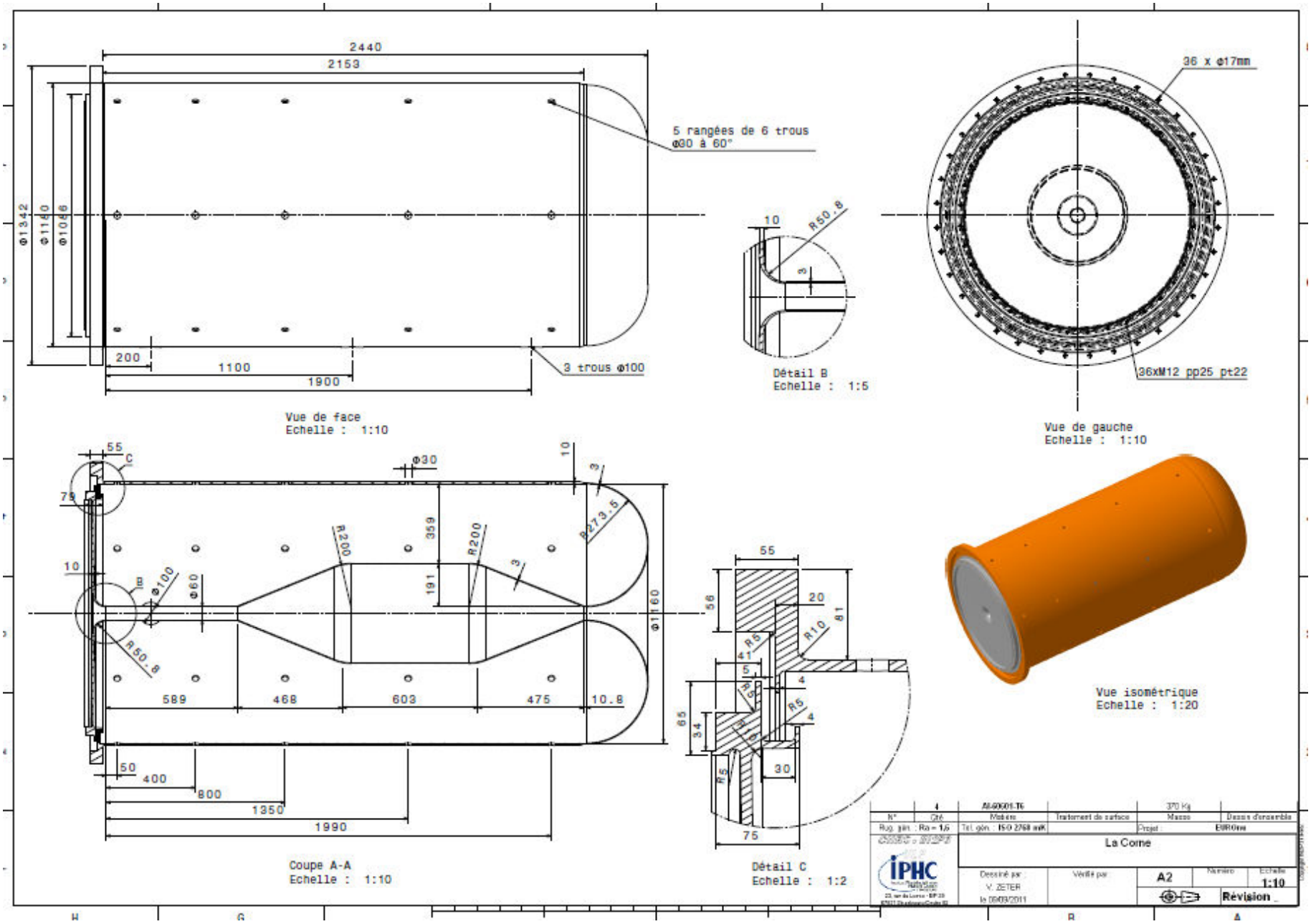
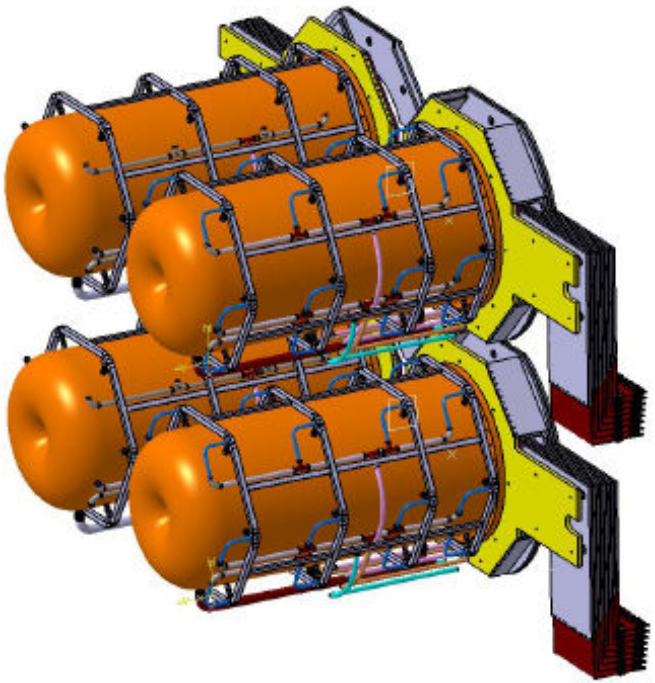
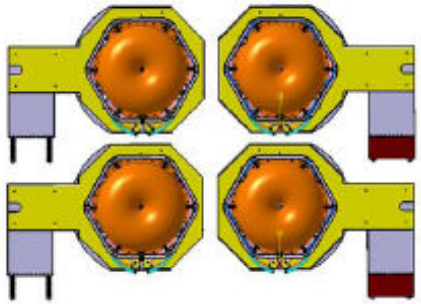
Static and dynamic study of supporting system for four horns assembly

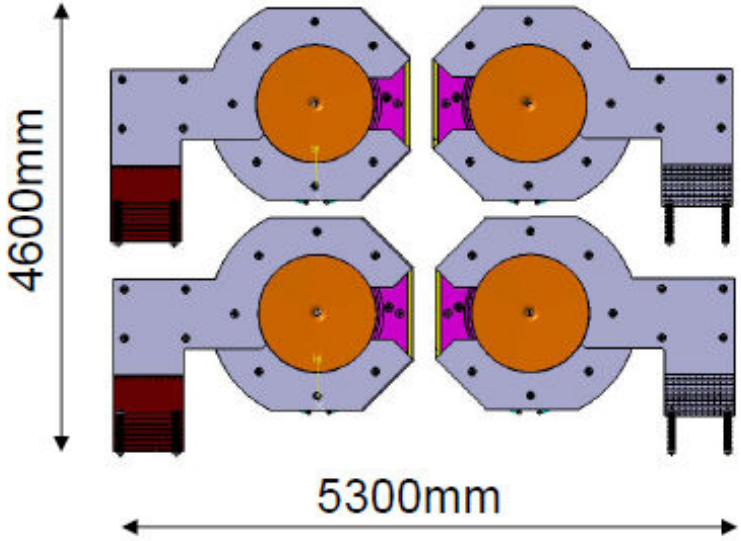
Bogdan Szybiński, Cracow Univ. of Technology
Piotr Cupiał, AGH Univ. of Science andTechnology


2440
2153
Φ1342
Φ1140
Φ1046
5 rangées de 6 trous
Φ30 à 60°
200
1100
1900
3 trous Φ100
Vue de face
Echelle : 1:10
10
R50.8
3
Détail B
Echelle : 1:5
36 x Φ17mm
36xM12 pp25 pt22
Vue de gauche
Echelle : 1:10
55
C
75
10
B
Φ100
Φ60
Φ30
R200
359
191
R213.5
Φ1160
R50.8
589
468
603
475
10.8
50
400
800
1350
1990
Coupe A-A
Echelle : 1:10
56
20
R10
81
R5
41
5
4
34
30
75
Détail C
Echelle : 1:2
Vue isométrique
Echelle : 1:20
AU-6061-T6
370 Kg
Rug. gén. : Ra = 1,6
Tol. gén. : ISO 2768 mK
Projet : EUROnu
La Corne
IPHC
Dessiné par : V. ZETER
le 09/03/2011
Vérifié par :
A2
Numéro
Echelle 1:10
Révision _

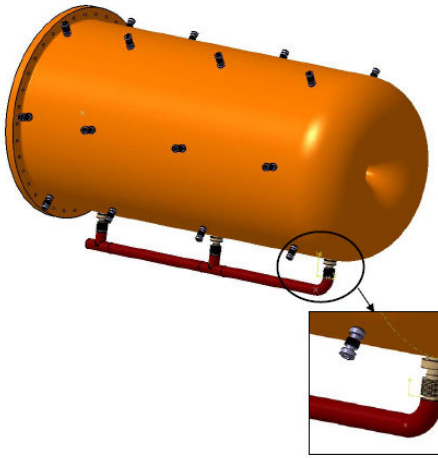


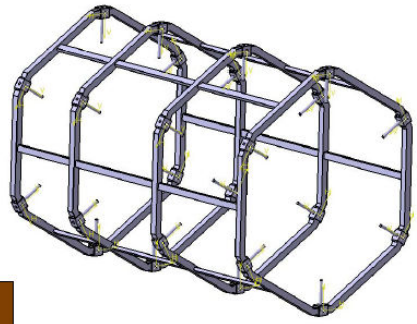
Vue provisoire des 4 cornes





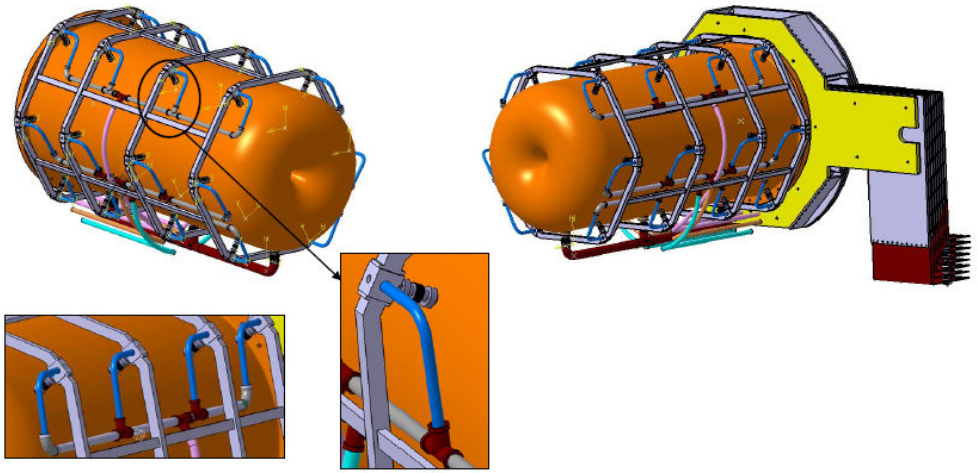
Conducteur externe – les soufflets pour le circuit de refroidissement et la sortie d'eau

