

# Dumbbell top bracket

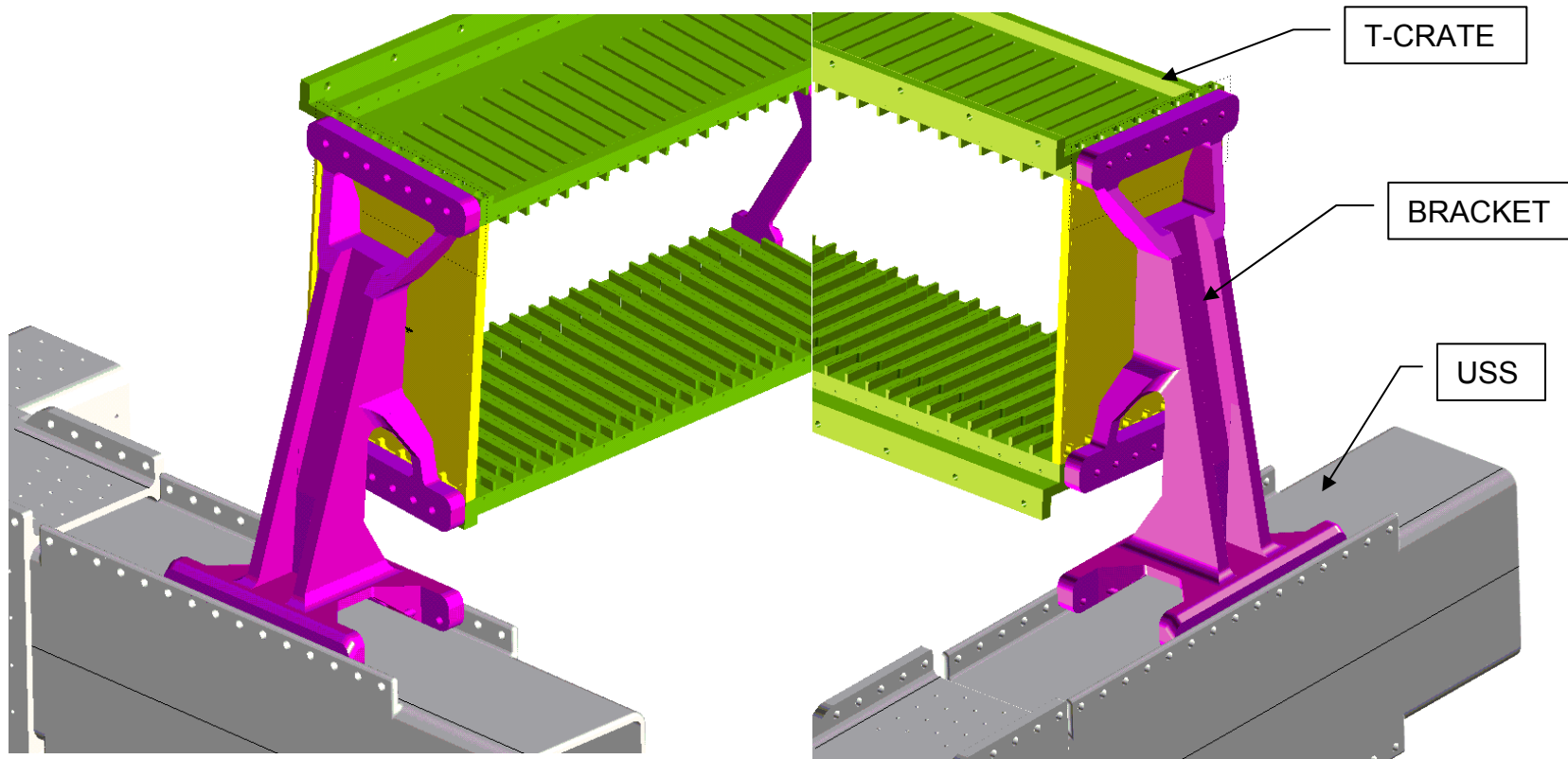
Massimiliano Olivier

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# TOP BRACKET (“The dumbbell”)

- Top bracket optimization ongoing in parallel for the RAM radiator
- Load Case 2050
- New top bracket design to reduce loads in the USS bolts and brackets bolts

