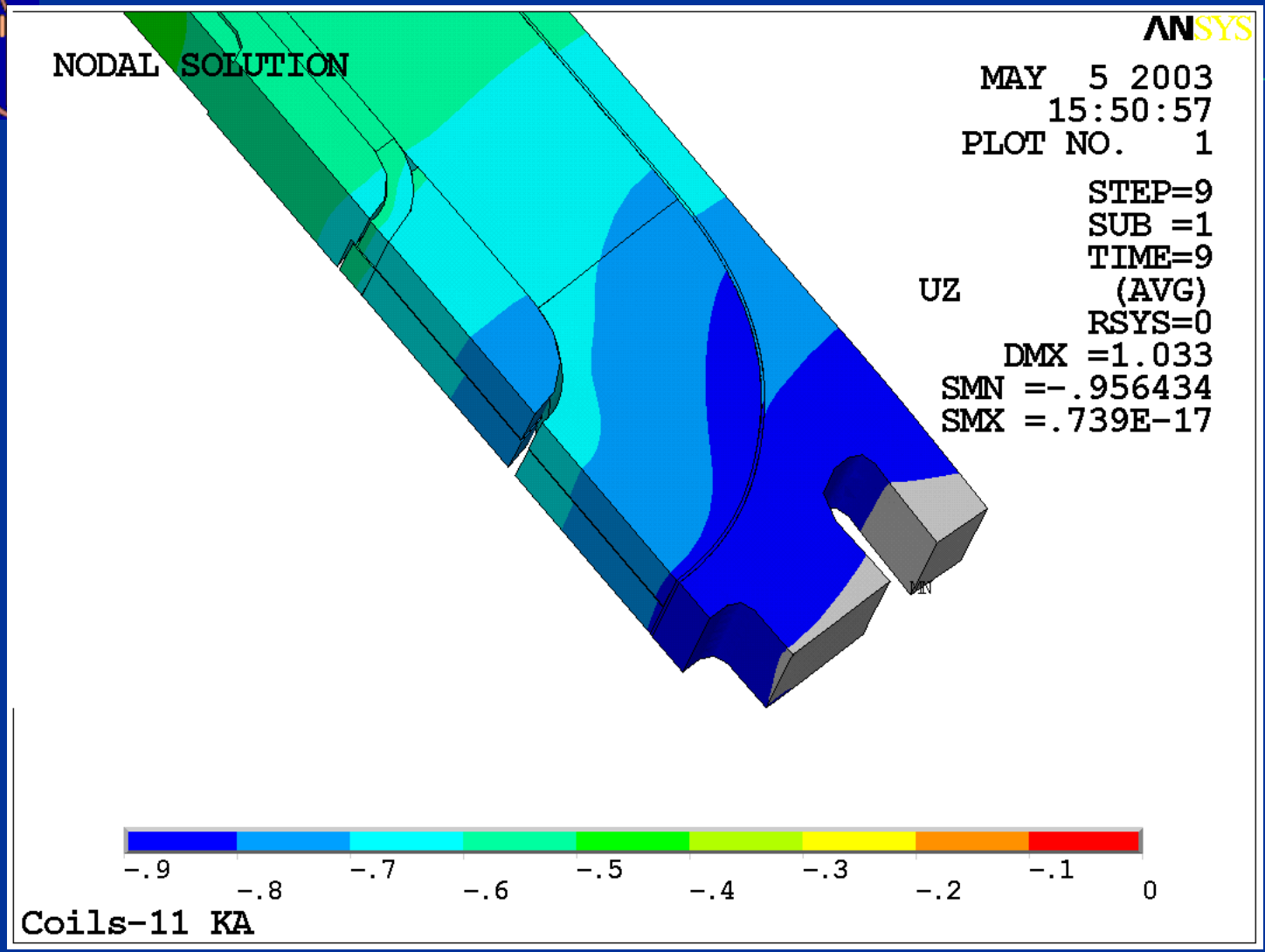


Training Studies (coil-pole axial slippage – layer 1)