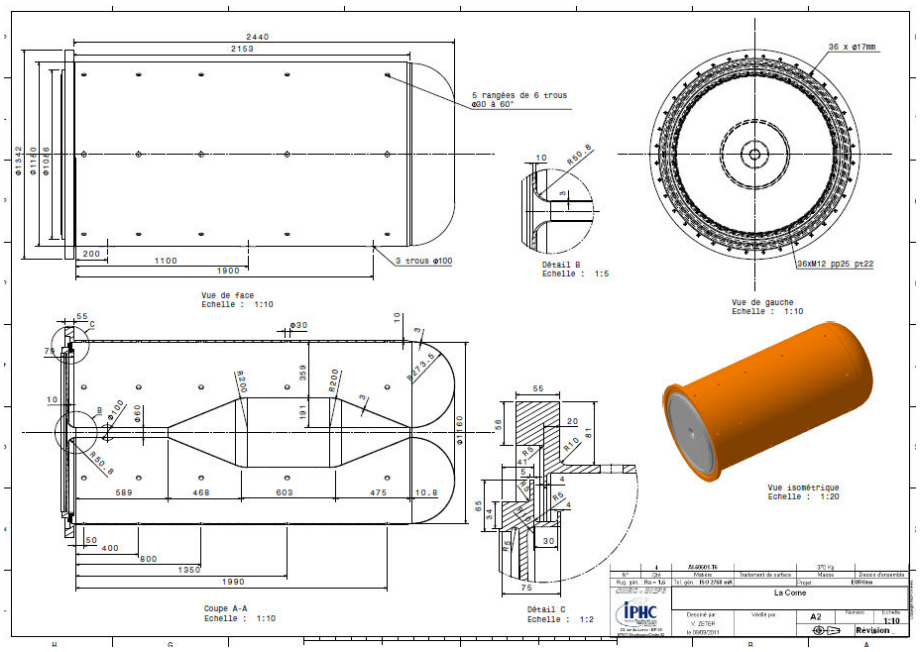


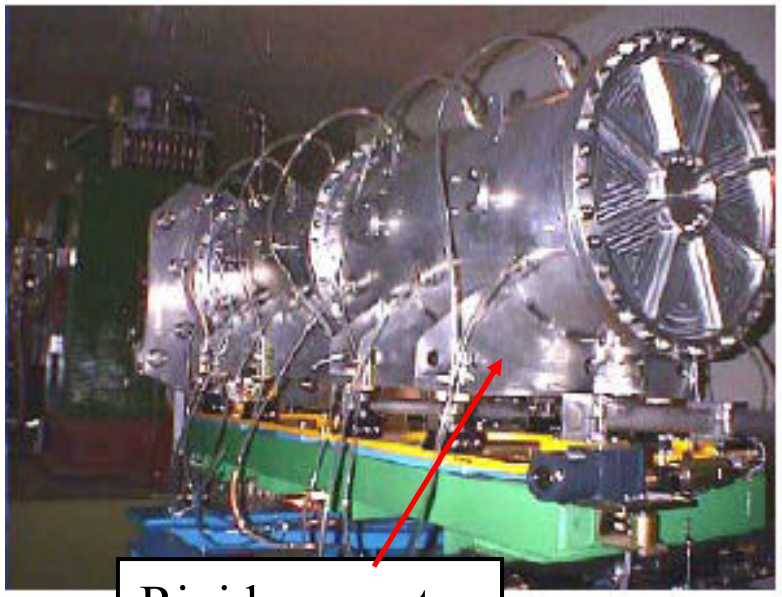


La structure qui soutien la corne et les tuyaux de refroidissement

L'ensemble de la Corne

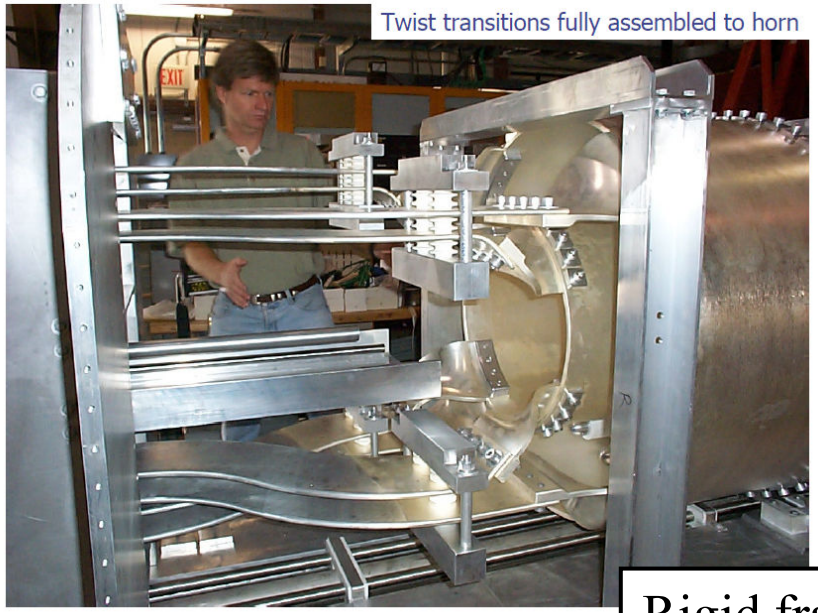






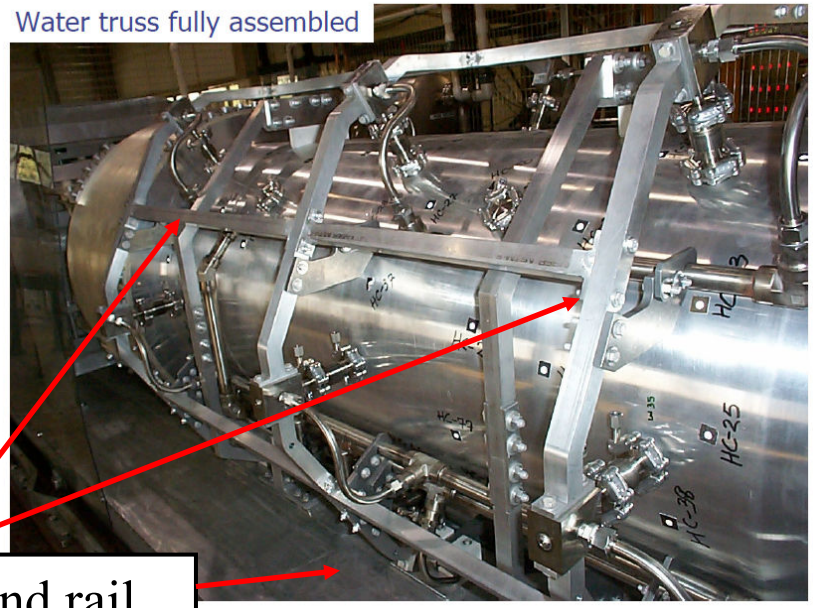
Rigid support

5

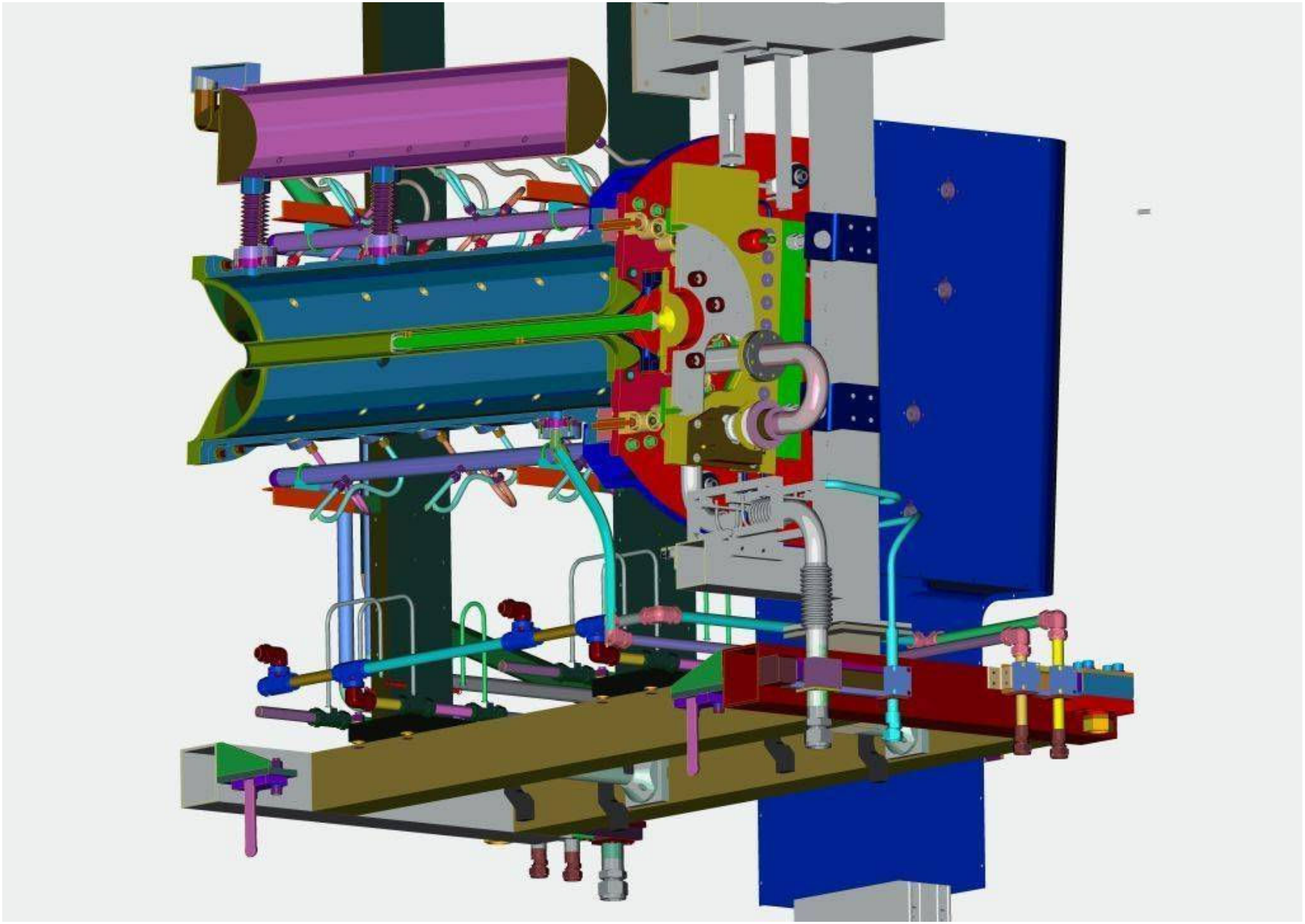


Twist transitions fully assembled to horn

Water truss fully assembled

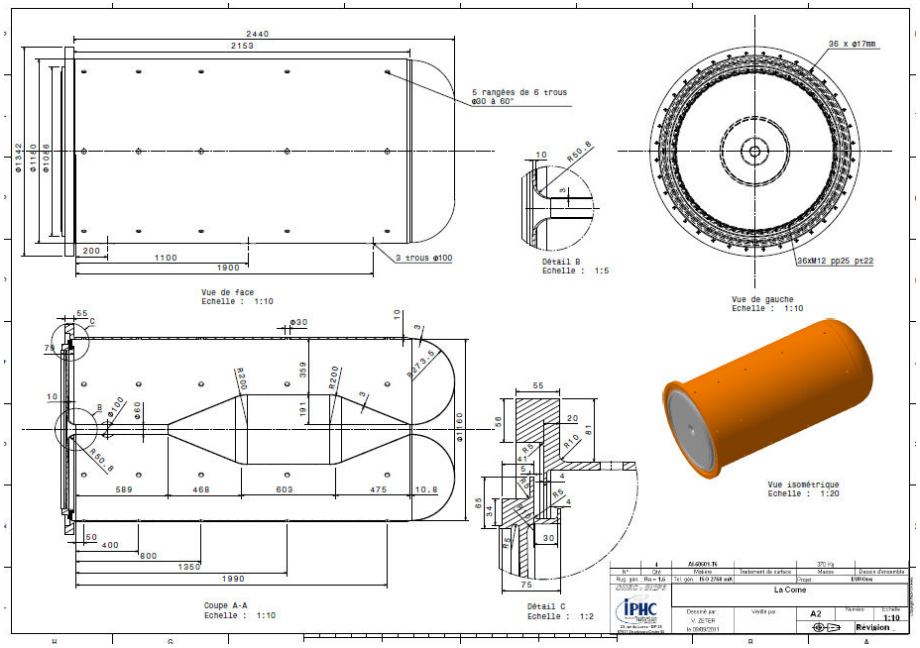


Rigid frame and rail

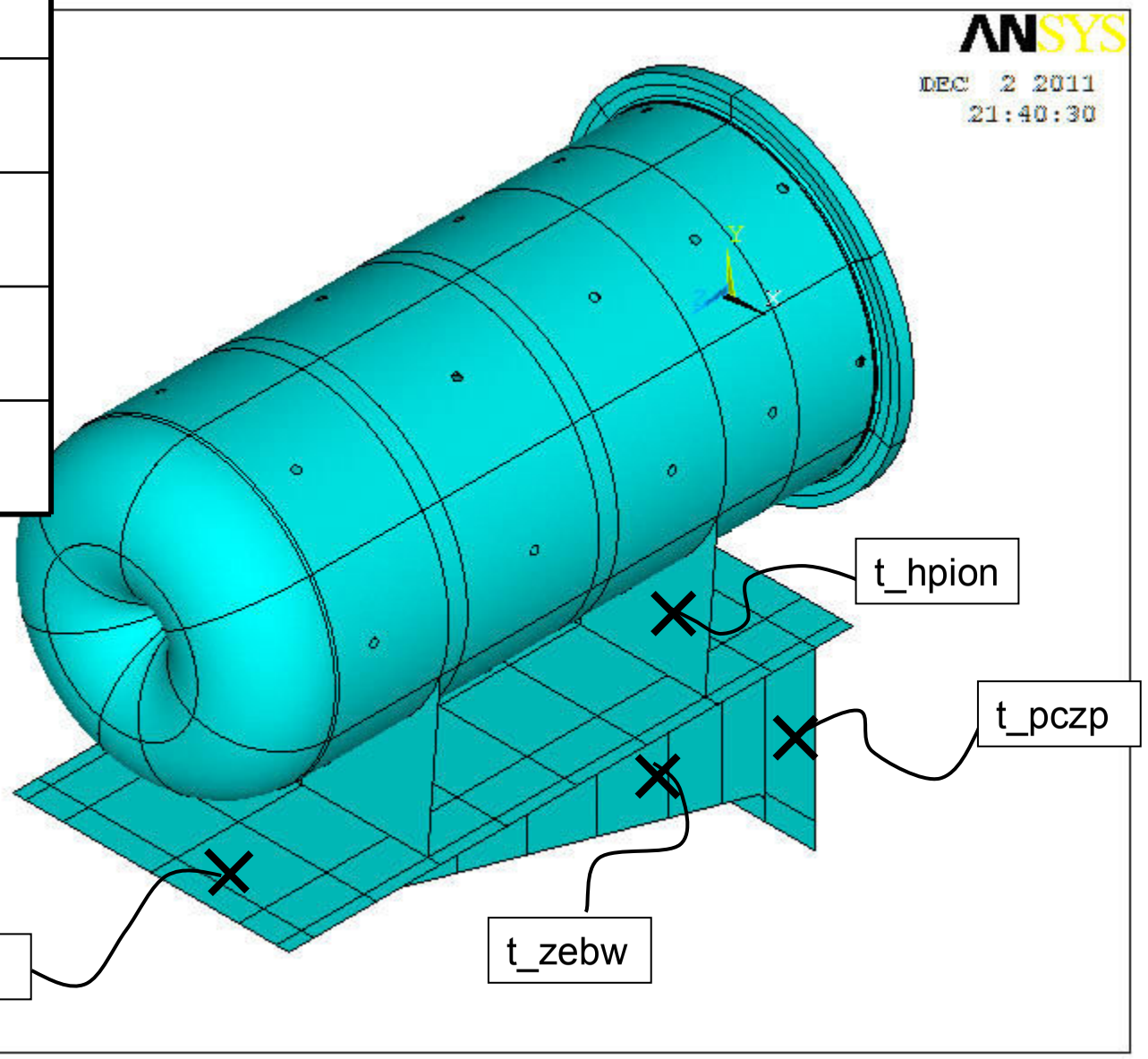


Support system of horn:

- Separate for each horn or common for 4 horns?
- System of horn positioning (compensation of deflections and tilt)
  - Frame + system of adjusting nuts
  - Two separate frames, each frame for two horns (top and bottom position)

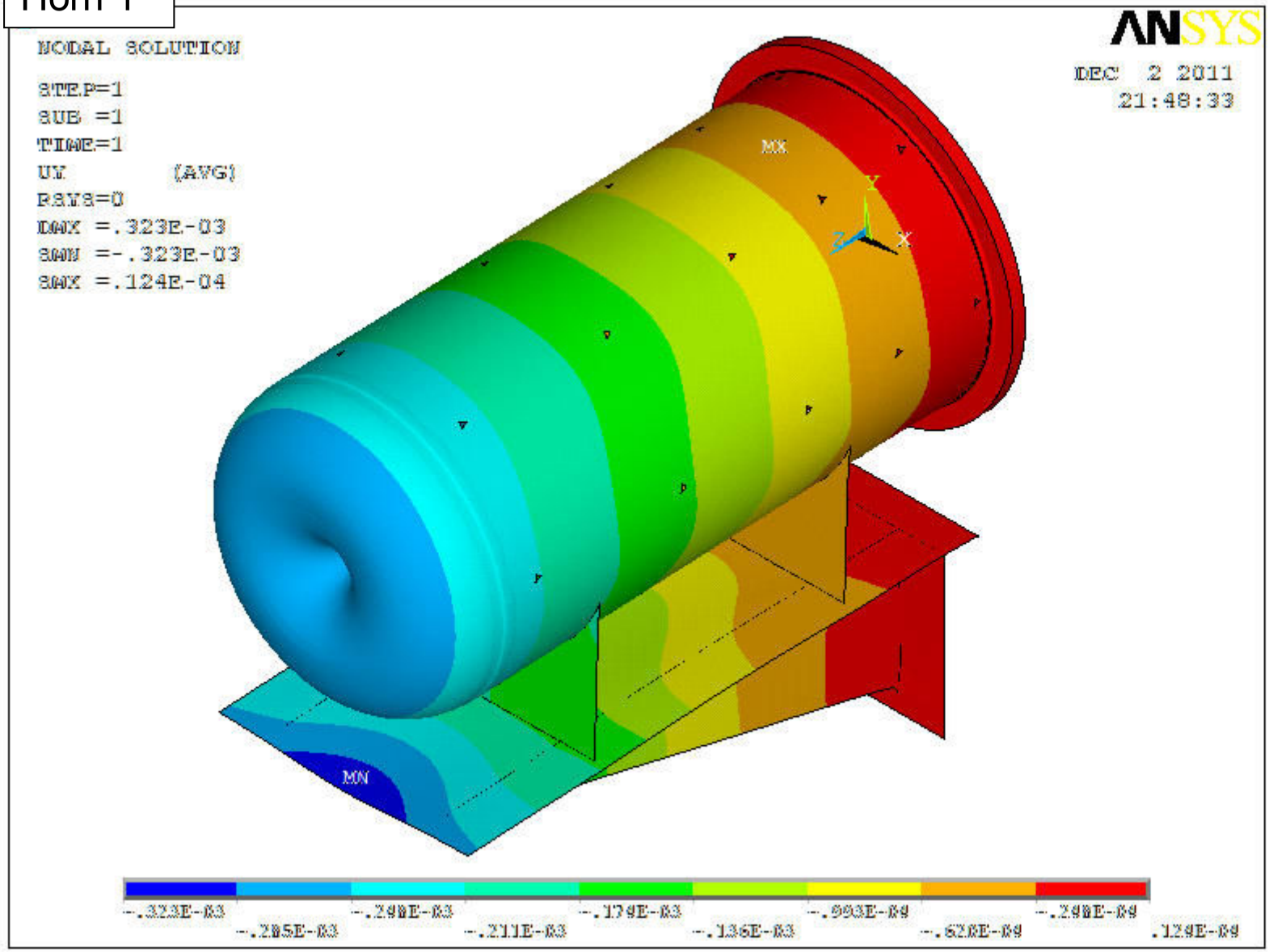


thickness	Value for ‘horn1’ in *mm*	Value for ‘horn2’ in *mm*
t_hpion	5.	12.
t_pdol	10.	20.
t_zebw	5.	15.
t_pczp	10.	20.

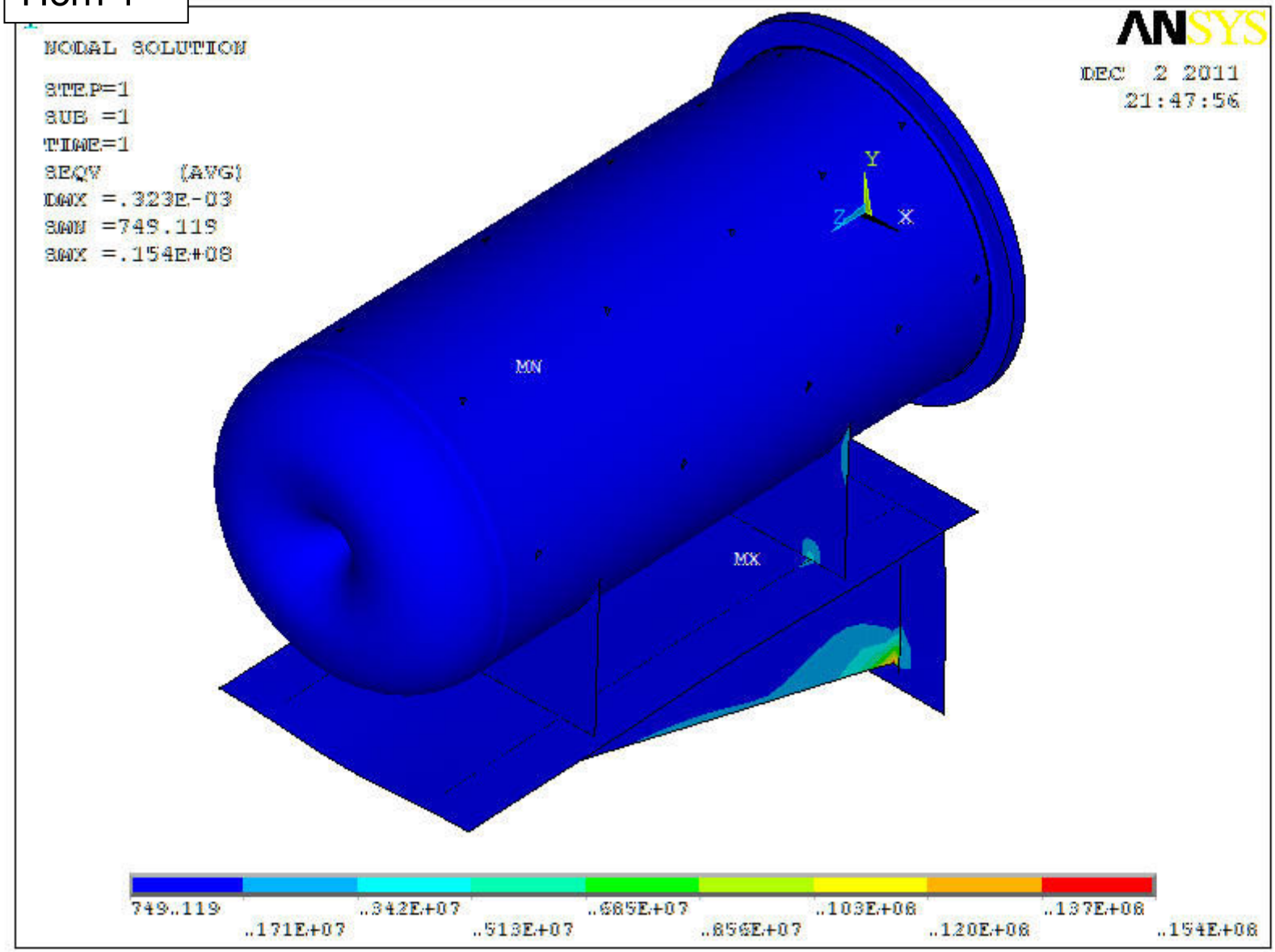


Slide 5 as an inspiration

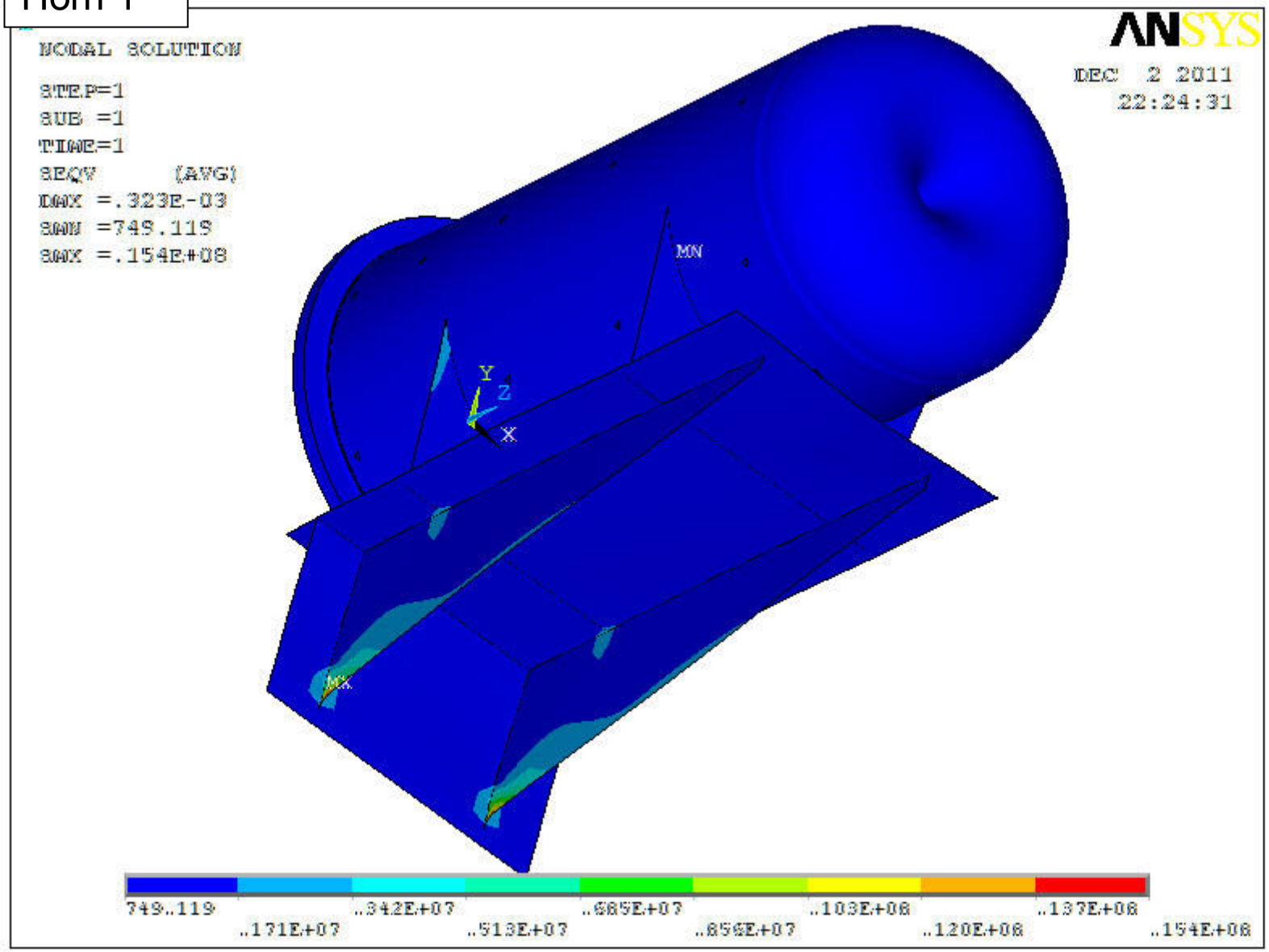
Horn 1


NODAL SOLUTION
STEP=1
SUB =1
TIME=1
UY (AVG)
RSYS=0
DMX =.323E-03
SMN =-.323E-03
SMX =.124E-04
ANSYS
DEC 2 2011
21:48:33
MX
MN
-.323E-03
-.285E-03
-.248E-03
-.211E-03
-.173E-03
-.136E-03
-.993E-04
-.626E-04
-.258E-04
.124E-04

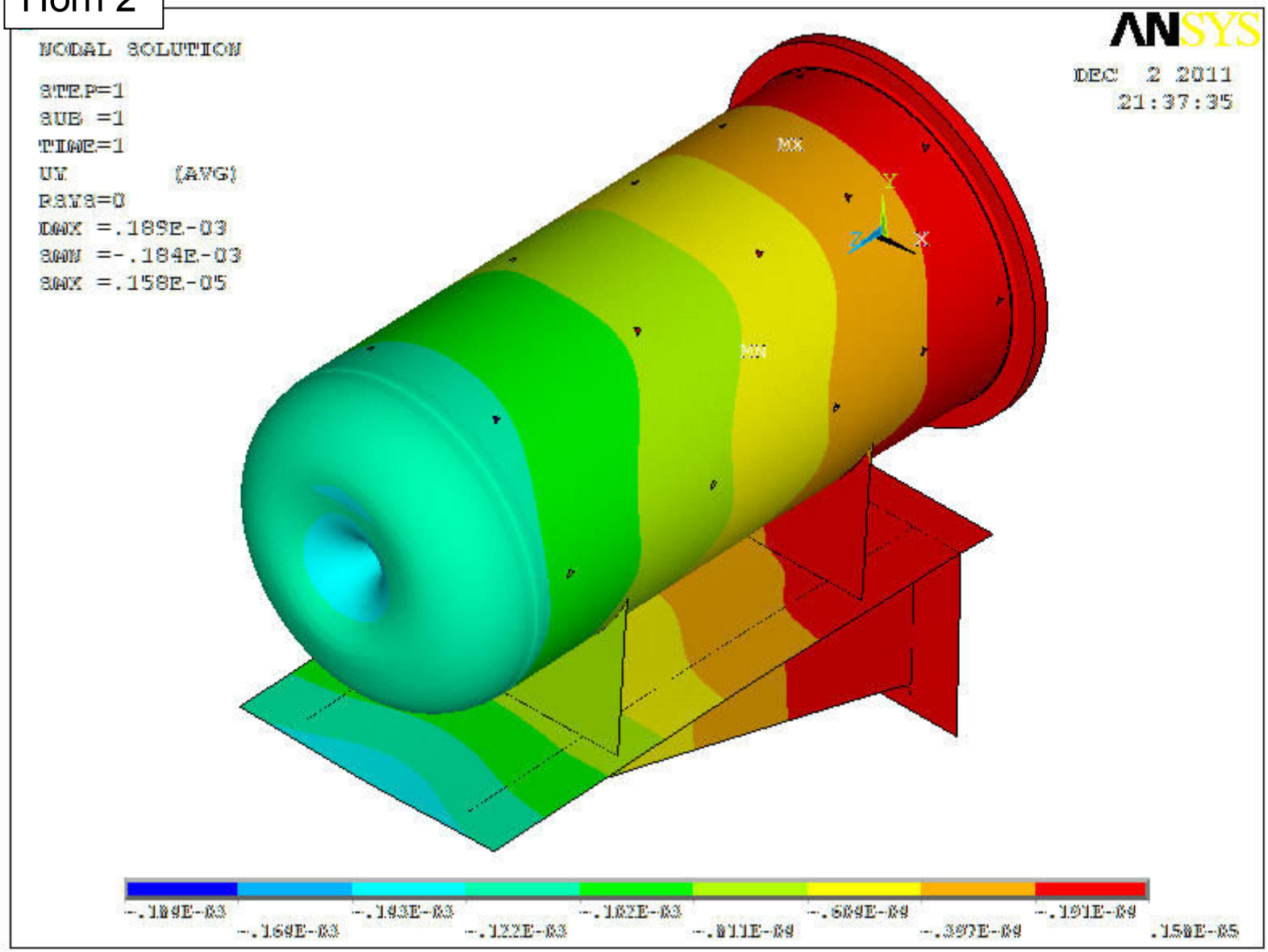
Horn 1


NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
DMX =.323E-03
SMN =748.119
SMX =.154E+08
ANSYS
DEC 2 2011
21:47:56
Y
Z
X
MN
MX
748.119
.171E+07
.342E+07
.513E+07
.685E+07
.856E+07
.103E+08
.120E+08
.137E+08
.154E+08