## TOP BRACKET

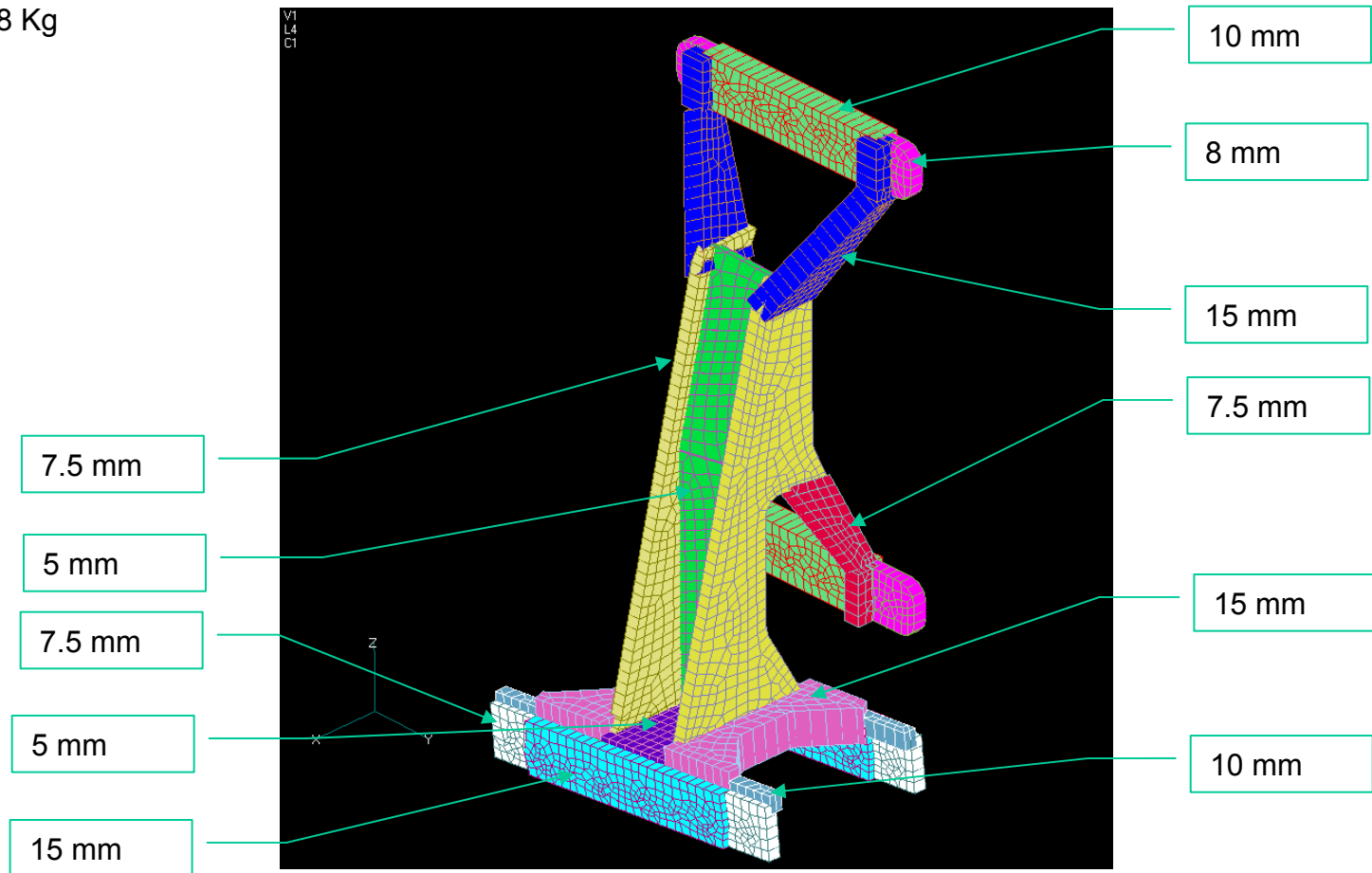


# AMS 02 –Thermal Control System Design



## STARTING POINT

MASS: 2.08 Kg



# AMS 02 –Thermal Control System Design



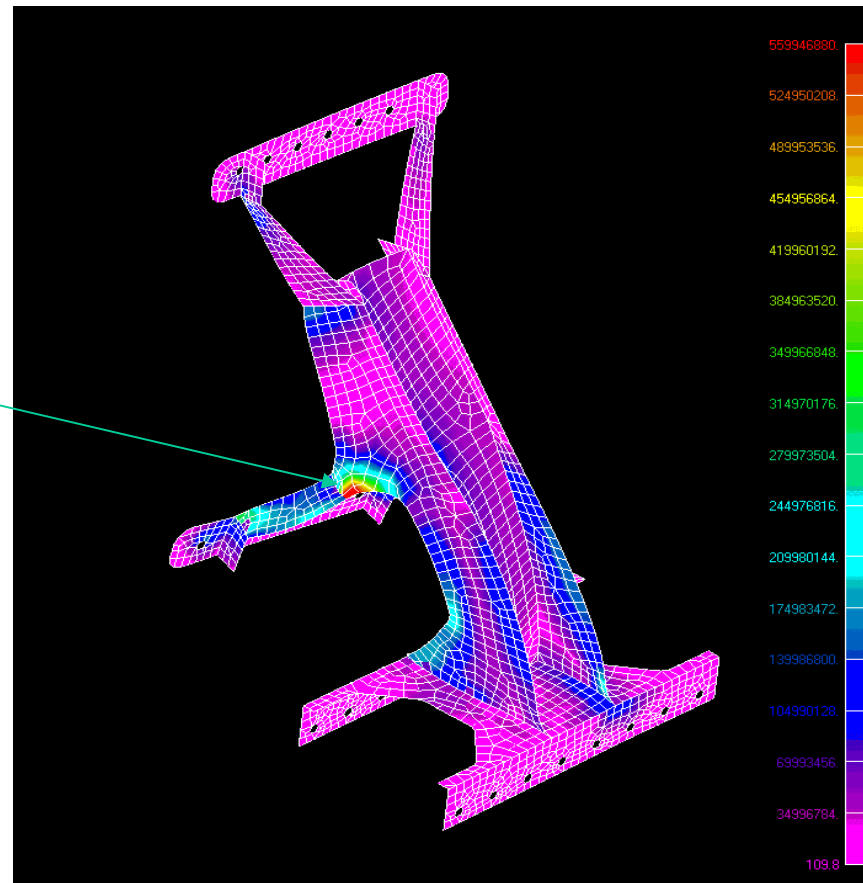
STARTING POINT

Mosy= -0.43

Mosu= -0.60

MAXIMUM STRESS: 559 MPa

Max stress:  
559 MPa

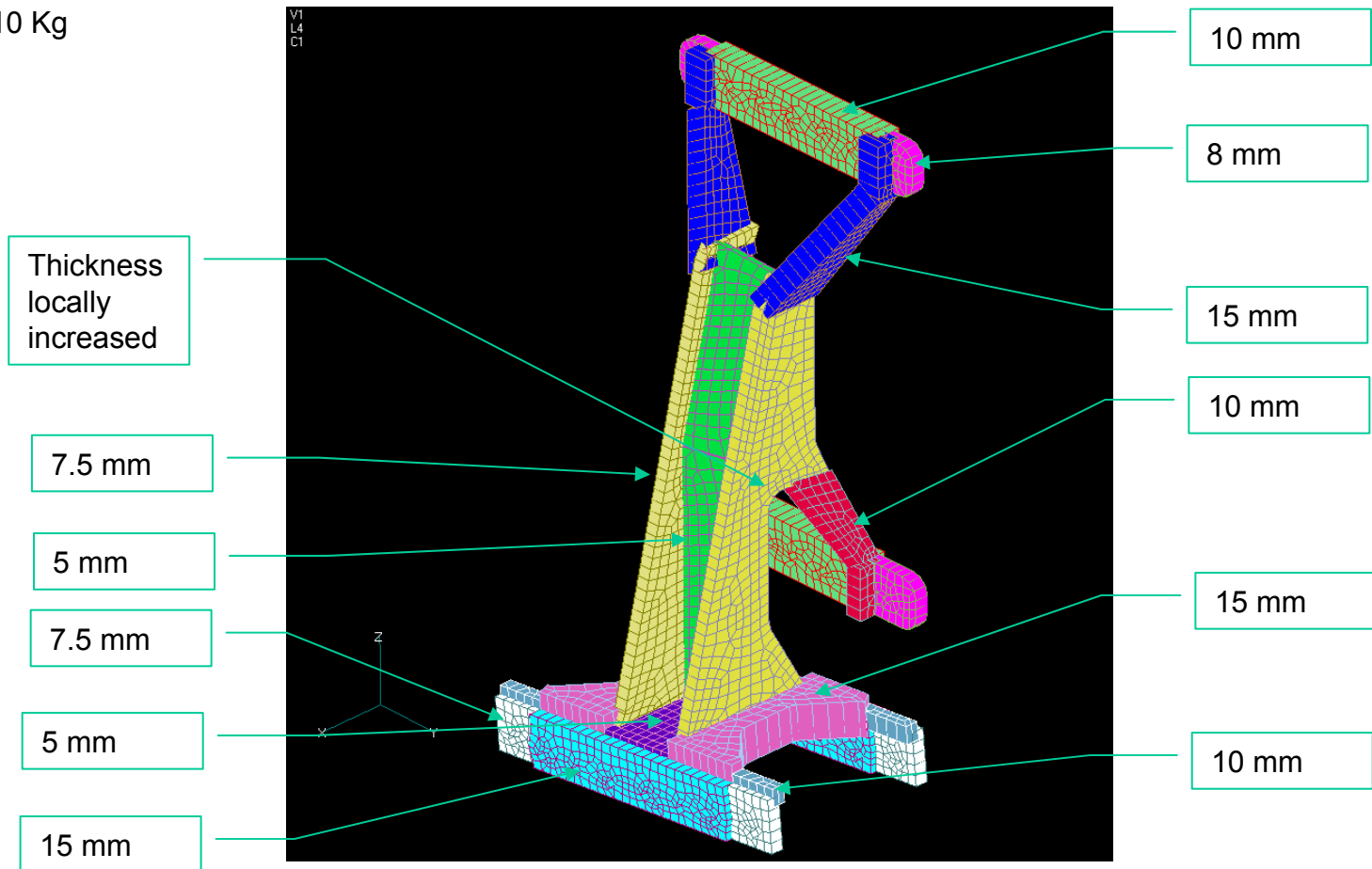


# AMS 02 –Thermal Control System Design



Step 1

