

Vacuum Vessel Analysis

NCSX Engineering Meeting

13 Feb. 2002

F. Dahlgren

Analysis Model Details

- Nastran FEA Model - 1/3 (1-period)
- Cyclic Symmetric B.C.s, Vertical supports adjacent to the neutral beam ports @ mid-plane.
- Loading conditions: 1 atmosphere external pressure, disruption forces from 175kA & 350kA filamentary plasmas (self-force + coil forces).
- 5727 2-D plate elements, 5718 grid points, 32709 dofs

NCSX - Vacuum Vessel Model

Cyclic-Symmetric B.C.'s
(MPC's)

Vertical Supports
(SPC's)

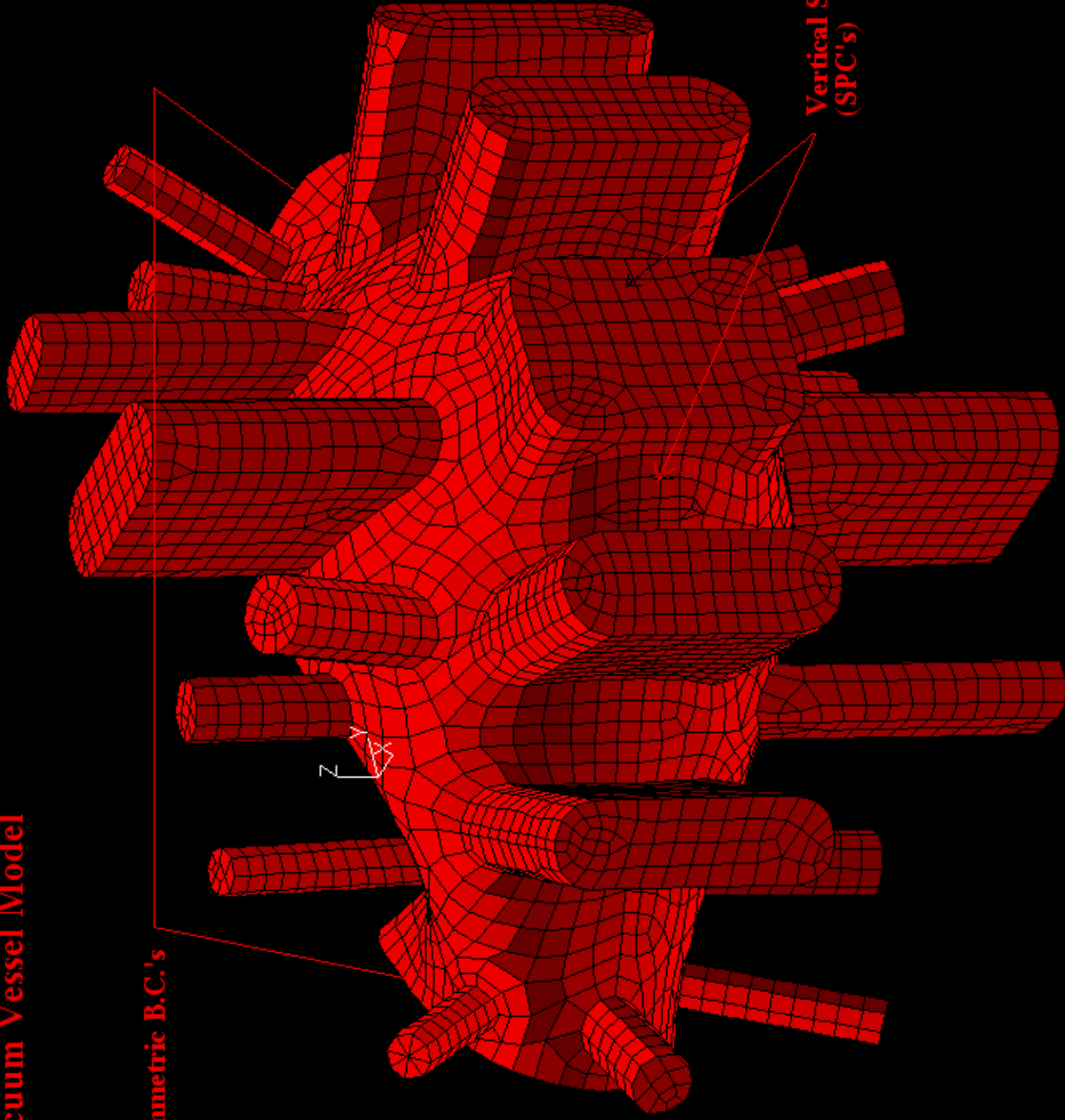
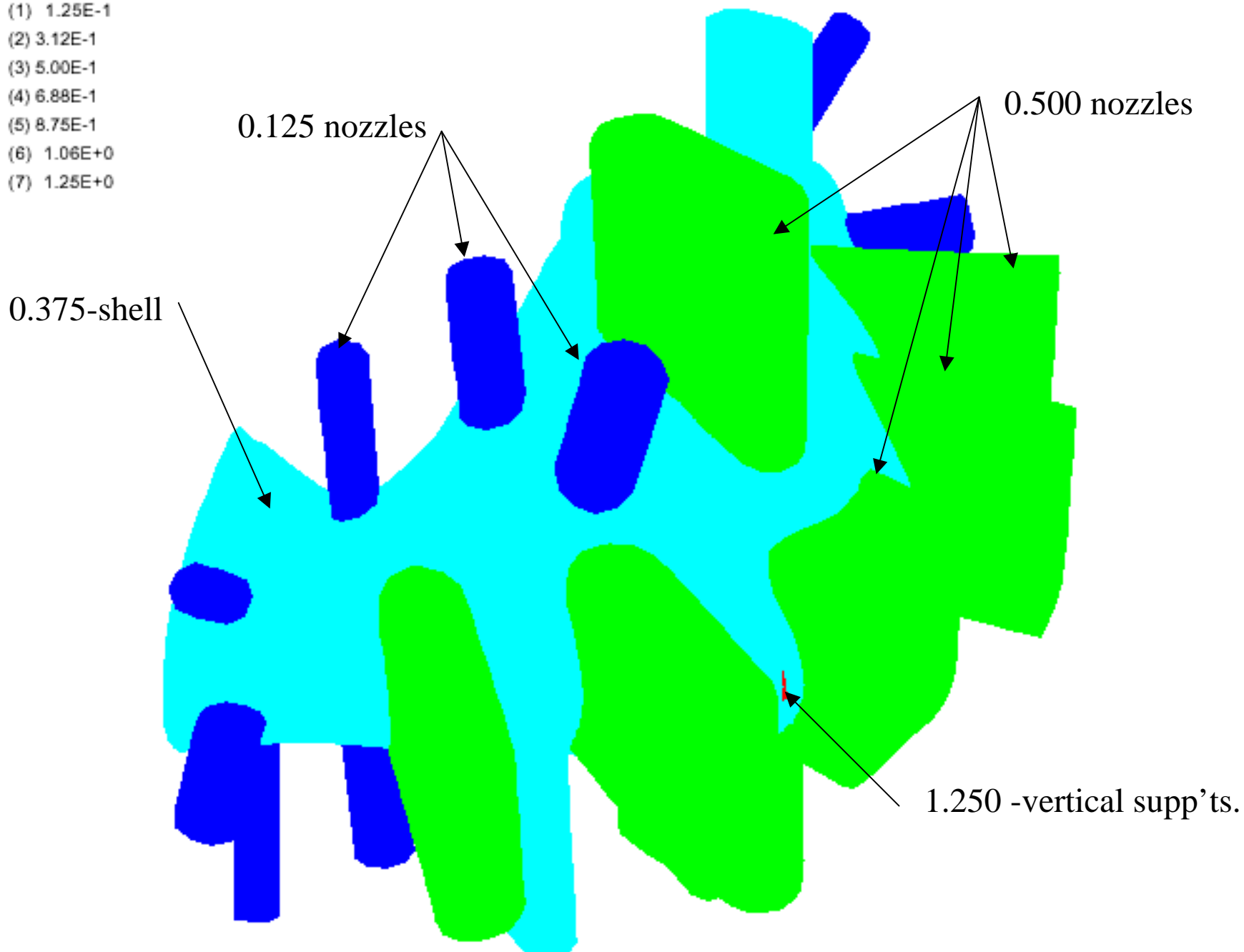
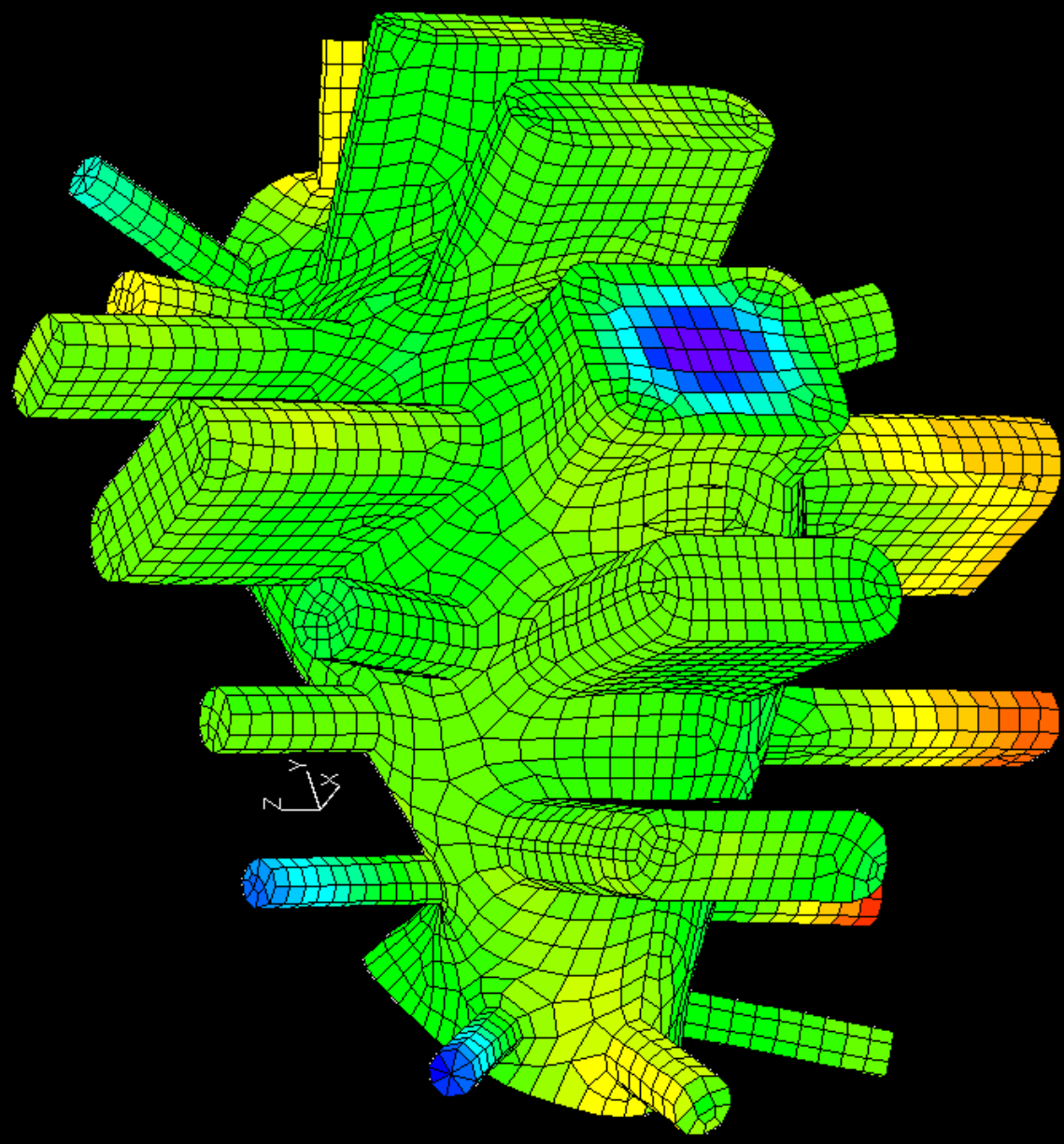
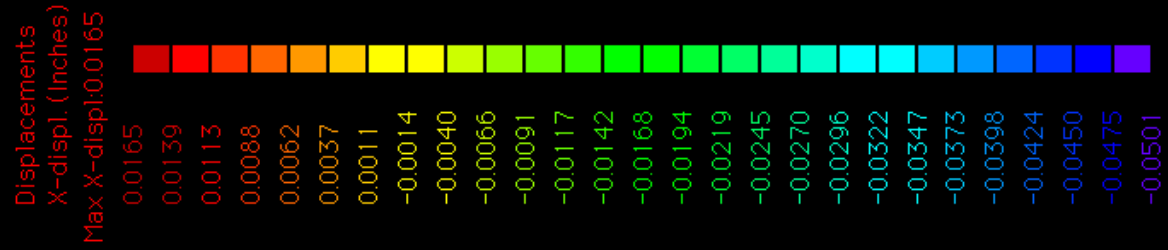
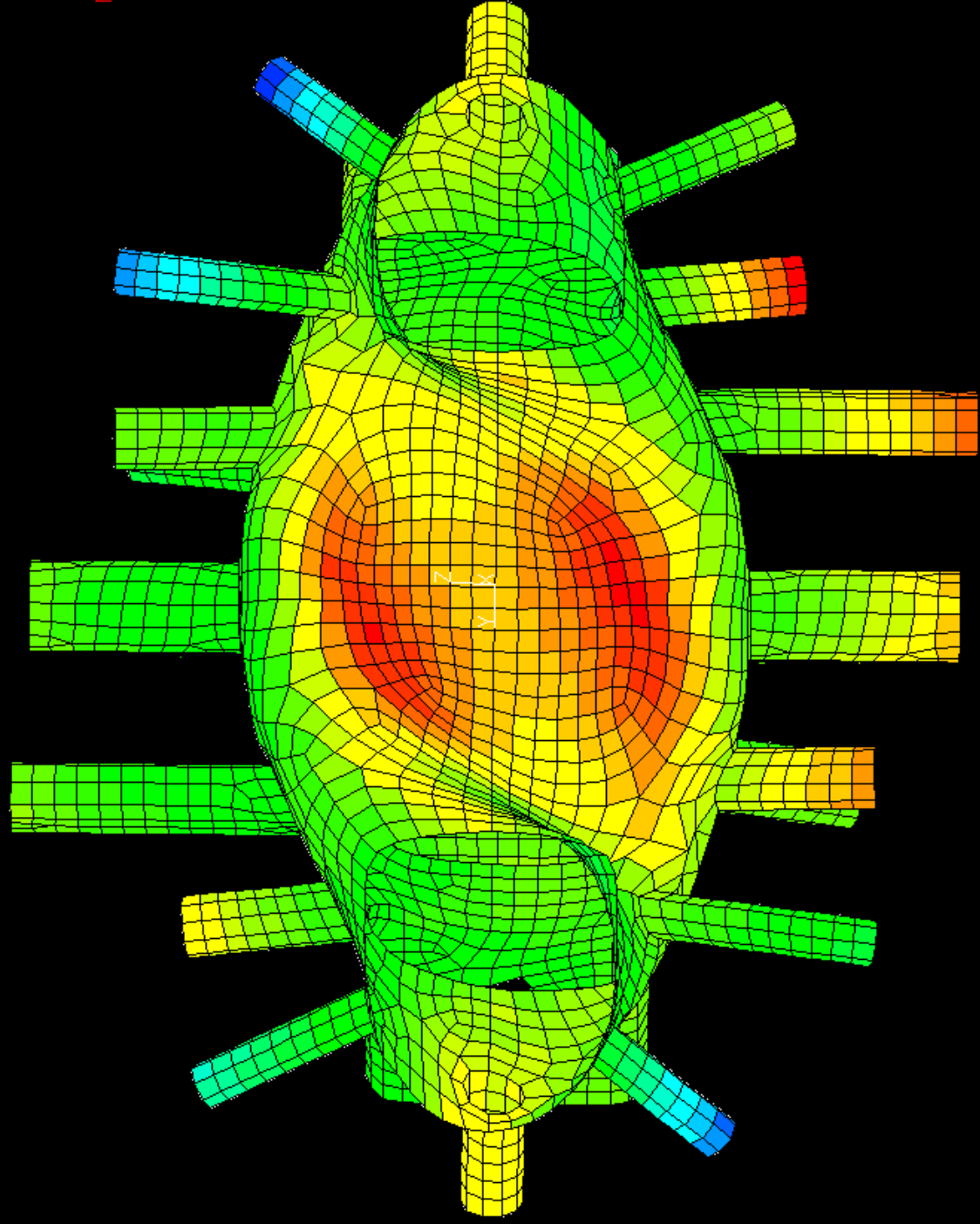


Plate thickness

- (1) 1.25E-1
- (2) 3.12E-1
- (3) 5.00E-1
- (4) 6.88E-1
- (5) 8.75E-1
- (6) 1.06E+0
- (7) 1.25E+0

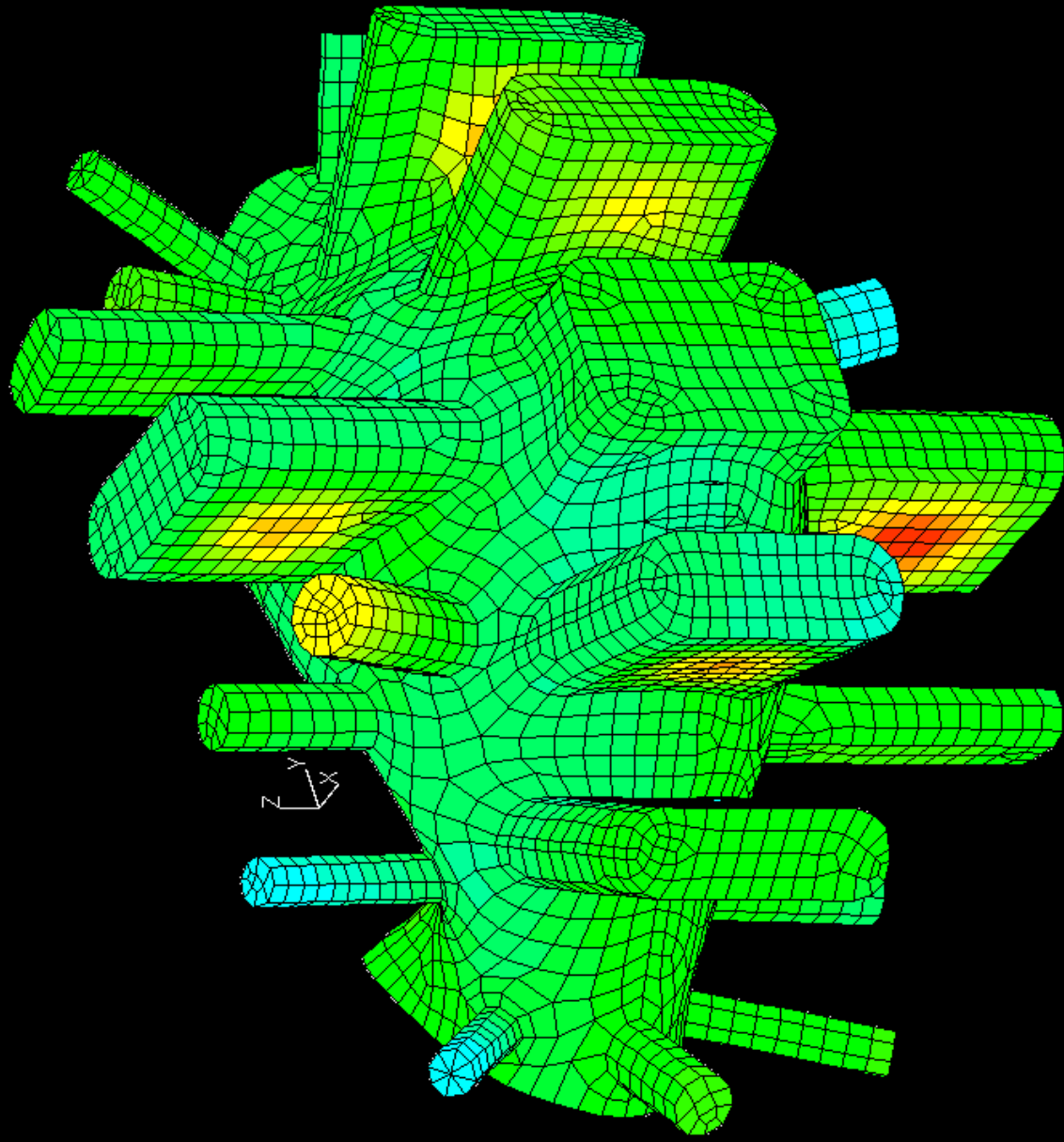






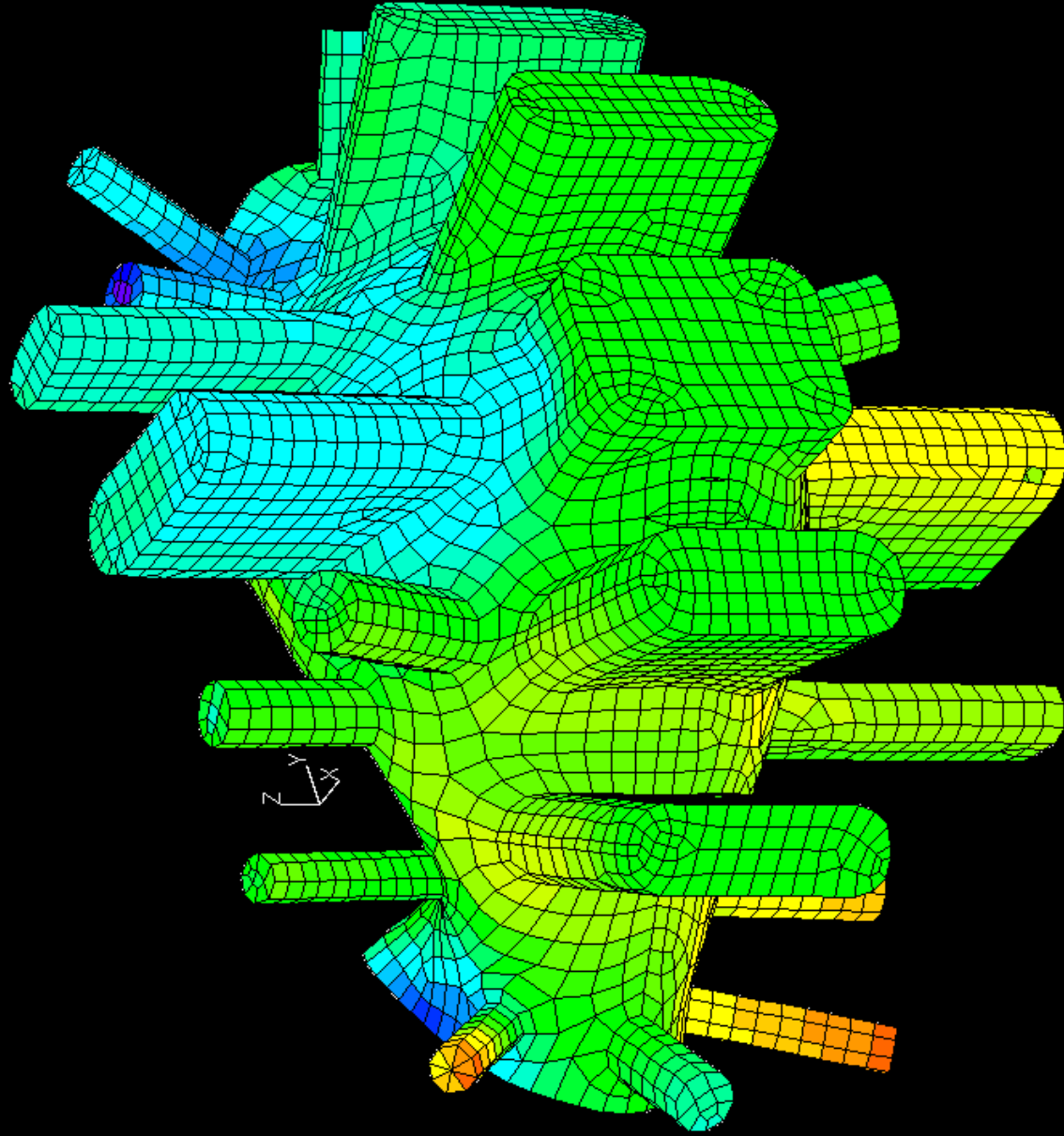
Displacements
X-displ. (Inches)
Max X-displ: 0.0165