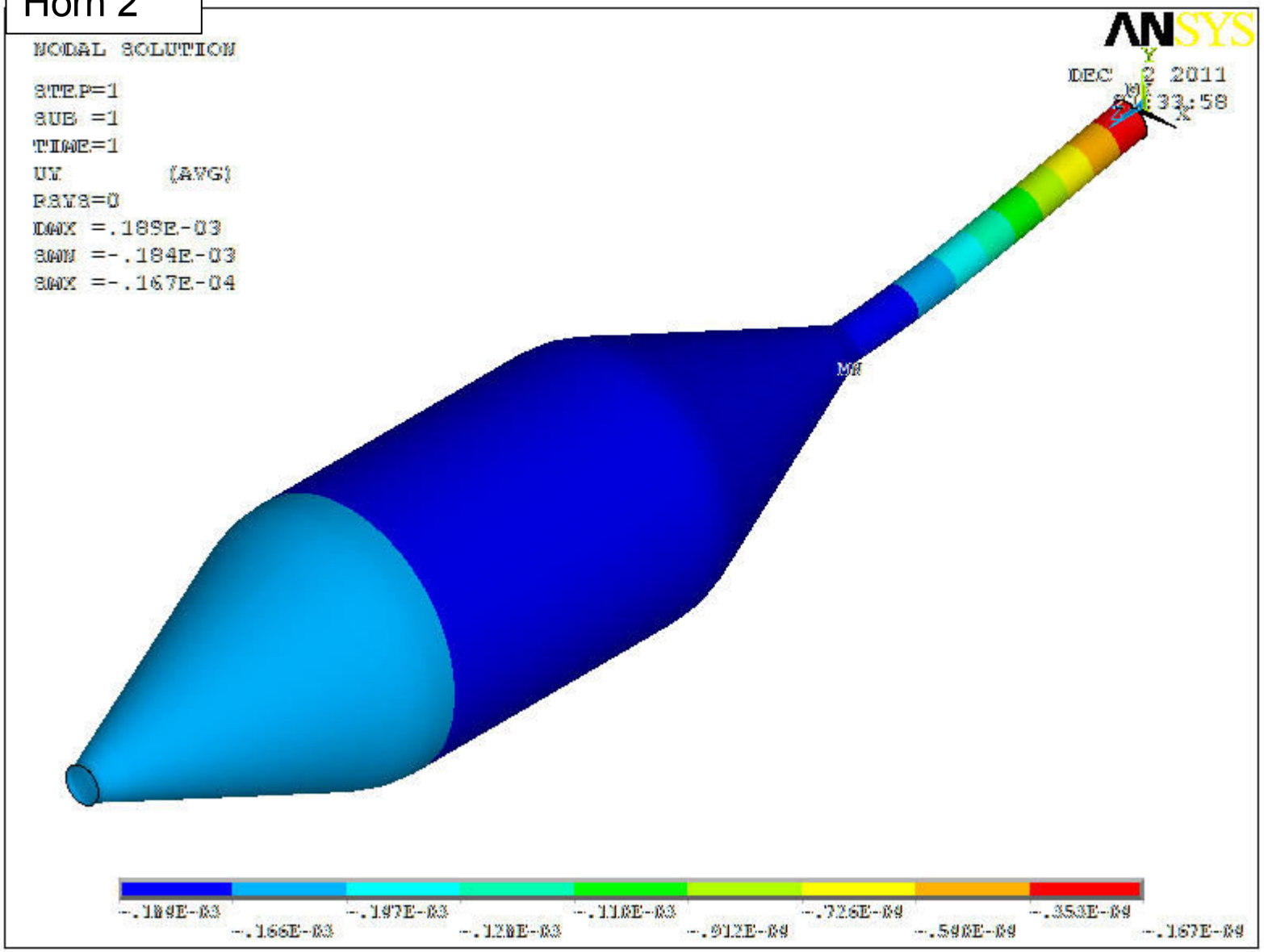
Horn 1


NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
DMX =.323E-03
SMN =749.119
SMX =.154E+08
ANSYS
DEC 2 2011
22:24:31
MN
MX
Y
Z
X
749.119
.171E+07
.342E+07
.513E+07
.685E+07
.856E+07
.103E+08
.120E+08
.137E+08
.154E+08

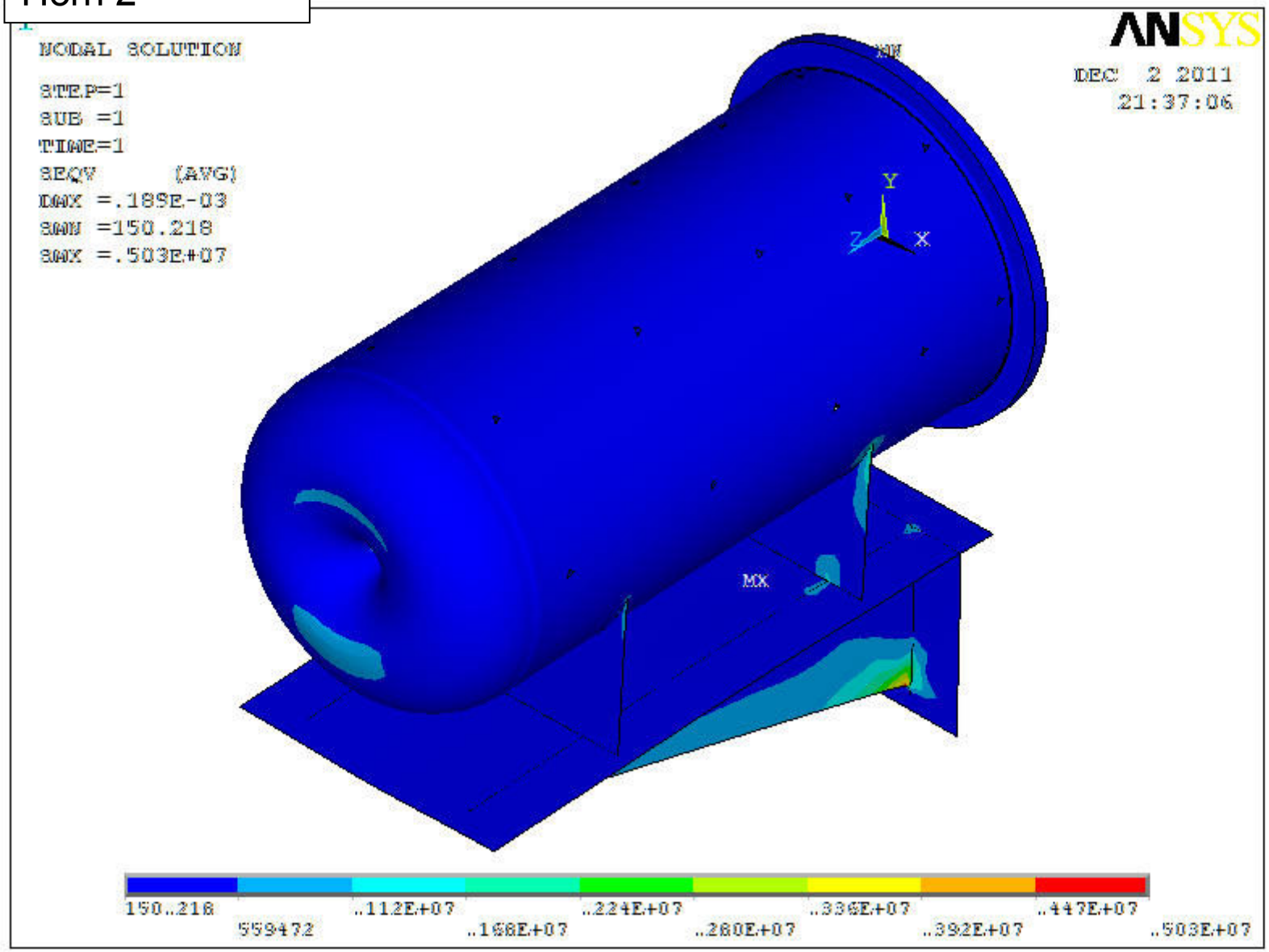
Horn 2


NODAL SOLUTION
STEP=1
SUB =1
TIME=1
UY (AVG)
RSYS=0
DMX =.189E-03
SMN =-.184E-03
SMX =.158E-05
ANSYS
DEC 2 2011
21:37:35
MX
MN
Y
Z
X
-.184E-03
-.169E-03
-.153E-03
-.122E-03
-.182E-03
-.911E-04
-.699E-04
-.487E-04
-.191E-04
.158E-05

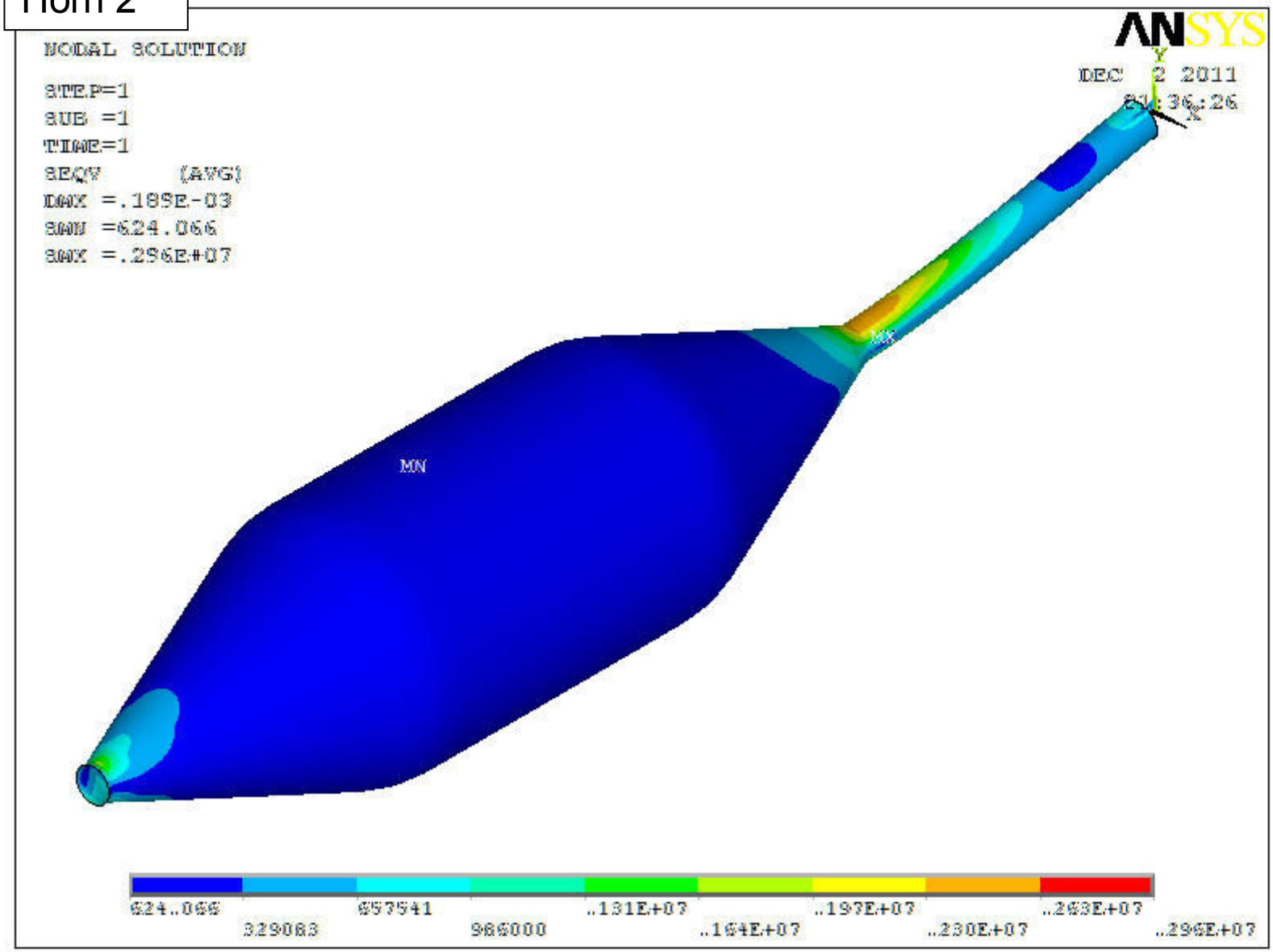
Horn 2


NODAL SOLUTION
STEP=1
SUB =1
TIME=1
UY (AVG)
RSYS=0
DMX =.189E-03
SMN =-.184E-03
SMX =-.167E-04
ANSYS
DEC 2 2011
MN
-.184E-03
-.166E-03
-.147E-03
-.128E-03
-.110E-03
-.912E-04
-.726E-04
-.539E-04
-.353E-04
-.167E-04

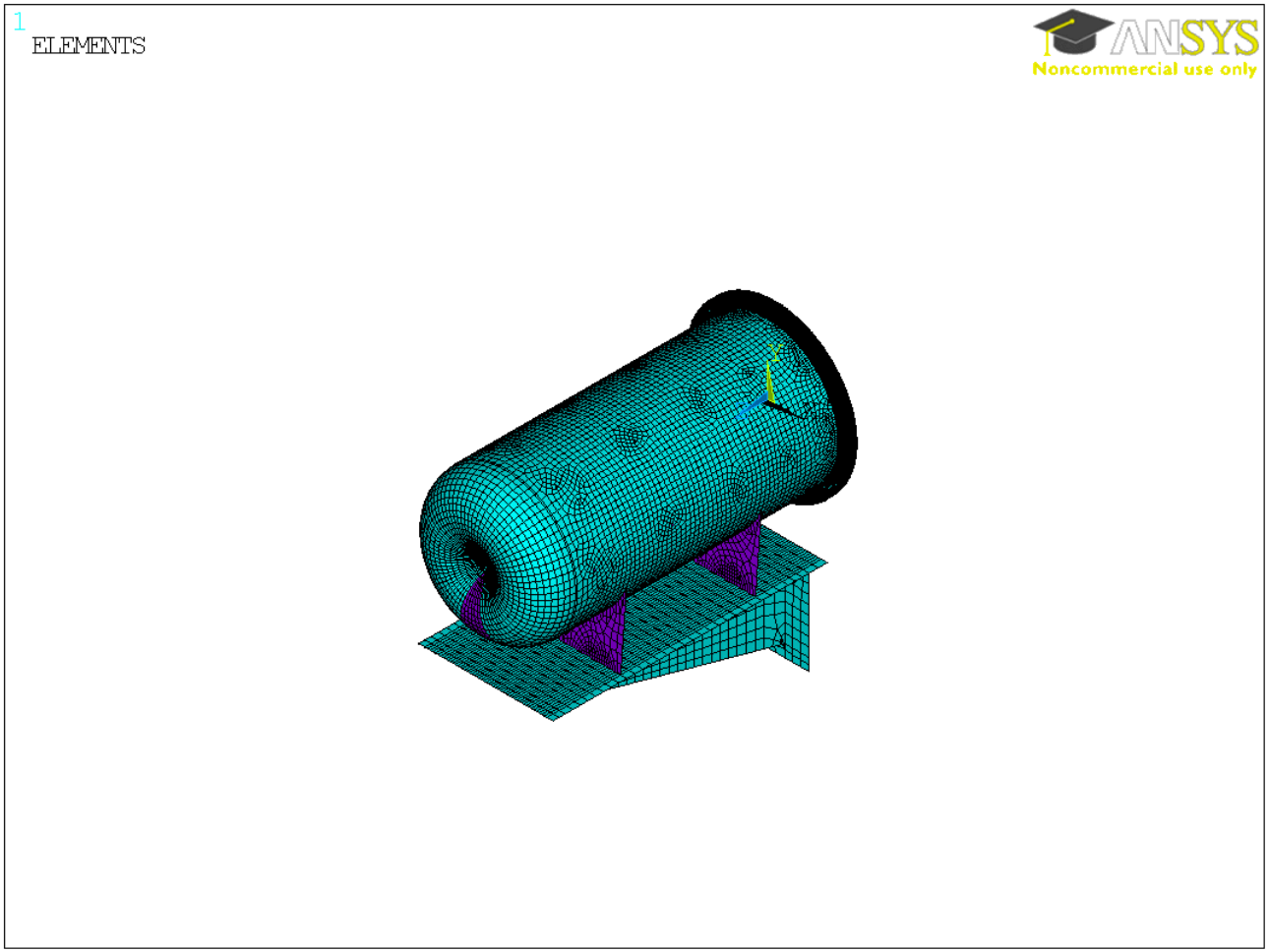
Horn 2


NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
DMX =.185E-03
SMN =150.218
SMX =.503E+07
ANSYS
DEC 2 2011
21:37:06
MN
MX
Y
Z
X
150.218
559472
.112E+07
.168E+07
.224E+07
.280E+07
.336E+07
.392E+07
.447E+07
.503E+07

Horn 2


NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
DMX =.188E-03
SMN =624.066
SMX =.296E+07
ANSYS
DEC 2 2011
MN
MX
624.066
329063
657541
986000
.131E+07
.164E+07
.197E+07
.230E+07
.263E+07
.296E+07

Modal analysis of a single horn with support



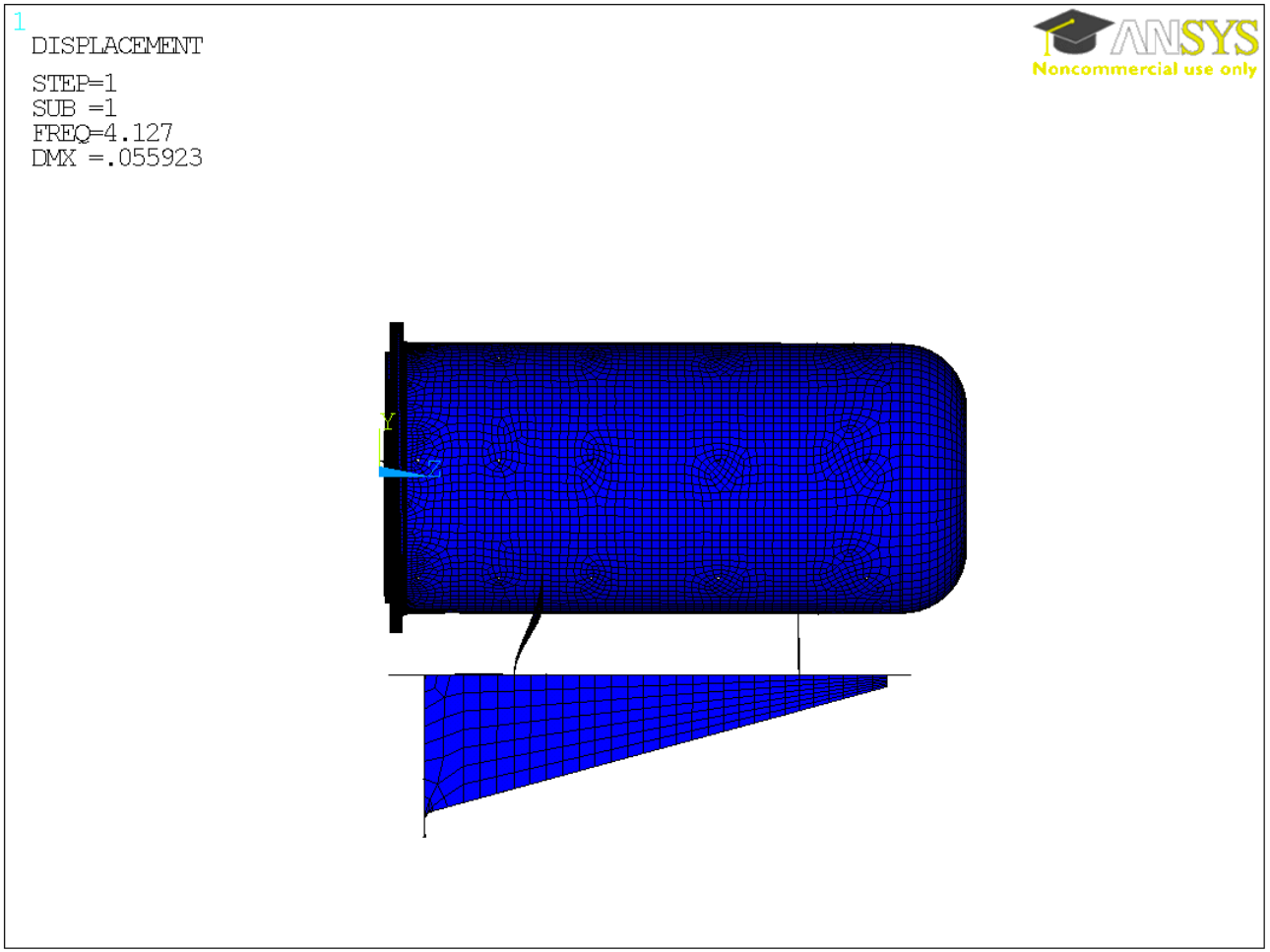
Modal results for the first configuration (the more flexible one, horn 1)

Lowest twenty natural frequencies

1	4.1271 Hz
2	4.1646 Hz
3	27.609 Hz
4	29.374 Hz
5	32.555 Hz
6	33.056 Hz
7	35.177 Hz
8	40.161 Hz
9	47.884 Hz
10	48.768 Hz
11	54.748 Hz
12	56.326 Hz
13	62.289 Hz
14	64.626 Hz
15	65.602 Hz
16	69.779 Hz
17	82.107 Hz
18	84.637 Hz
19	87.261 Hz
20	87.691 Hz