MASS: 2.10 Kg



# AMS 02 –Thermal Control System Design



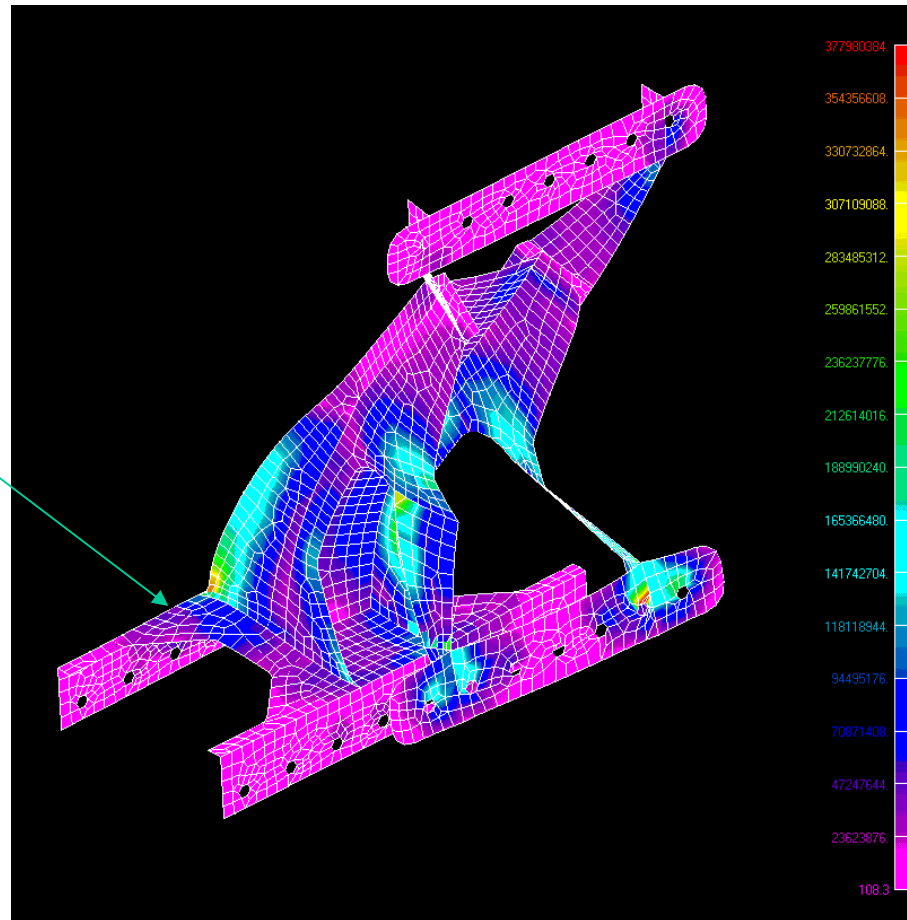
Step 1

Mosy= -0.15

Mosu= -0.41

MAXIMUM STRESS: 377 MPa

Max  
stress:  
377 MPa



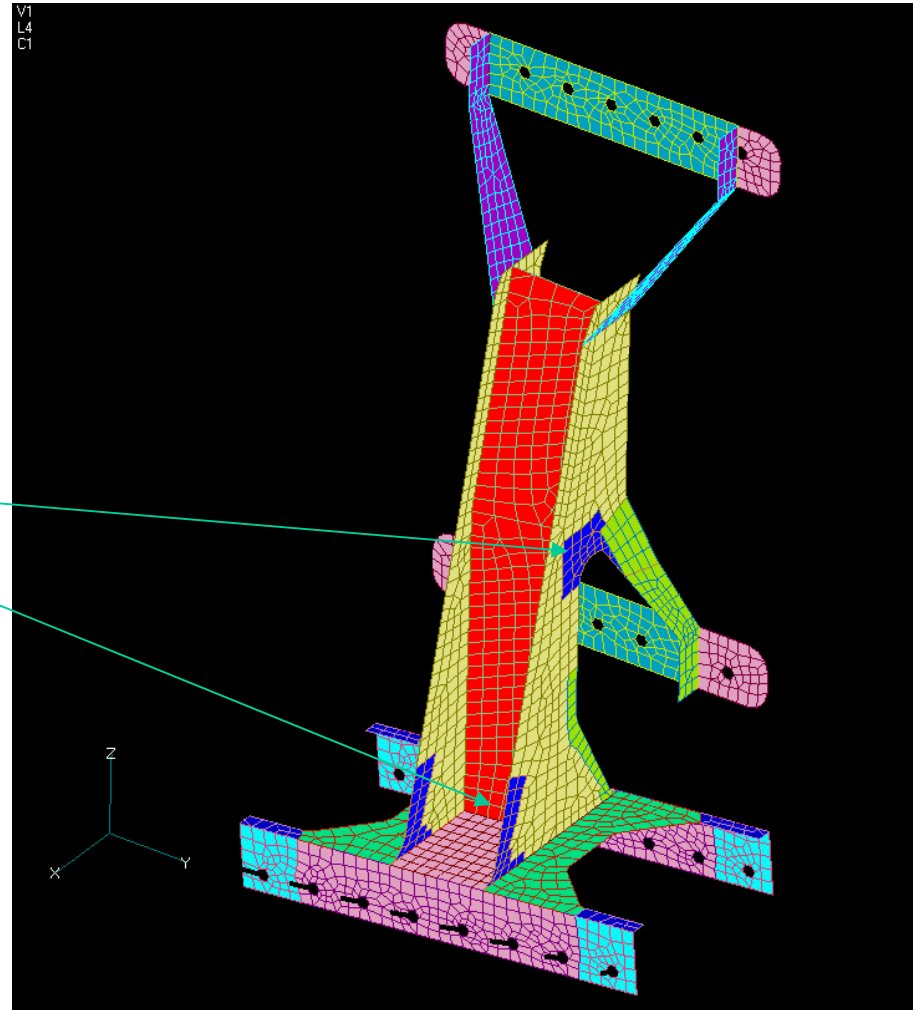
# AMS 02 –Thermal Control System Design



Step 2

MASS: 2.29 kg

Geometry locally  
modified  
Thickness  
increased