0.0165	0.0139	0.0113	0.0088	0.0062	0.0037	0.0011	-0.0014	-0.0040	-0.0066	-0.0091	-0.0117	-0.0142	-0.0168	-0.0194	-0.0219	-0.0245	-0.0270	-0.0296	-0.0322	-0.0347	-0.0373	-0.0398	-0.0424	-0.0450	-0.0475	-0.0501
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Displacements
 Y-displ. (Inches)
 Max Y-displ: 0.0448

0.0448
0.0414
0.0379
0.0345
0.0310
0.0275
0.0241
0.0206
0.0171
0.0137
0.0102
0.0068
0.0033
-0.0002
-0.0036
-0.0071
-0.0106
-0.0140
-0.0175
-0.0210
-0.0244
-0.0279
-0.0313
-0.0348
-0.0383
-0.0417
-0.0452



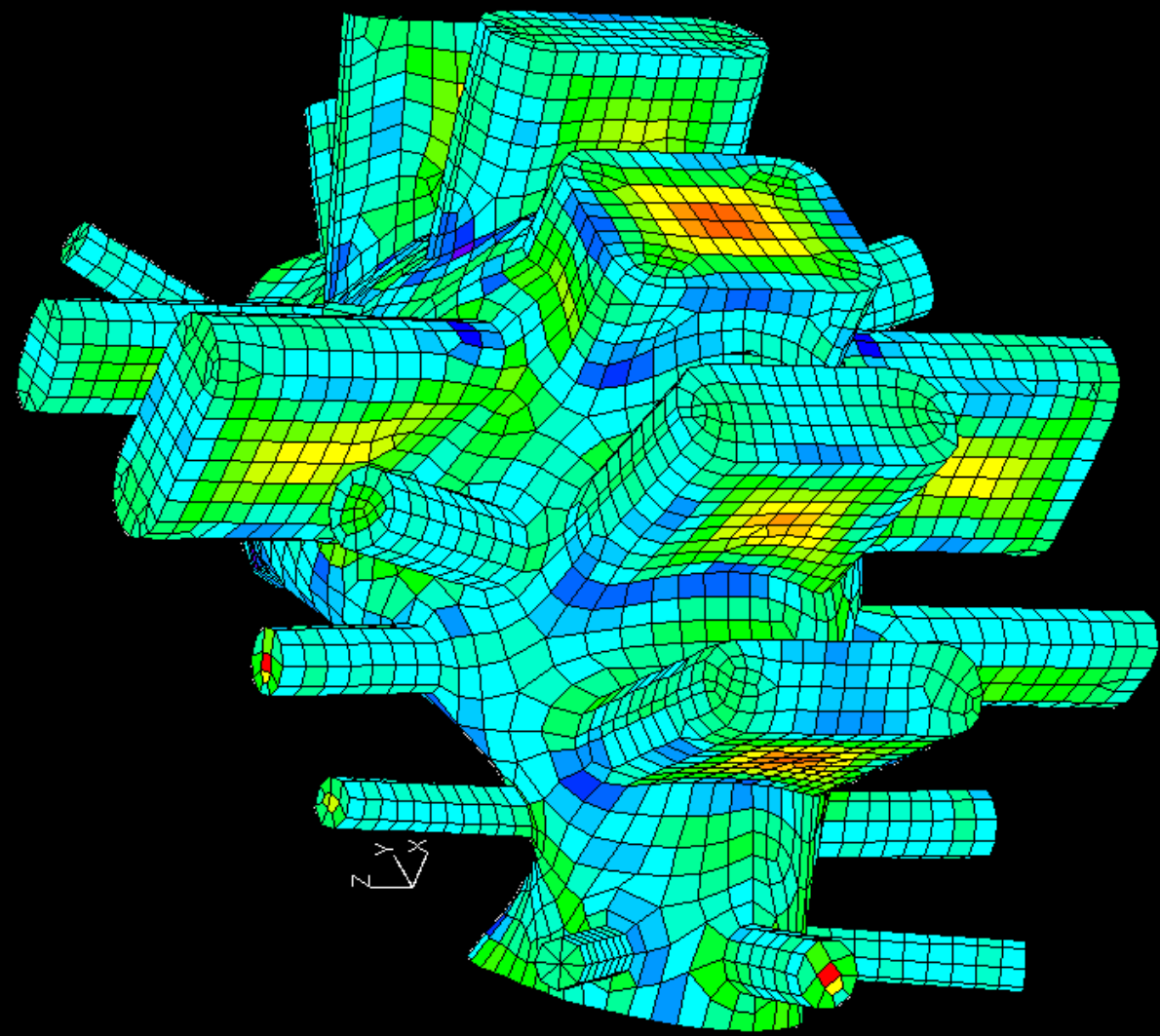
Displacements
Z-displ. (Inches)
Max Z-disp1 0.0239

0.0239	0.0219	0.0199	0.0179	0.0159	0.0139	0.0119	0.0099	0.0079	0.0060	0.0040	0.0020	-0.0000	-0.0020	-0.0040	-0.0060	-0.0080	-0.0100	-0.0120	-0.0140	-0.0160	-0.0180	-0.0200	-0.0220	-0.0240	-0.0260	-0.0279
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FEAMAC/Nastran Model
 Title: NCSX-VV CYCLIC-SYMM B.C.'S
 Subcase 1: 1 Atmosphere External Pressure

Run Date: FEB 12,2002

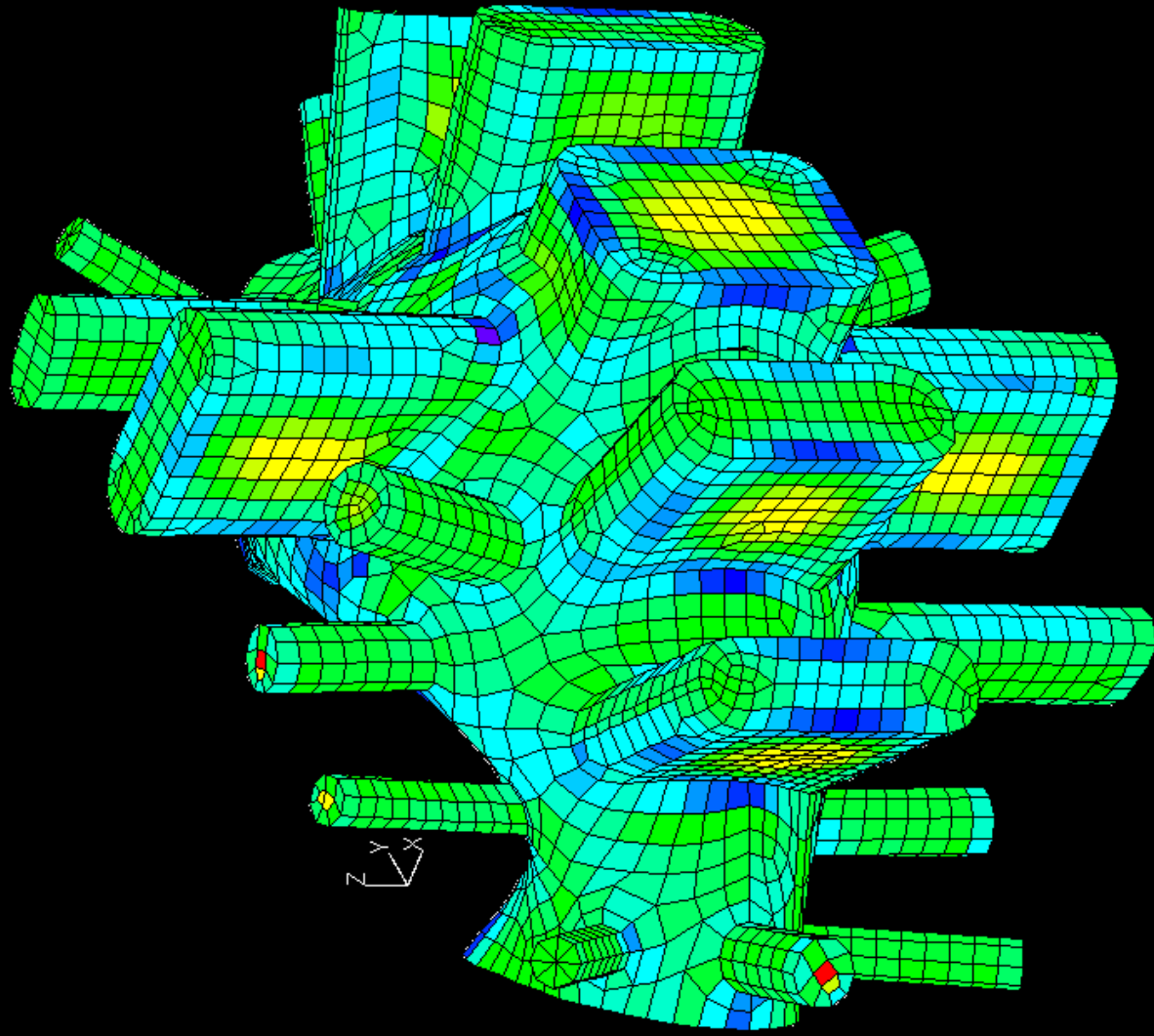


Stress Levels

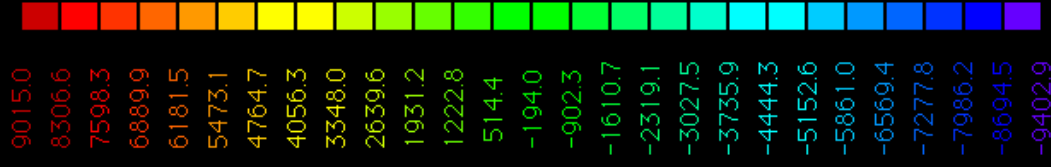
Smaj.Pr.-Z1 - (psi)

Peak Smaj.Pr. Z1 surf.: 9616.3

9616.3
9052.4
8488.5
7924.7
7360.8
6796.9
6233.0
5669.1
5105.2
4541.3
3977.5
3413.6
2849.7
2285.8
1721.9
1158.0
594.1
30.2
-533.6
-1097.5
-1661.4
-2225.3
-2789.2
-3353.1
-3917.0
-4480.9
-5044.7



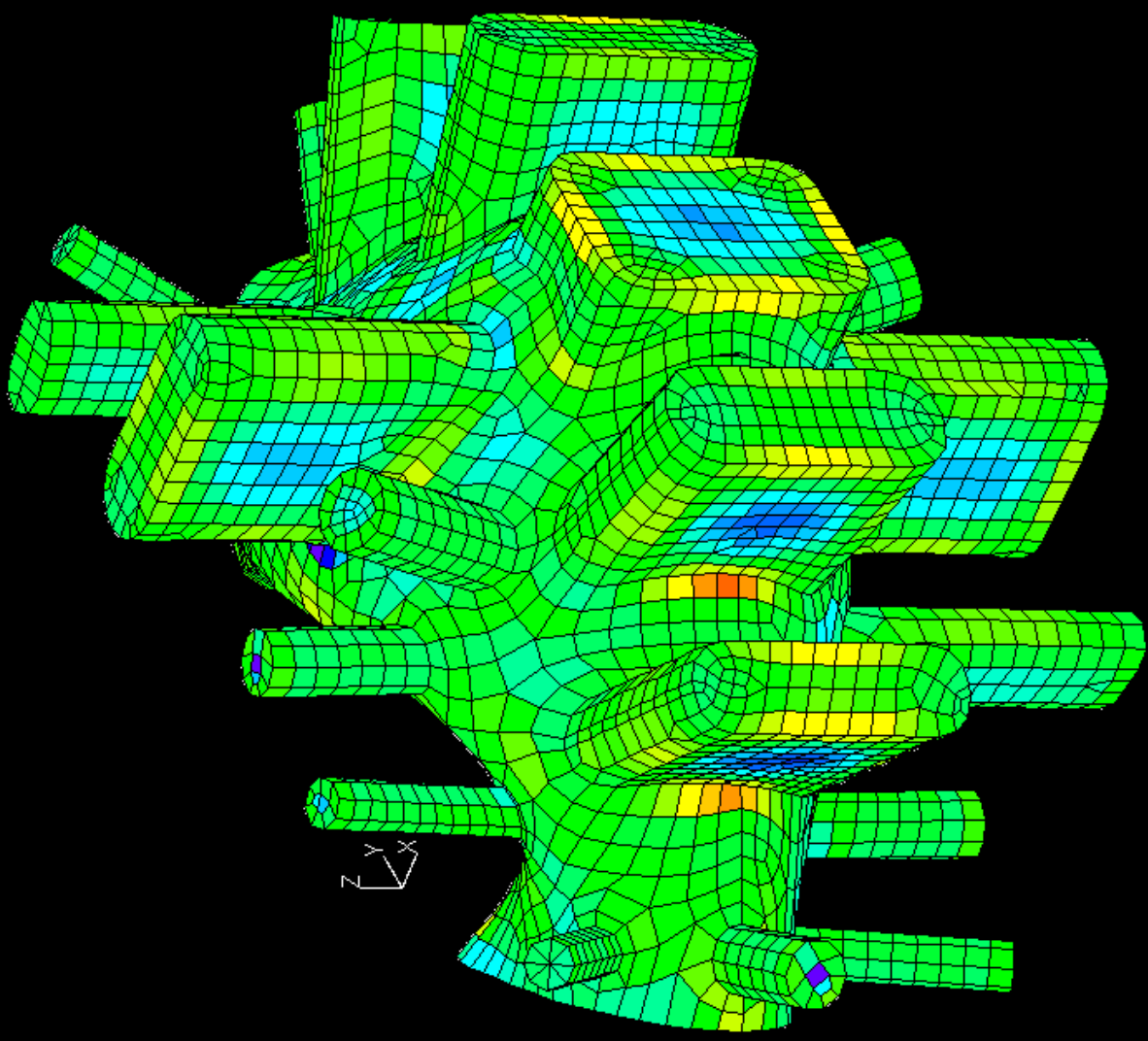
Stress Levels
Smin,Pr,-Z1 - (ps
Peak Smin,Pr,Z1 surf.: -940





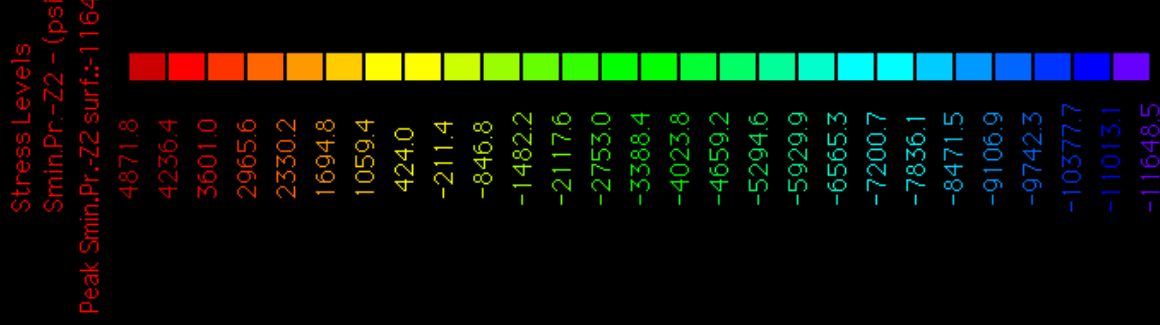
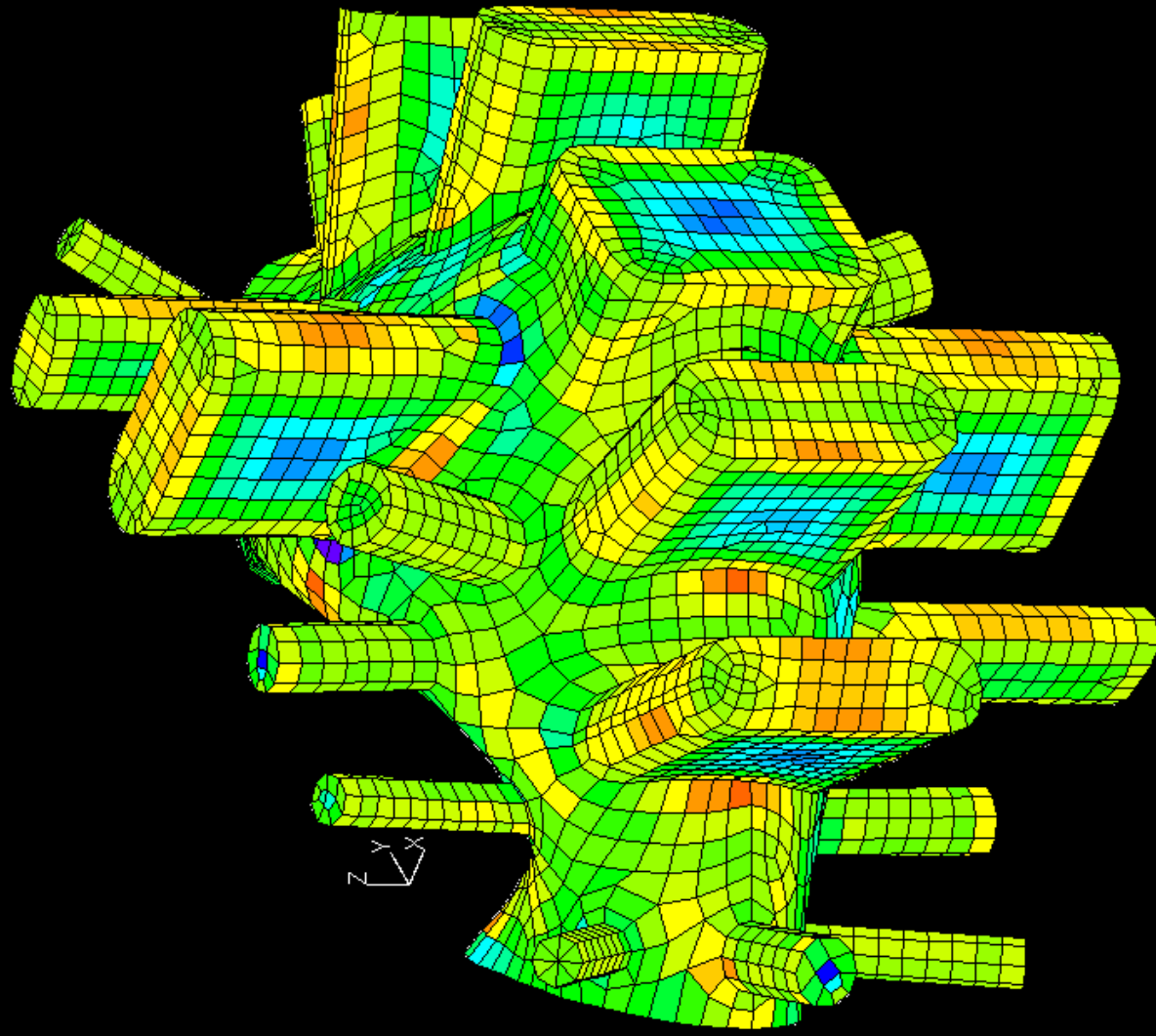
FEA/MAC/Nastran Model
 Title: NCSX-VV CYCLIC-SYMM B.C.'S
 Subcase 1: 1 Atmosphere External Pressure