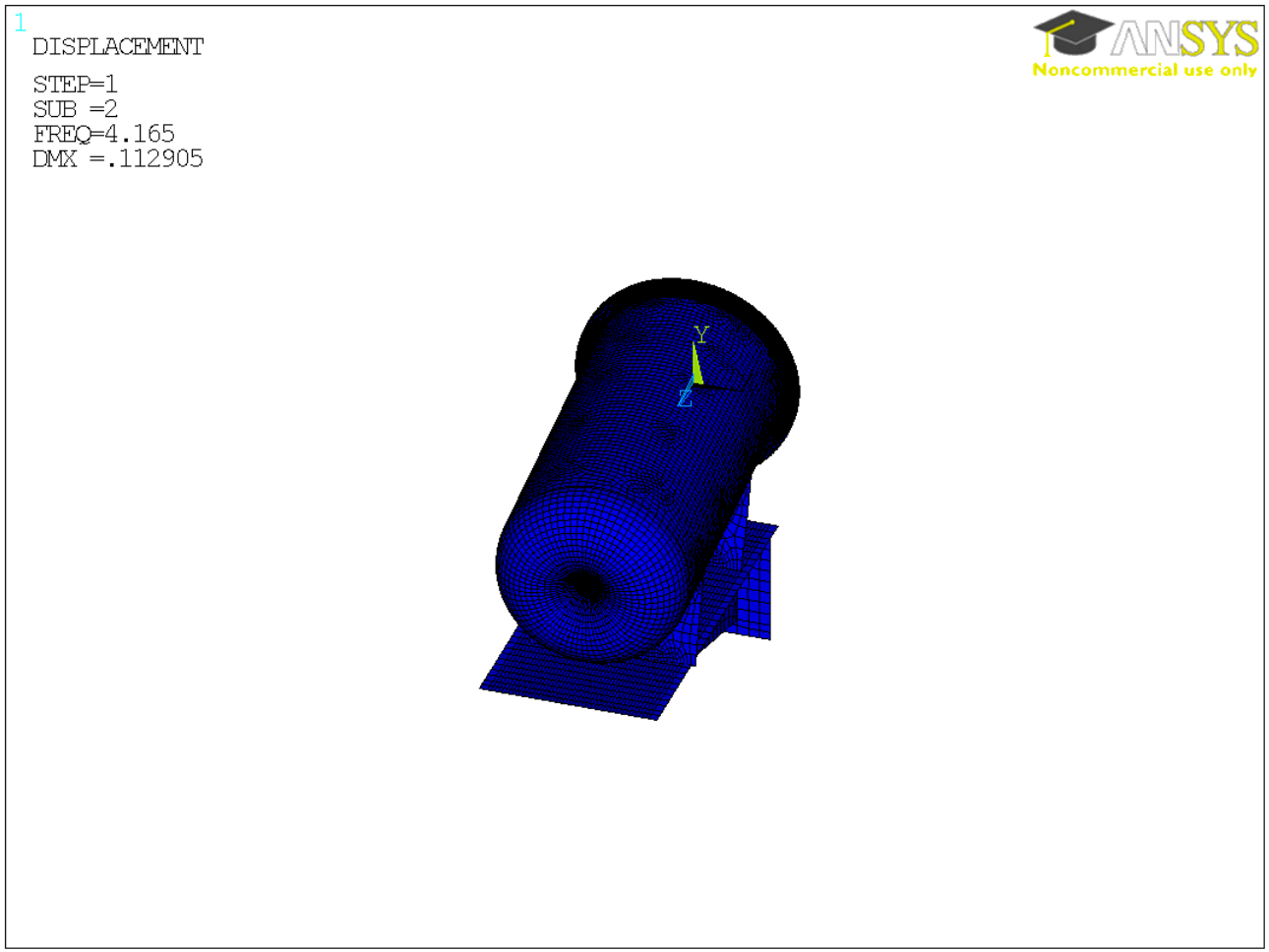
Horn 1

First mode (4.1 Hz) - longitudinal



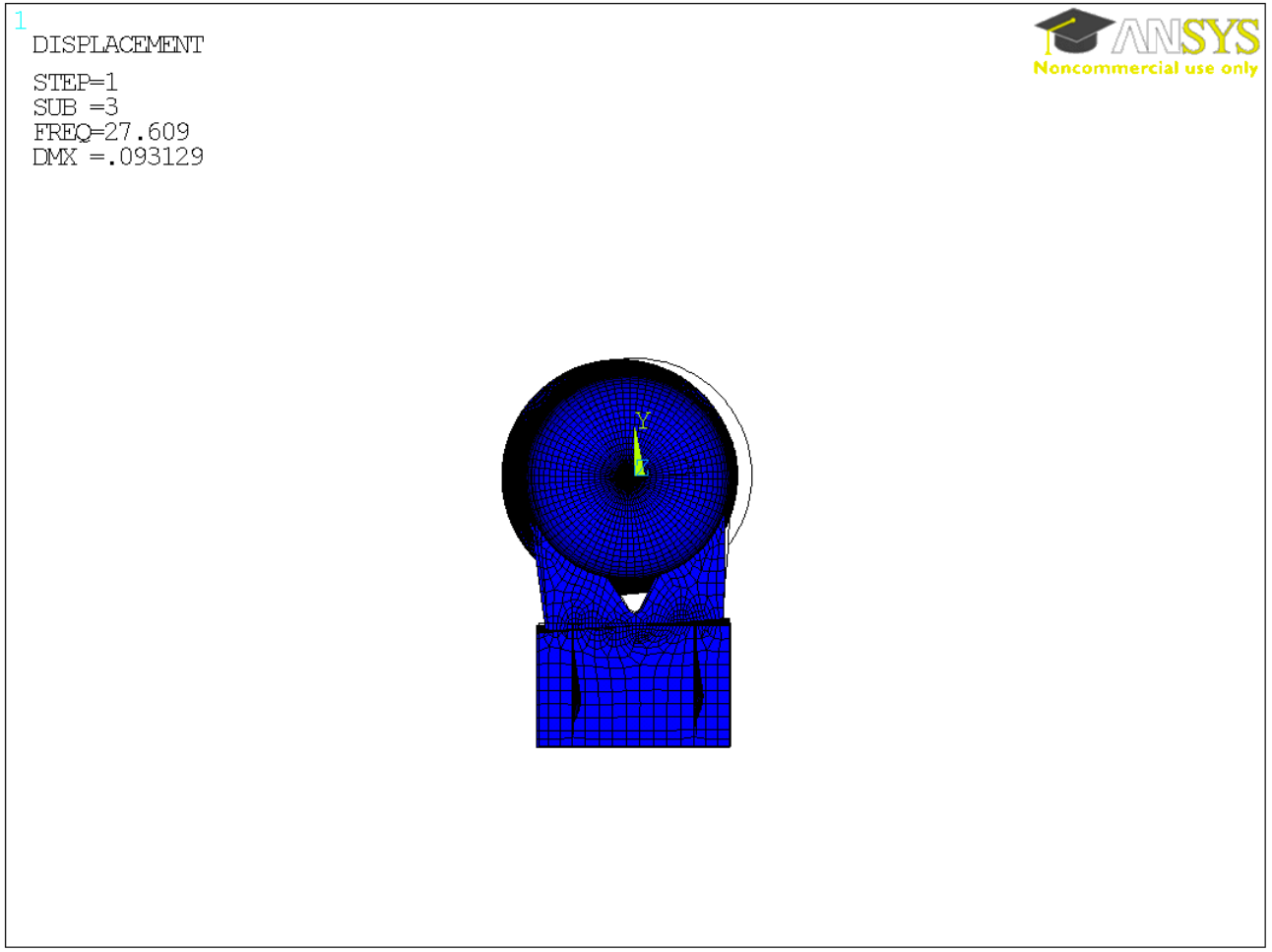
Horn 1

Second mode (4.2 Hz) - torsional



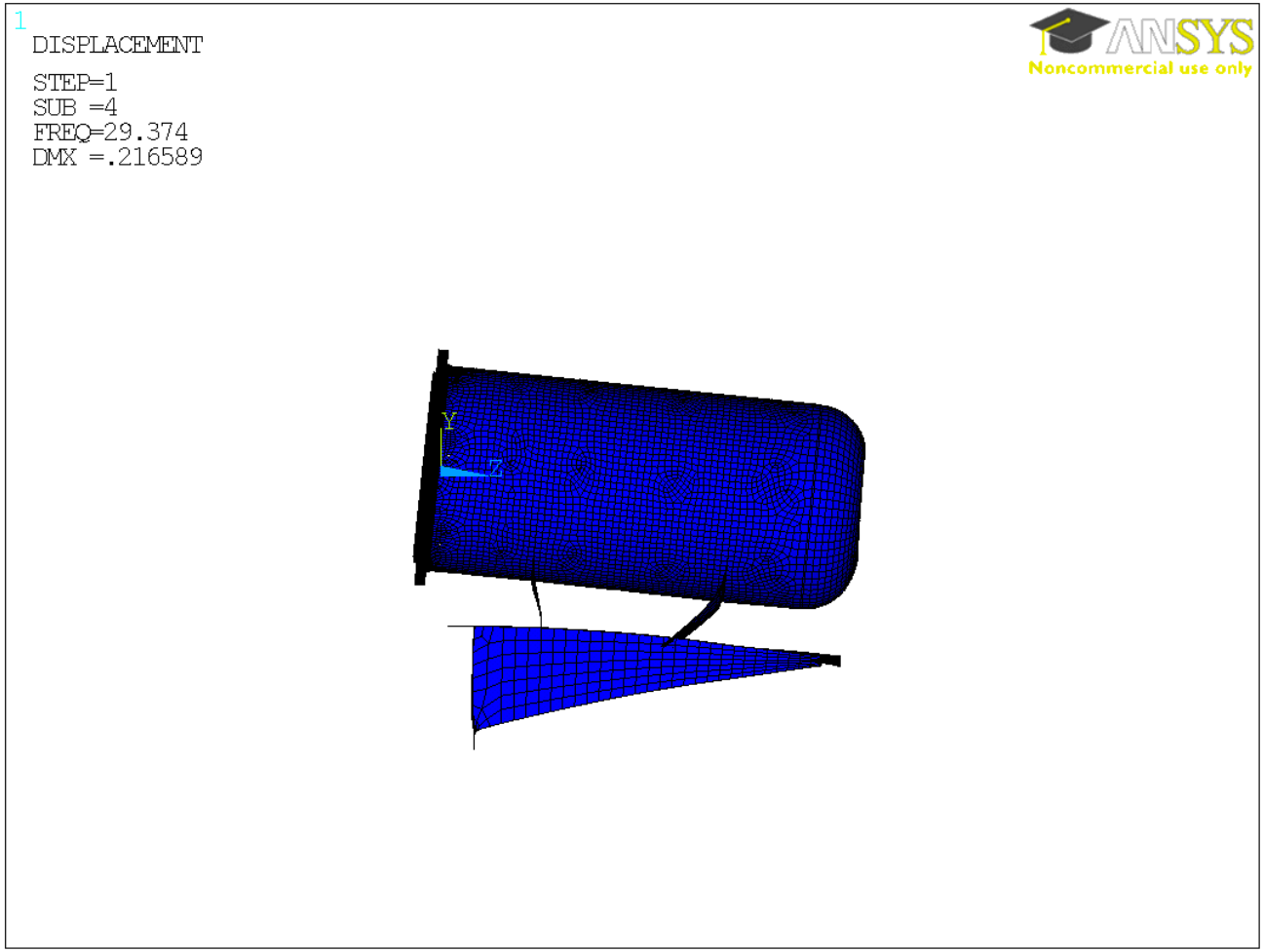
Horn 1

Third mode (27.6 Hz) – swing mode



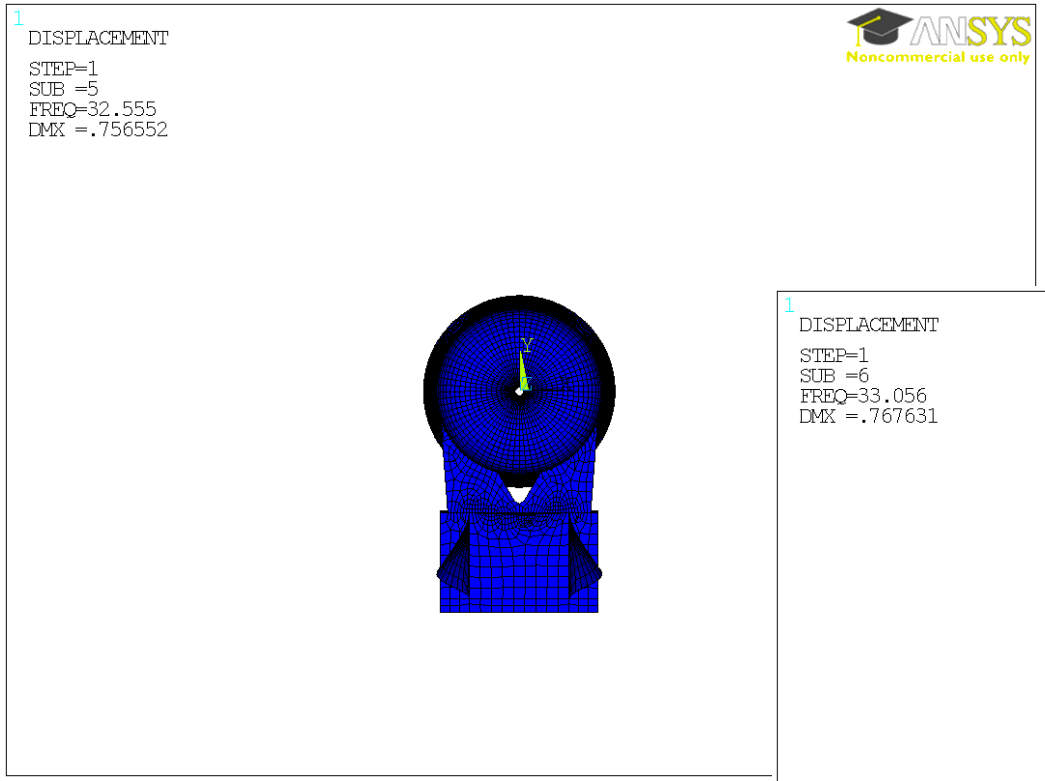
Horn 1

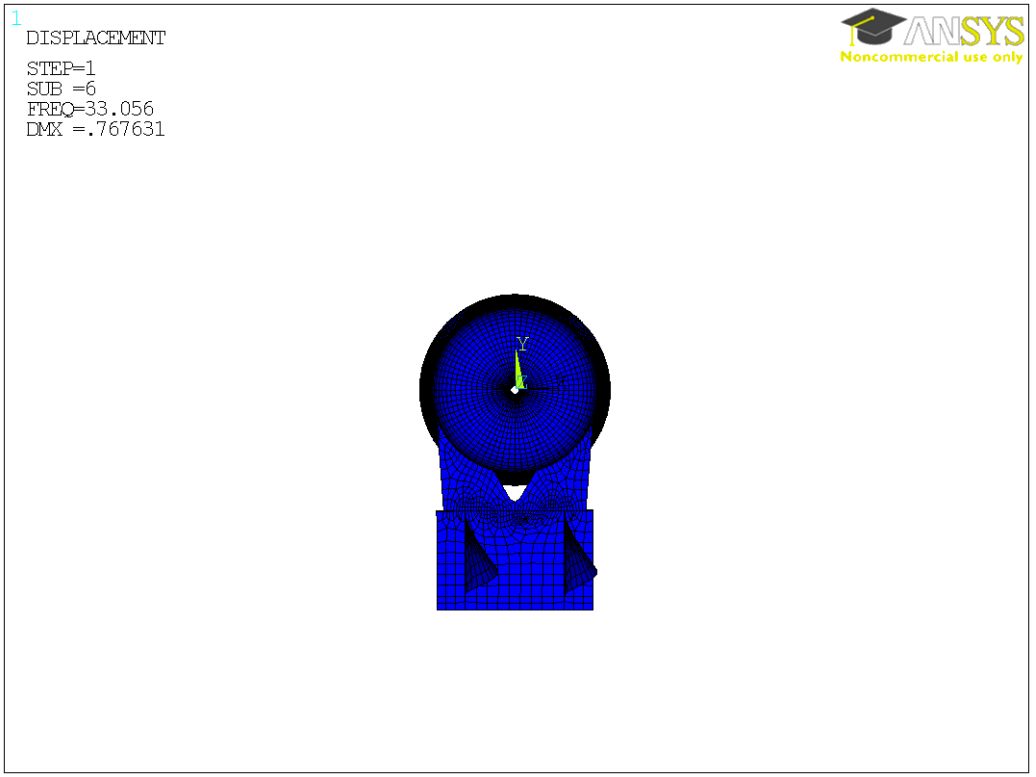
Fourth mode (27.6 Hz) – support bending



Horn 1

Fifth and sixth mode (32.6 and 33.1 Hz) – rib deformation mode





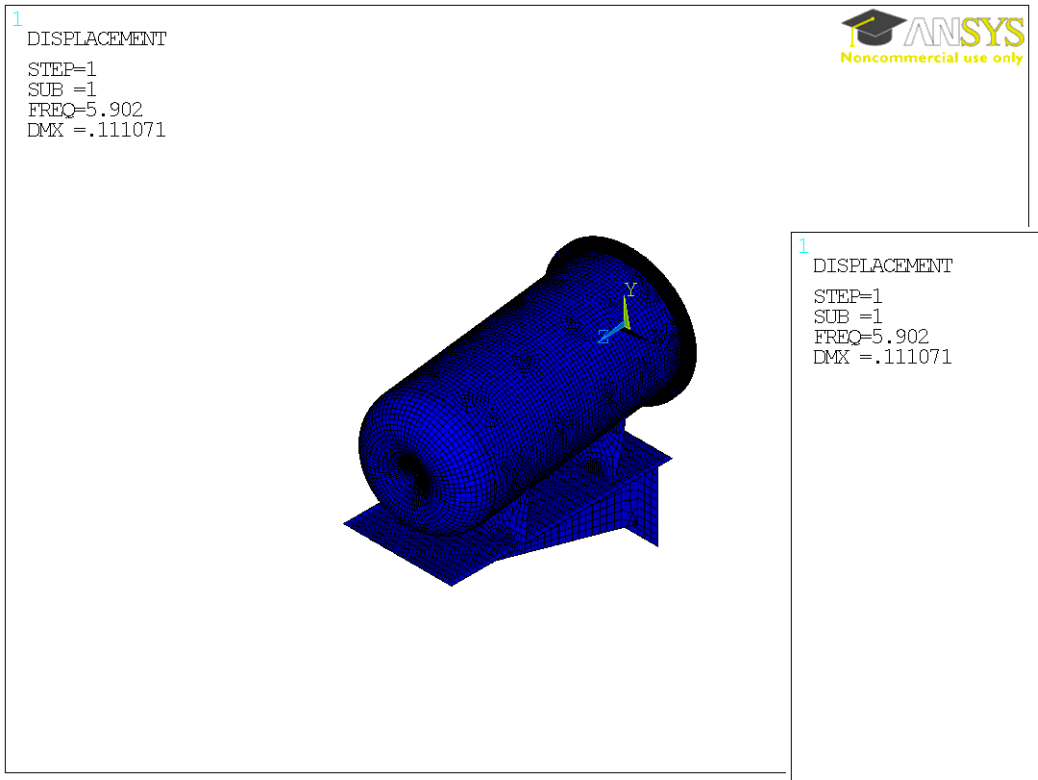
Modal results for the second configuration (after stiffening)

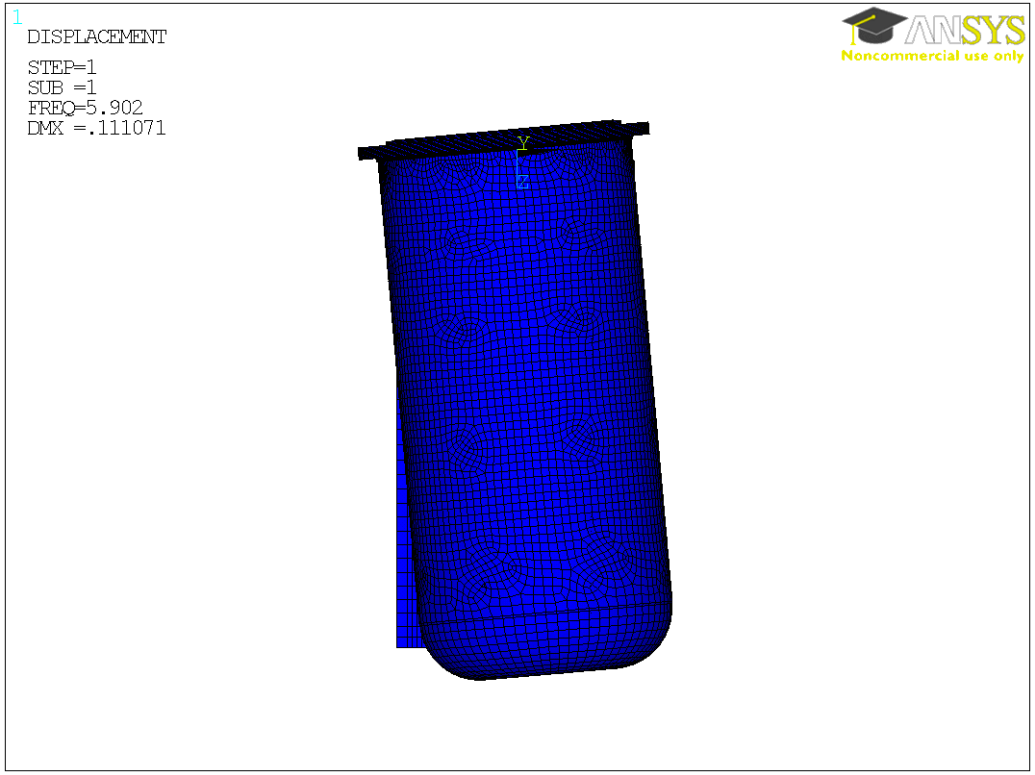
Lowest twenty natural frequencies (in parentheses values for the previous configuration)

1	5.9022 Hz	(4.13 Hz)
2	13.411 Hz	(4.16 Hz)
3	34.964 Hz	(27.6 Hz)
4	44.190 Hz	(29.4 Hz)
5	49.040 Hz	(32.6 Hz)
6	50.157 Hz	(33.1 Hz)
7	64.436 Hz	(35.2 Hz)
8	74.757 Hz	(40.2 Hz)
9	86.319 Hz	(47.9 Hz)
10	87.328 Hz	(48.8 Hz)
11	87.468 Hz	(54.7 Hz)
12	91.605 Hz	(56.3 Hz)
13	92.603 Hz	(62.3 Hz)
14	116.14 Hz	(64.6 Hz)
15	118.54 Hz	(65.6 Hz)
16	125.85 Hz	(69.8 Hz)
17	132.60 Hz	(82.1 Hz)
18	140.84 Hz	(84.6 Hz)
19	143.13 Hz	(87.3 Hz)
20	151.15 Hz	(87.7 Hz)