# AMS 02 –Thermal Control System Design



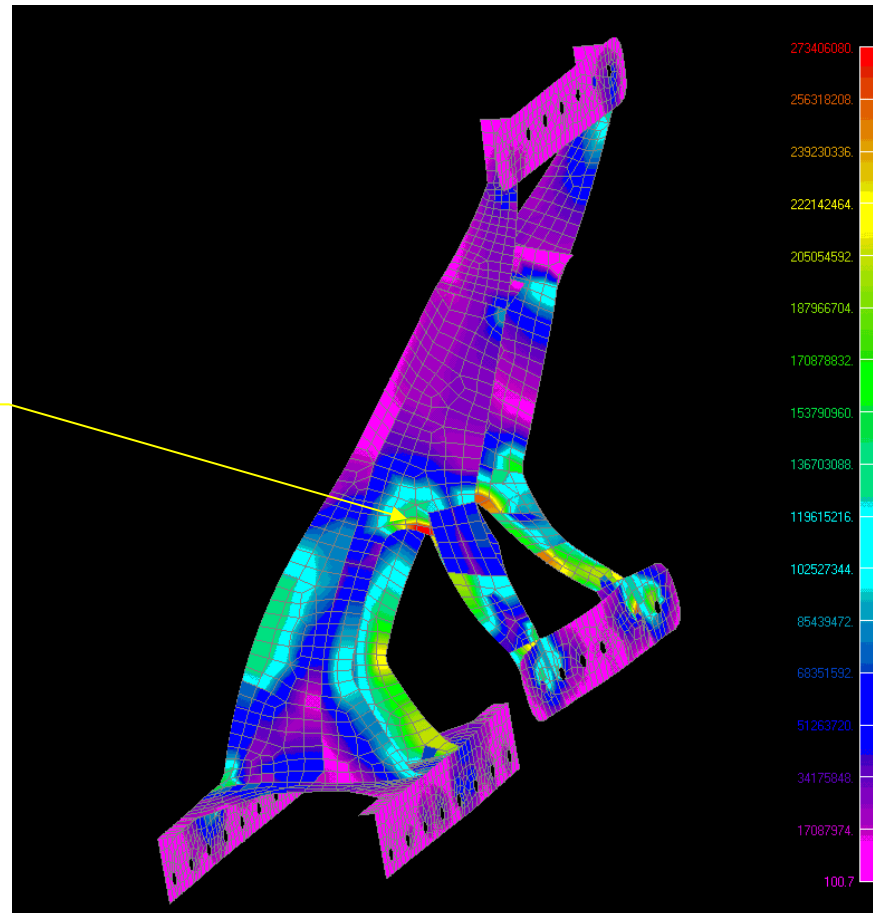
Step 2

Mosy= 0.17

Mosu= -0.18

MAXIMUM STRESS: 273 MPa

Max stress:  
273 MPa

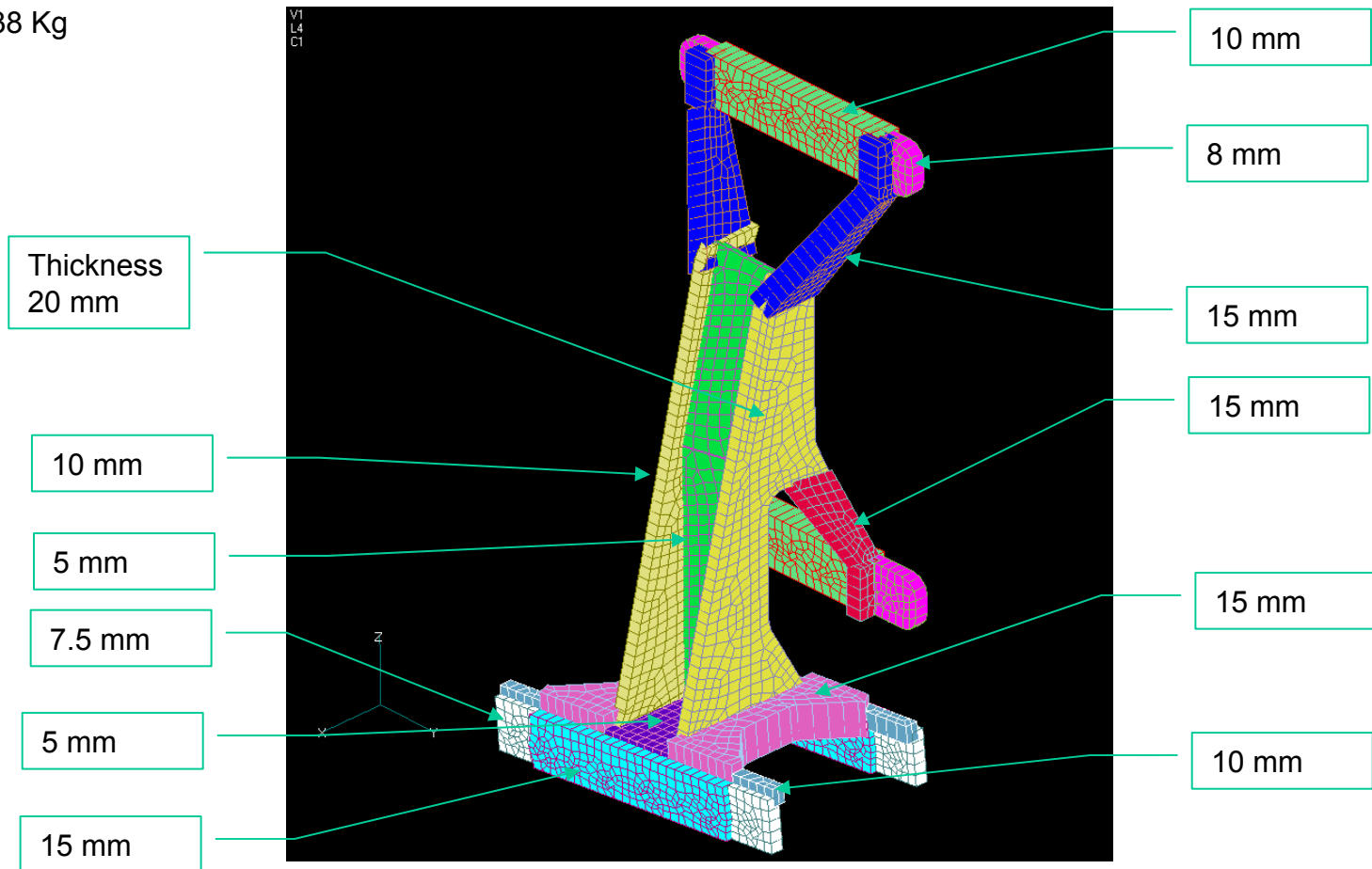


# AMS 02 –Thermal Control System Design



Step 3

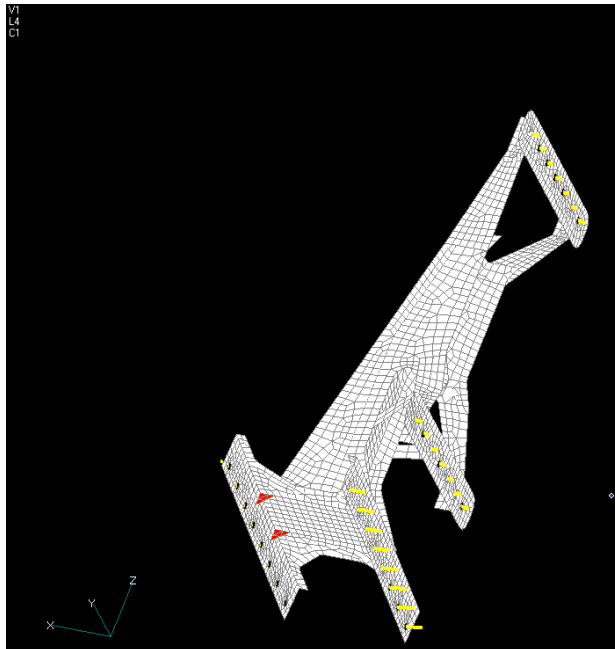
MASS: 2.38 Kg



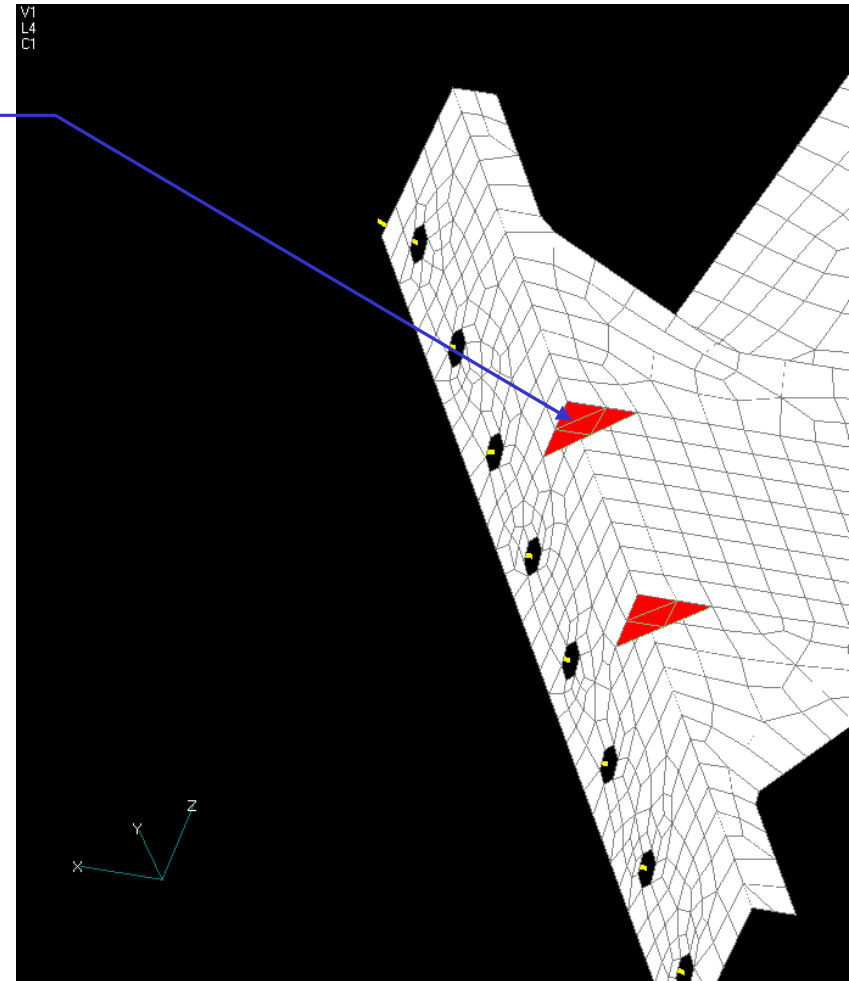
# AMS 02 –Thermal Control System Design



Step 3



Two ribs  