Run Date: FEB 12, 2002



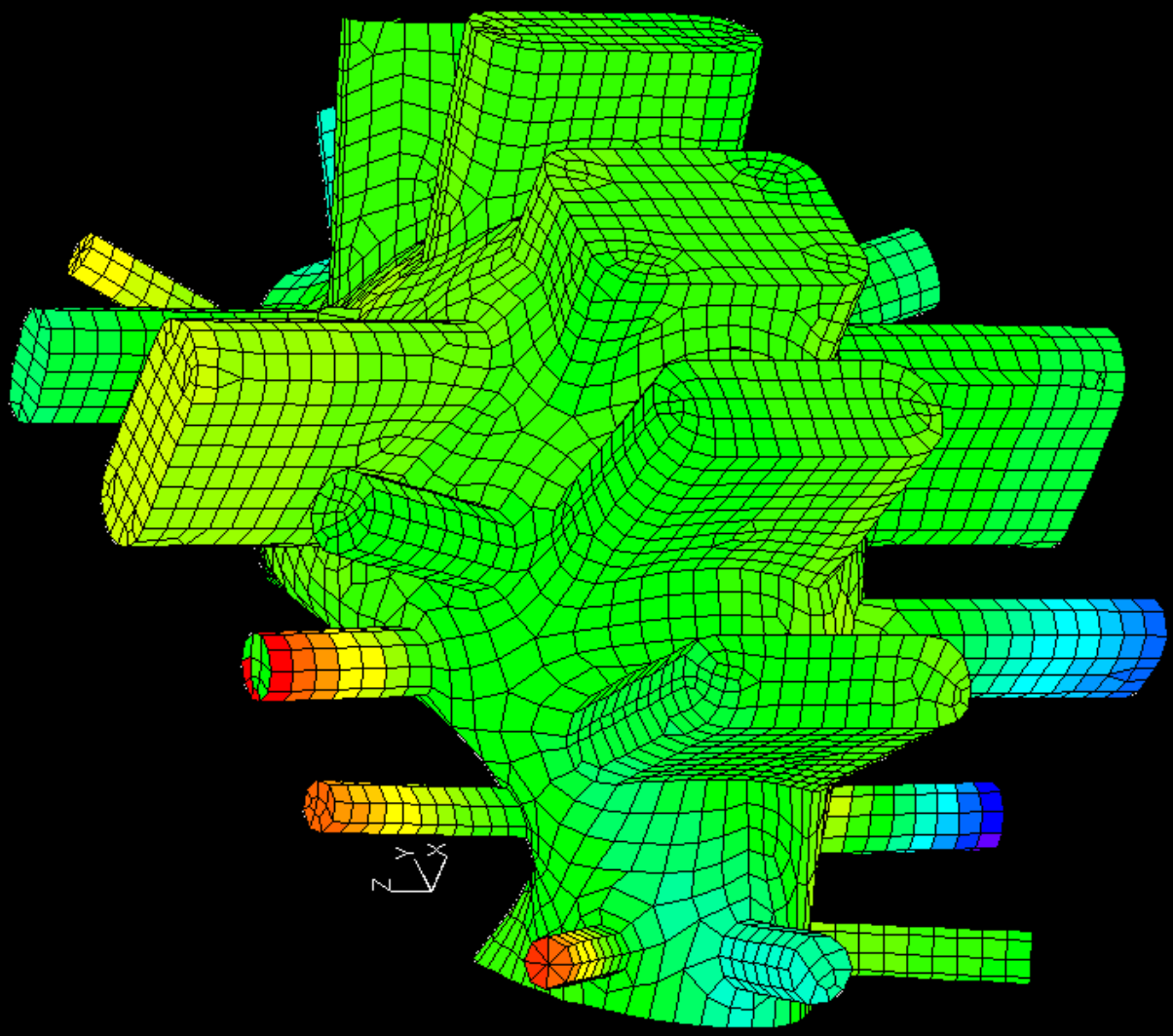
Stress Levels
 SmajPr.-Z2 - (ps)
 Peak SmajPr.-Z2 surf.: 11413.4

11413.4
10575.2
9736.9
8898.7
8060.4
7222.2
6383.9
5545.7
4707.5
3869.2
3031.0
2192.7
1354.5
516.3
-322.0
-1160.2
-1998.5
-2836.7
-3675.0
-4513.2
-5351.4
-6189.7
-7027.9
-7866.2
-8704.4
-9542.7
-10380.9





FEA/MAC/Nastran Model
Title: NCSX-VV CYCLIC-SYMM B.C.'S
Subcase 2: = 175kA-DISRUPTION SELF + COIL FORCES
Run Date: FEB 12,2002



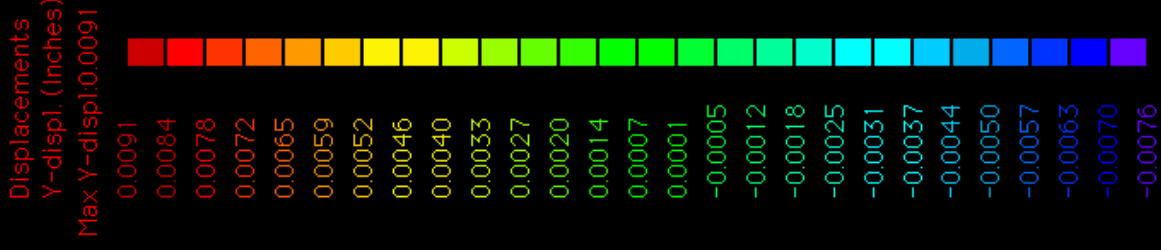
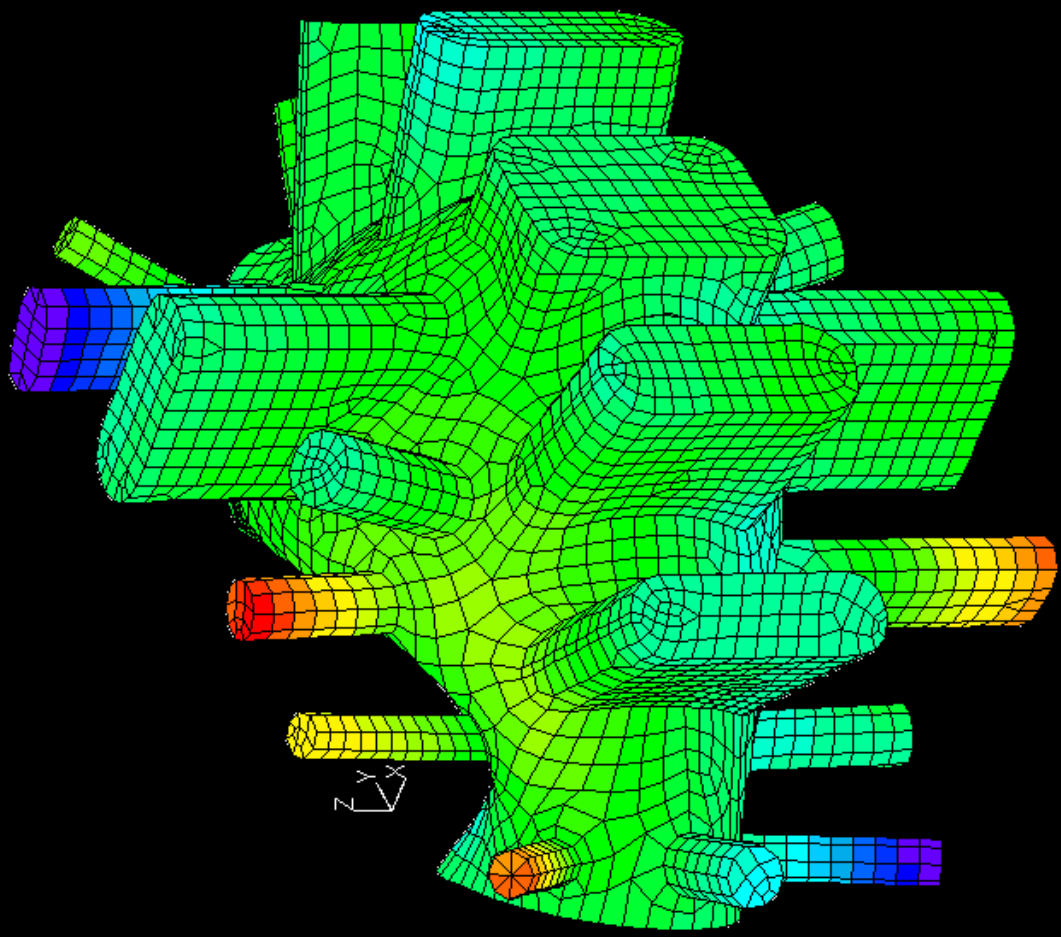
Displacements
X-displ. (Inches)
Max X-displ: 0.0134

0.0134
0.0122
0.0111
0.0100
0.0089
0.0078
0.0066
0.0055
0.0044
0.0033
0.0022
0.0010
-0.0001
-0.0012
-0.0023
-0.0034
-0.0046
-0.0057
-0.0068
-0.0079
-0.0091
-0.0102
-0.0113
-0.0124
-0.0135
-0.0147
-0.0158



FEAMAC/Nastran Model
 Title: NCSX-VV CYCLIC-SYMM B.C.'S
 Subcase 2: = 175kA-DISRUPTION SELF + COIL FORCES

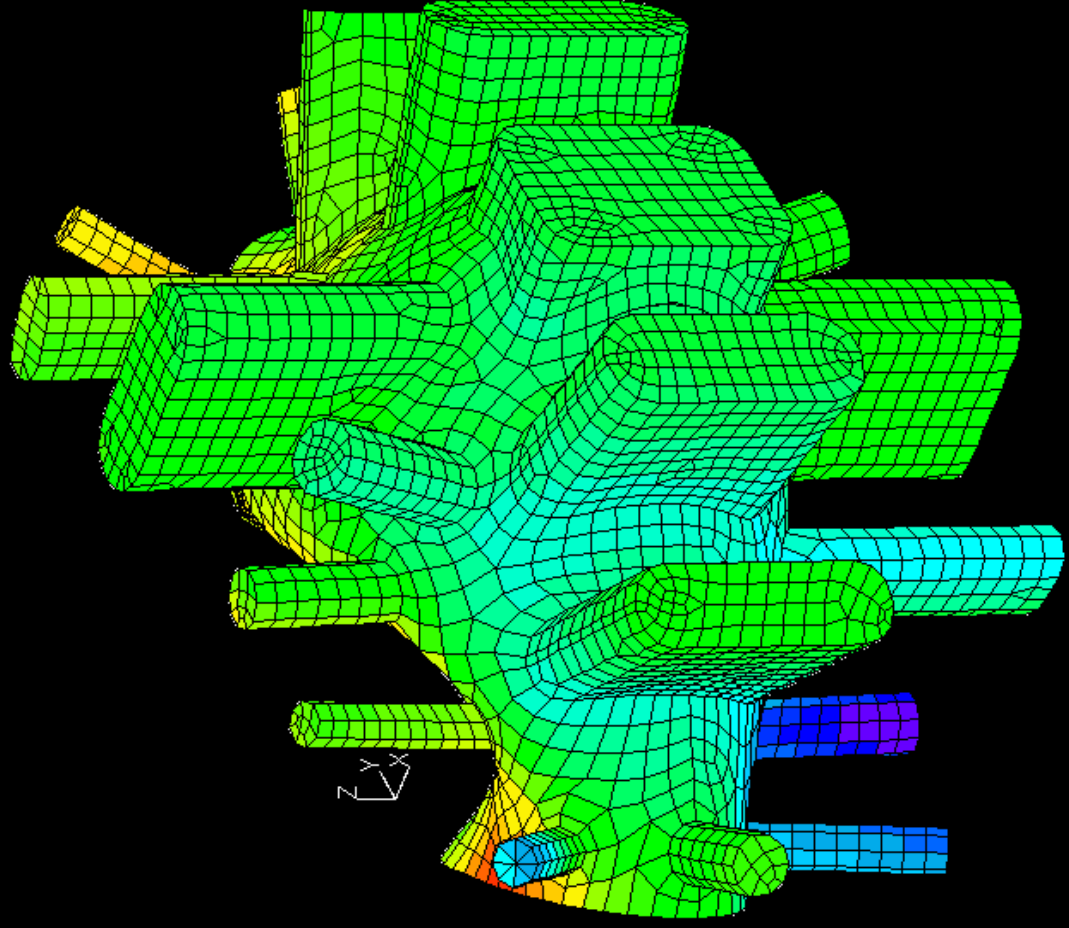
Run Date: FEB 12, 2002



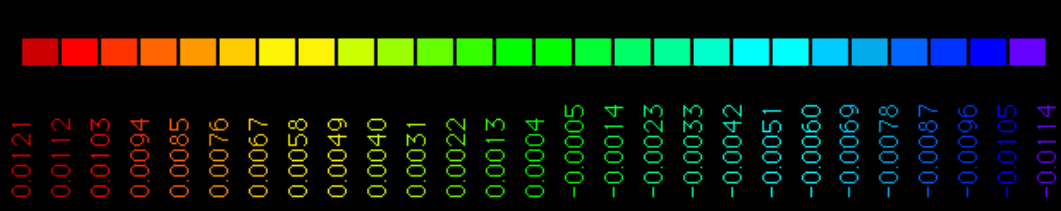


FEAMAC/Nastran Model
 Title: NCSX-VV CYCLIC-SYMM B.C.'S
 Subcase 2: = 175kA-DISRUPTION SELF + COIL FORCES

Run Date: FEB 12, 2002



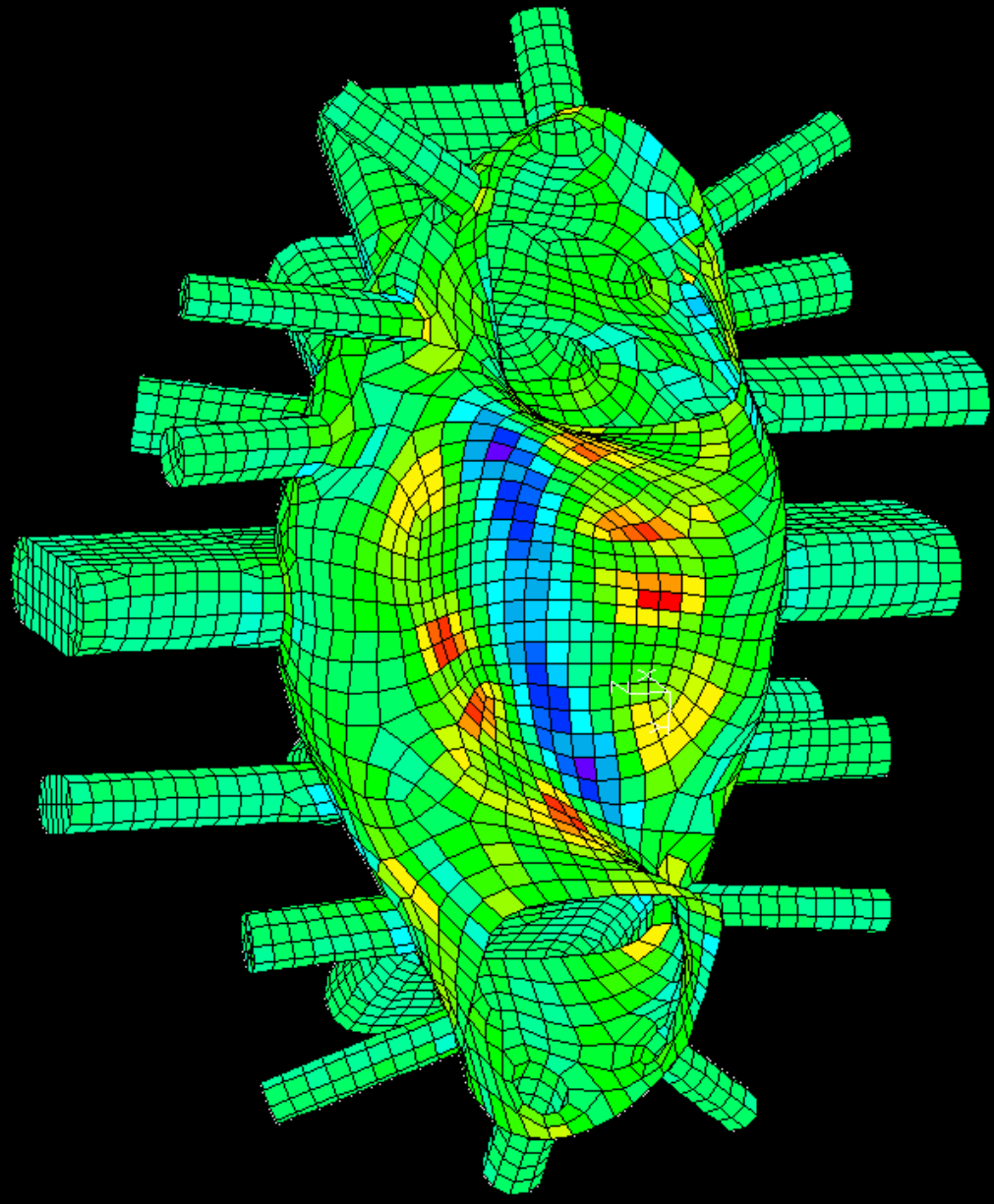
Displacements
 Z-displ. (Inches)
 Max Z-displ. 0.0121





FEA/MAC/Nastran Model
 Title: NCSX-VV CYCLIC-SYMM.B.C.'S
 Subcase 2: = 175kA-DISRUPTION SELF + COIL FORCES

Run Date: FEB 12, 2002



Stress Levels

Smaj.Pr.-Z1 - (psi)

Peak Smaj.Pr. Z1 surf.: 3354.4

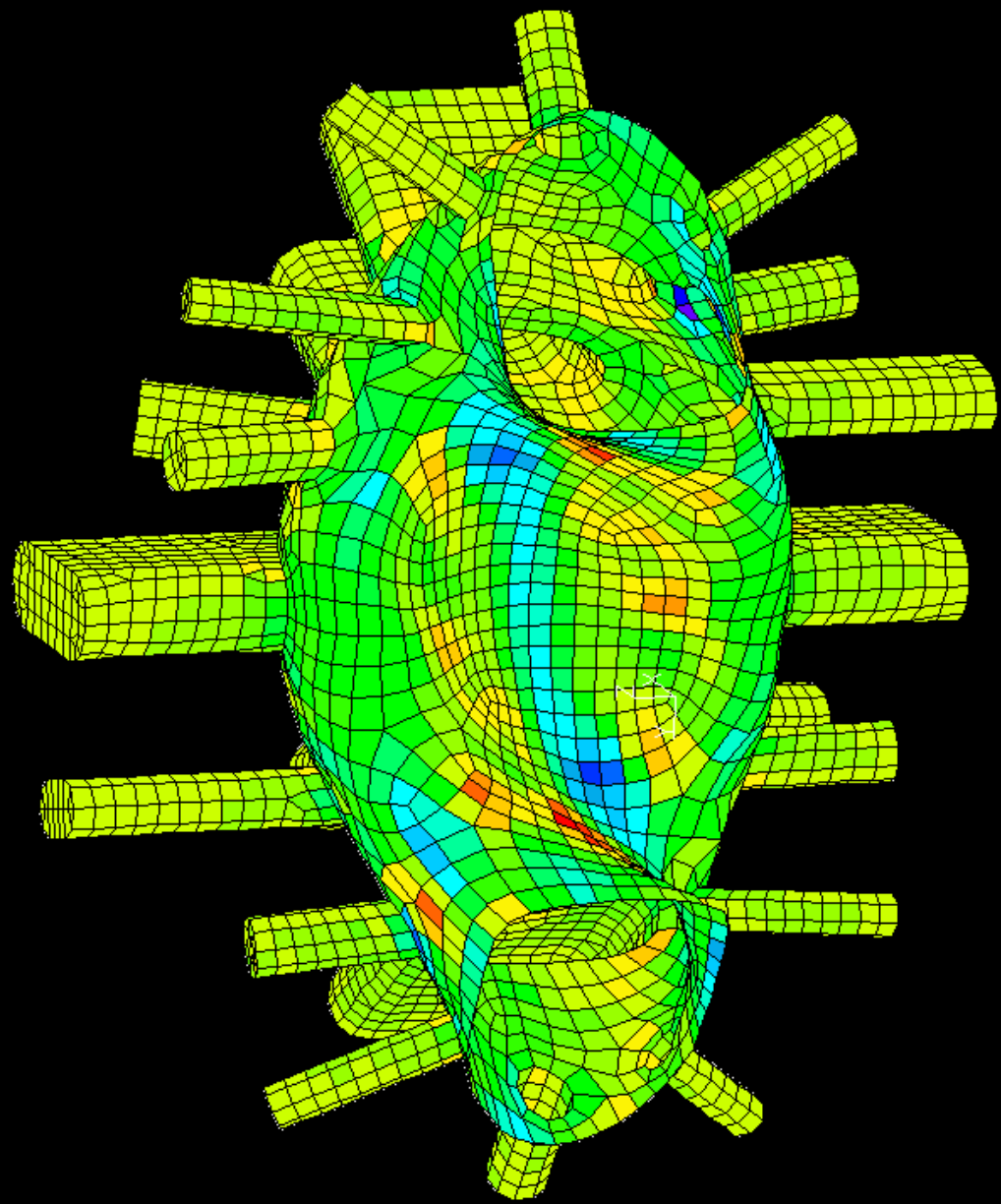
3354.4
3131.4
2908.4
2685.4
2462.4
2239.4
2016.4
1793.3
1570.3
1347.3
1124.3
901.3
678.3
455.3
232.2
9.2
-213.8
-436.8
-659.8
-882.8
-1105.8
-1328.9
-1551.9
-1774.9
-1997.9
-2220.9
-2443.9



FEAMAC/Nastran Model
 Title: NCSX-VV CYCLIC-SYMM B.C.'S
 Subcase 2: = 175kA-DISRUPTION SELF + COIL FORCES

Run Date: FEB 12, 2002

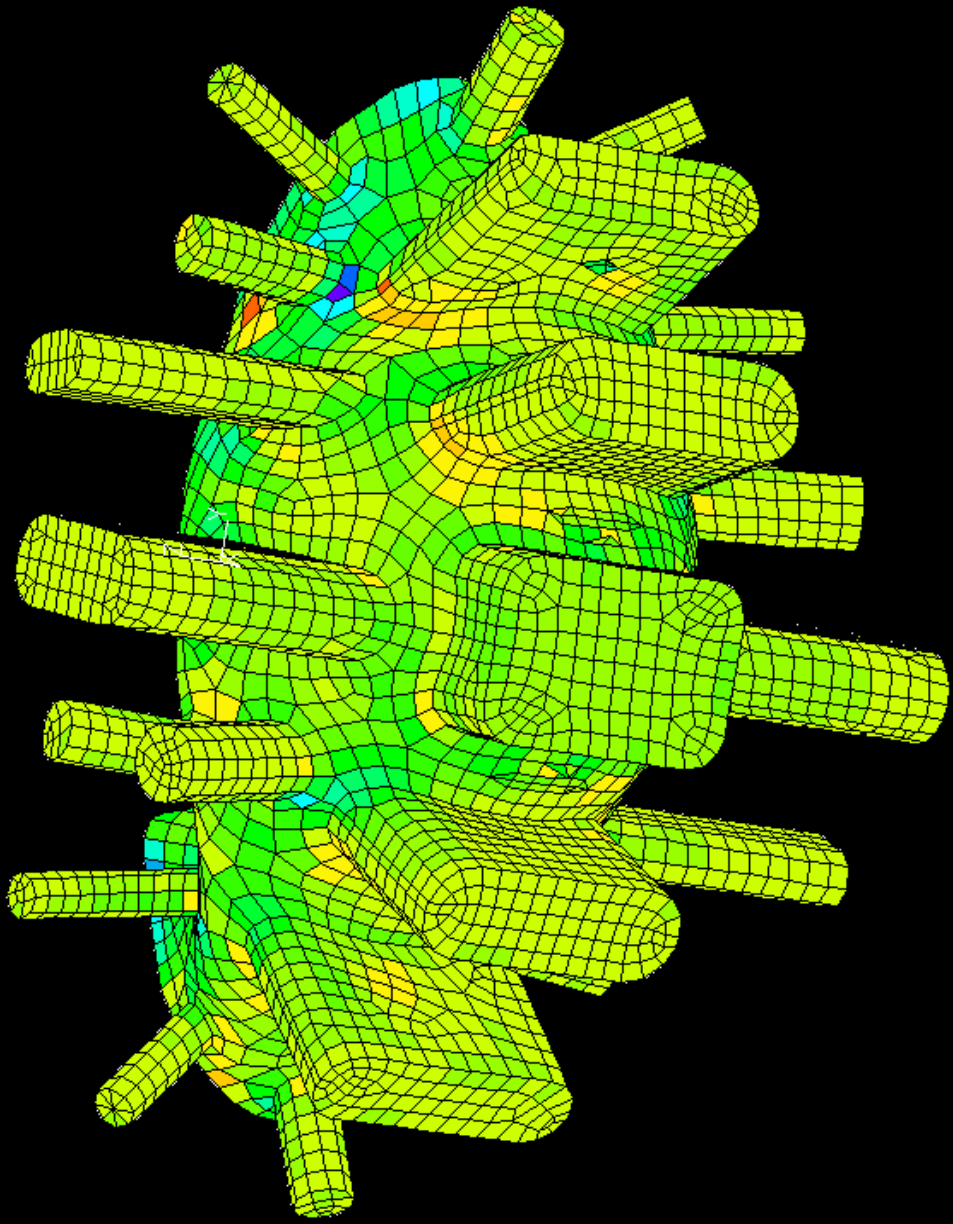
Stress Levels
 Smin,Pr.-Z1 - (psi)
 Peak Smin,Pr.Z1 surf.: -3873.4