Horn 2

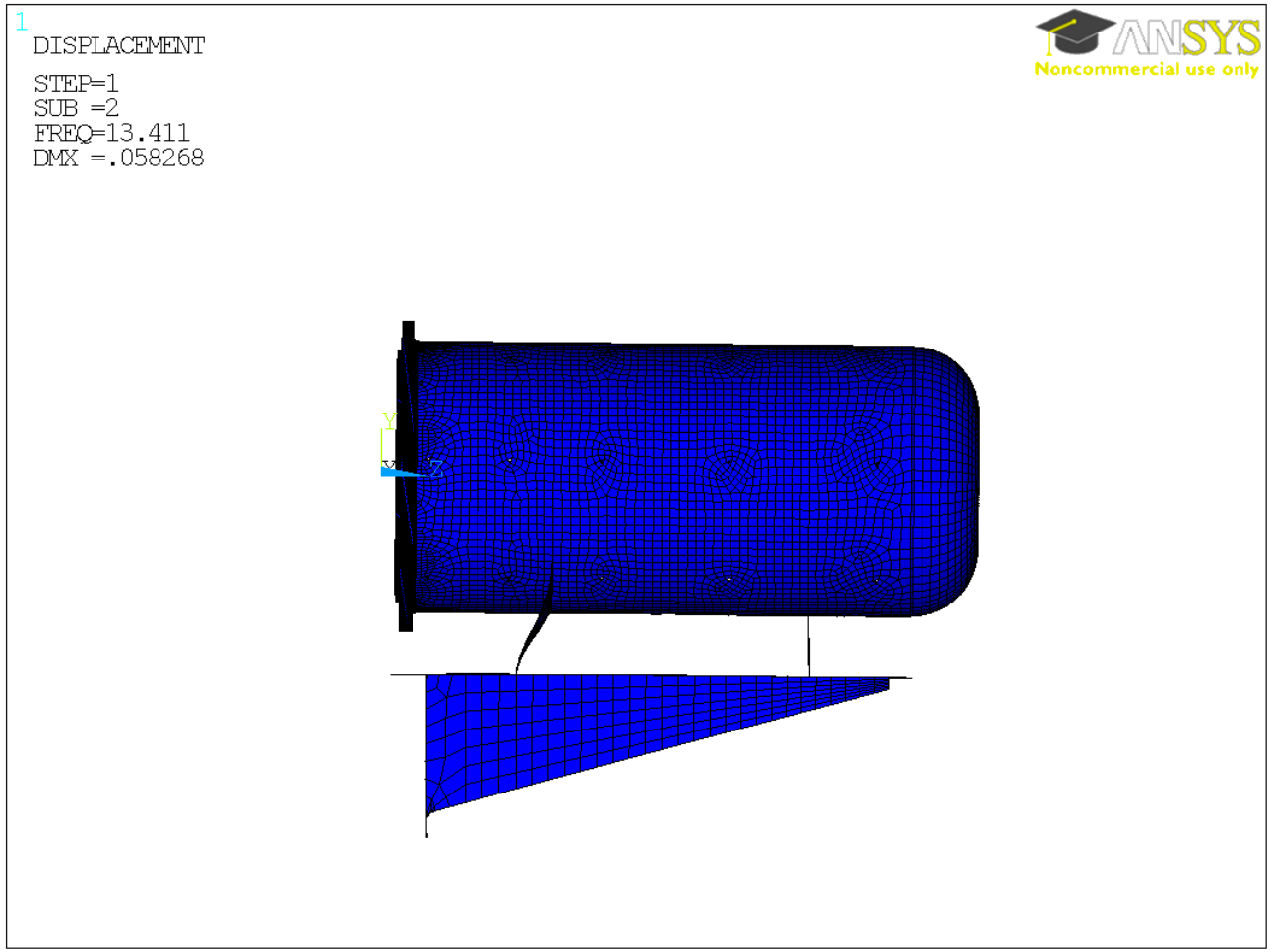
First mode (5.9 Hz) - torsional





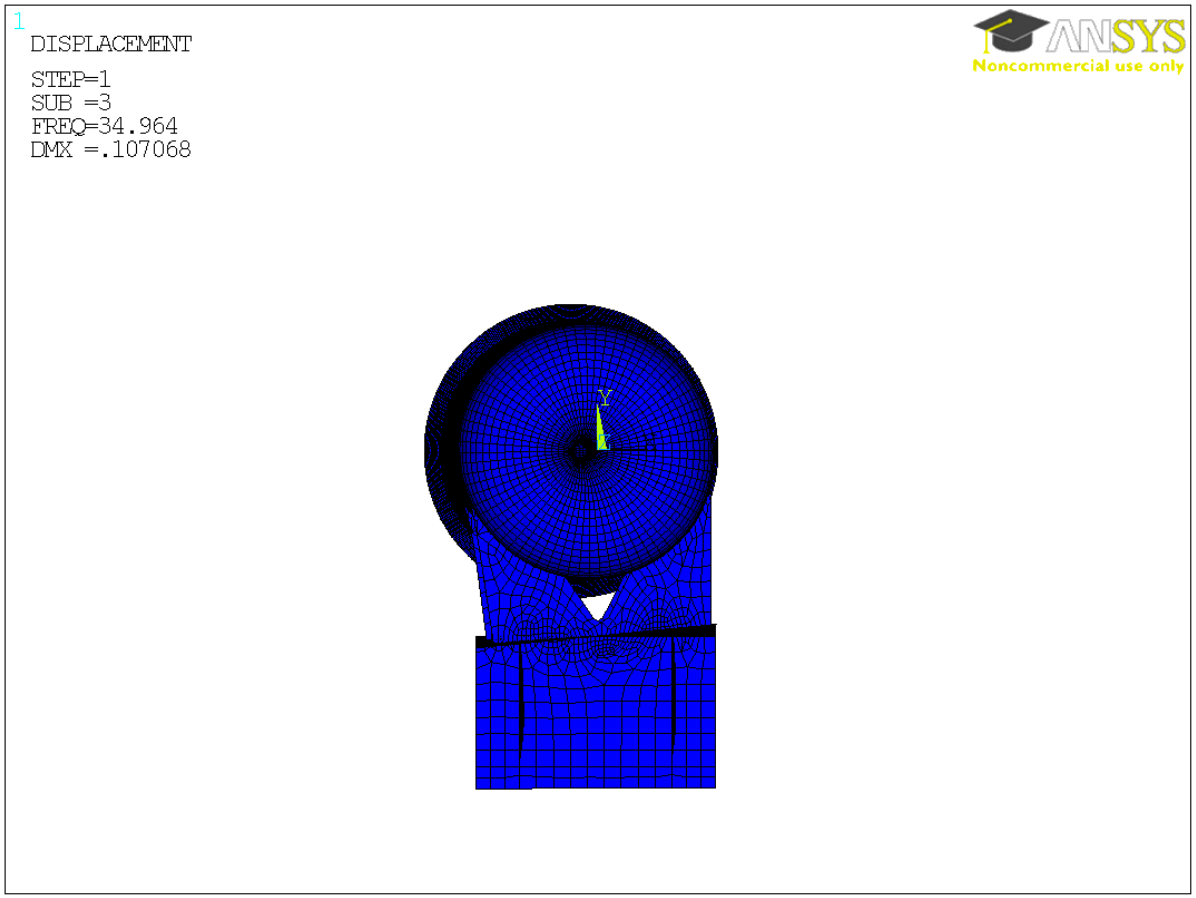
Horn 2

Second mode (13.4 Hz) - longitudinal



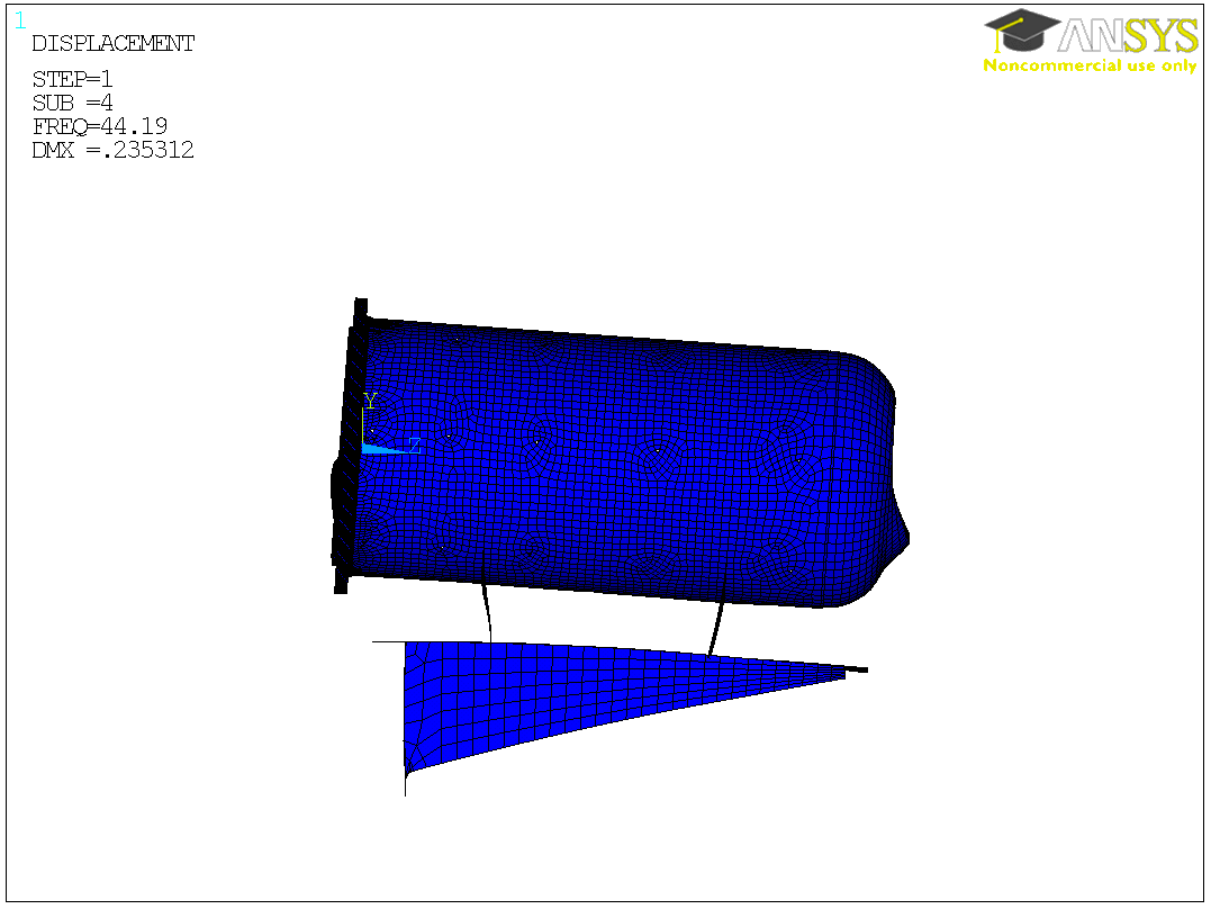
Horn 2

Third mode (35.0 Hz) – swing mode



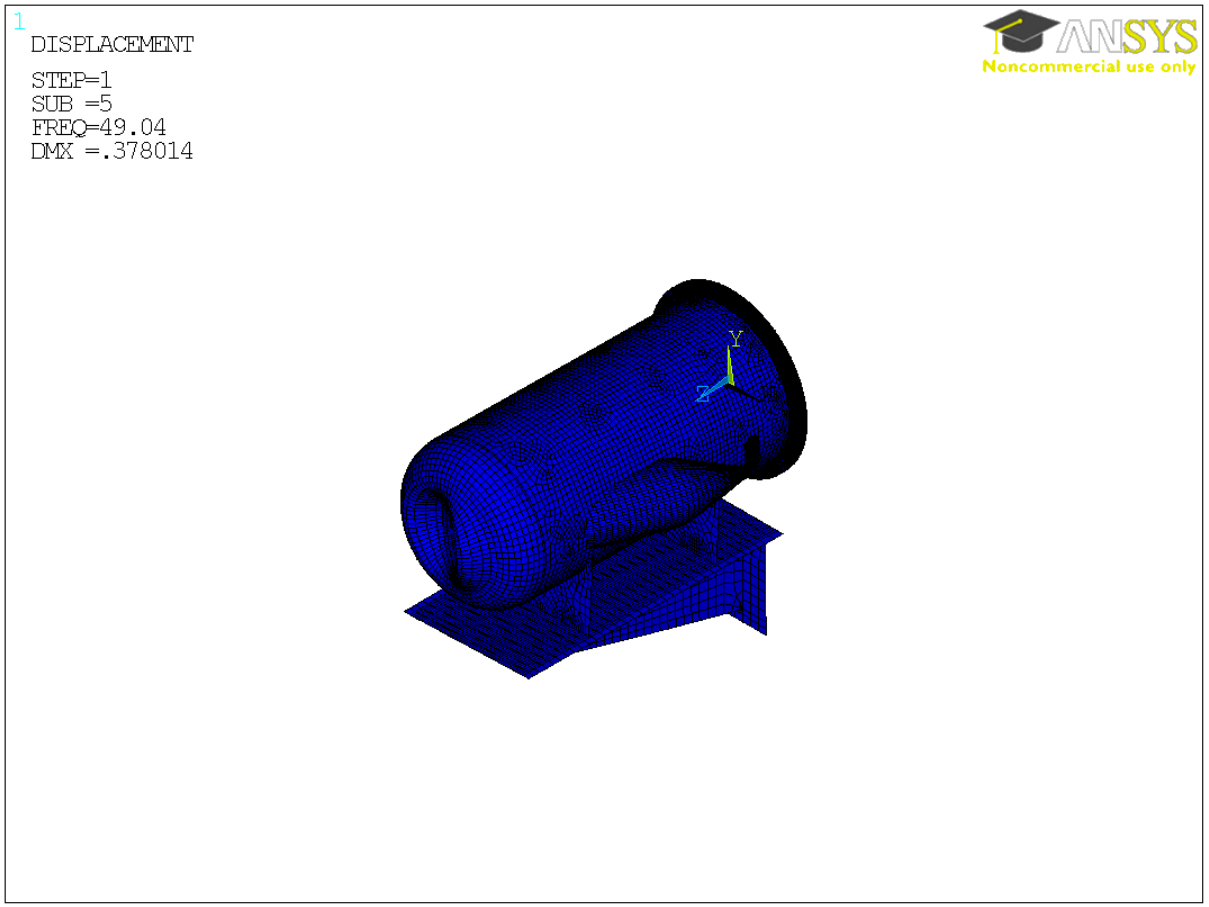
Horn 2

Fourth mode (44.2 Hz) – support bending
with some horn outer skin deformation



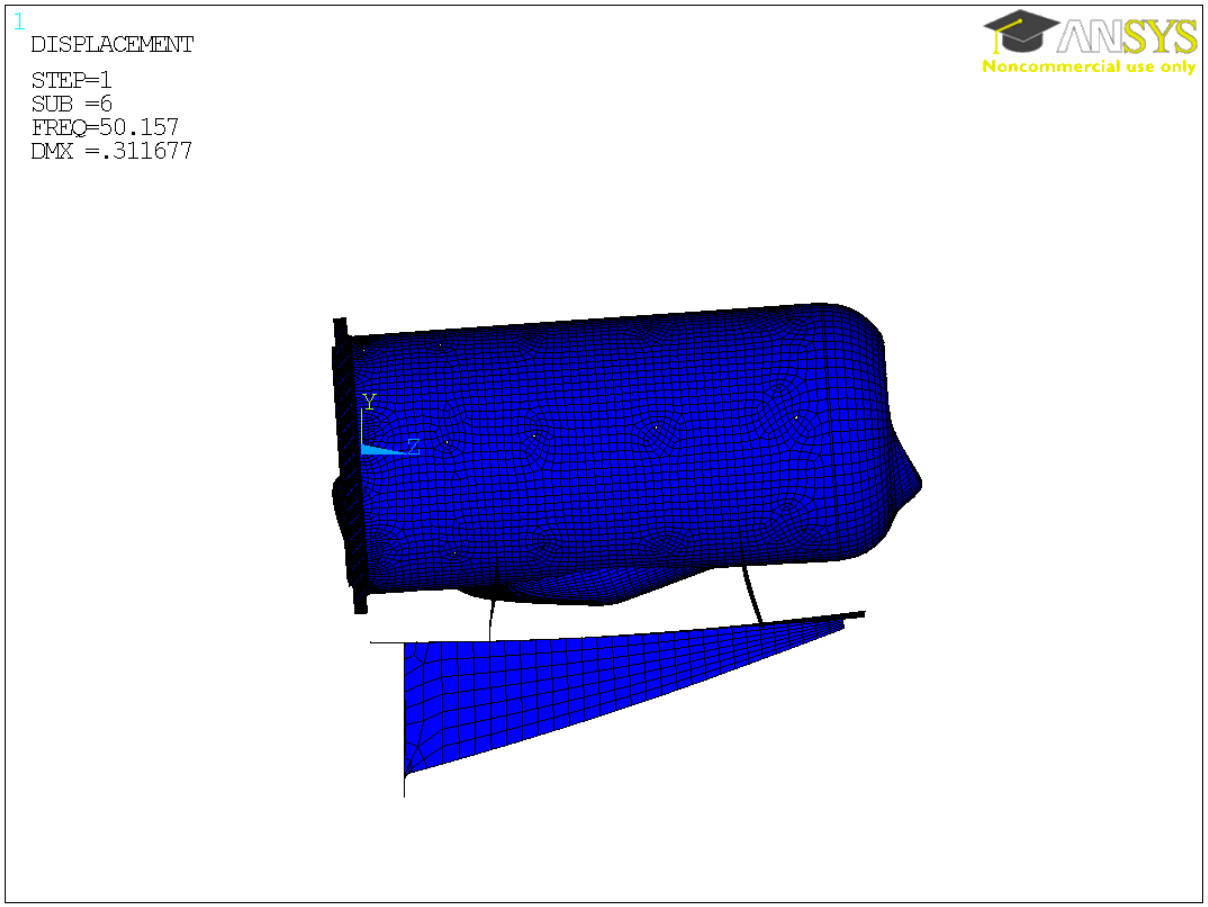
Horn 2

Fifth mode (49.0 Hz) – horn deformation



Horn 2

Sixth mode (50.2 Hz)



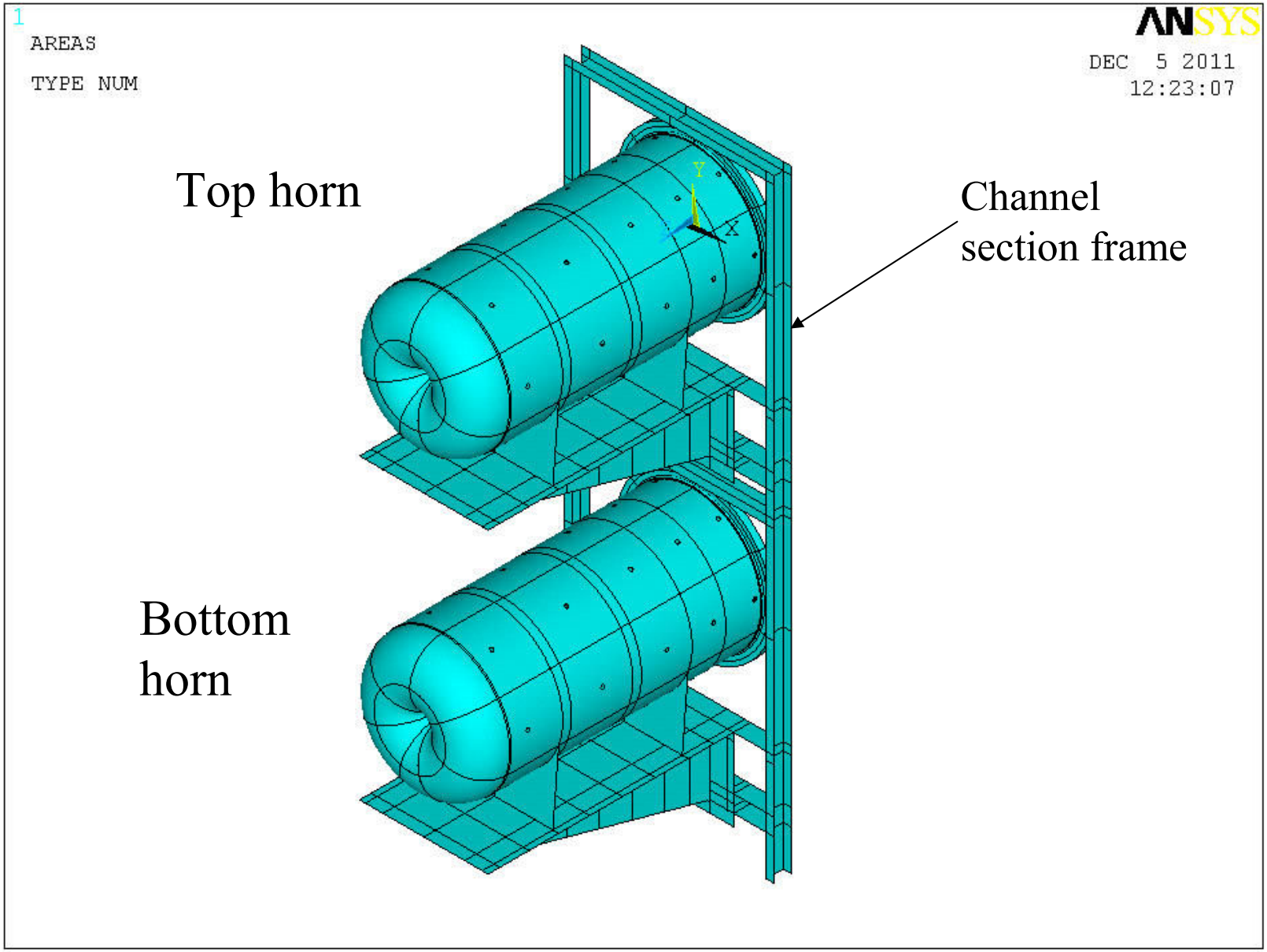
Summary of the modal analysis of a horn with a support:

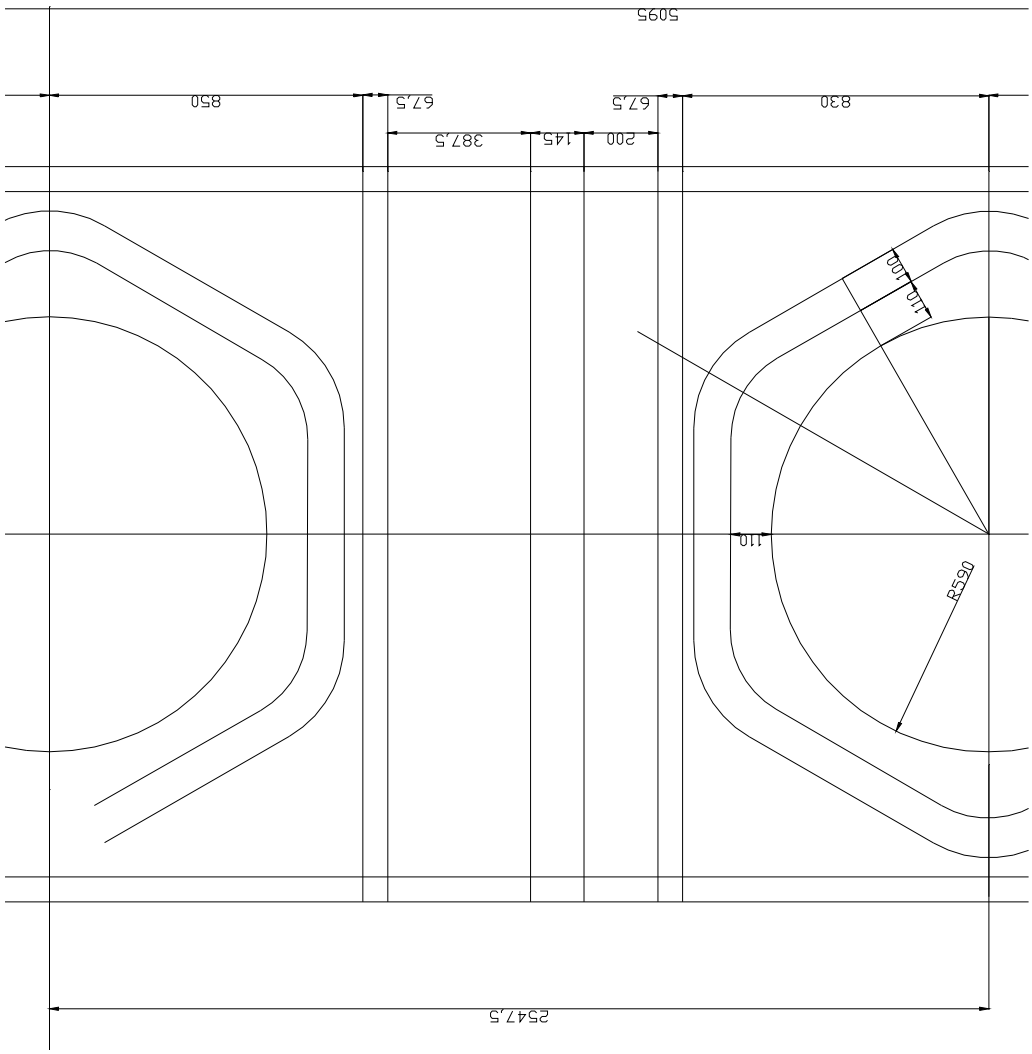
•The first design of the support was quite fexible from the dynamic point of view – i.e. modes with rib deformations exist with frequencies about 33 Hz