have been  
added



# AMS 02 –Thermal Control System Design



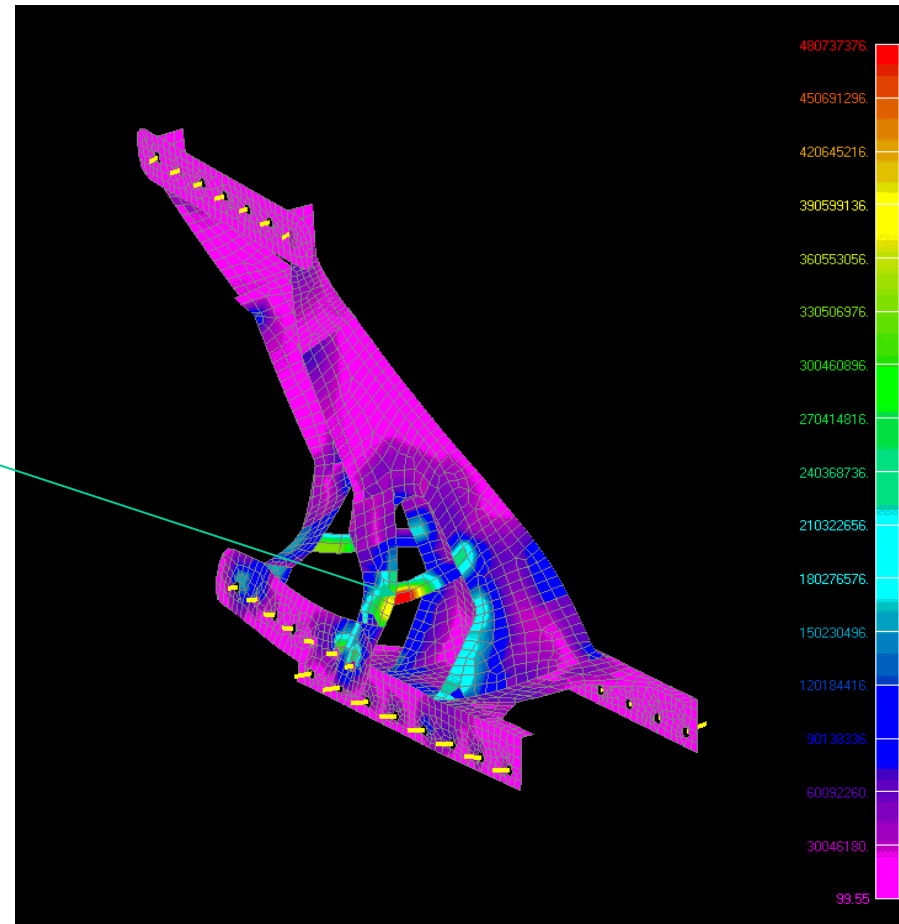
Step 3

MAXIMUM STRESS: 480 MPa

Mosy= -0.33

Mosu= -0.53

Max  
stress:  
480 MPa



# AMS 02 – Thermal Control System Design

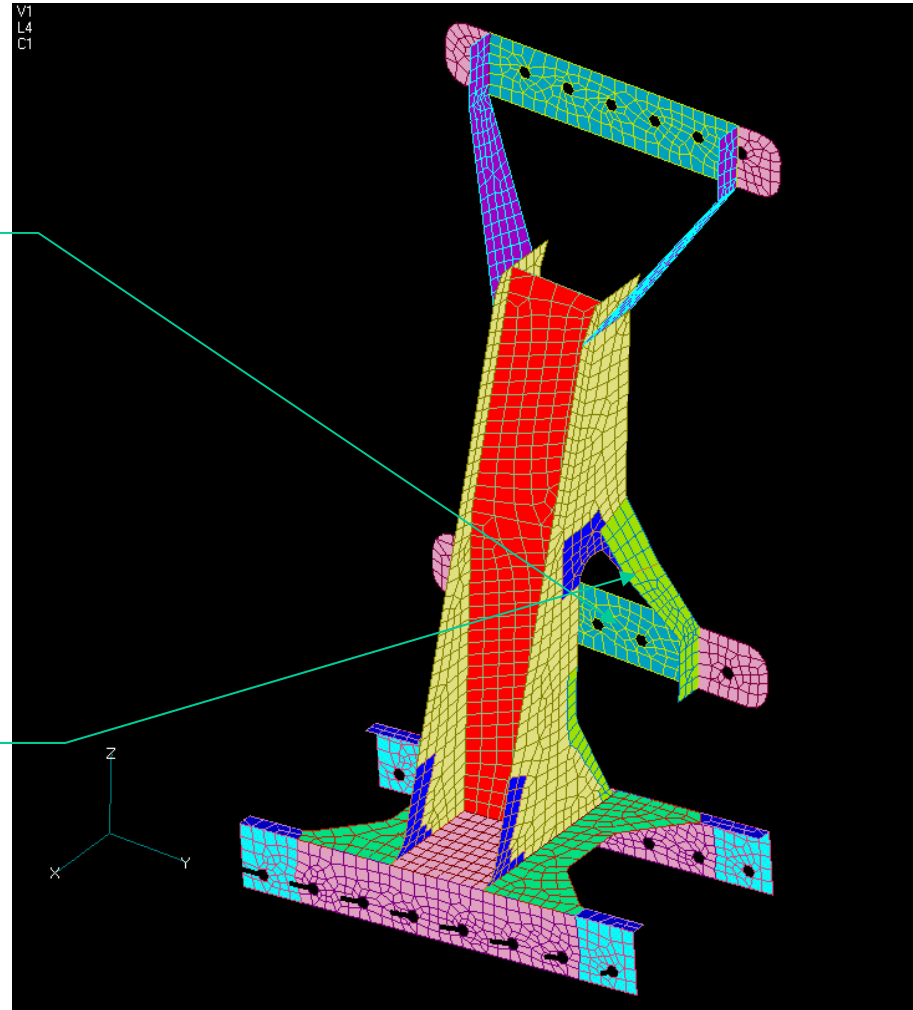


Step 4

MASS: 2.58 kg

7.5 mm

5 mm



# AMS 02 –Thermal Control System Design



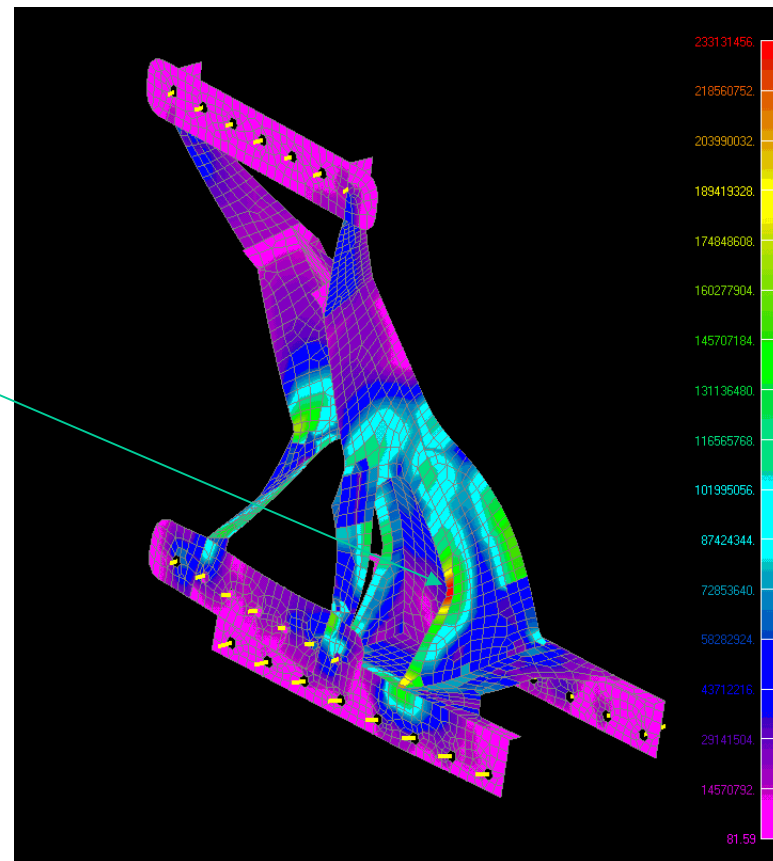