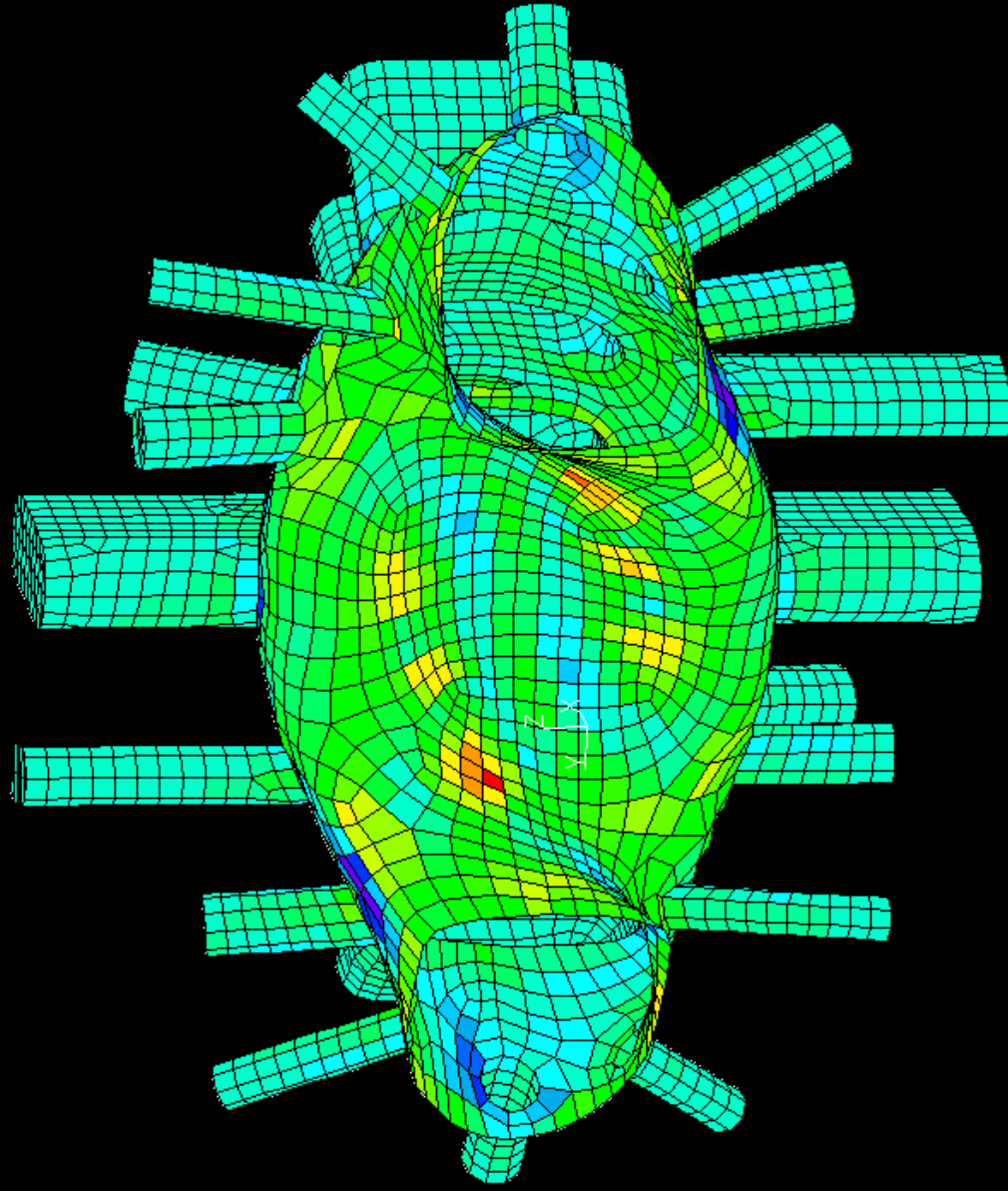
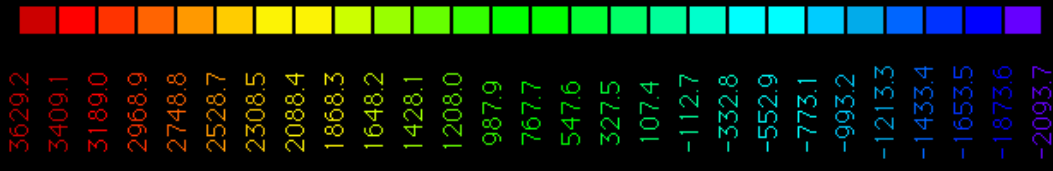


FEAMAC/Nastran Model
Title: NCSX-VV CYCLIC-SYMM B.C.'S
Subcase 2: = 175kA-DISRUPTION SELF + COIL FORCES
Run Date: FEB 12,2002

Stress Levels
Smin,Pr.-Z1 - (psi)
Peak Smin,Pr.Z1 surf.: -3873.4



Stress Levels
SmajPr.-Z2 - (psi)
Peak SmajPr.-Z2 surf.: 3629.2

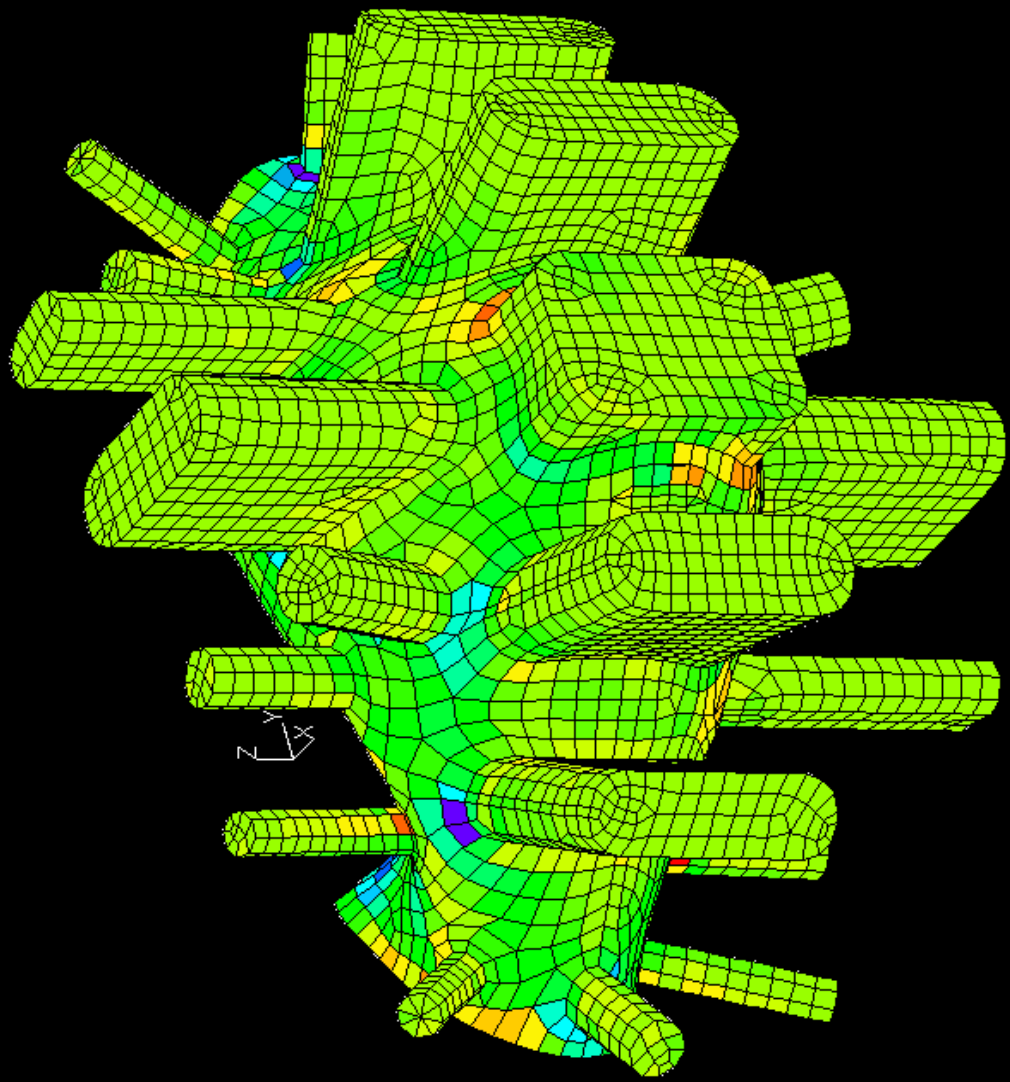
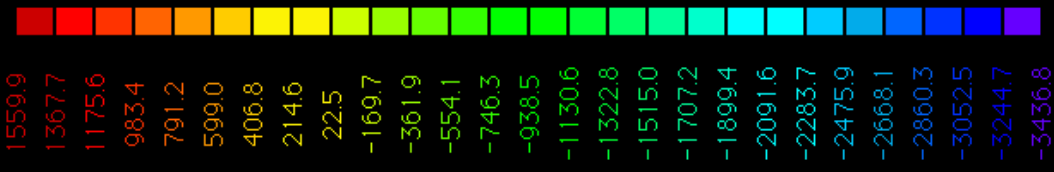




FEAMAC/Nastran Model
Title: NCSX-VV CYCLIC-SYMM B.C.'S
Subcase 2: = 175kA-DISRUPTION SELF + COIL FORCES

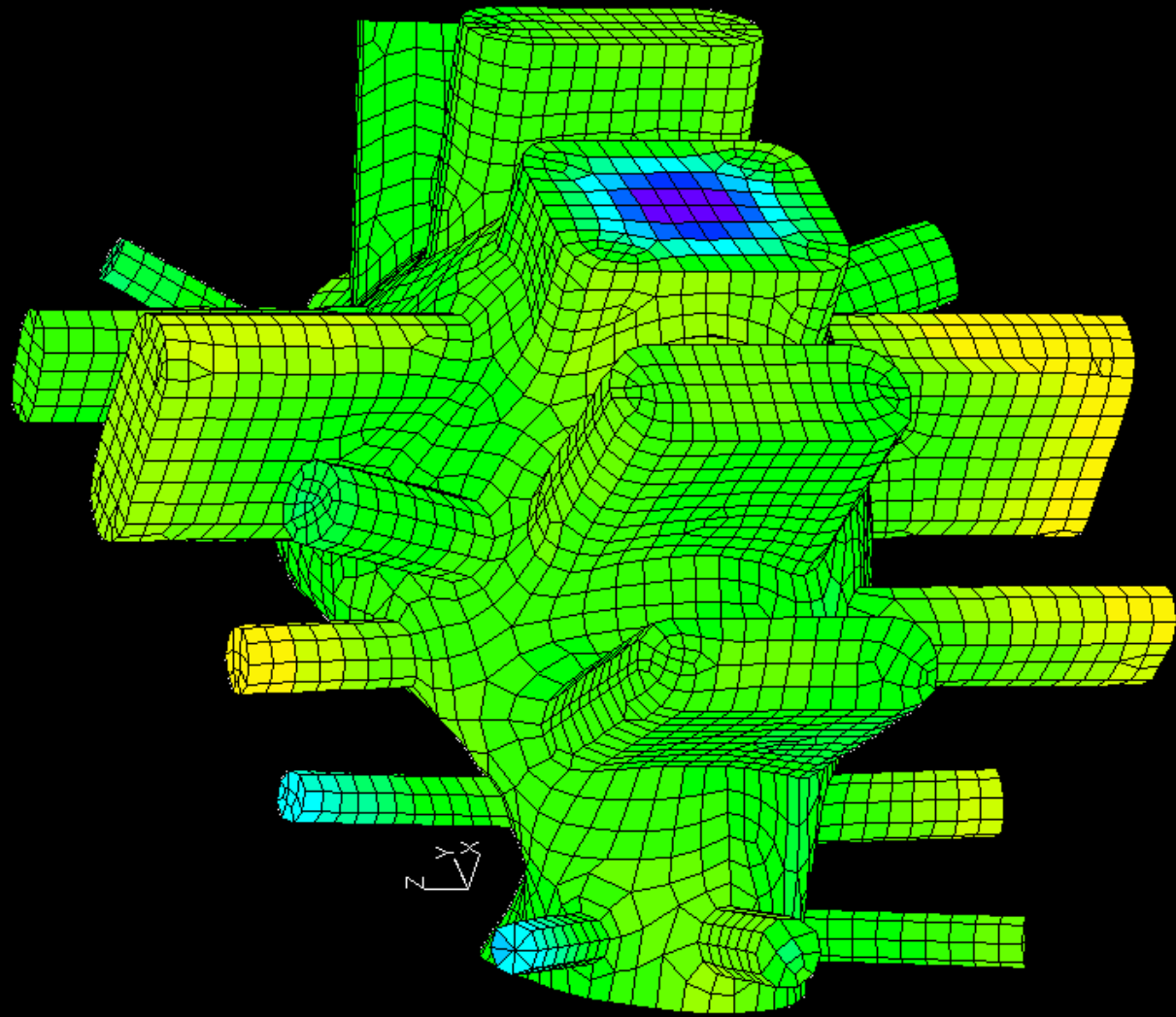
Run Date: FEB 12, 2002

Stress Levels
Smin.Pr.-Z2 - (psi)
Peak Smin.Pr.-Z2 surf.: -3436.8





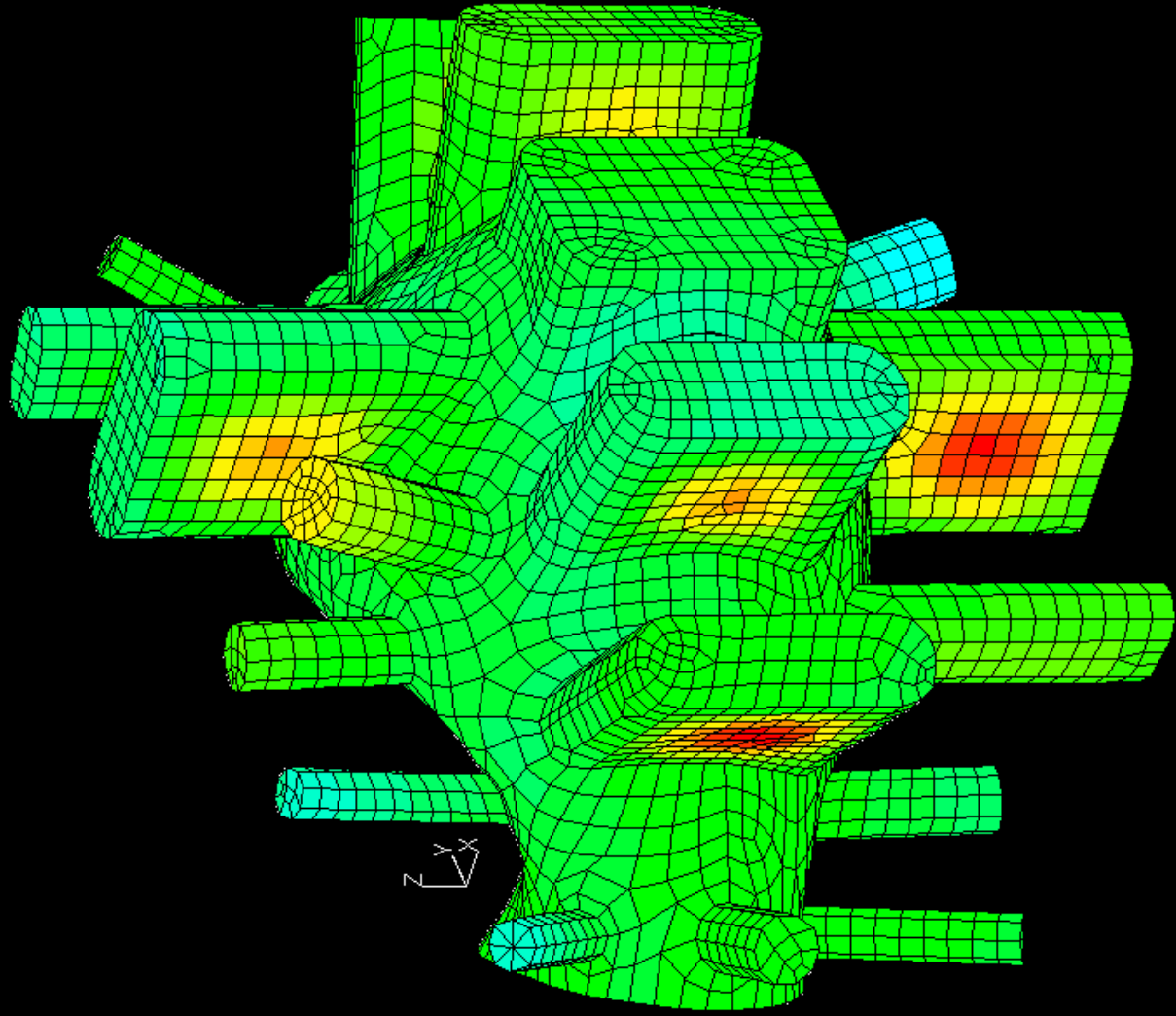
FEA/MAC/Nastran Model
Title: NCSX-VV CYCLIC-SYMM B.C.'S
Subcase 3: = 1-BAR PRESSURE + 175kA-DISRUPTION SELF + COIL FORCES
Run Date: FEB 12, 2002



Displacements
X-displ. (Inches)

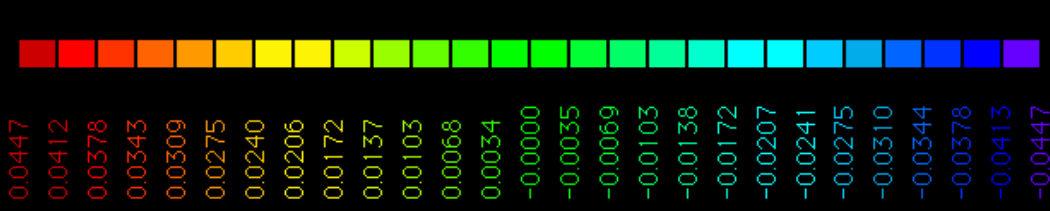
Max X-displ: 0.0183





Displacements
Y-disp]. (Inches)

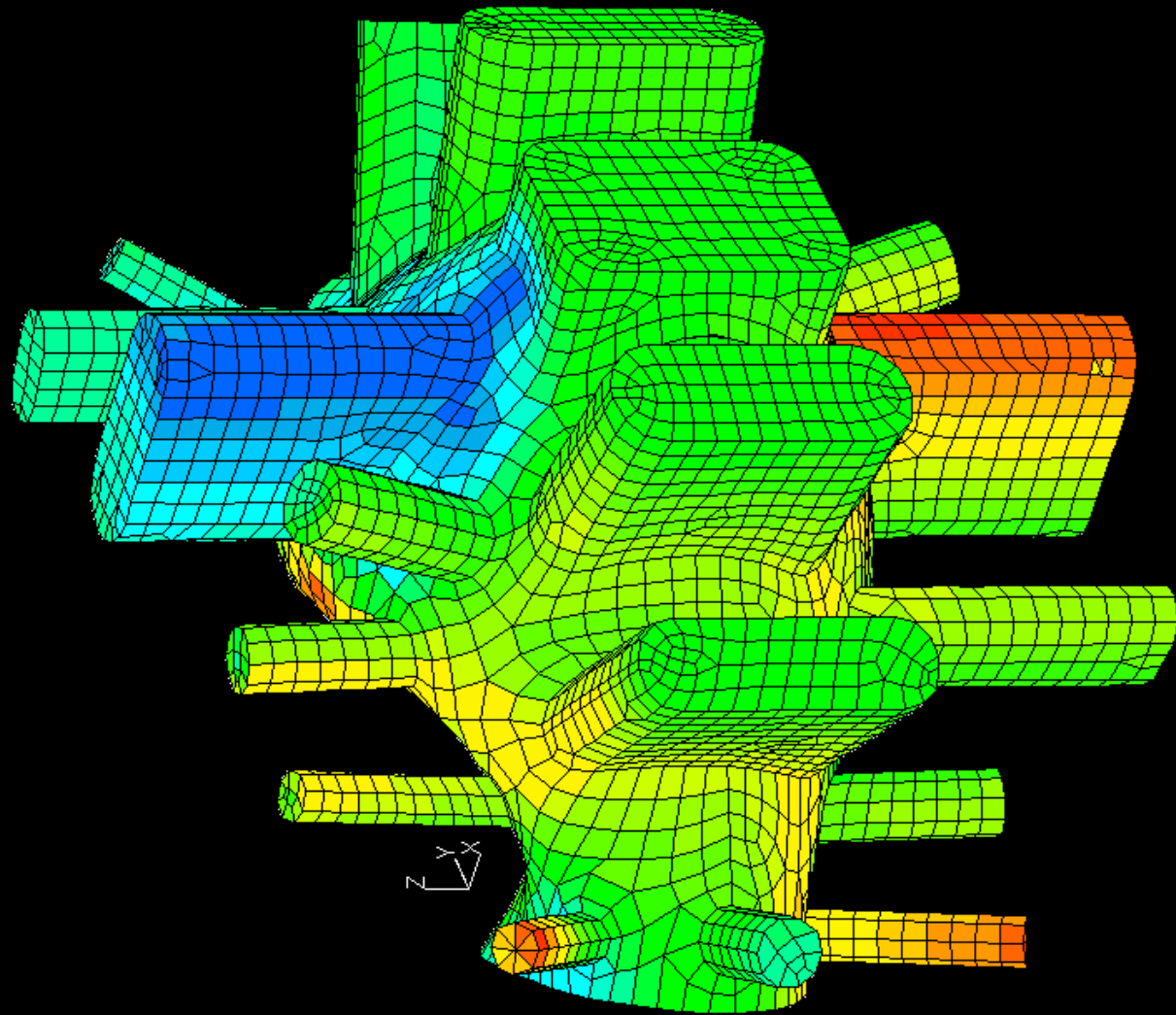
Max Y-disp]:0.0447





FEA/MAC/Nastran Model
Title: NCSX-VV CYCLIC-SYMM B.C.'S
Subcase 3: = 1-BAR PRESSURE + 175kA-DISRUPTION SELF + COIL FORCES