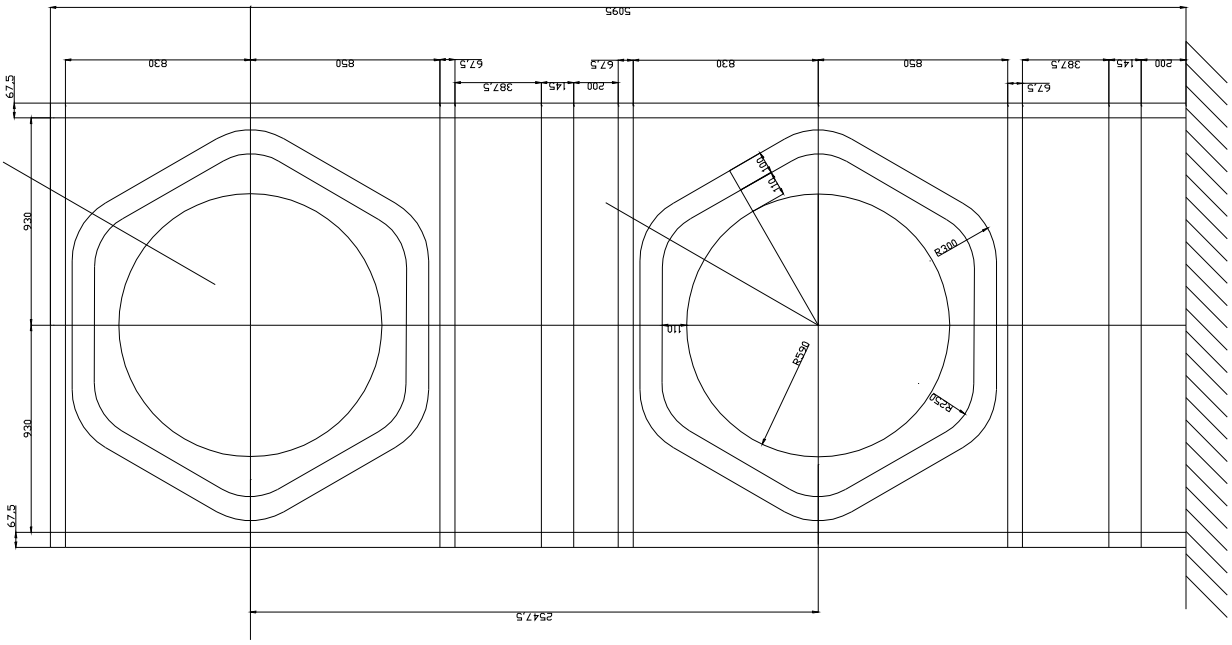
•Changes have been introduced to make the horn support system more rigid (the support plate thickness has been increased from 10 to 20 mm, the rib thickness has been increased from 5 mm to 15 mm). More changes are still possible in order to make the support stiffer still.

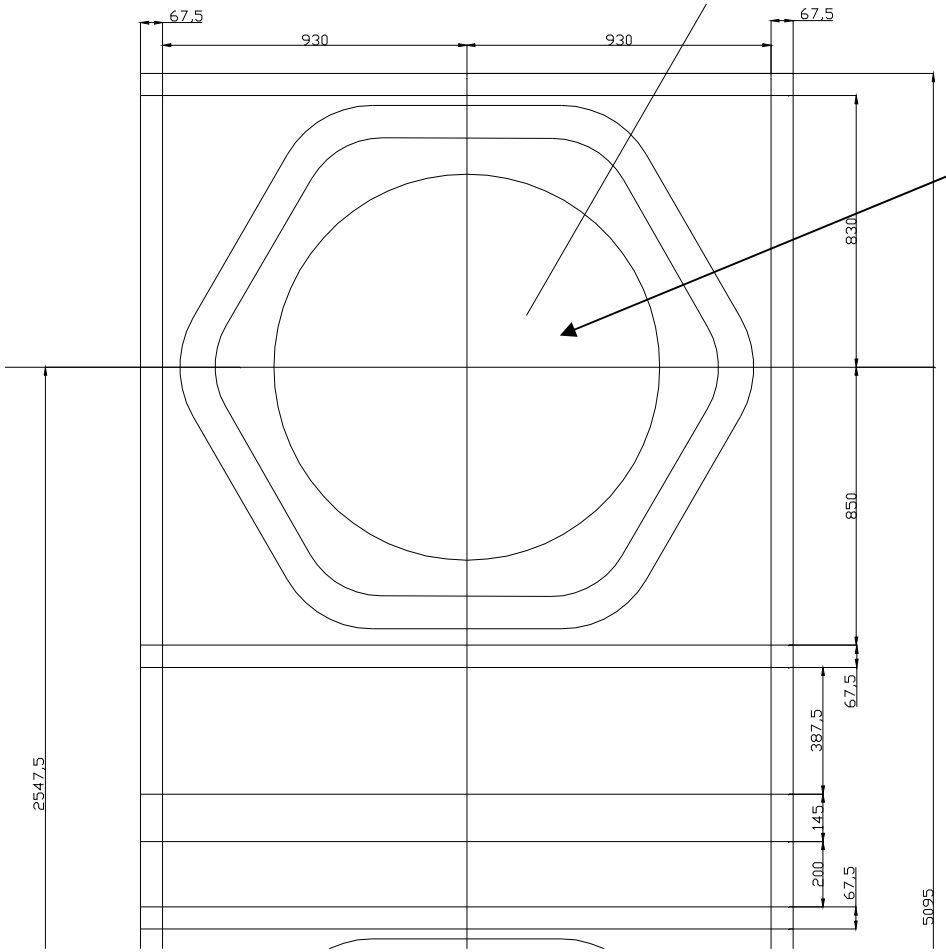
•The ultimate assesment of the vibration levels needs to be done if the preliminary design is acceptable, depending on the possible vibration sources (the dynamic load on the horn, excitation from the cooling system etc.).

Proposed arrangement of two horns assemblied in one frame

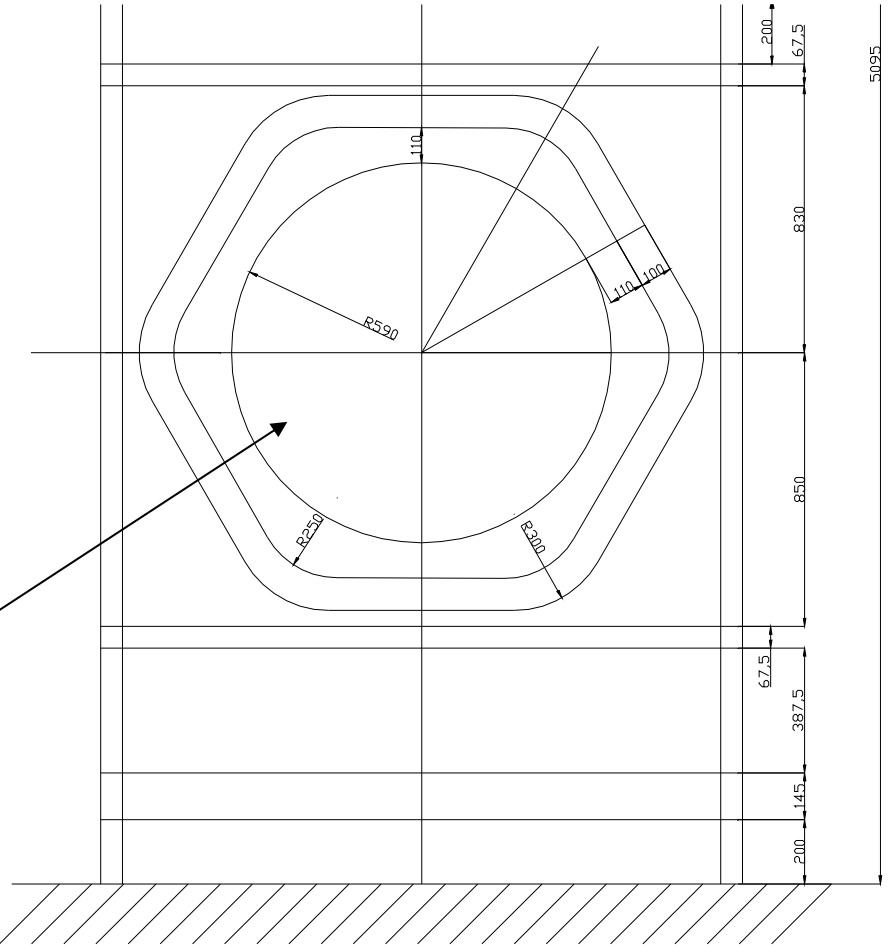

1
AREAS
TYPE NUM
ANSYS
DEC 5 2011
12:23:07
Top horn
Channel
section frame
Bottom
horn
Y
X


5095
850
67,5
67,5
830
387,5
145
200
R590
110
2547,5

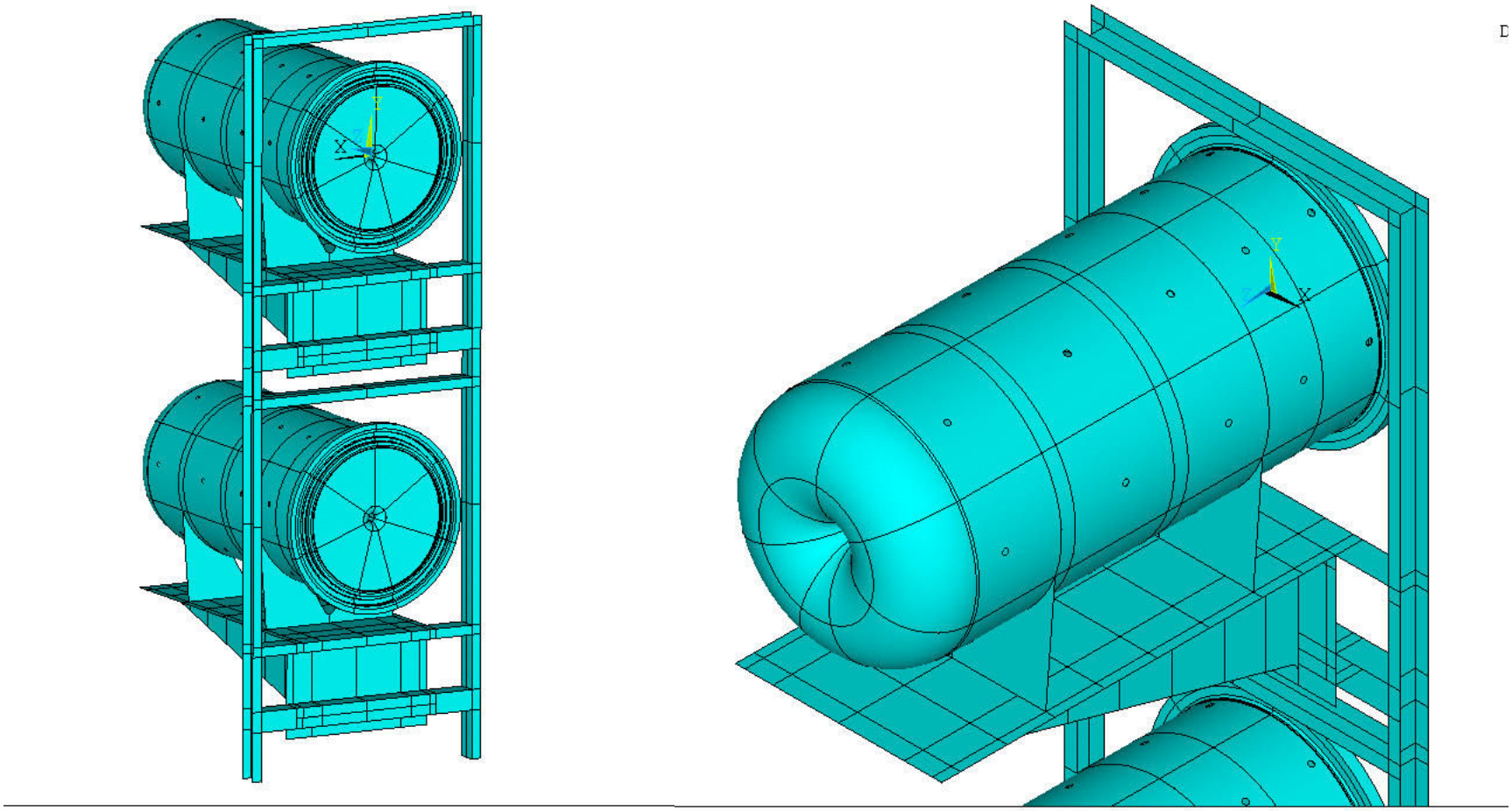

5095
830
850
67,5
67,5
830
850
387,5
145
200
67,5
67,5
930
930
R300
R590
R530
110
2547,5

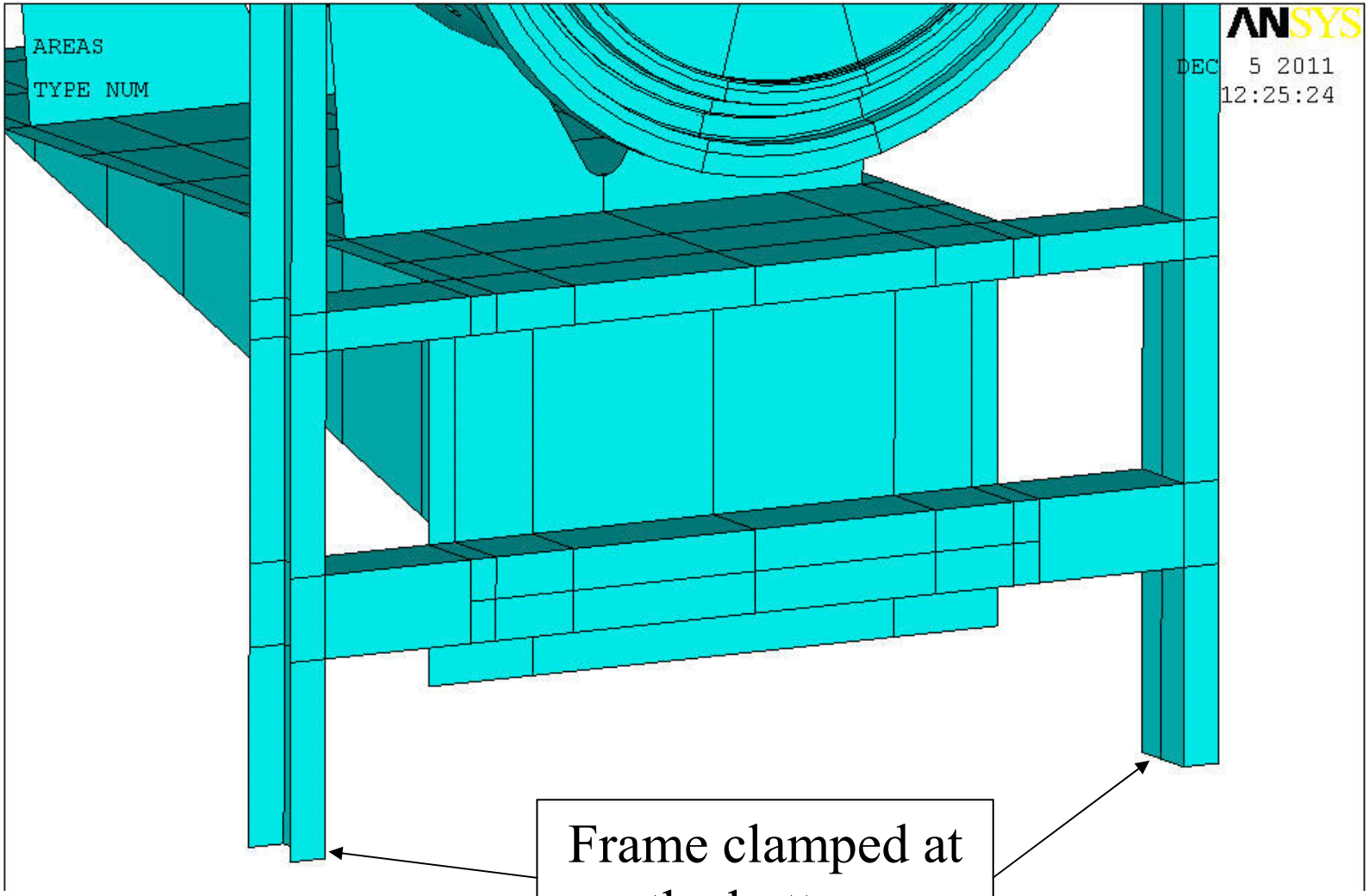


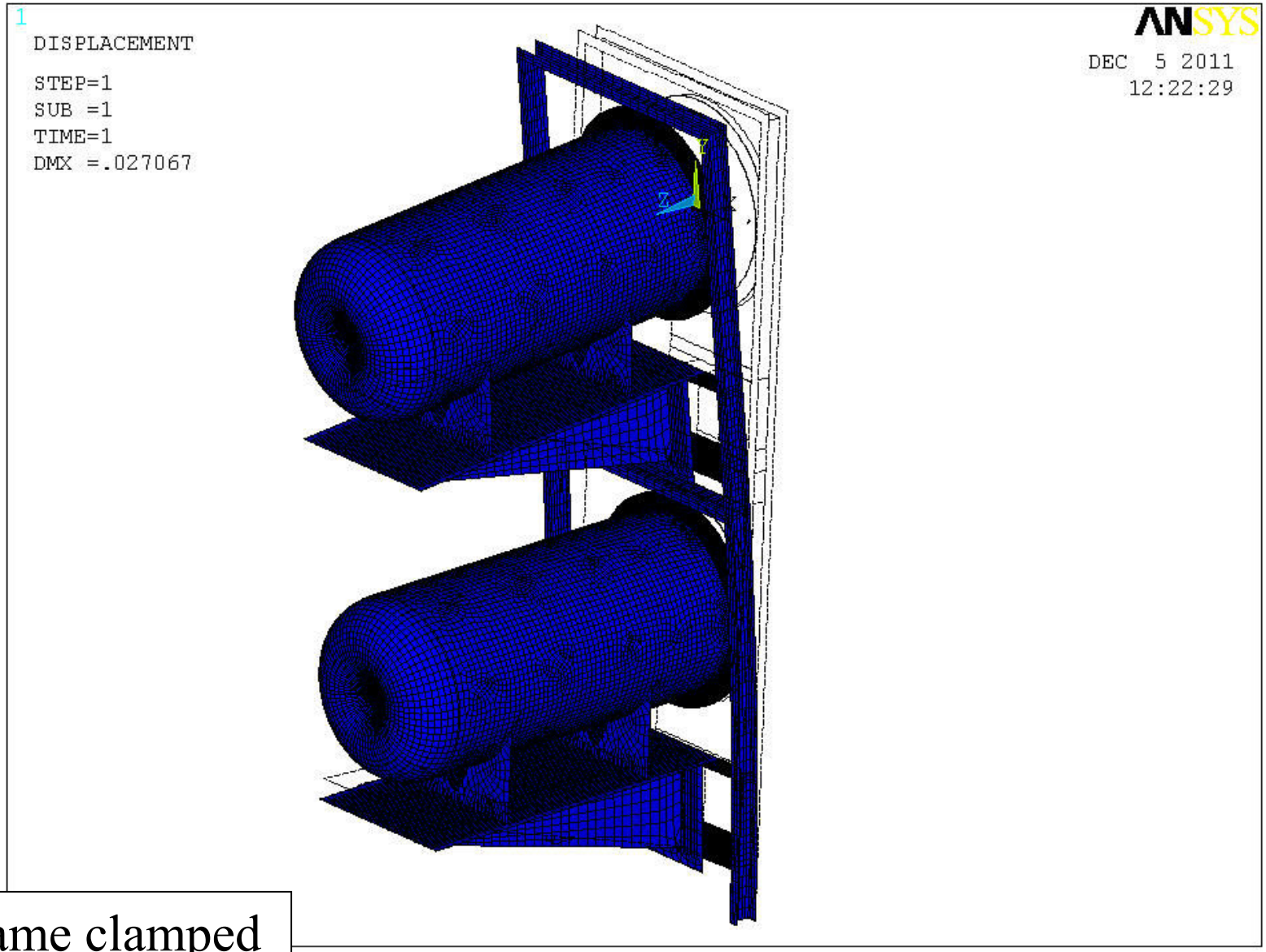
Top horn with frame for cooling water supply