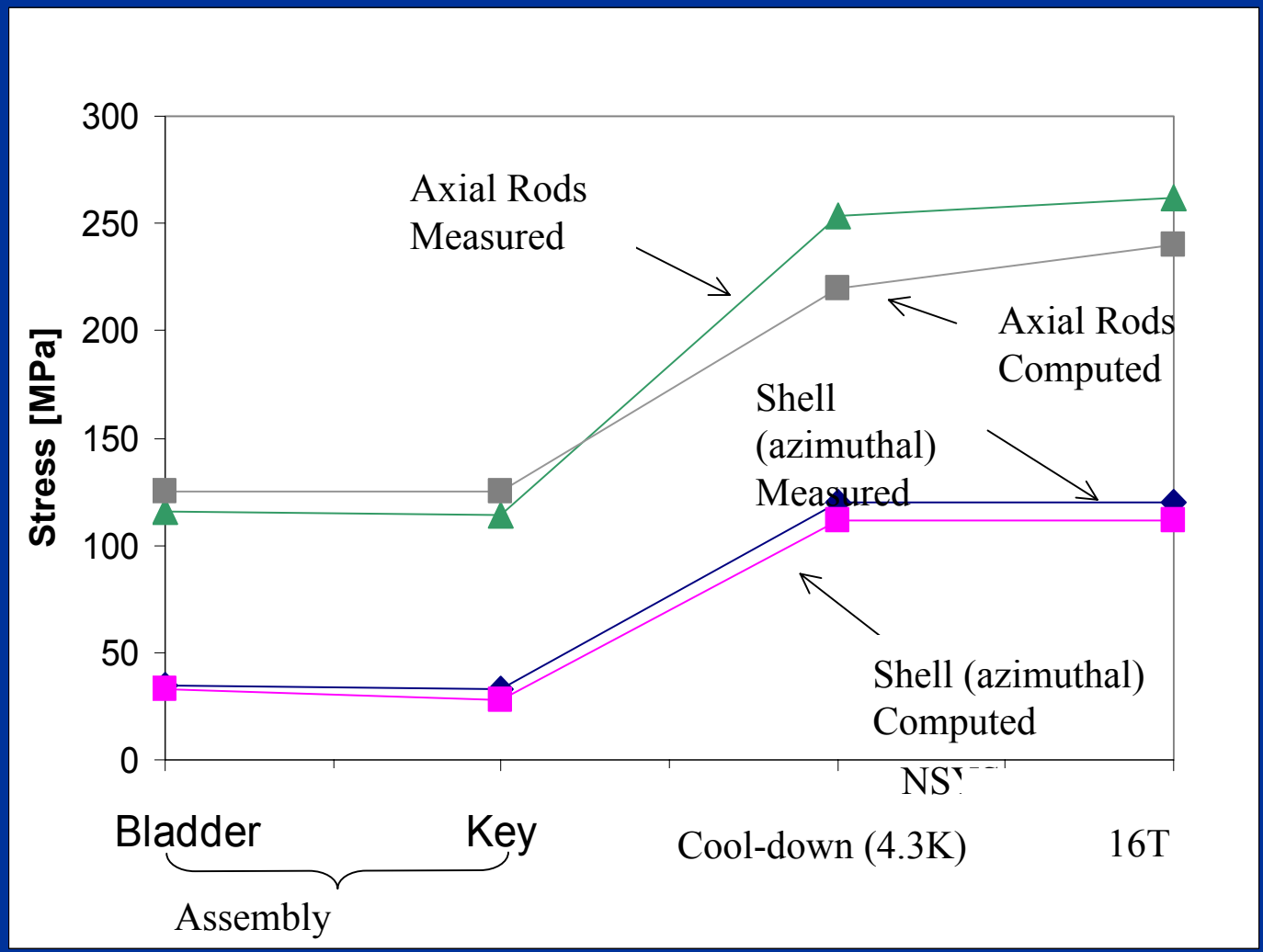


End Plate and Rods


1
ANSYS
Y
Z
X


NODAL SOLUTION
ANSYS
MAY 5 2003
15:50:57
PLOT NO. 1
STEP=9
SUB =1
TIME=9
UZ (AVG)
RSYS=0
DMX =1.033
SMN =-.956434
SMX =.739E-17
MN
-.9
-.8
-.7
-.6
-.5
-.4
-.3
-.2
-.1
0
Coils-11 KA

HD-1 Measured



Pre-stress and Training

We are just beginning to quantify the relation between transverse and axial stress during operation, and its impact on coil displacements.

Study sensitivity of pre-stress on coil displacements

- Transverse and axial
- Consider friction