Run Date: FEB 12, 2002



Displacements
Z-displ. (Inches)

Max Z-displ|0.0149

0.0149

0.0136

0.0123

0.0110

0.0098

0.0085

0.0072

0.0059

0.0046

0.0033

0.0020

0.0007

-0.0006

-0.0019

-0.0032

-0.0044

-0.0057

-0.0070

-0.0083

-0.0096

-0.0109

-0.0122

-0.0135

-0.0148

-0.0161

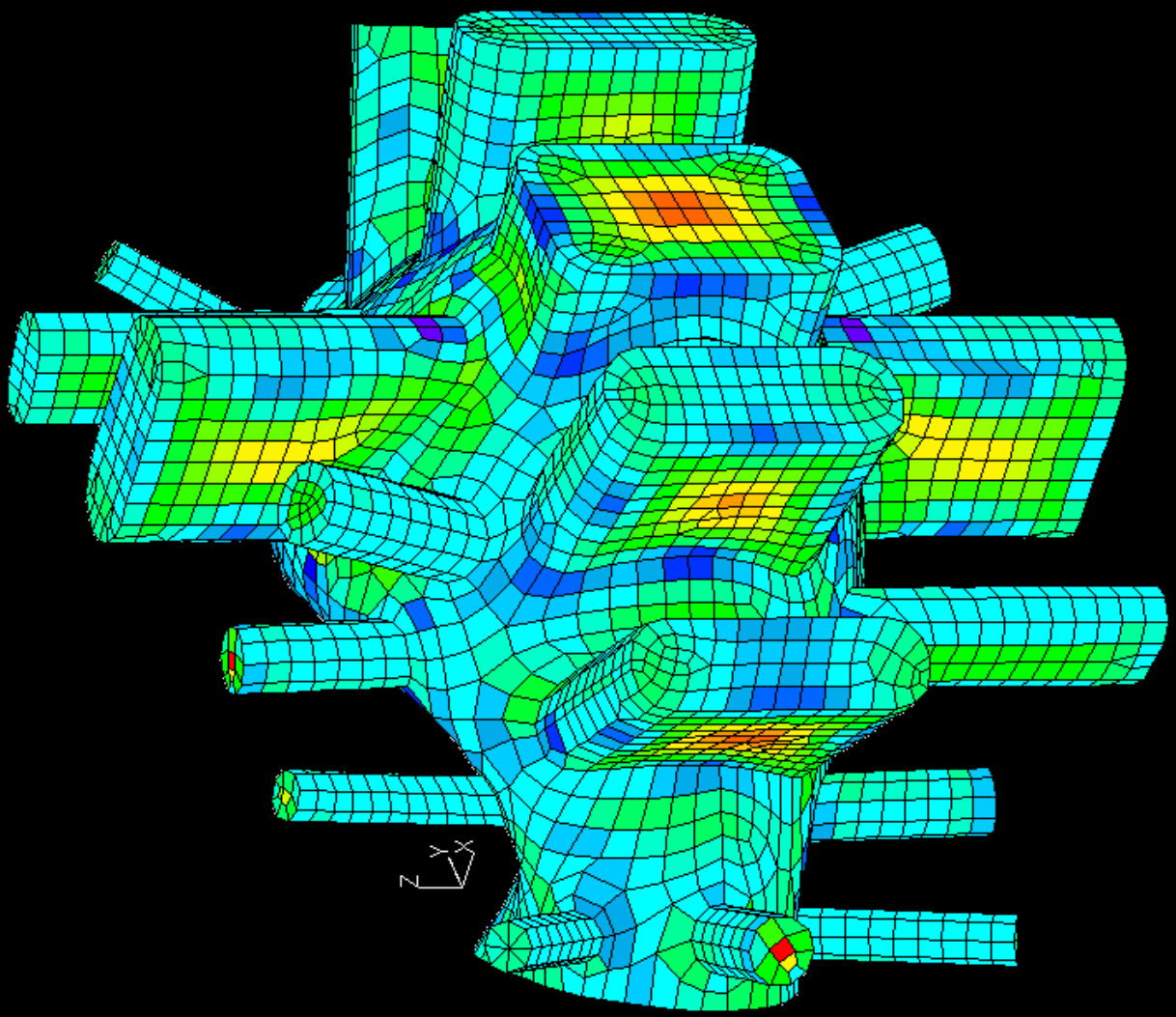
-0.0174

-0.0186



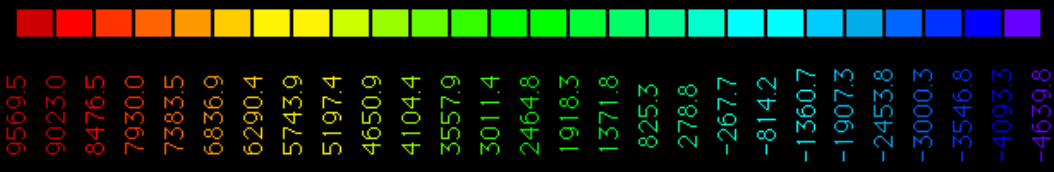
FEAMAC/Nastran Model
Title: NCSX-VV CYCLIC-SYMM B.C.'S
Subcase 3: = 1-BAR PRESSURE + 175kA-DISRUPTION SELF + COIL FORCES

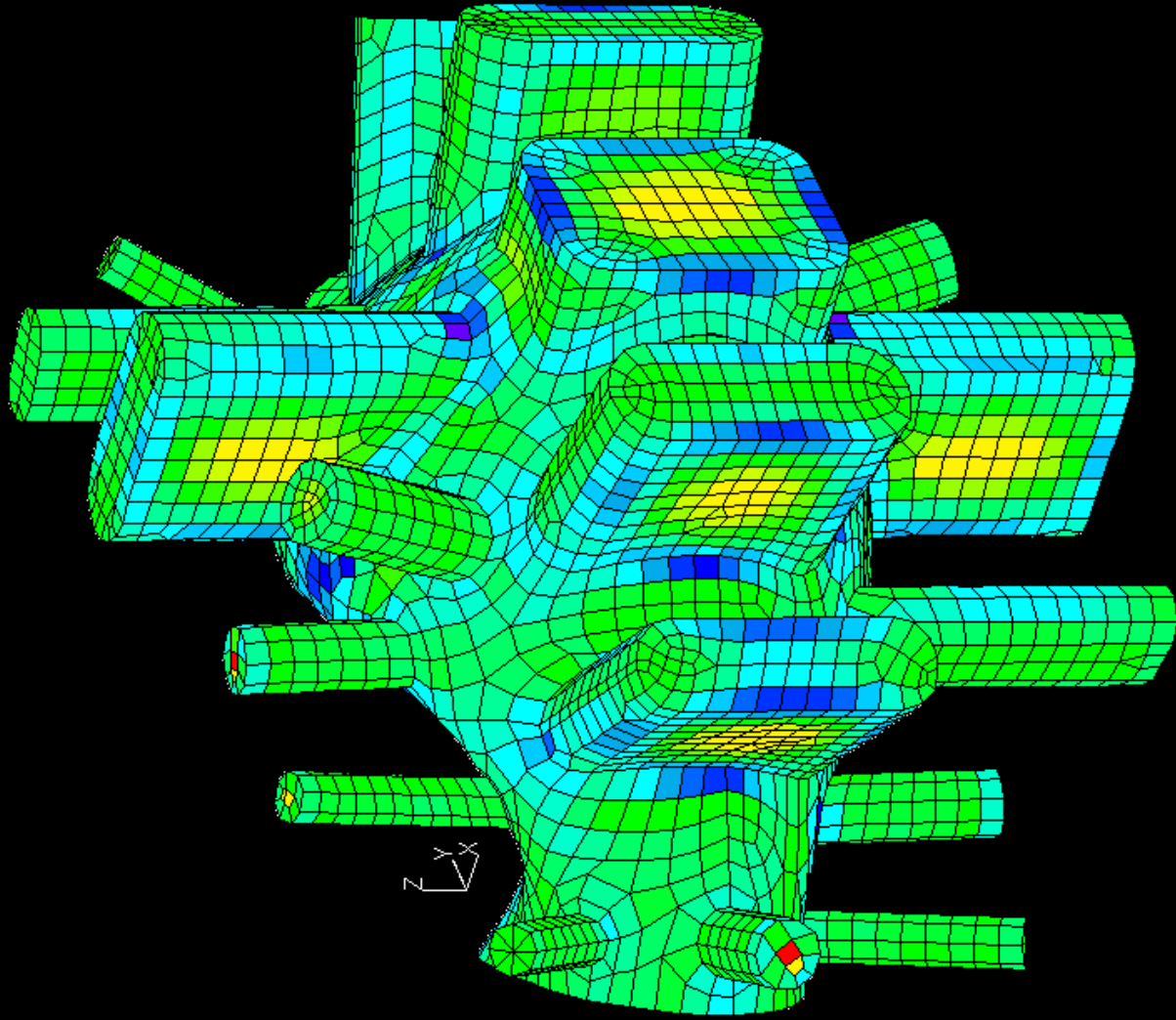
Run Date: FEB 12, 2002



Stress Levels

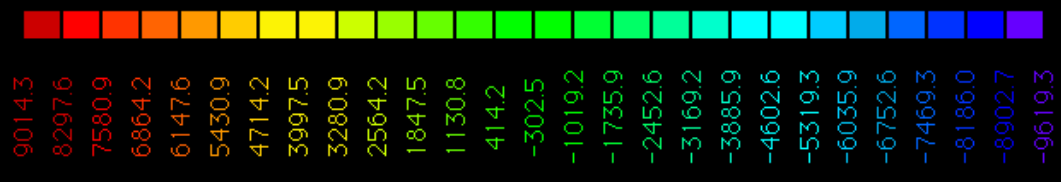
SmajPr.-Z1 - (psi)
Peak SmajPr.Z1 surf.: 9569.9





Stress Levels

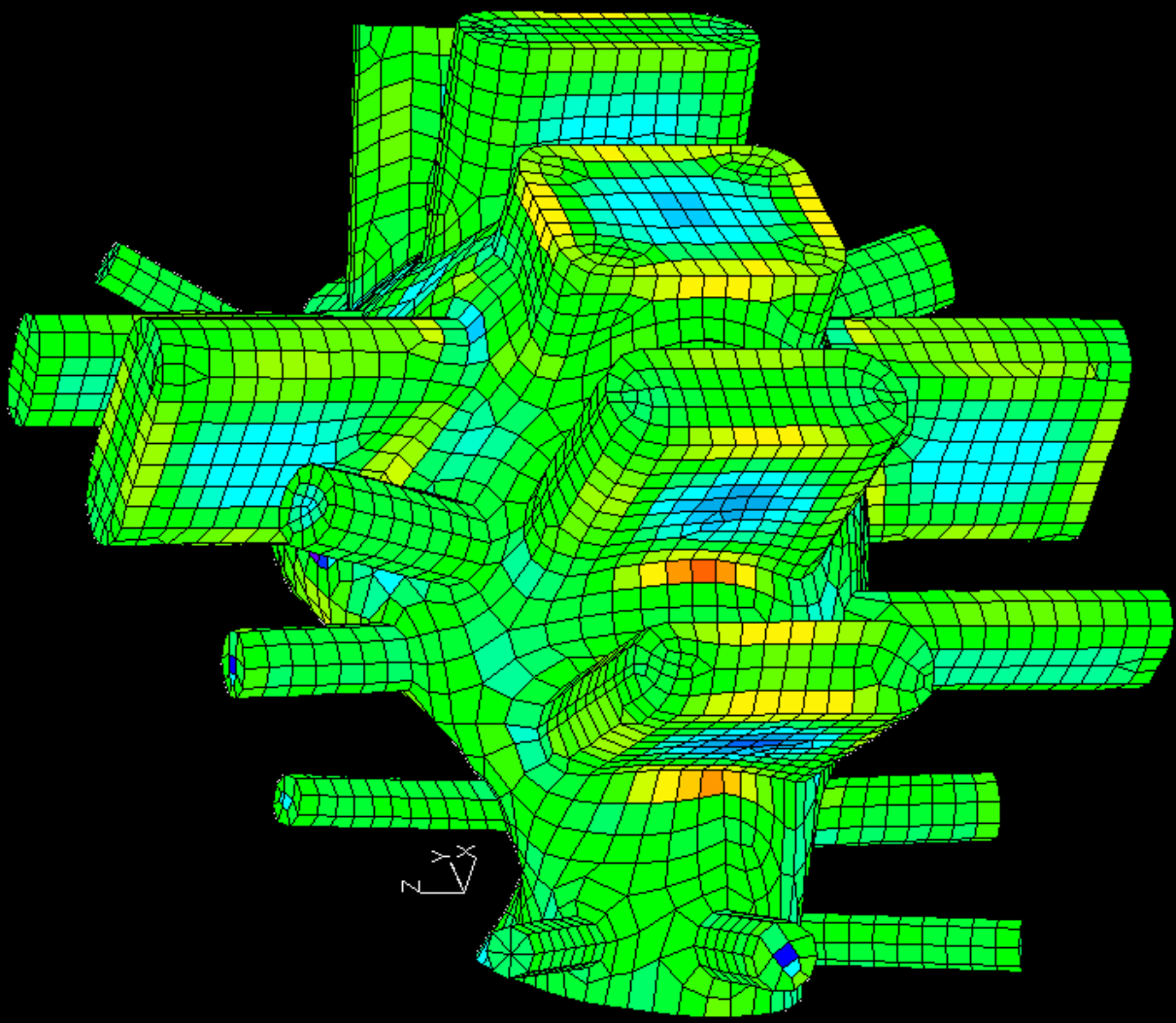
Smin,Pr,-Z1 - (psi)
Peak Smin,Pr,Z1 surf.: -9619.3





FEAMAC/Nastran Model
 Title: NCSX-VV CYCLIC-SYMM B.C.'S
 Subcase 3: = 1-BAR PRESSURE + 175kA-DISRUPTION SELF + COIL FORCES

Run Date: FEB 12, 2002

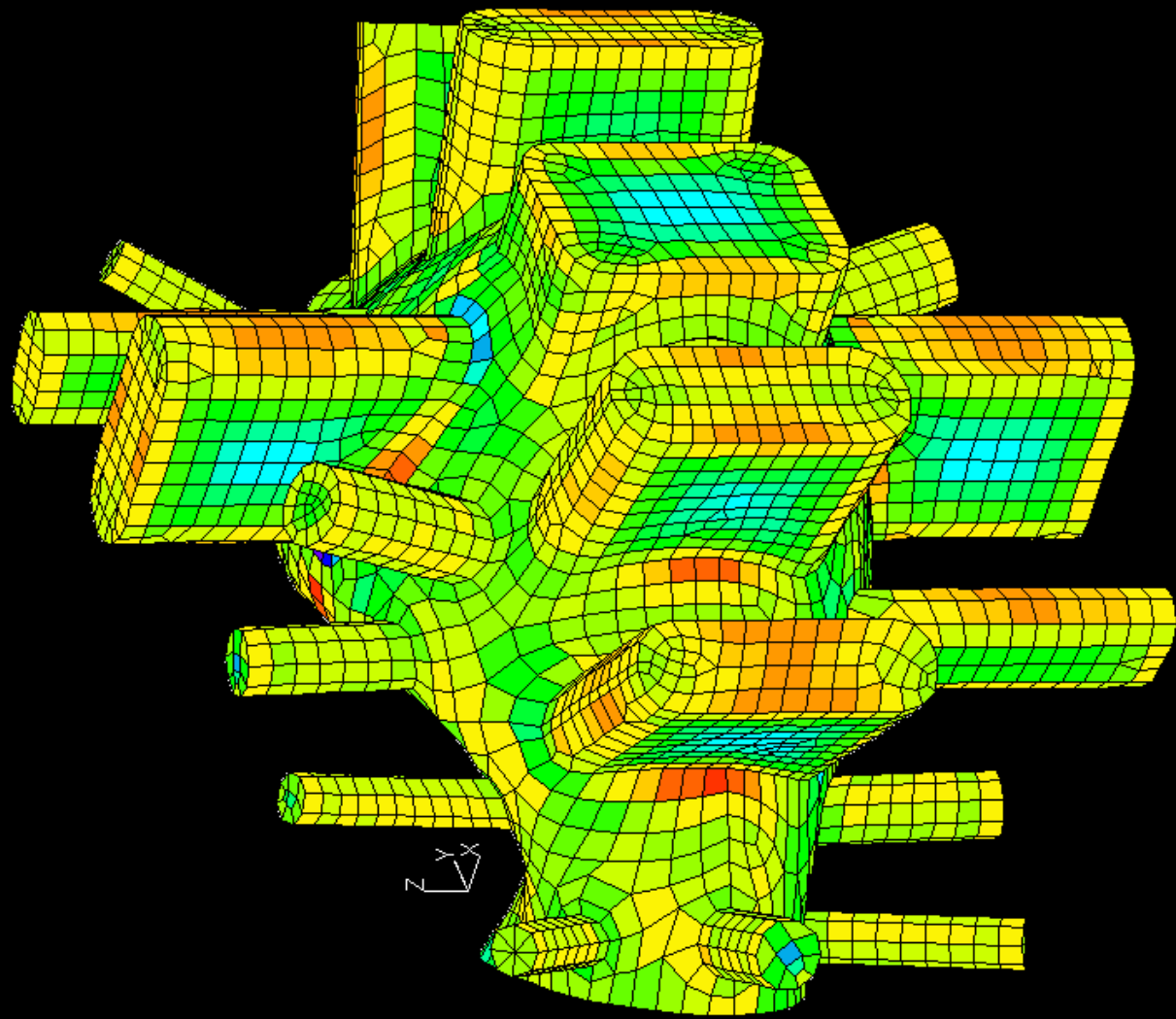


Stress Levels

Smaj,Pr,-Z2 - (psi)
 Peak Smaj,Pr,-Z2 surf.: 11760.5

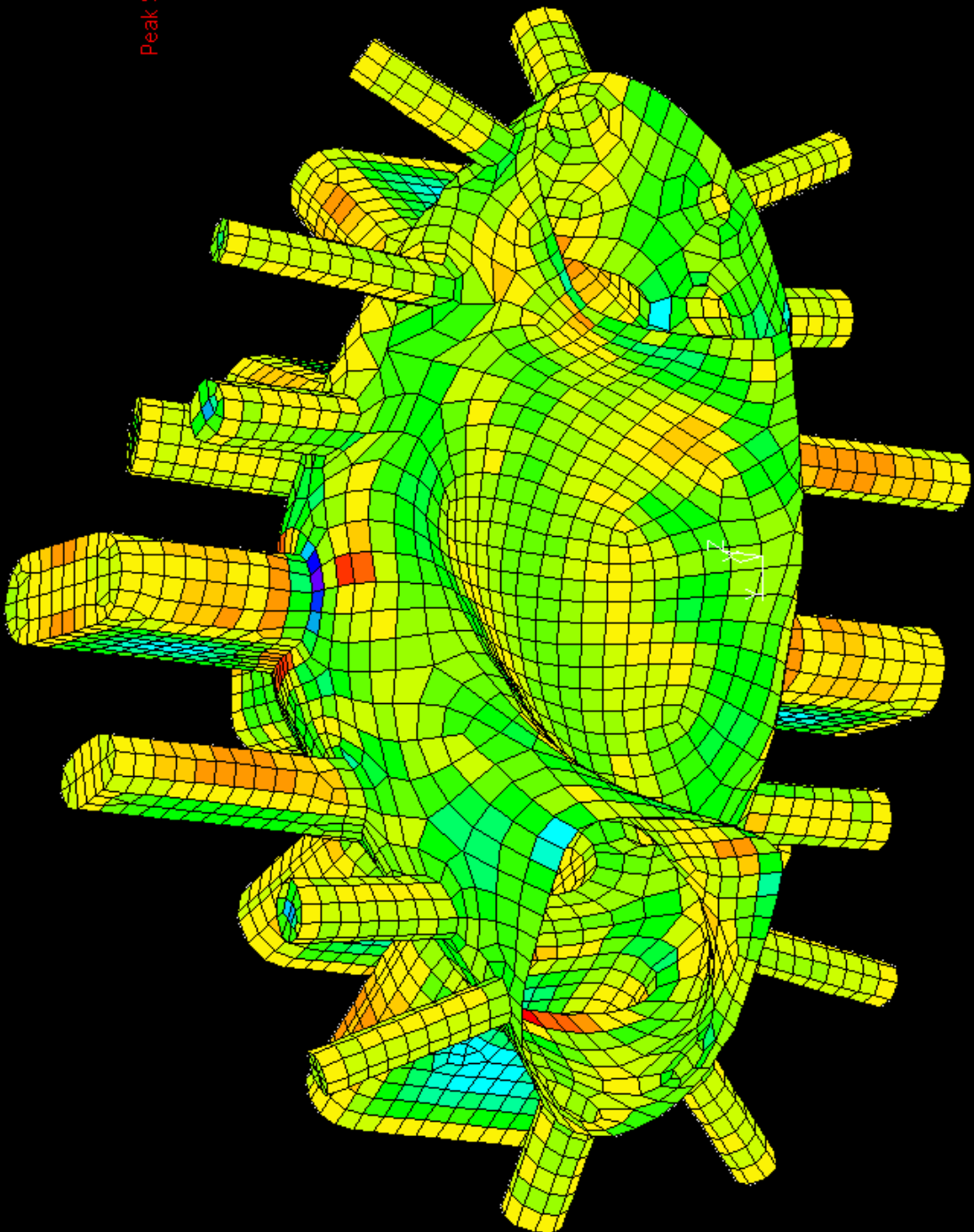


FEA/MAC/Nastran Model
Title: NCSX-VV CYCLIC-SYMM B.C.'S
Subcase 3: = 1-BAR PRESSURE + 175kA-DISRUPTION SELF + COIL FORCES
Run Date: FEB 12, 2002