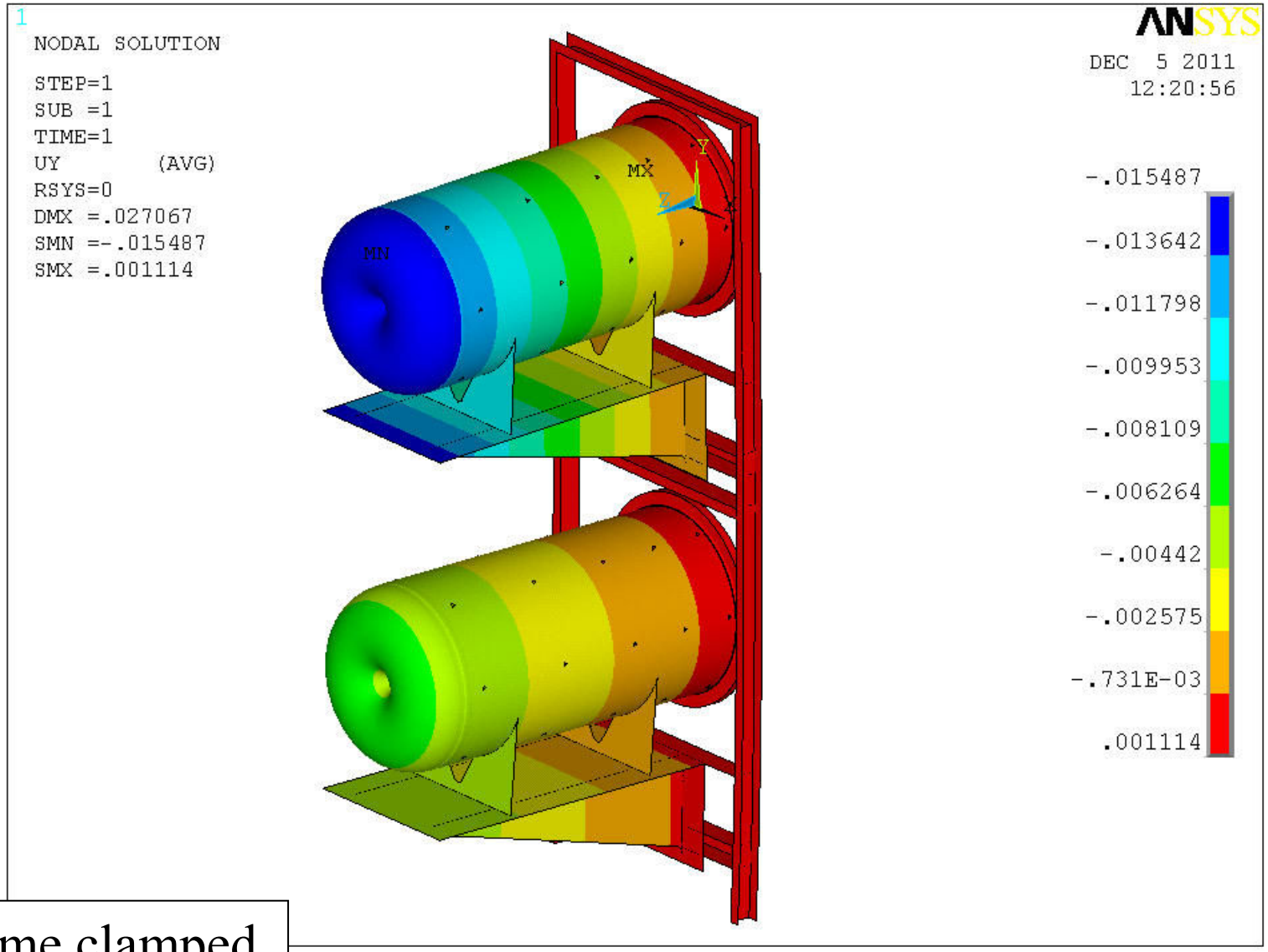
Bottom horn with frame for cooling water supply