Step 4

Mosy= 0.37

Mosu= -0.04

MAXIMUM STRESS: 233 MPa

Max  
stress:  
233 MPa



# AMS 02 –Thermal Control System Design

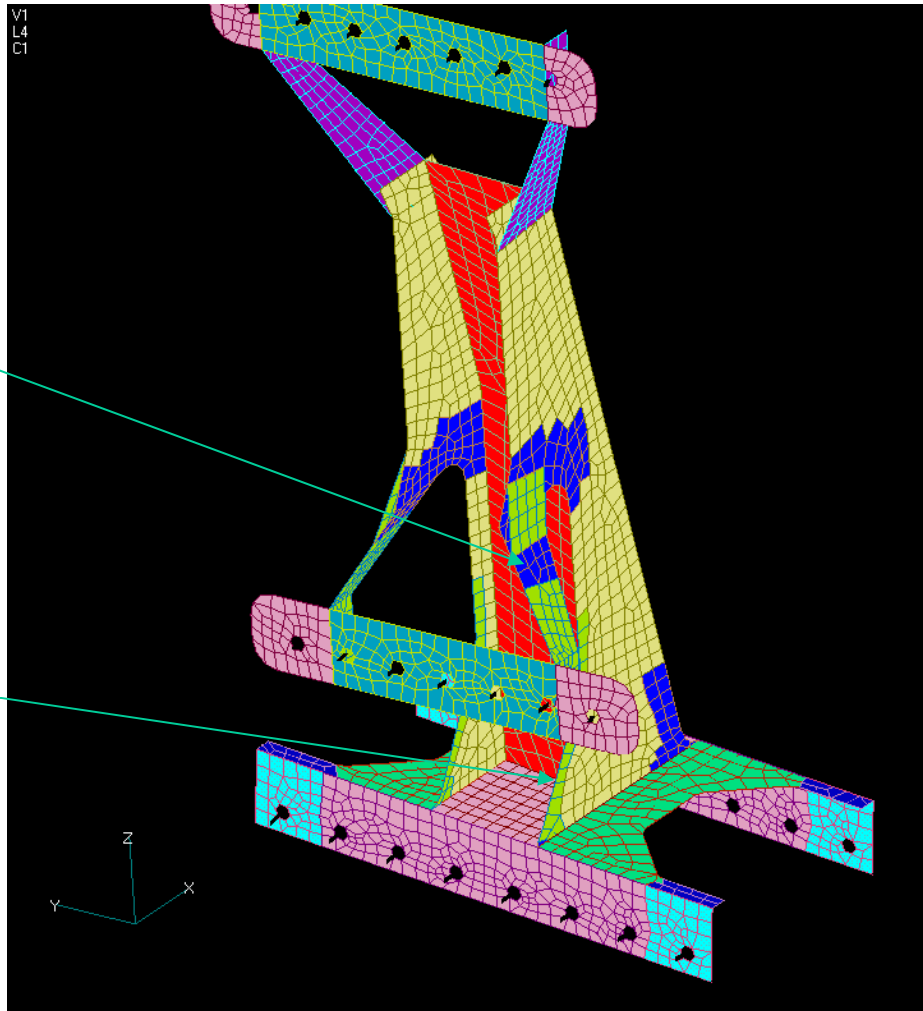


Step 5

MASS: 2.67 kg

Thickness  
locally  
increased

Thickness  
locally  
increased



# AMS 02 –Thermal Control System Design



Step 5

Final Wall  
Thicknesses

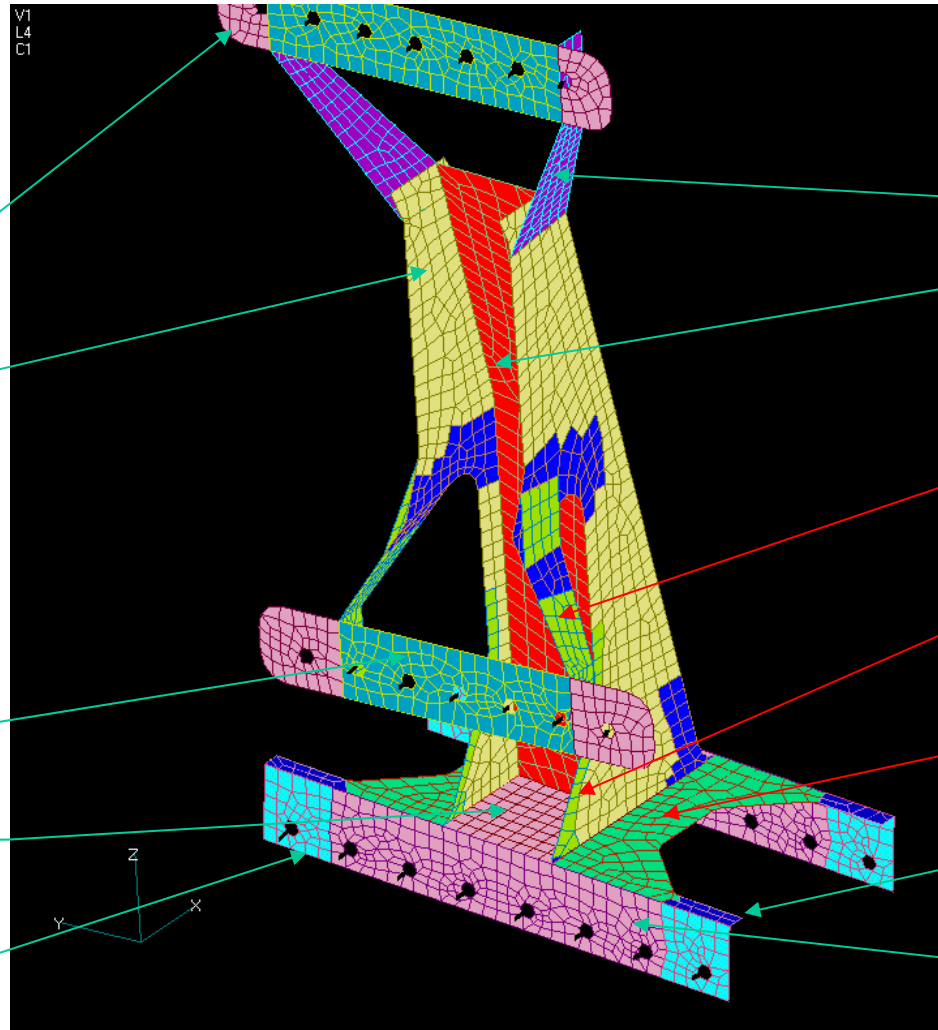
8 mm

10 mm

20 mm