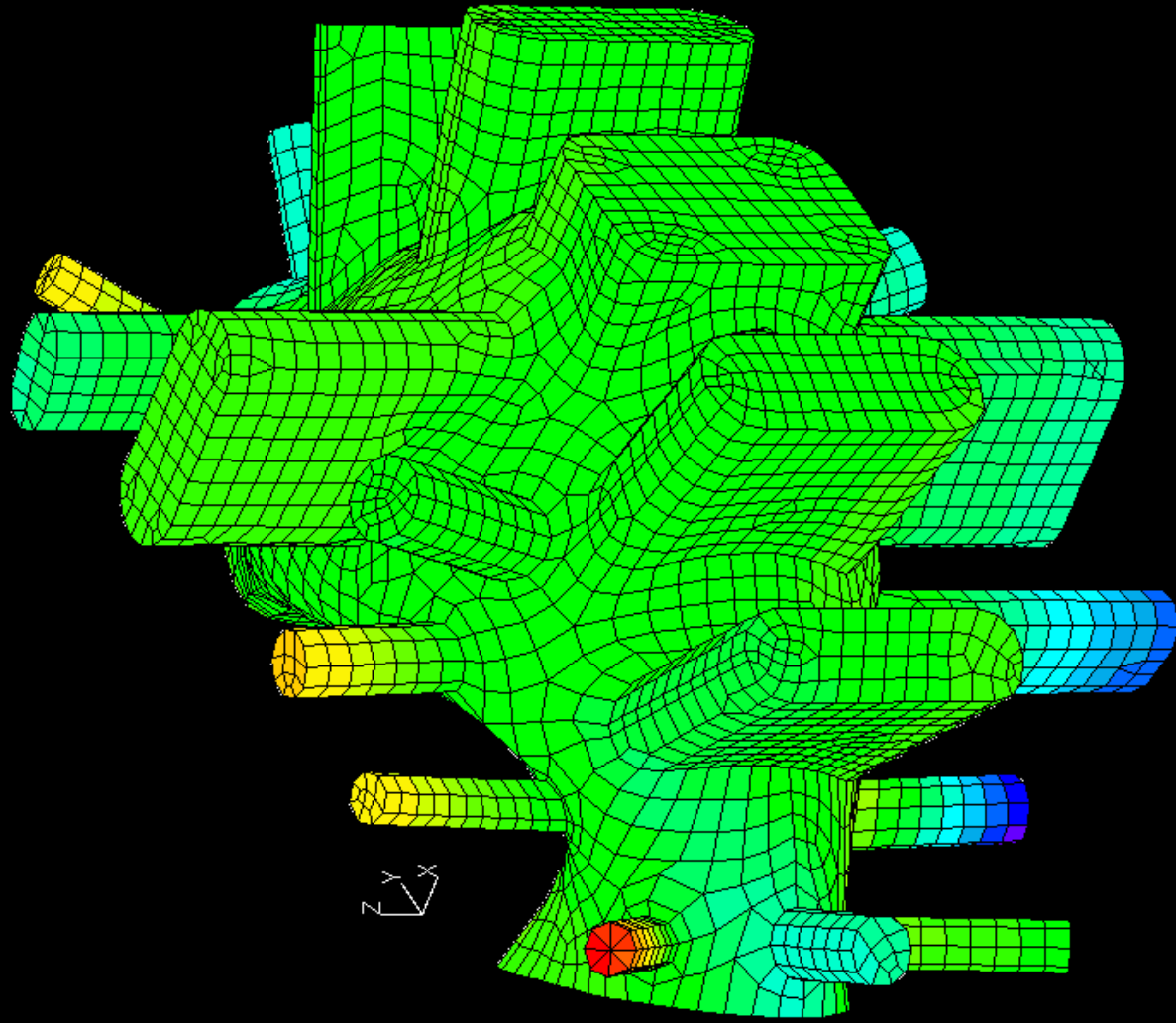
Stress Levels
Smin,Pr,-Z2 - (ps)
Peak Smin,Pr,-Z2 surf.:- 13932.1

4848.6
4126.3
3404.0
2681.6
1959.3
1237.0
514.6
-207.7
-930.1
-1652.4
-2374.7
-3097.1
-3819.4
-4541.7
-5264.1
-5986.4
-6708.7
-7431.1
-8153.4
-8875.7
-9598.1
-10320.4
-11042.8
-11765.1
-12487.4
-13209.8
-13932.1

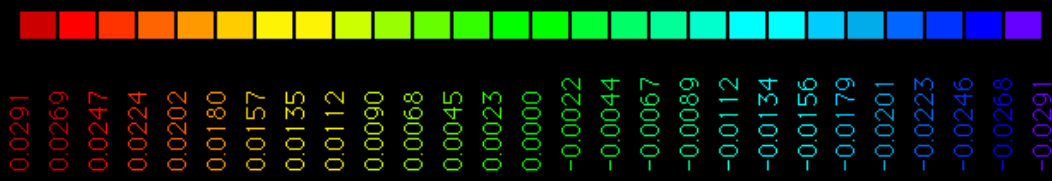


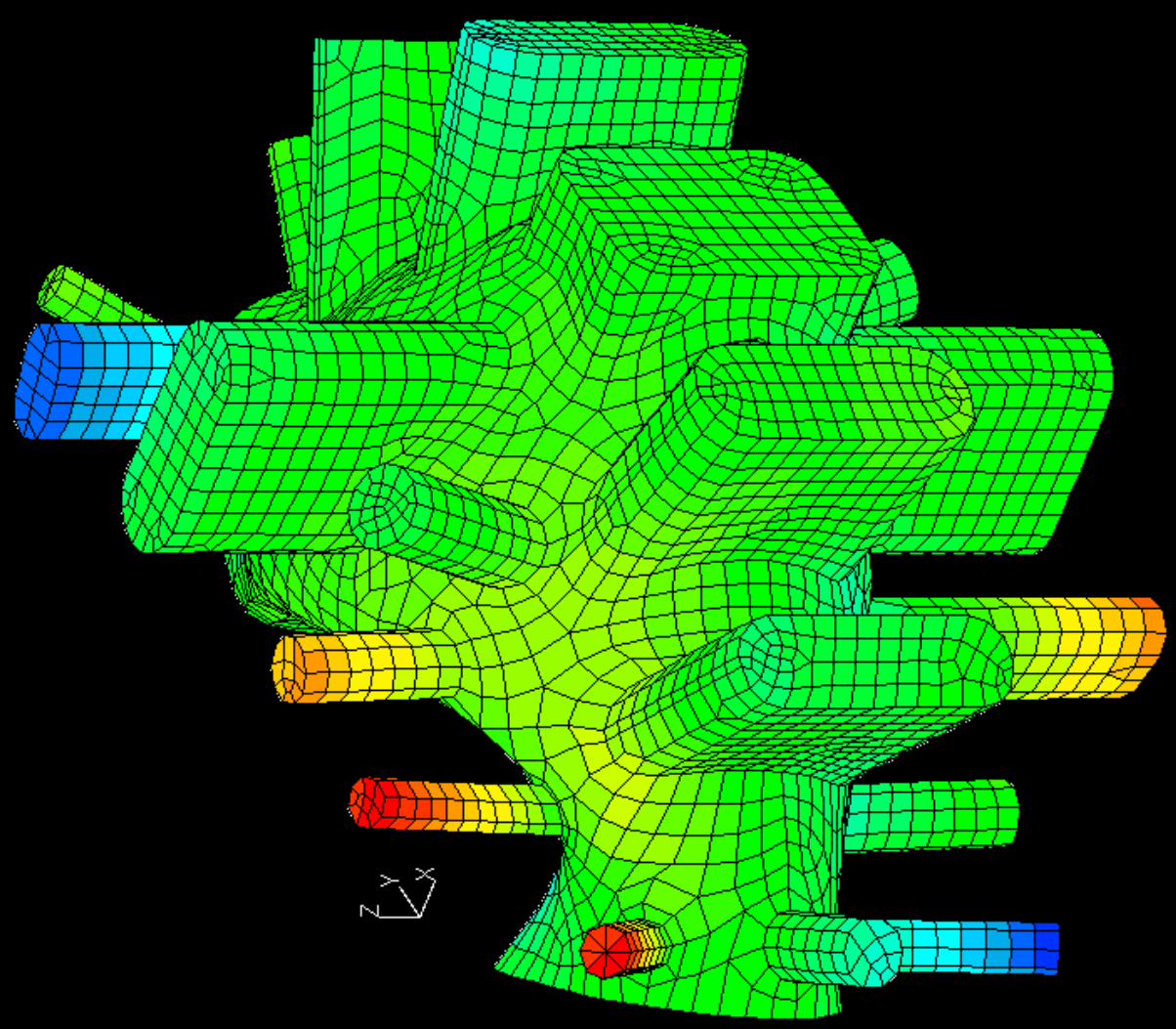
Stress Levels
Smin,Pr,-Z2 - (psi)
Peak Smin,Pr,-Z2 surf.:-13932.1



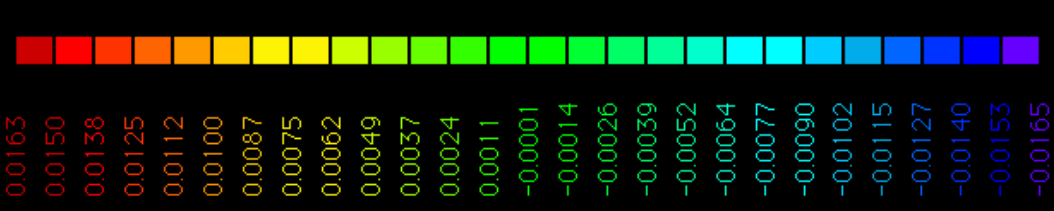


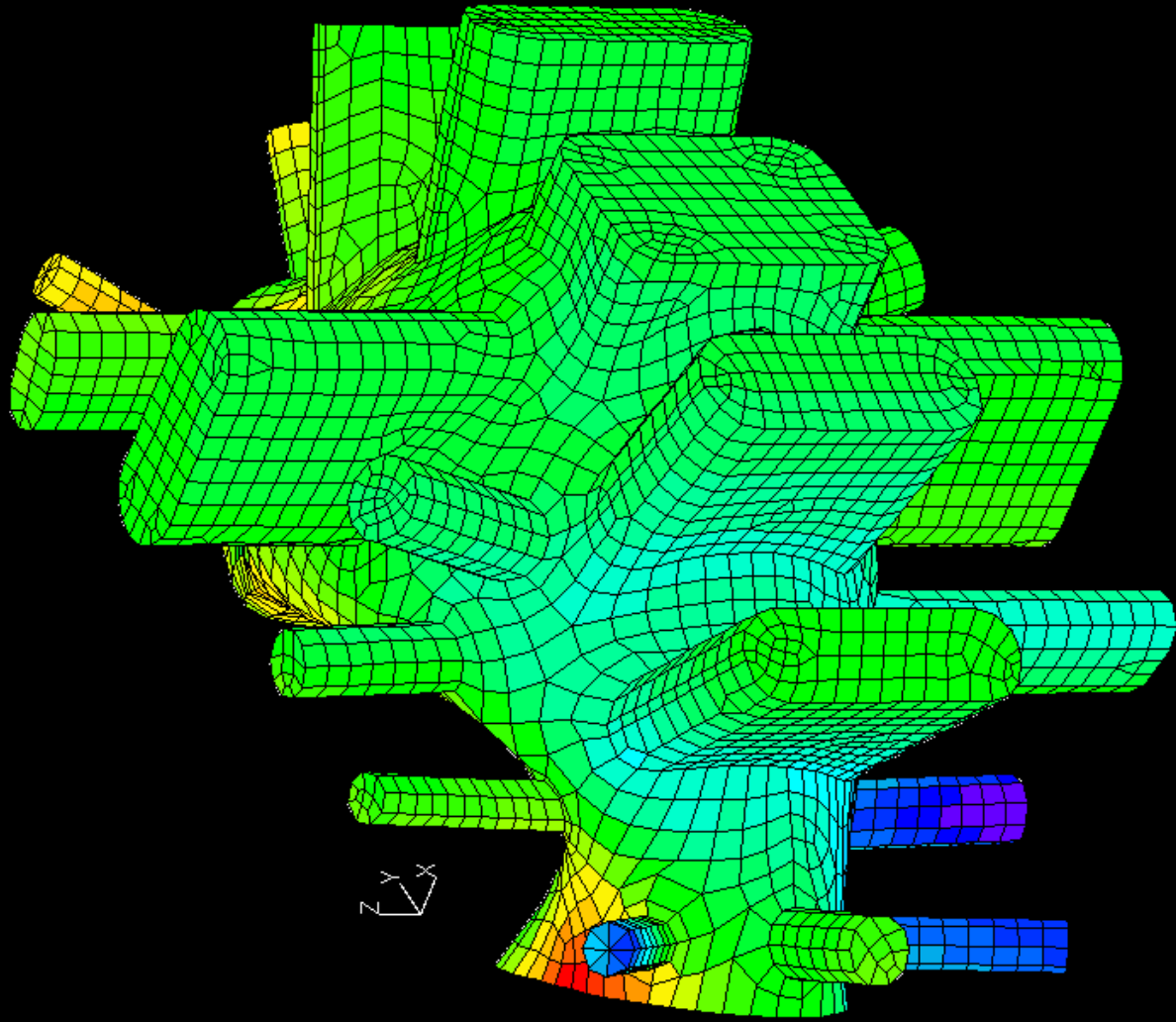
Displacements
X-displ. (Inches)
Max X-displ: 0.0291





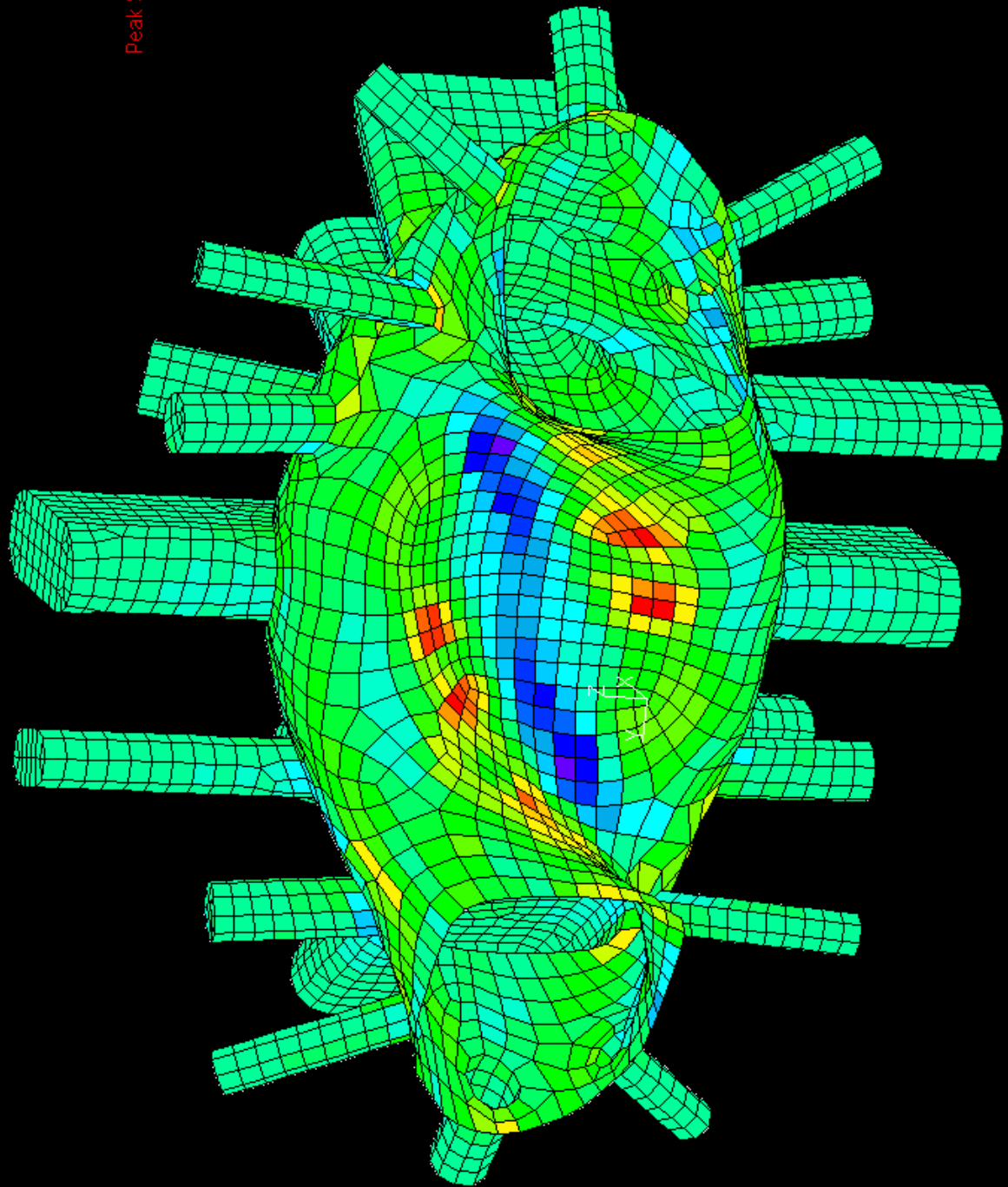
Displacements
Y-displ. (Inches)
Max Y-displ: 0.0163





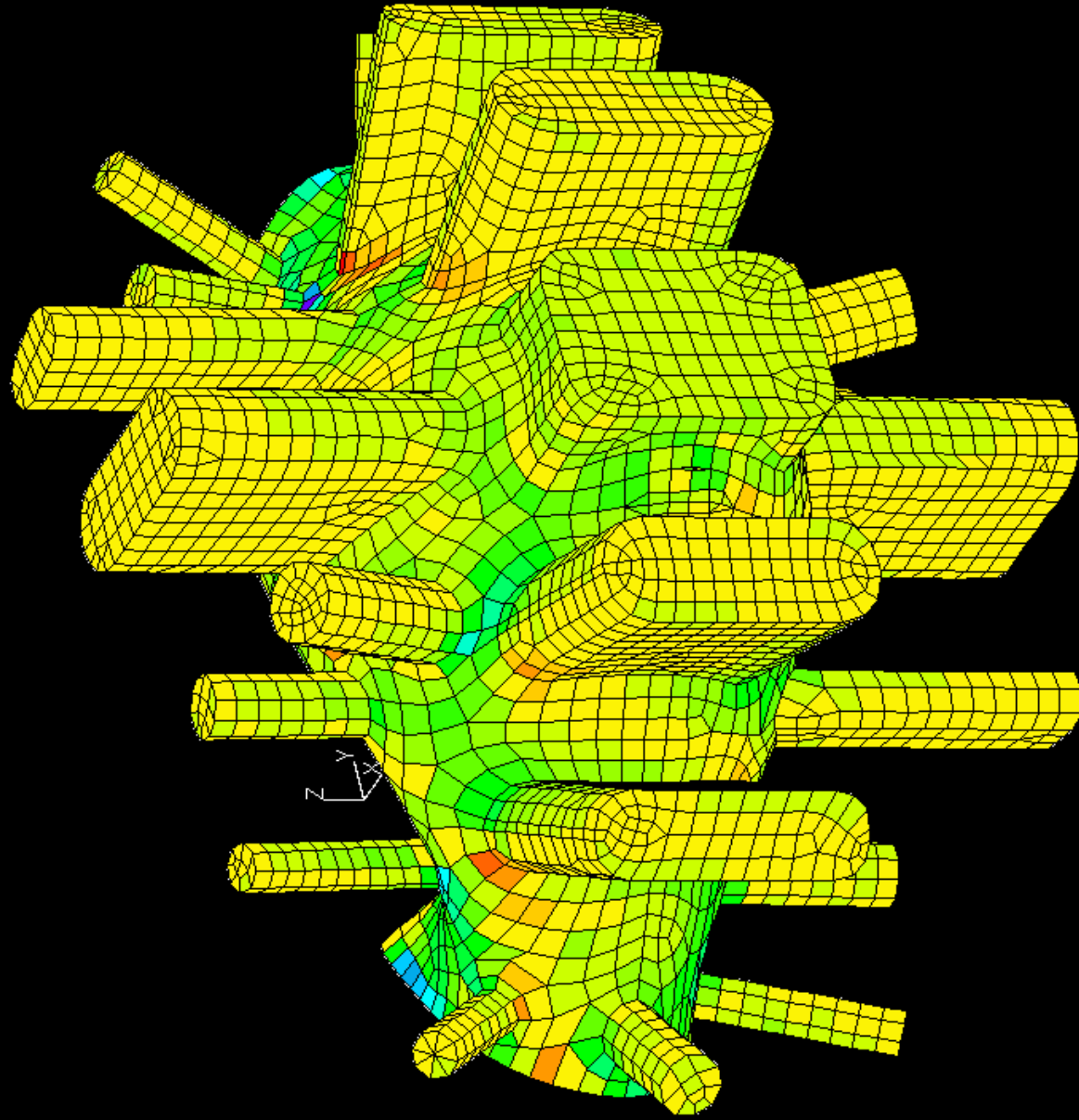
Displacements
Z-displ. (Inches)
Max Z-disp|0.0217

0.0217
0.0201
0.0185
0.0169
0.0153
0.0137
0.0121
0.0105
0.0088
0.0072
0.0056
0.0040
0.0024
0.0008
-0.0008
-0.0024
-0.0041
-0.0057
-0.0073
-0.0089
-0.0105
-0.0121
-0.0137
-0.0154
-0.0170
-0.0186
-0.0202



Stress Levels
Smaj.Pr.-Z1 - (psi)
Peak Smaj.Pr. Z1 surf.: 6076.1

6076.1
5690.0
5303.9
4917.8
4531.7
4145.5
3759.4
3373.3
2987.2
2601.1
2215.0
1828.9
1442.8
1056.7
670.5
284.4
-101.7
-487.8
-873.9
-1260.0
-1646.1
-2032.2
-2418.4
-2804.5
-3190.6
-3576.7
-3962.8



Stress Levels

Smin,Pr,-Z1 - (psi)