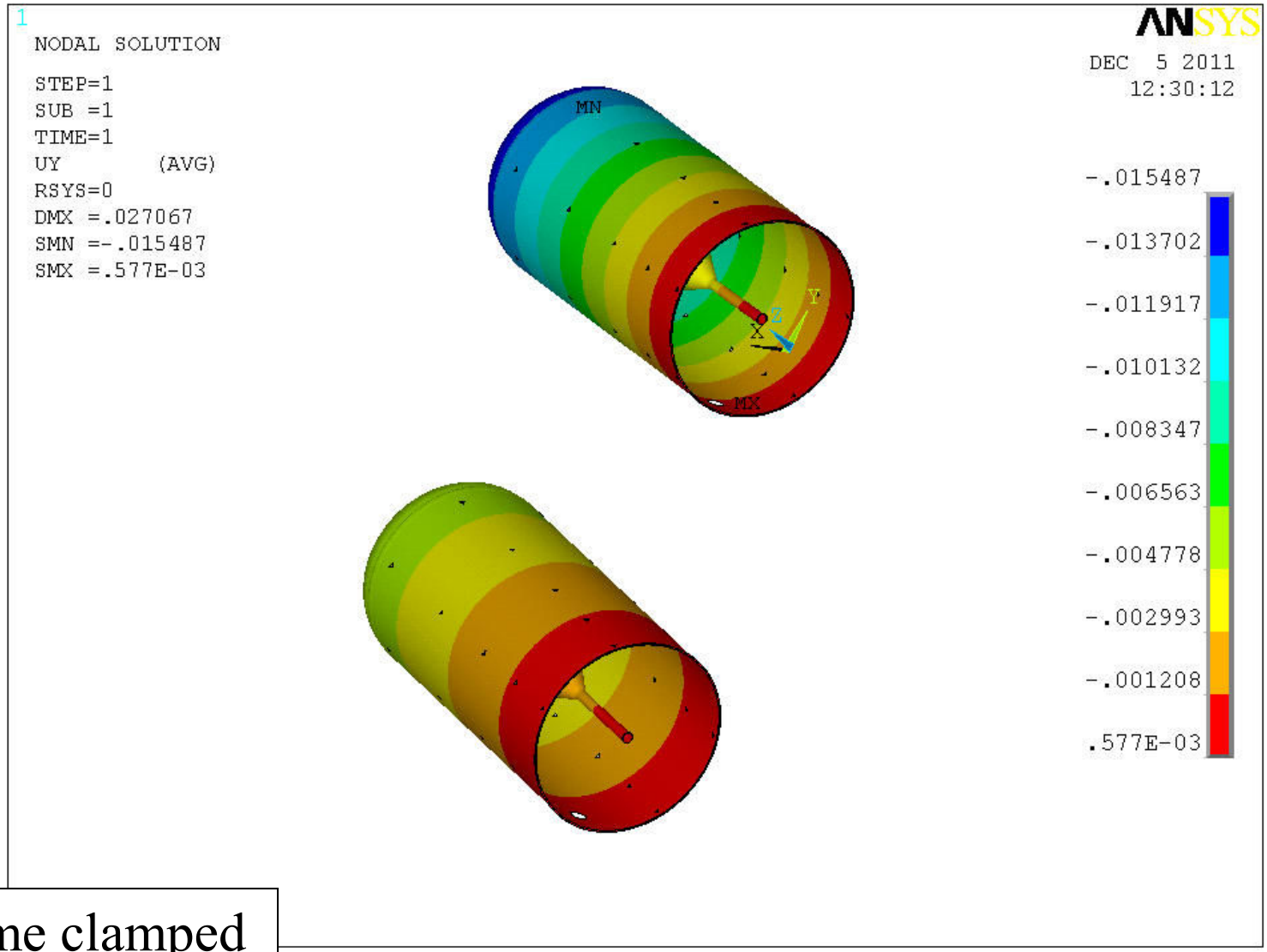

AREAS
TYPE NUM
ANSYS
DEC 5 2011
12:25:24
Frame clamped at the bottom



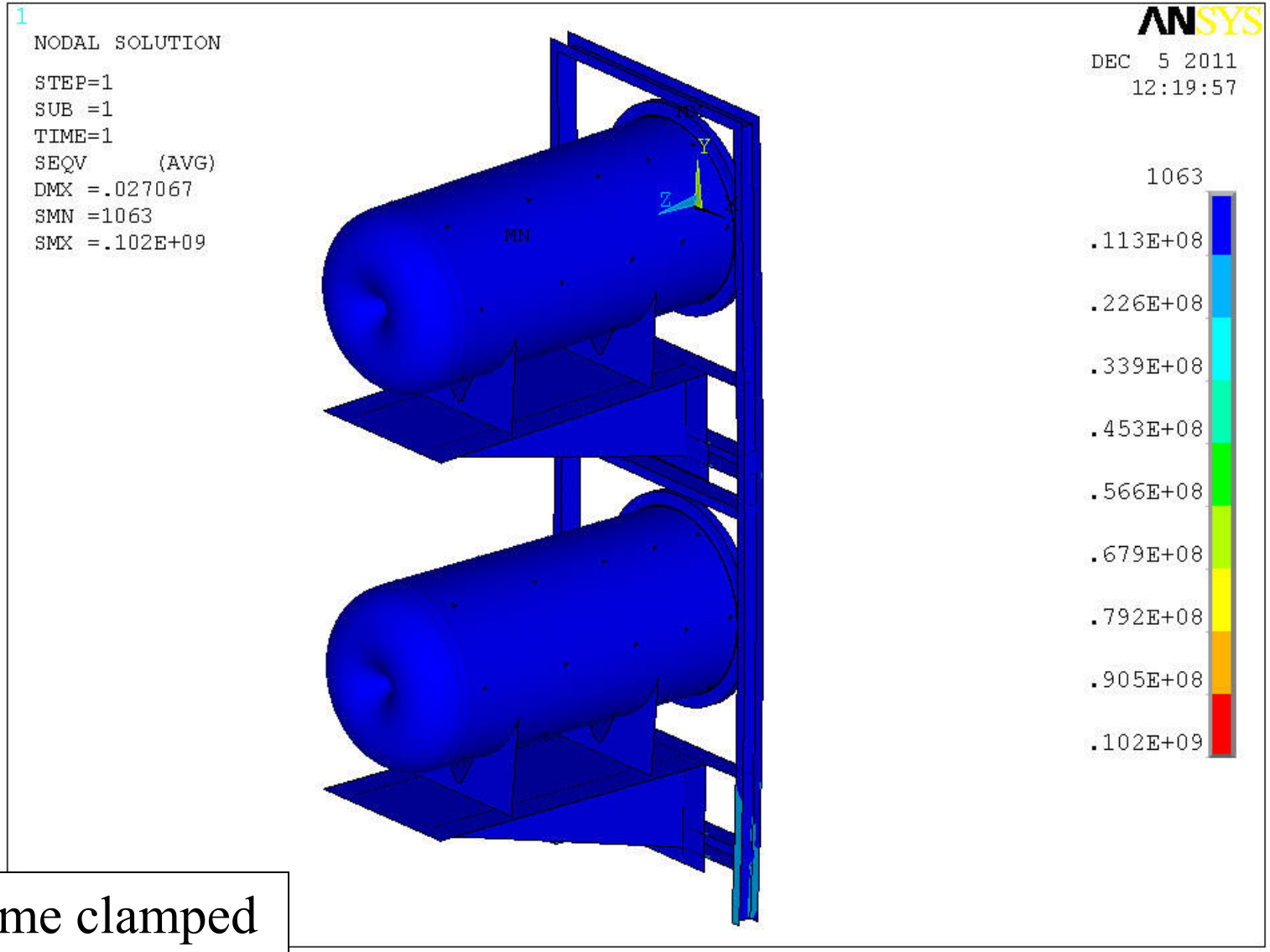
Frame clamped at the bottom



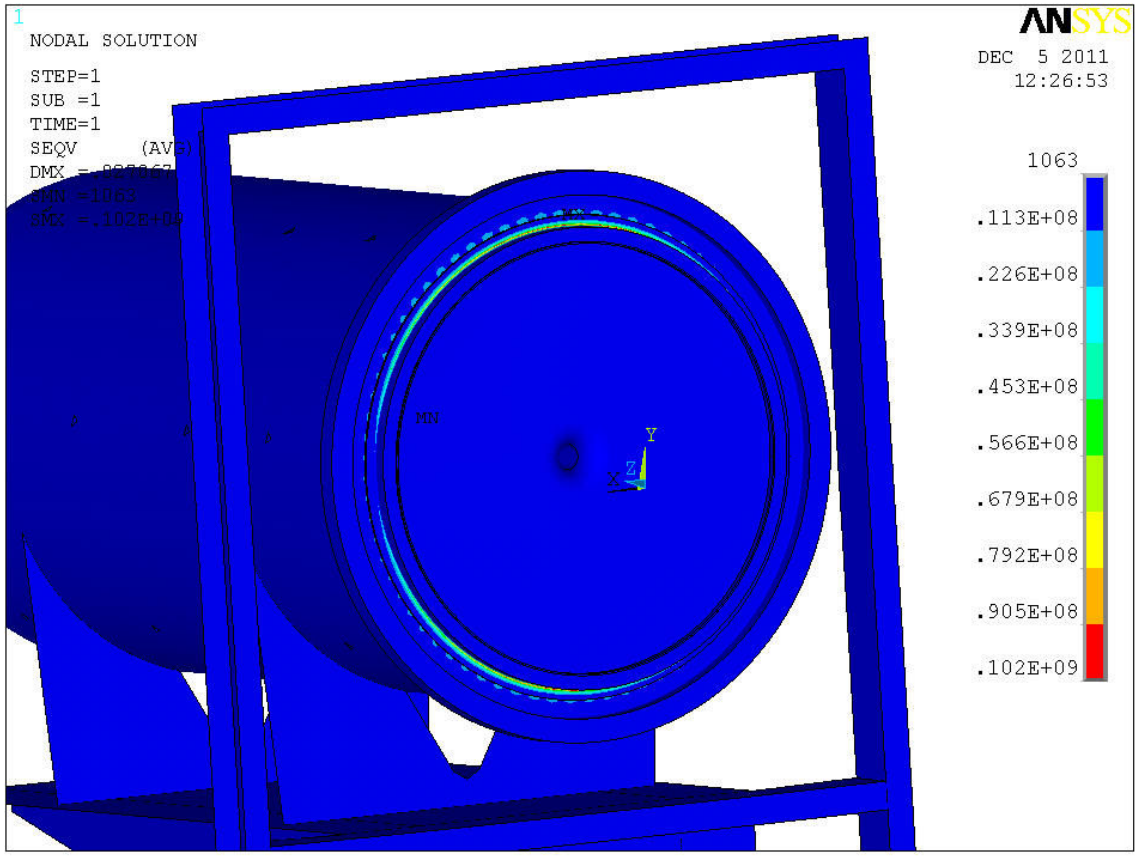
Frame clamped at the bottom

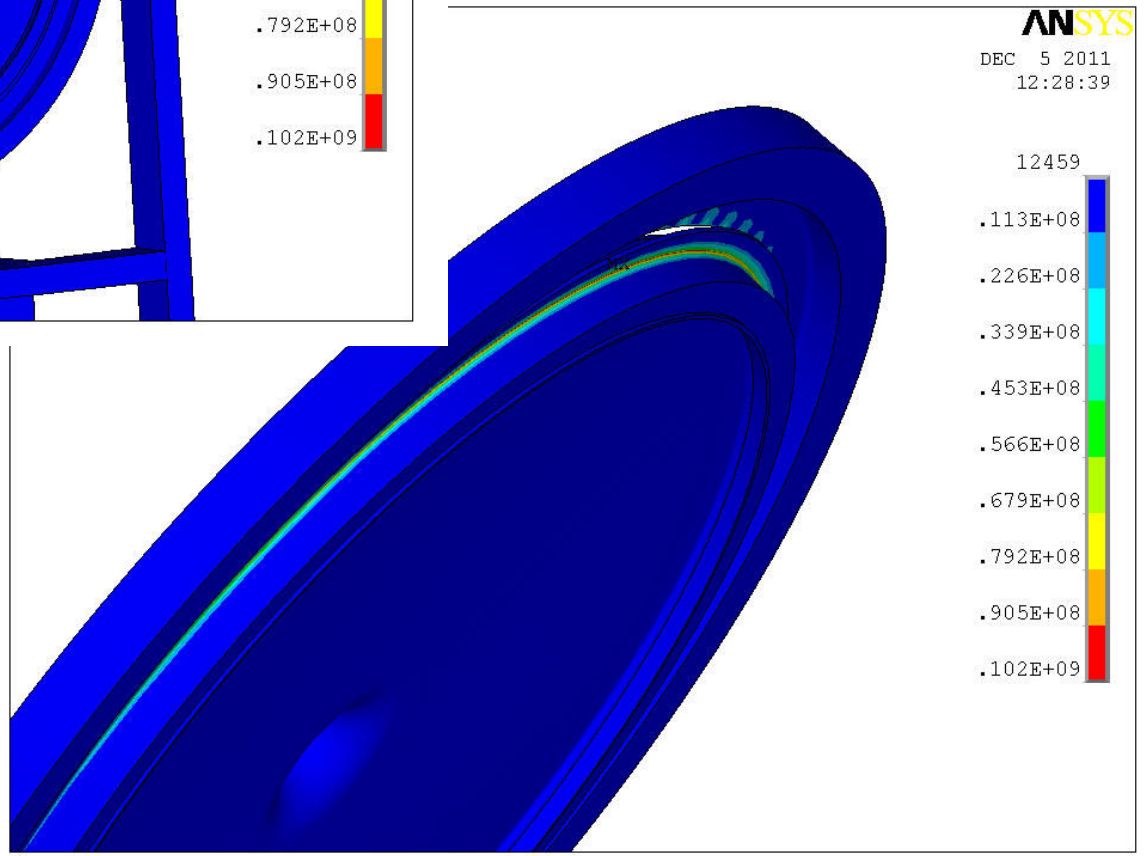


Frame clamped at the bottom

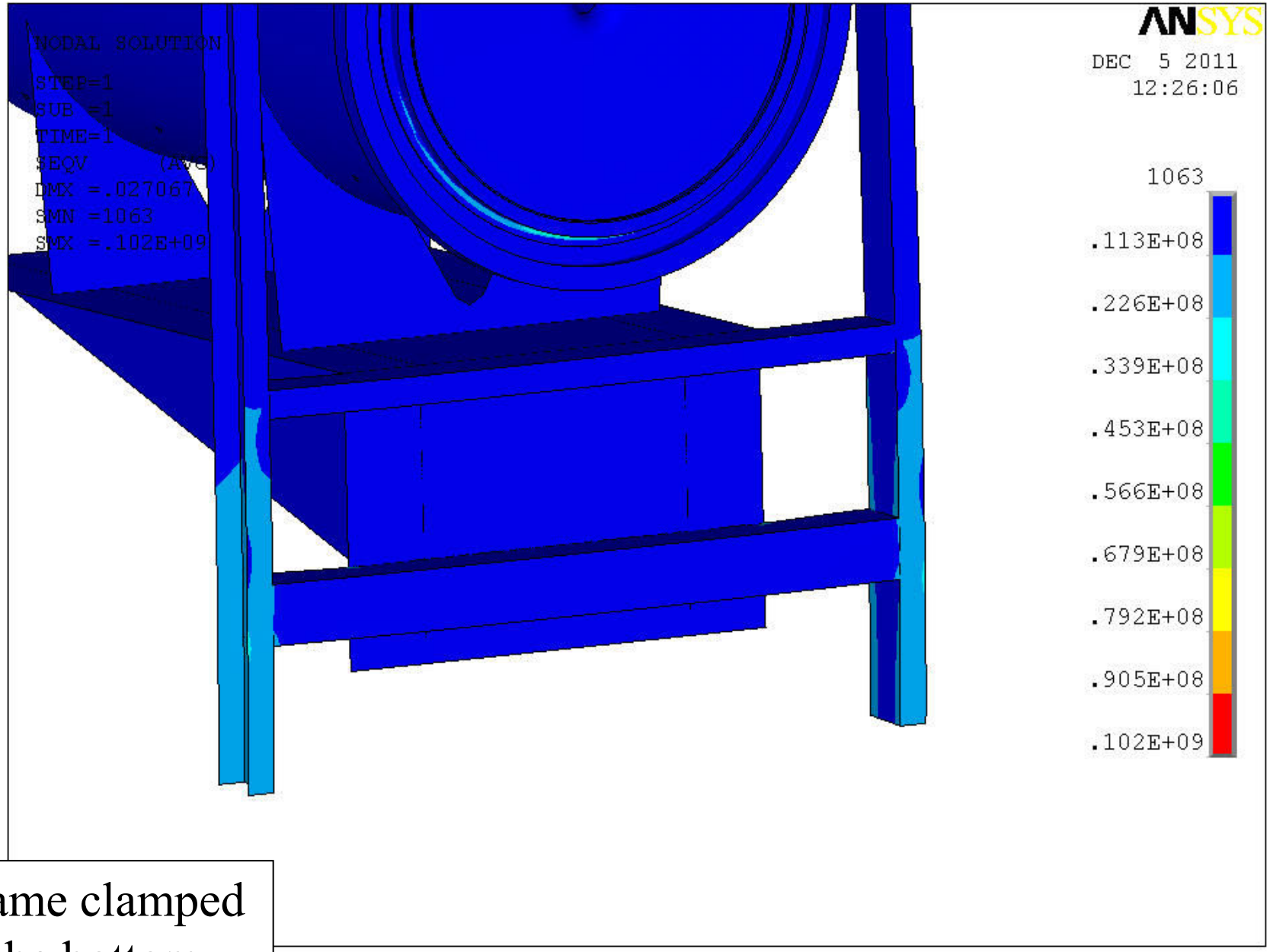


Frame clamped at the bottom

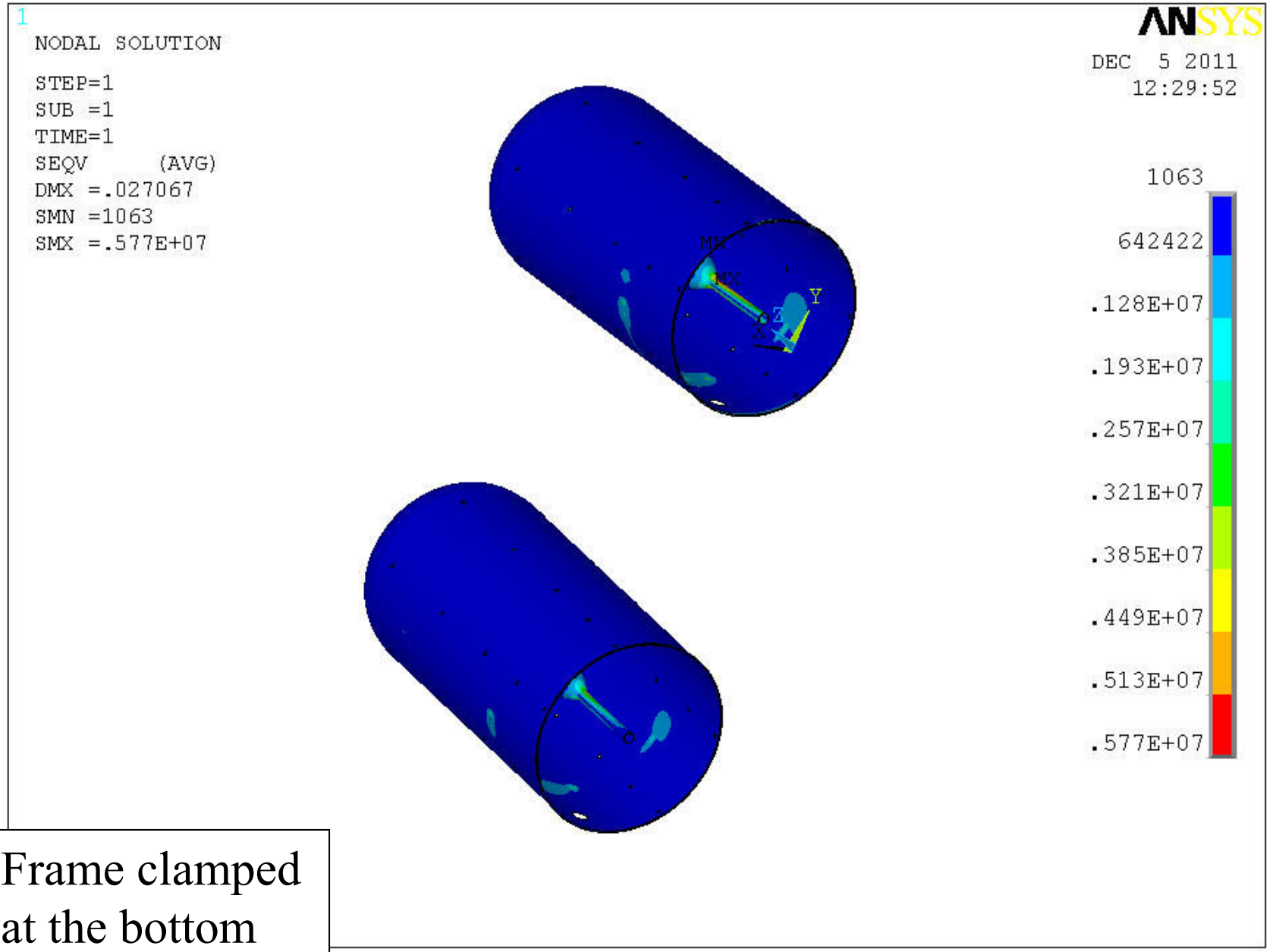




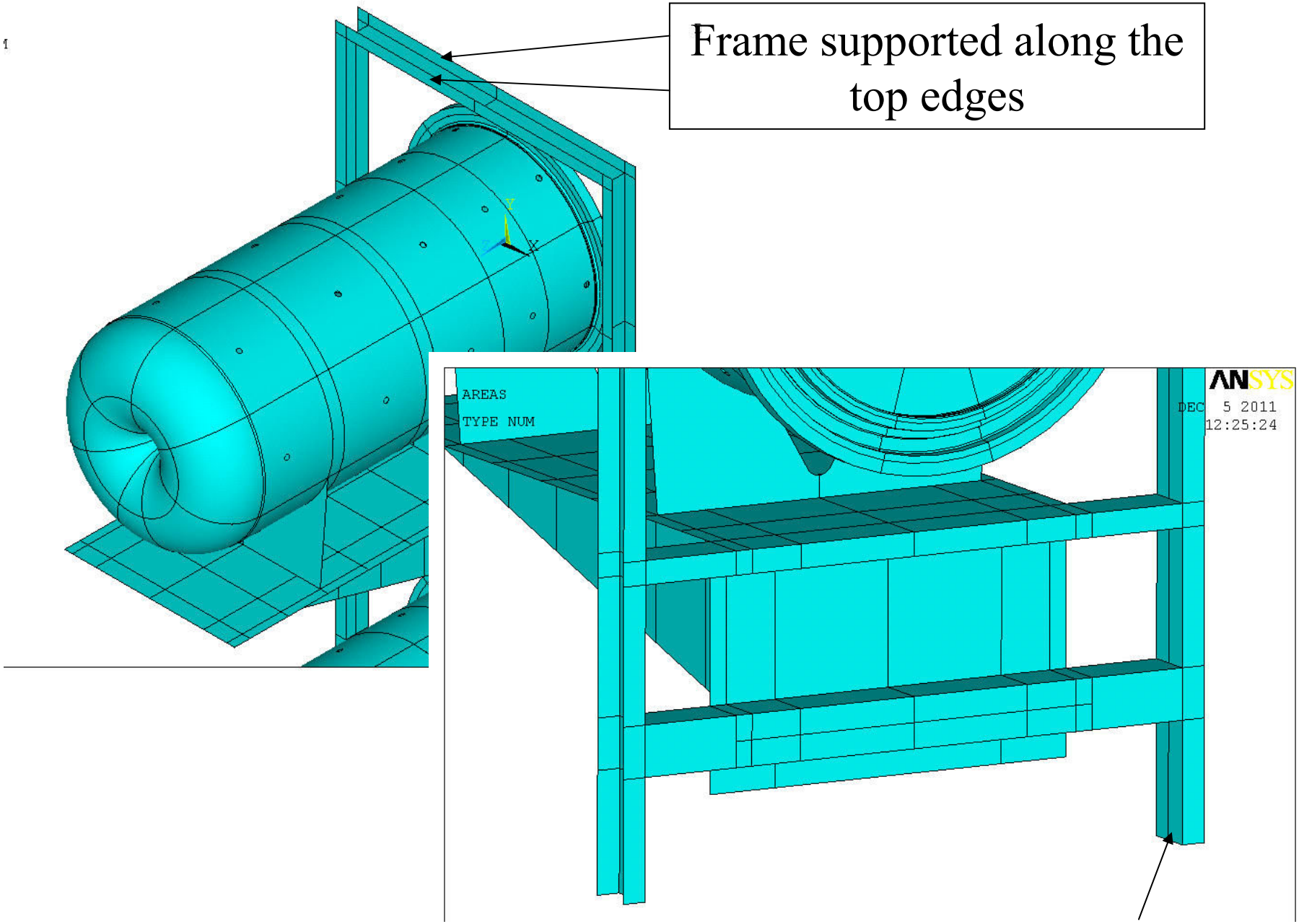
Frame clamped at the bottom

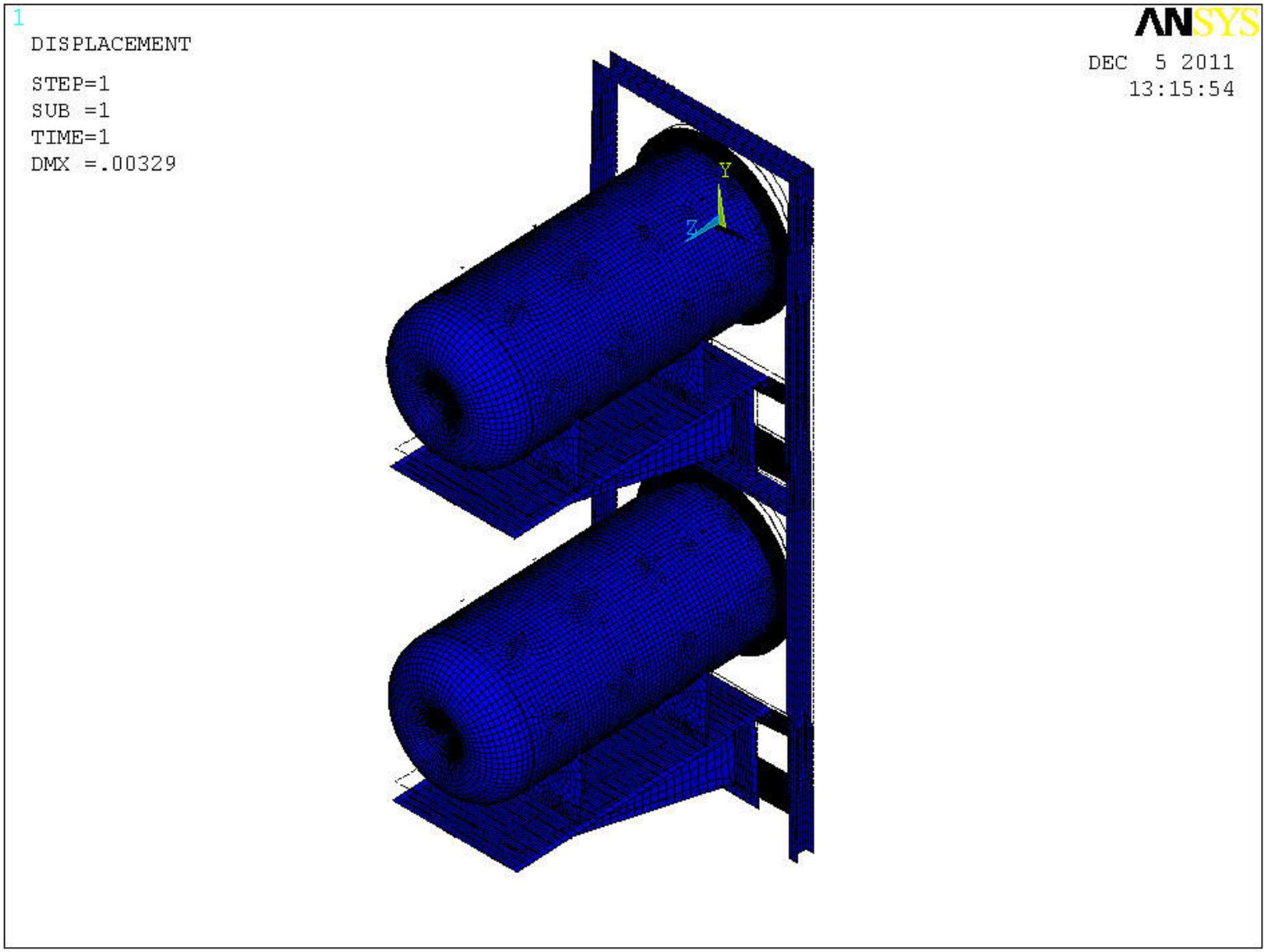


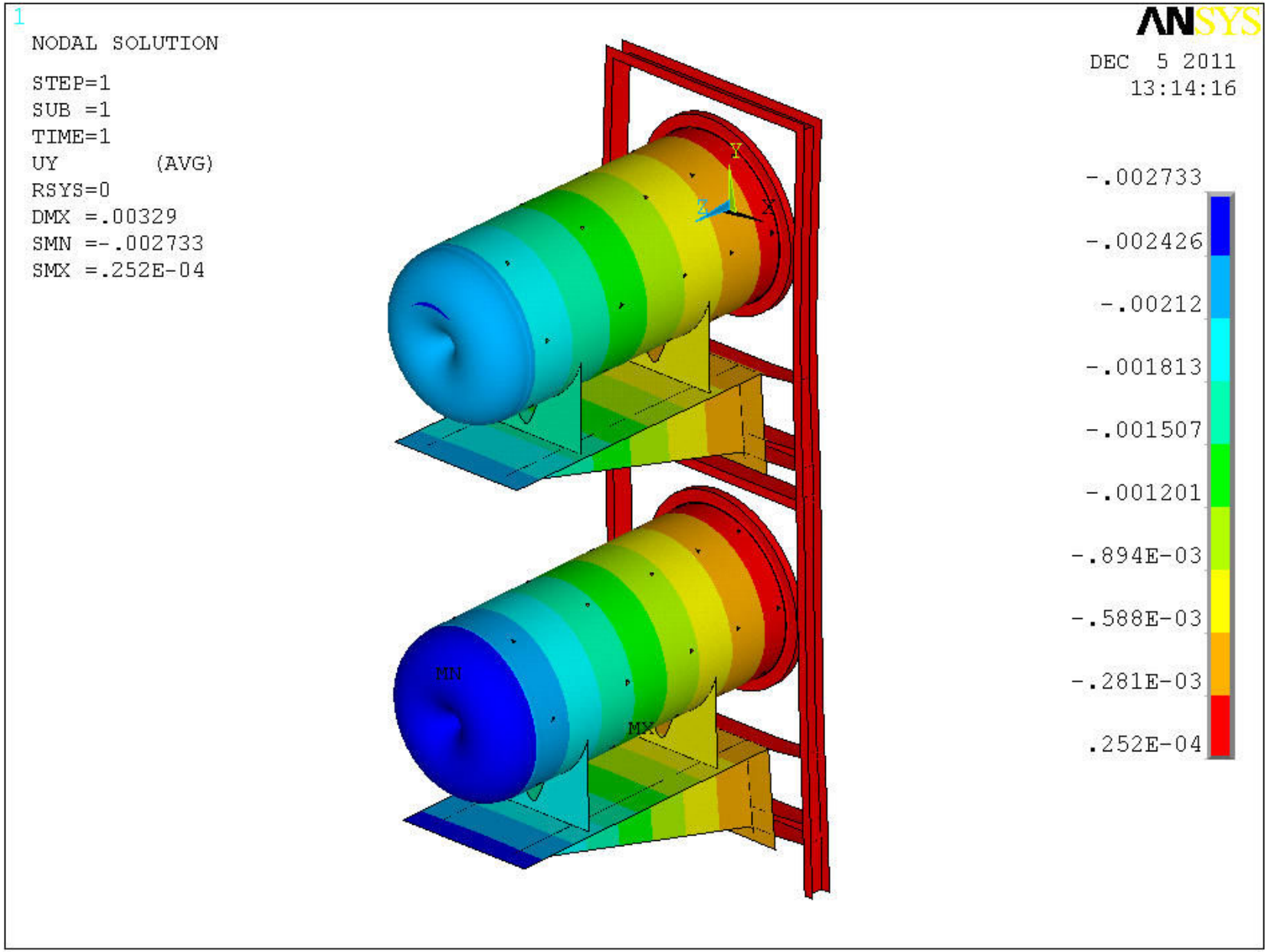
Frame clamped at the bottom

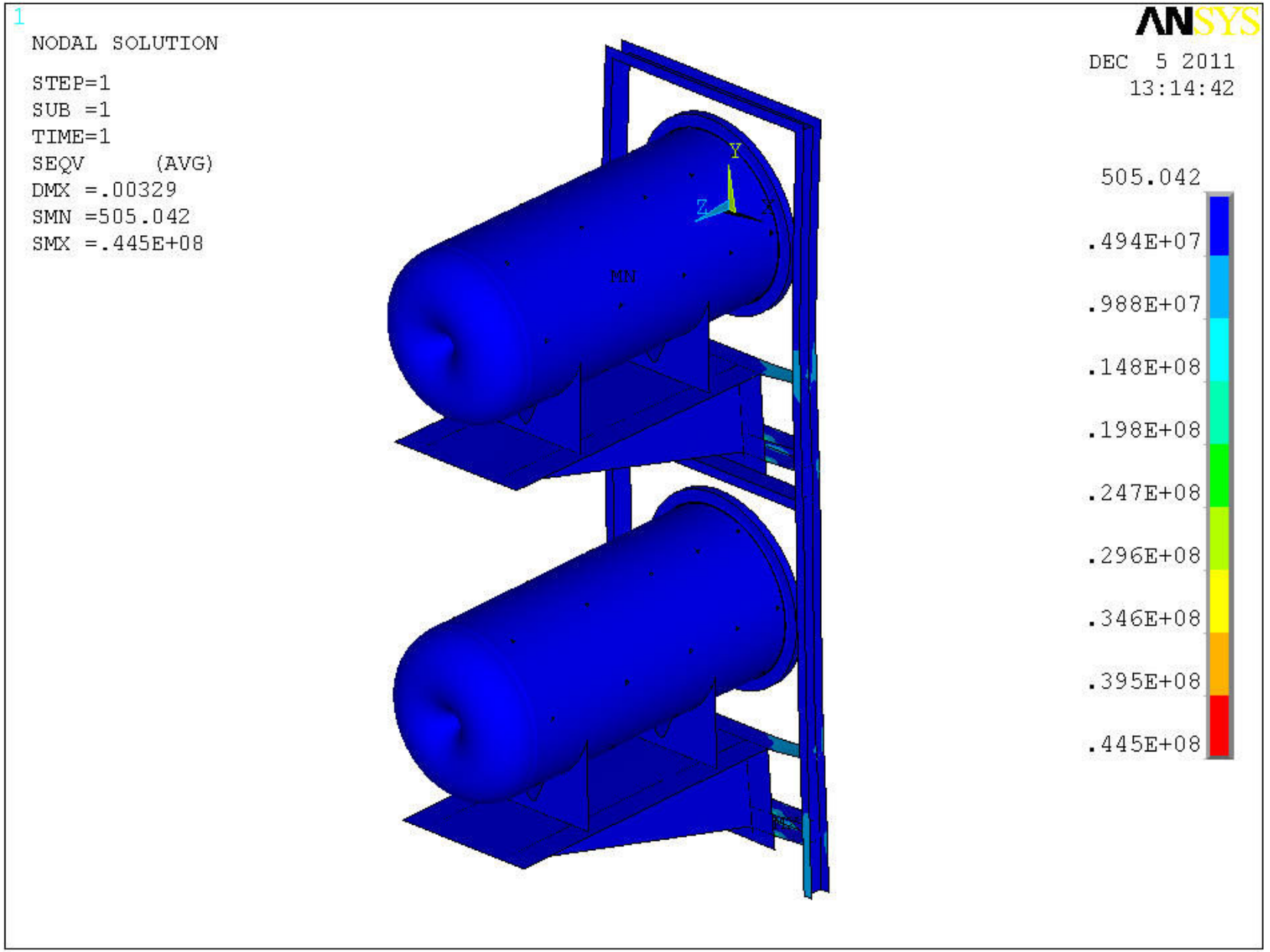


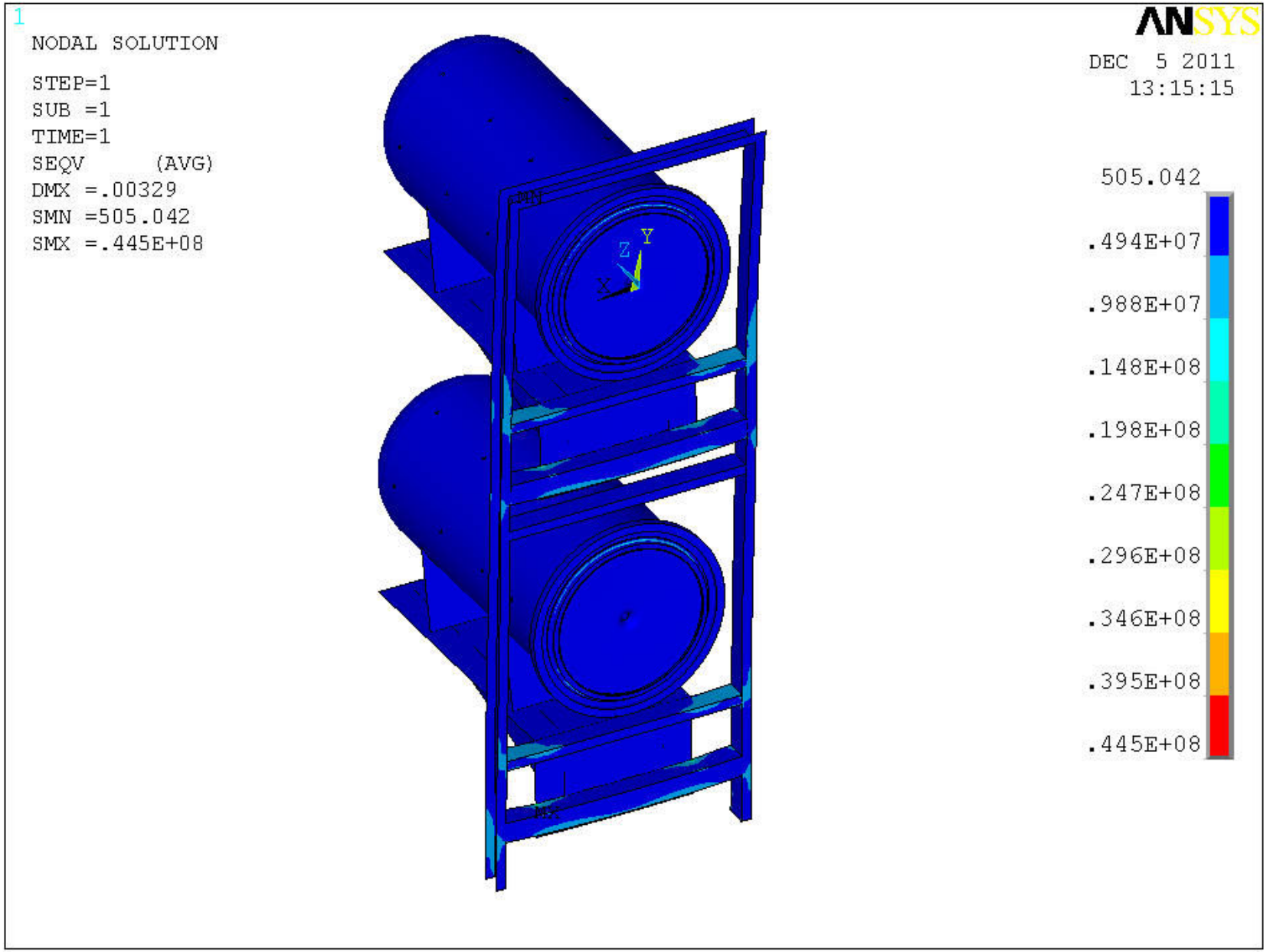
Frame clamped at the bottom


Frame supported along the top edges
AREAS
TYPE NUM
ANSYS
DEC 5 2011
12:25:24


1
DISPLACEMENT
STEP=1
SUB =1
TIME=1
DMX =.00329
ANSYS
DEC 5 2011
13:15:54
Y
Z


1
NODAL SOLUTION
STEP=1
SUB =1
TIME=1
UY (AVG)
RSYS=0
DMX =.00329
SMN =-.002733
SMX =.252E-04
ANSYS
DEC 5 2011
13:14:16
-.002733
-.002426
-.00212
-.001813
-.001507
-.001201
-.894E-03
-.588E-03
-.281E-03
.252E-04
MN
MX


1
NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
DMX =.00329
SMN =505.042
SMX =.445E+08
ANSYS
DEC 5 2011
13:14:42
505.042
.494E+07
.988E+07
.148E+08
.198E+08
.247E+08
.296E+08
.346E+08
.395E+08
.445E+08
MN
Y
Z
X


1
NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
DMX =.00329
SMN =505.042
SMX =.445E+08
ANSYS
DEC 5 2011
13:15:15
505.042
.494E+07
.988E+07
.148E+08
.198E+08
.247E+08
.296E+08
.346E+08
.395E+08
.445E+08
Y
Z
X

Thank you for your attention