5 mm

7.5 mm



15 mm

5 mm

25 mm

25 mm

15 mm

10 mm

15 mm

# AMS 02 –Thermal Control System Design



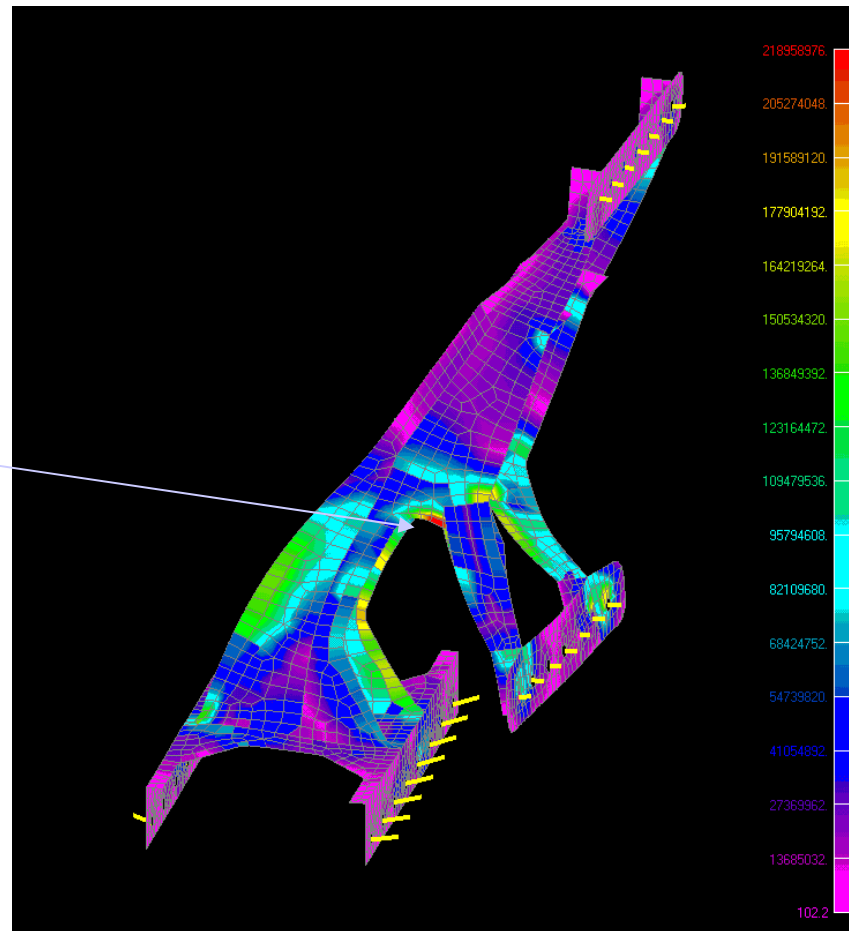
Step 5

Mosy= 0.46

Mosu= 0.02

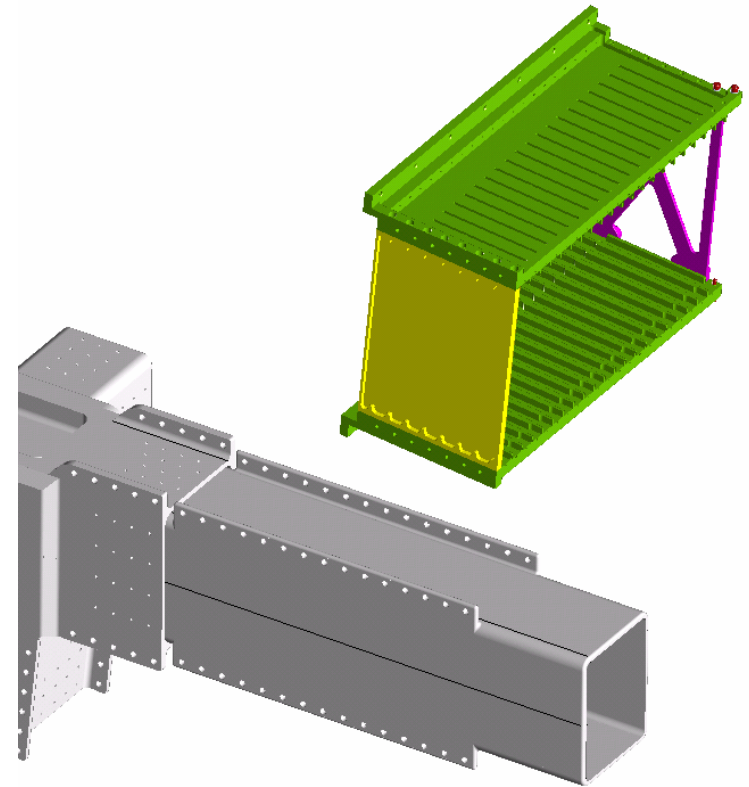
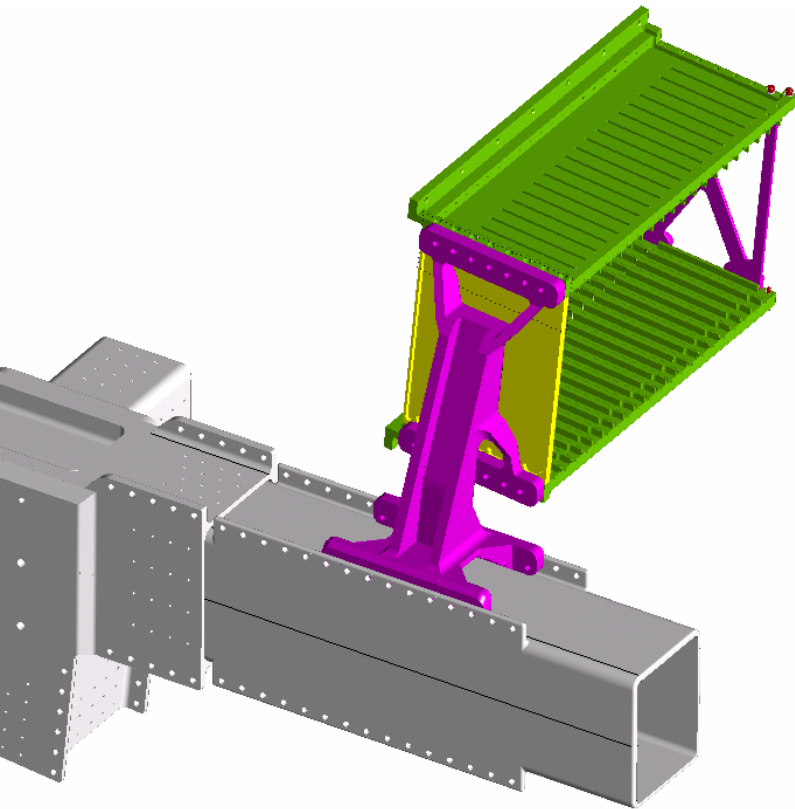
MAXIMUM STRESS: 219 MPa

Max  
stress:  
219 MPa



DUMBBELL TOP BRACKET  
VS.  
“LIGHT” TOP BRACKET  
  
(FORCES ON I/F BOLTS)