Peak Smin,Pr,Z1 surf.: -6885.1

2370.9

2014.9

1658.9

1302.9

946.9

590.9

234.9

-121.1

-477.1

-833.1

-1189.1

-1545.1

-1901.1

-2257.1

-2613.1

-2969.1

-3325.1

-3681.1

-4037.1

-4393.1

-4749.1

-5105.1

-5461.1

-5817.1

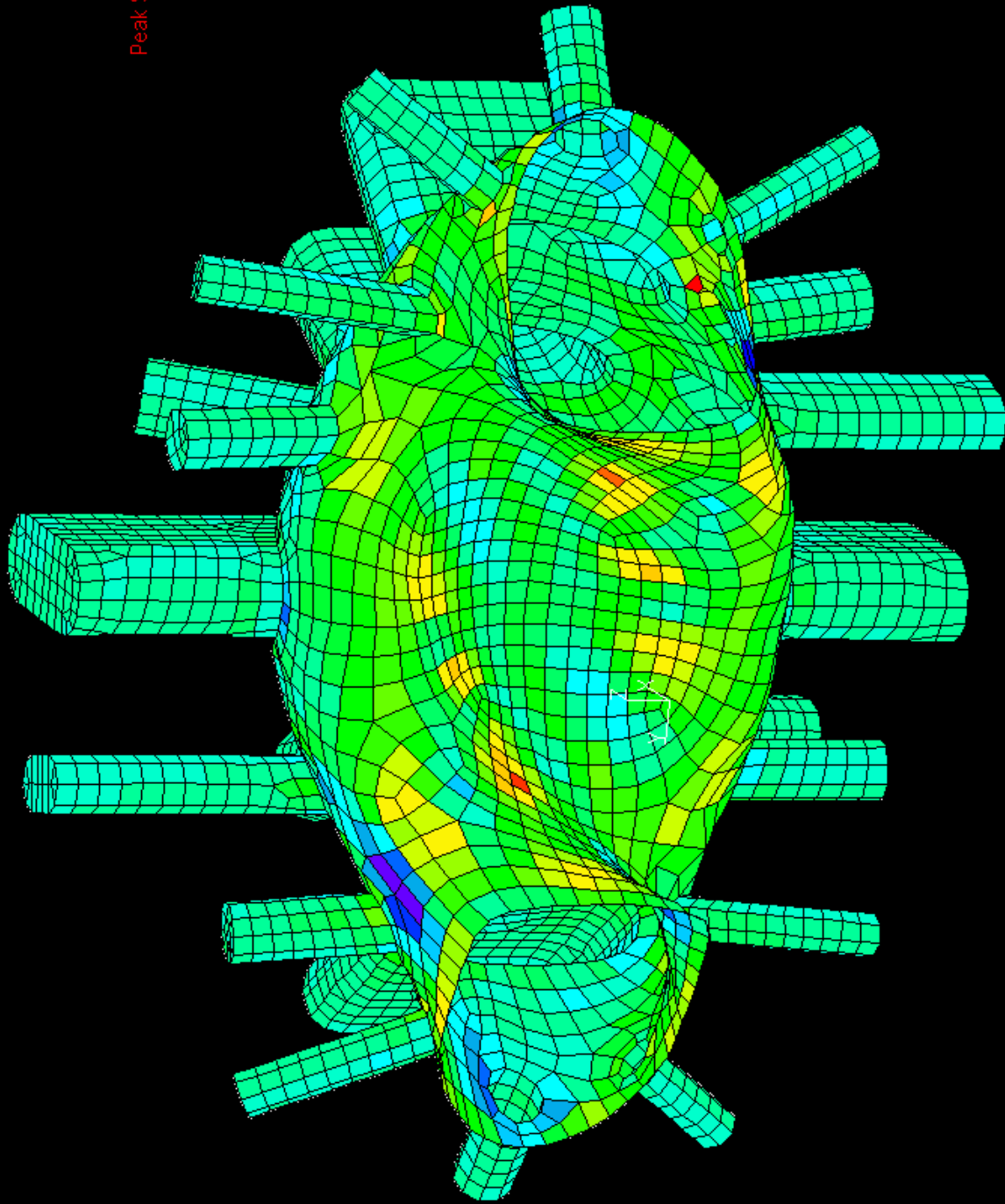
-6173.1

-6529.1

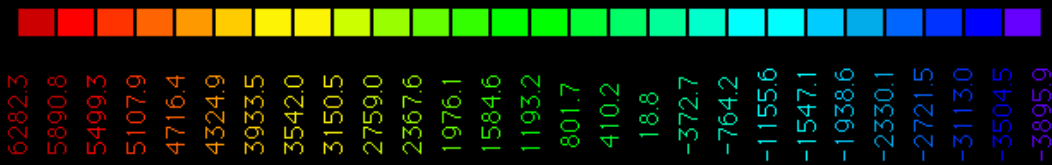
-6885.1



FEAMAC/Nastran Model
Title: NCSX-VV CYCLIC-SYMM B.C.'S
Subcase 2: = 350kA-DISRUPTION SELF + COIL FORCES
Run Date: FEB 11, 2002



Stress Levels
SmajPr.-Z2 - (ps
Peak SmajPr.-Z2 surf.: 628

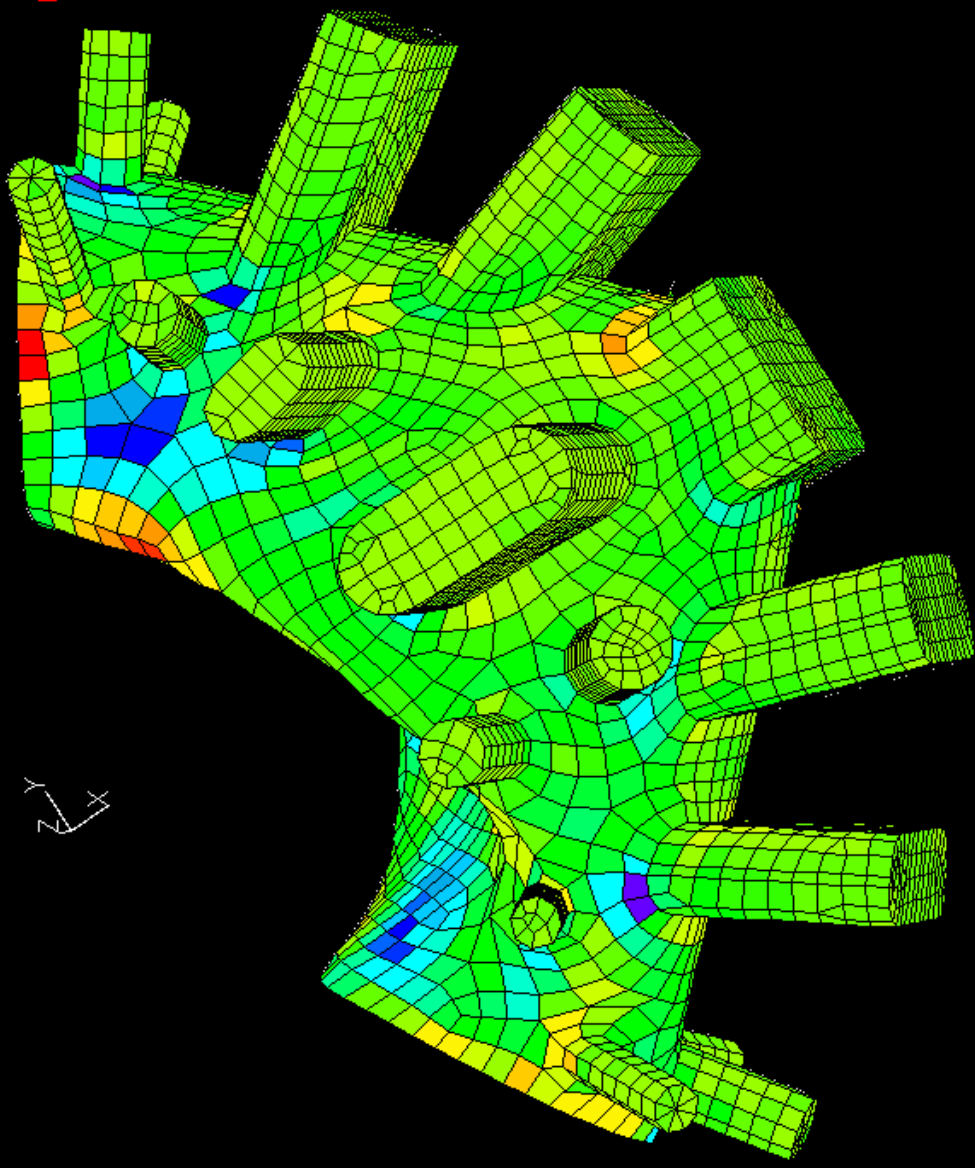
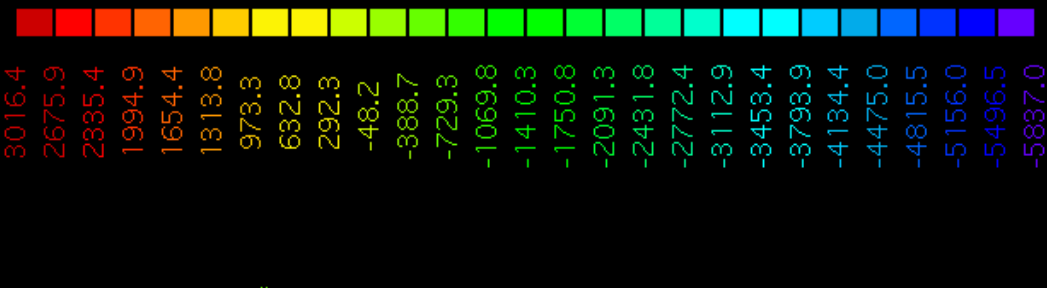


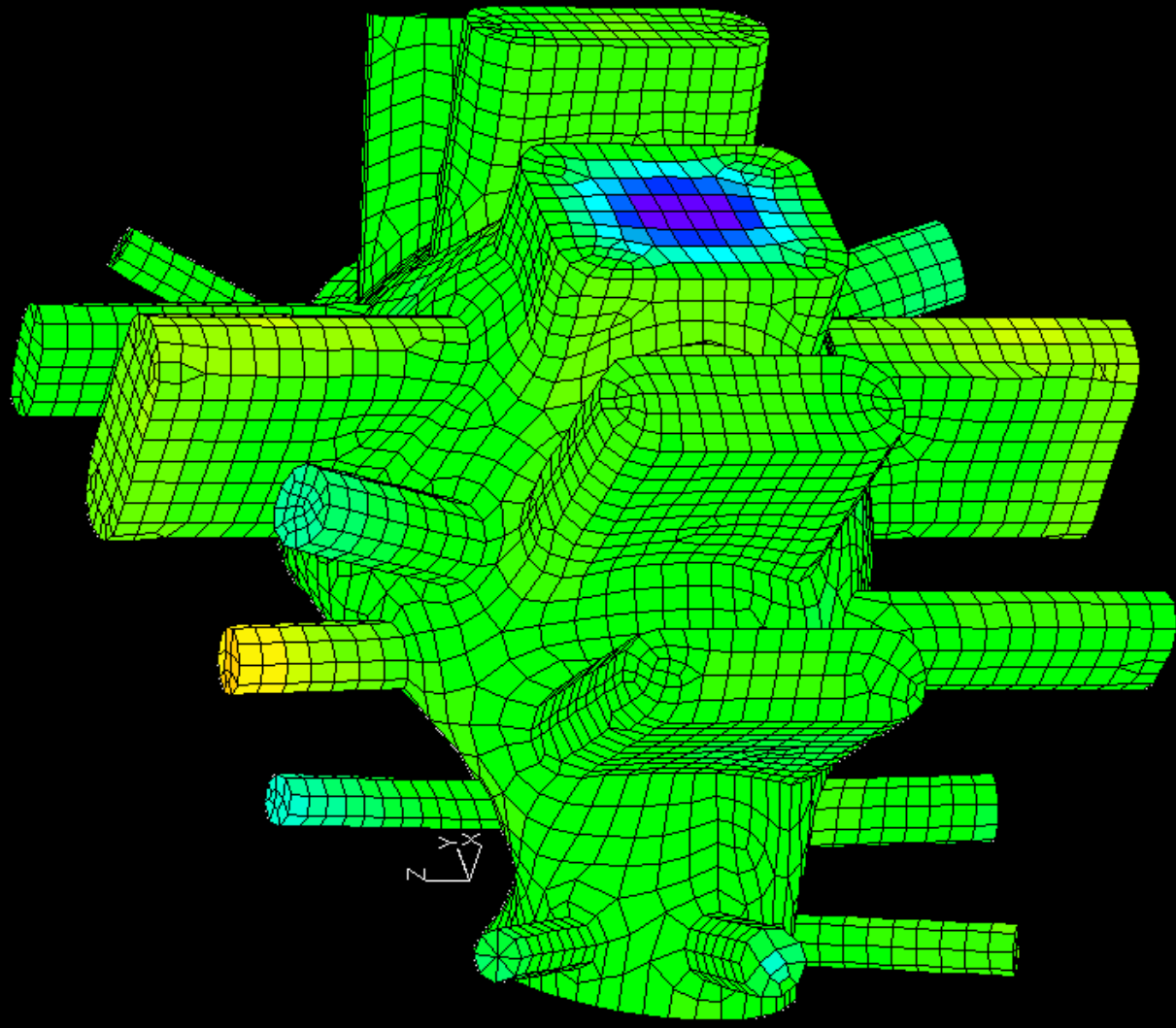


FE/MAC/Nastran Model
Title: NGSX-VV CYCLIC-SYMM B.C.'S
Subcase 2: = 350kA-DISRUPTION SELF + COIL FORCES

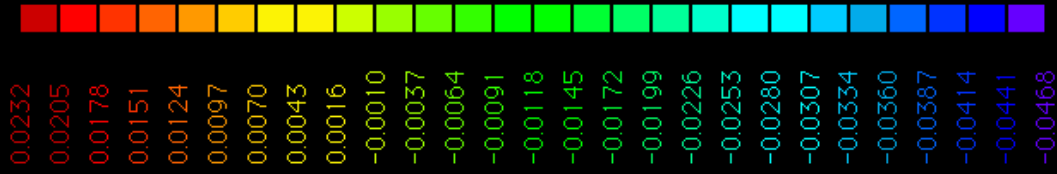
Run Date: FEB 11, 2002

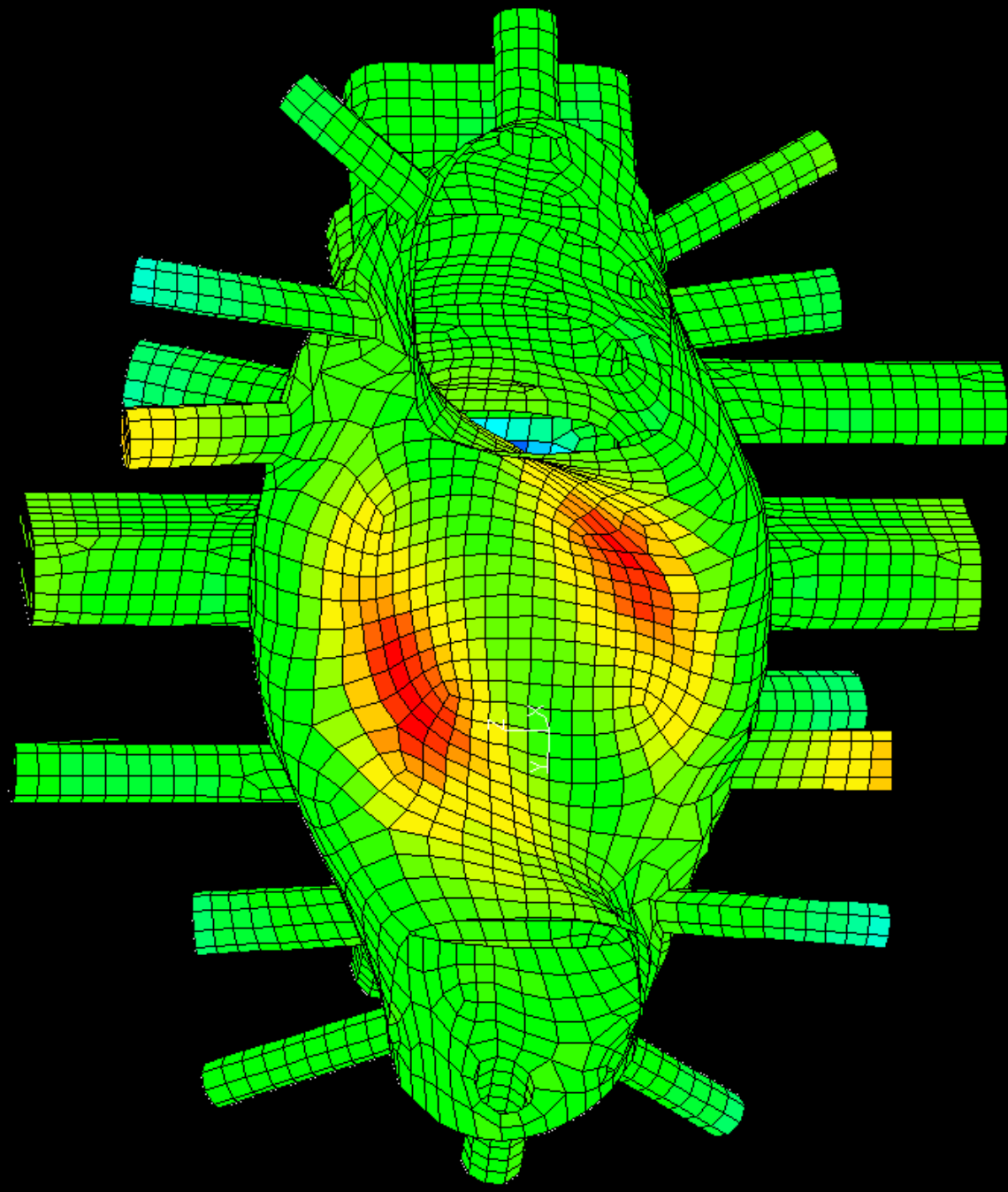
Stress Levels
Smin,Pr,-Z2 - (psi)
Peak Smin,Pr,-Z2 surf.: -5837.0





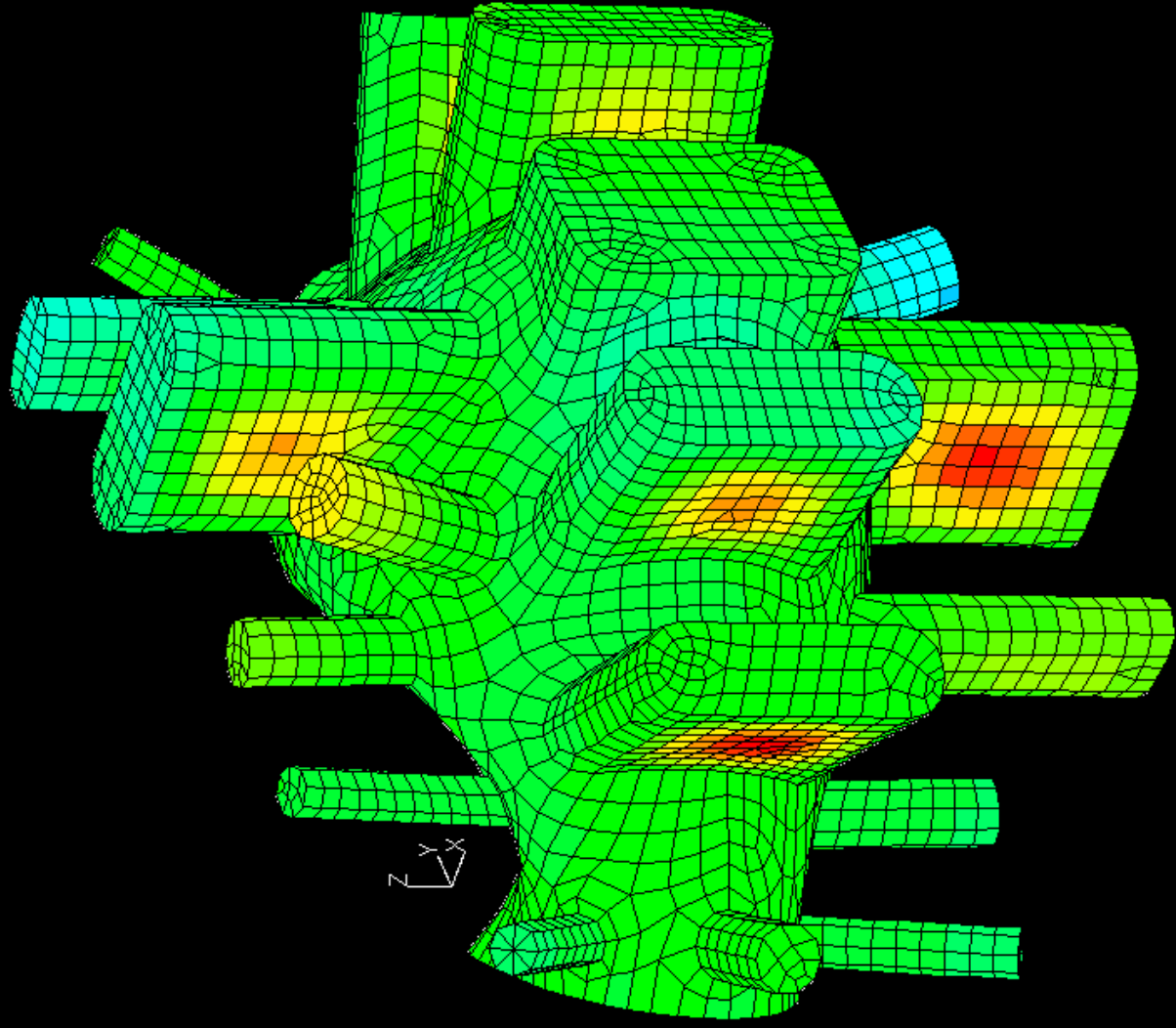
Displacements
X-displ. (Inches)
Max X-displ: 0.0232



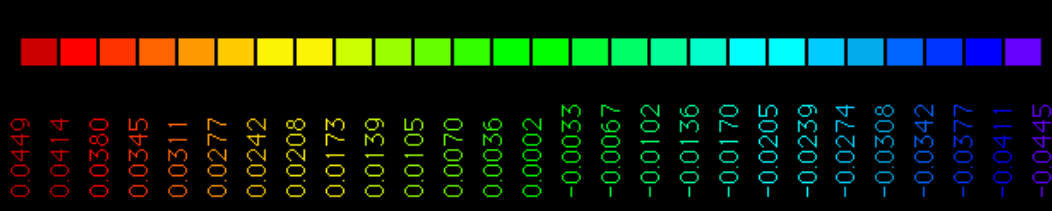


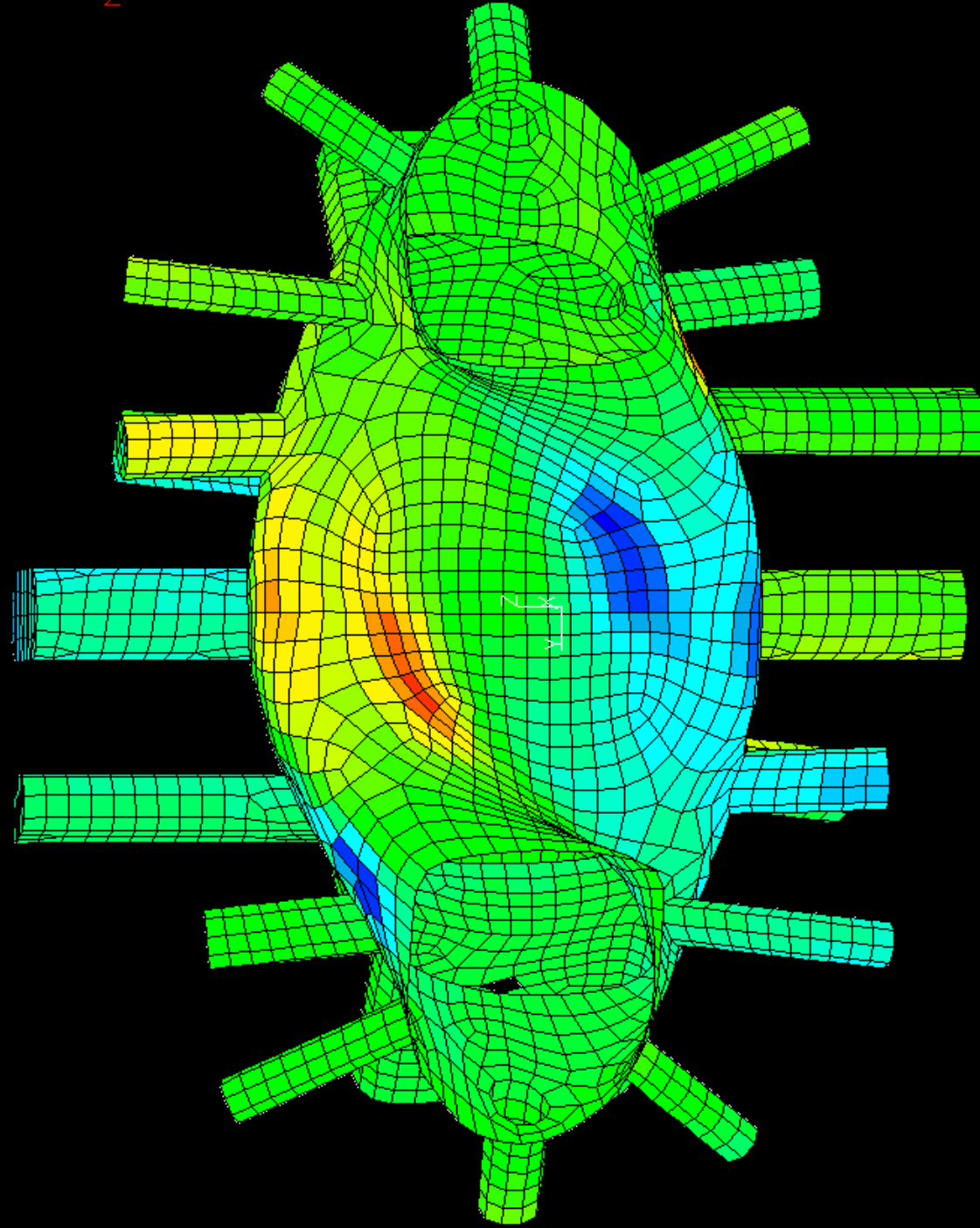
Displacements
X-displ. (Inches)
Max X-displ: 0.0232



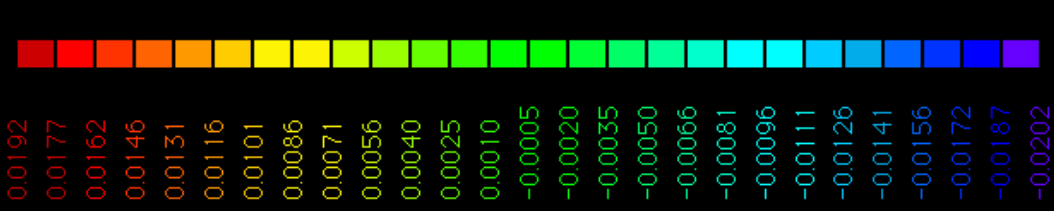


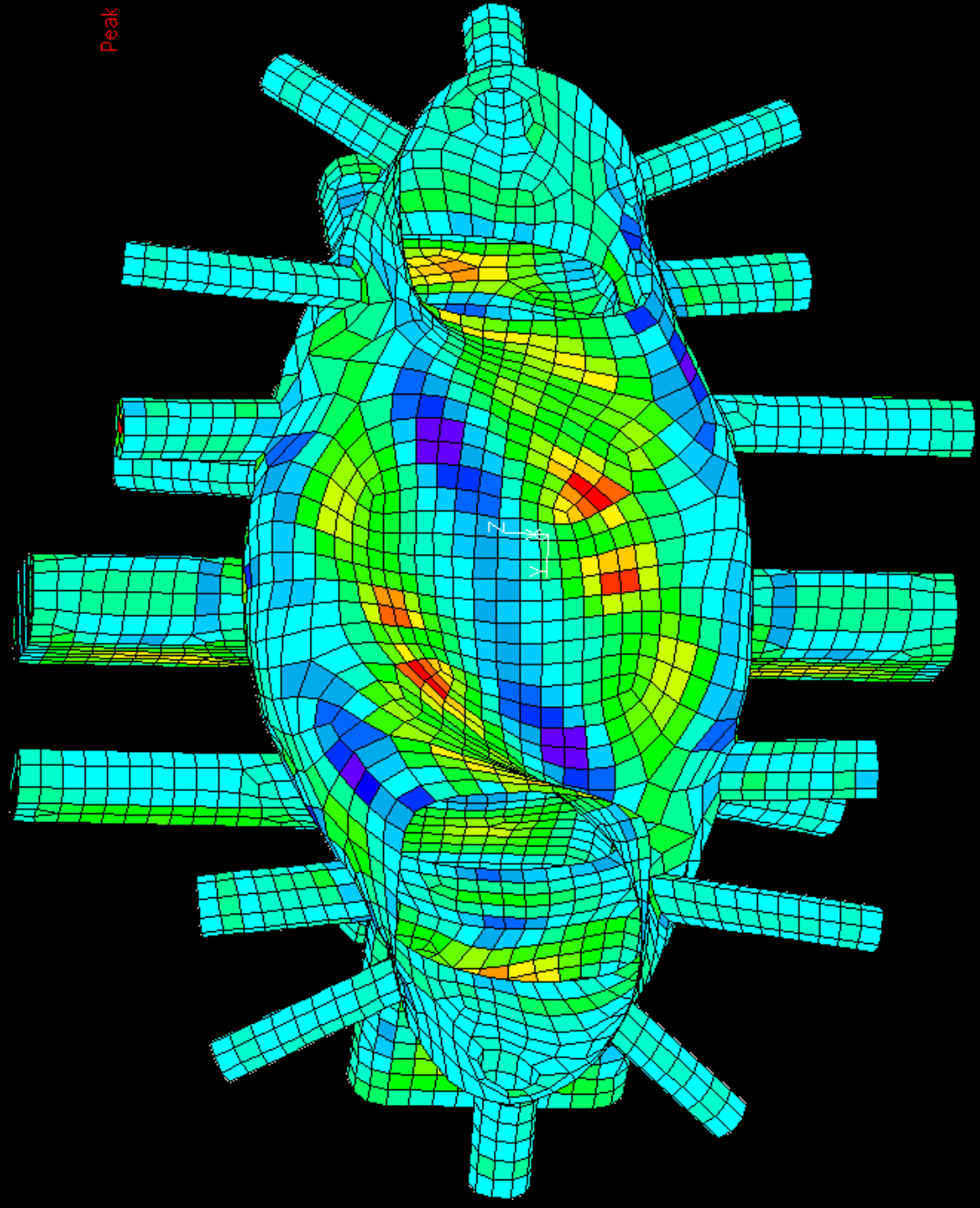
Displacements
Y-displ. (Inches)
Max Y-displ: 0.0449





Displacements
Z-displ. (Inches)
Max Z-disp|0.0192

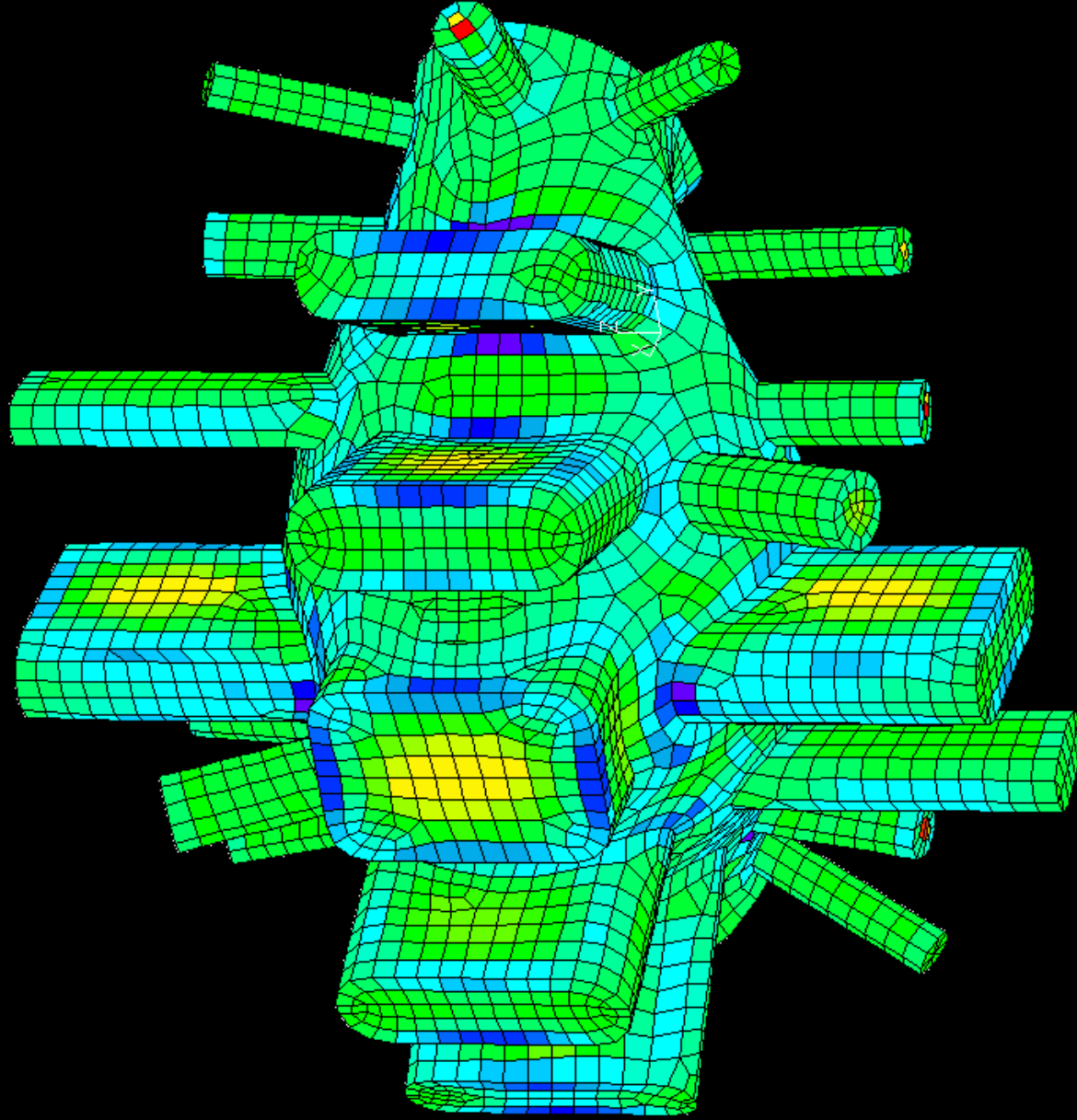




Stress Levels

SmajPr.-Z1 - (psi)
 Peak SmajPr.Z1 surf.: 9943.0

9943.0
9358.3
8773.6
8188.9
7604.2
7019.5
6434.8
5850.1
5265.4
4680.7
4096.0
3511.3
2926.6
2341.9
1757.2
1172.5
587.8
3.1
-581.6
-1166.3
-1751.0
-2335.7
-2920.4
-3505.0
-4089.7
-4674.4
-5259.1

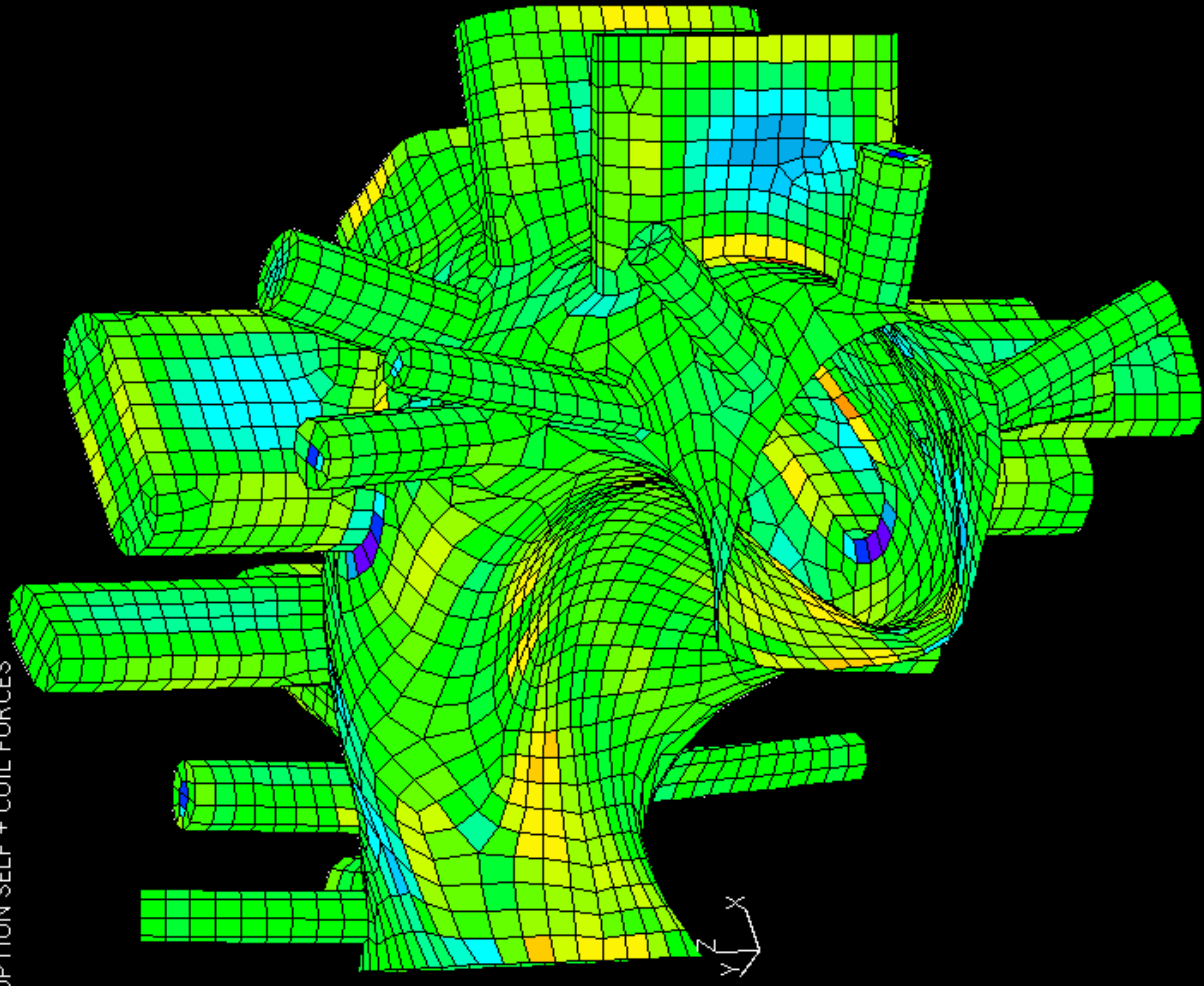


Stress Levels
Smin,Pr.-Z1 - (psi)
Peak Smin,Pr.Z1 surf.: -9389.8

9035.6
8326.9
7618.3
6909.6
6200.9
5492.3
4783.6
4074.9
3366.3
2657.6
1948.9
1240.3
531.6
-177.1
-885.7
-1594.4
-2303.1
-3011.8
-3720.4
-4429.1
-5137.8
-5846.4
-6555.1
-7263.8
-7972.4
-8681.1
-9389.8



Subcase 3: = 1 BAR + 350kA-DISRUPTION SELF + COIL FORCES



Stress Levels

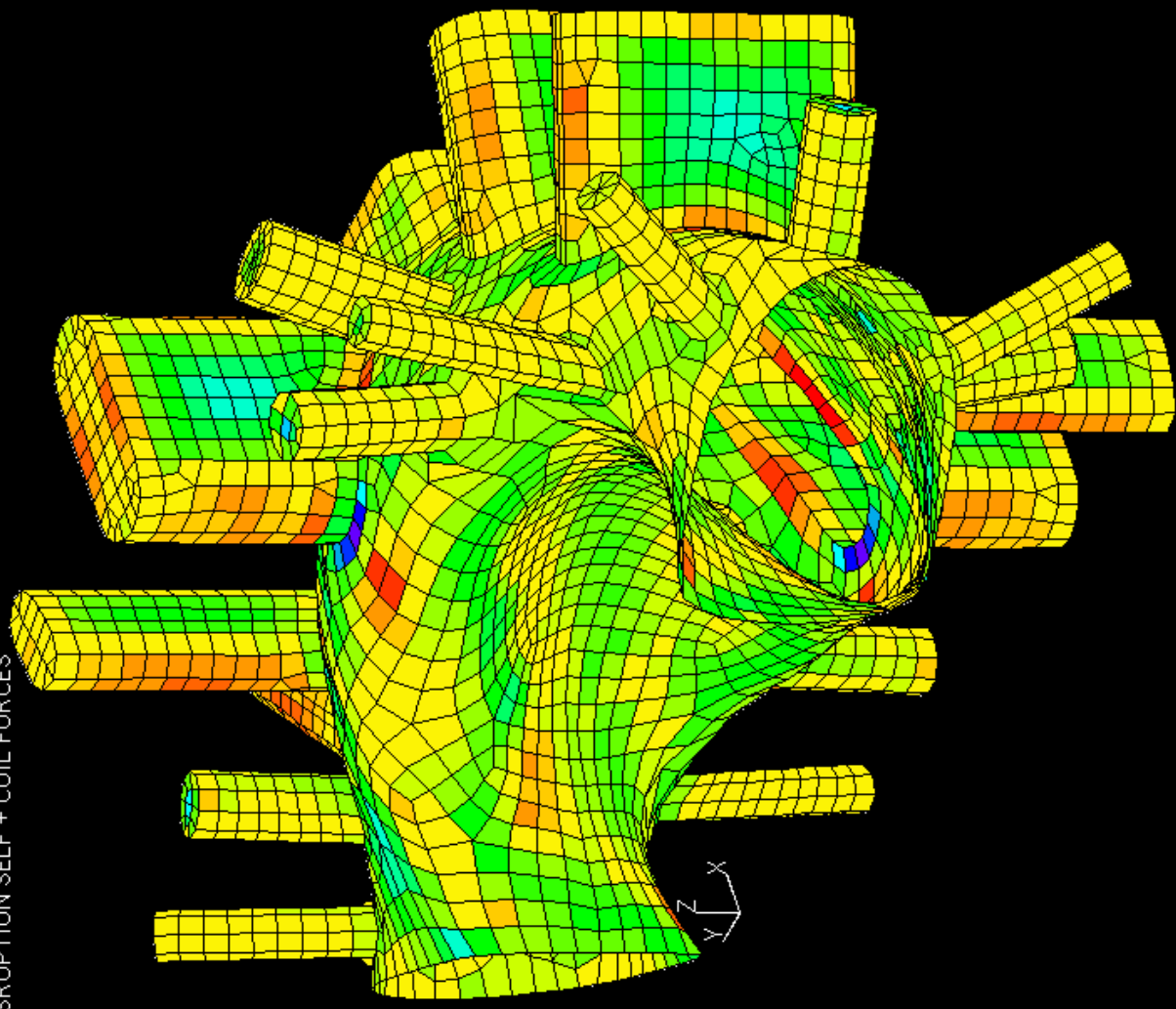
Smaj,Pr,-Z2 - (psi)

Peak Smaj,Pr,-Z2 surf.:-1190

11561.4
10658.8
9756.3
8853.7
7951.1
7048.5
6146.0
5243.4
4340.8
3438.2
2535.7
1633.1
730.5
-172.0
-1074.6
-1977.2
-2879.8
-3782.3
-4684.9
-5587.5
-6490.1
-7392.6
-8295.2
-9197.8
-10100.4
-11002.9
-11905.5



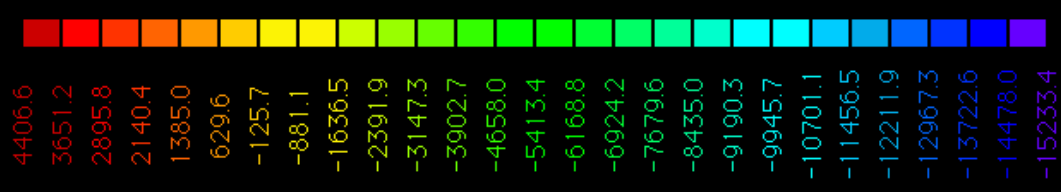
Subcase 3: = 1 BAR + 350kA-DISRUPTION SELF + COIL FORCES



Stress Levels

Smin,Pr,-Z2 - (psi)

Peak Smin,Pr,-Z2 surf.:-15233.4



Results Summary:

Peak Displacements:	Radial	Torr.	Vert.
Press.	-0.050"	0.045"	-0.028"
Press. + 175D	-0.049"	0.047"	-0.019"
Press. + 350D	-0.047"	0.045"	-0.020"

Peak stresses:	Mjr.or MinorPr.	Tresca
Press.	-11,648 psi	7,320 psi
Press. + 175D	-13,932 psi	7,598 psi
Press. + 350D	-15,233 psi	7,522 psi