# AMS 02 – Thermal Control System Design

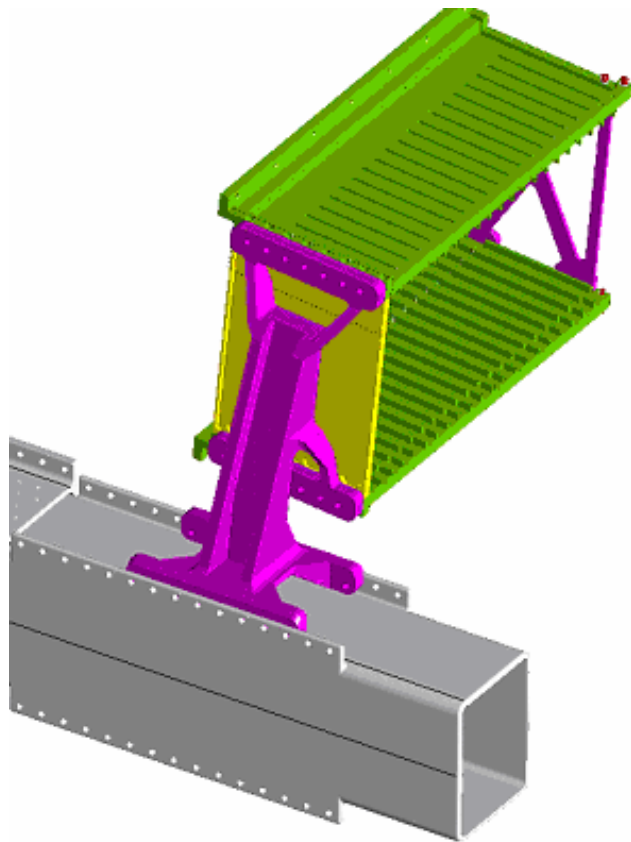


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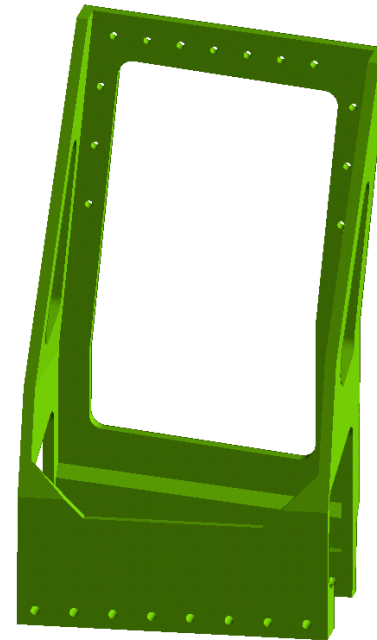
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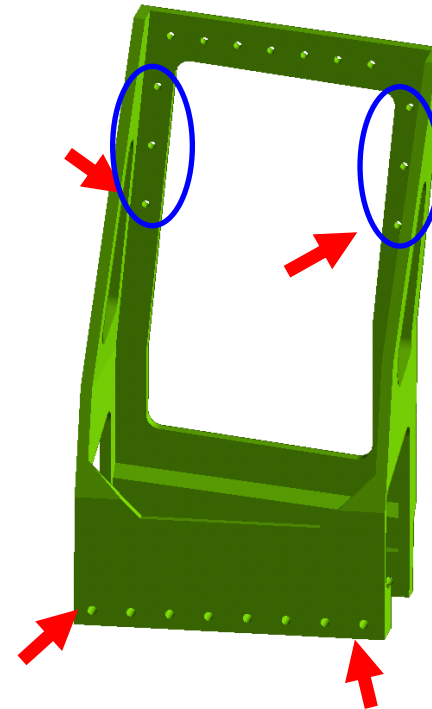
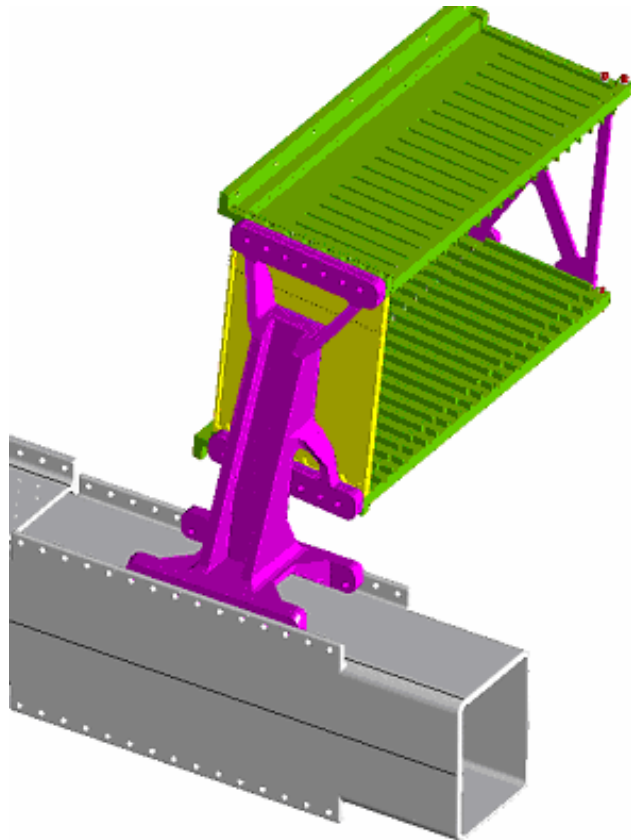
## Upper bracket

Dumbbell



Light





Appropriate design avoids force concentration on the screws indicated by red arrows.

Moreover it doesn't need the fixation to crate non-structural wall (blue circles)

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# USS AND CRATE IF BOLTS FORCE OPTIMIZATION

The proposed design (dumbbell bracket) induces on the interface bolts a

- lower peak value and
- more uniform force level,

therefore making more easy and taylorable the future detailed design.

- Moreover the dumbbell design uses on Crates the main walls that are more suited for fixation than the ones used with the upper light bracket.
- Considering that the mass is similar this bracket, even if with a much complex shape, is the preferred one.

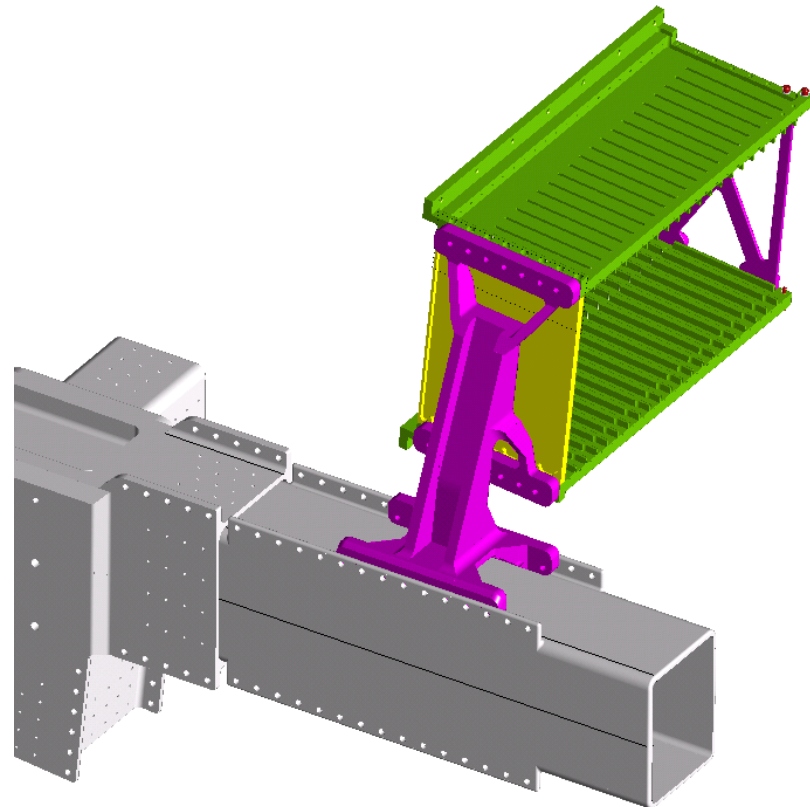
## CONCLUSIONS

- “The dumbbell” Bracket

Mass : 2.67 Kg

Advantages:

- relatively flexible mount
- crates lower bolt row used without stiffening the connection to the USS



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# OPTION 7

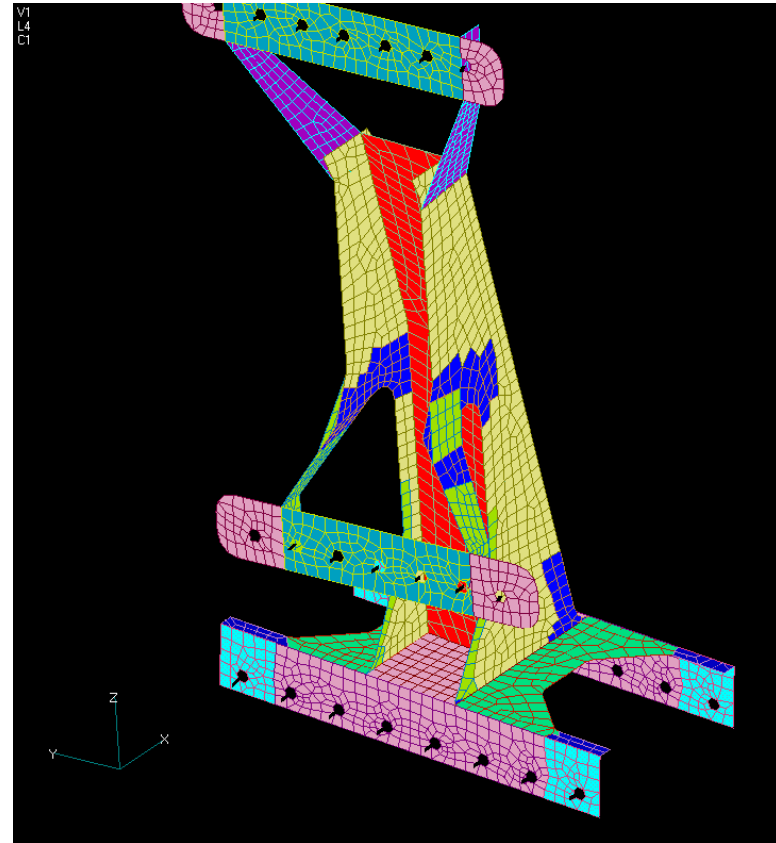
- OPTION 6 + New design for upper bracket
- Load cases selection
  - 1016, 1030, 1032, 1036, 1049, 1063,
  - 2004, 2016, 2031, 2032, 2036, 2040, 2049

# OPTION 7 – Upper brackets

Bracket mass:  
2.67 kg

Total mass saving:  
7.9 kg crates walls+  
3.4 kg mid Z brkt +  
2x 5.66 kg top brkt+  
2x 2.4 kg mid brkt+  
2x 5.1 kg bottom brkt =

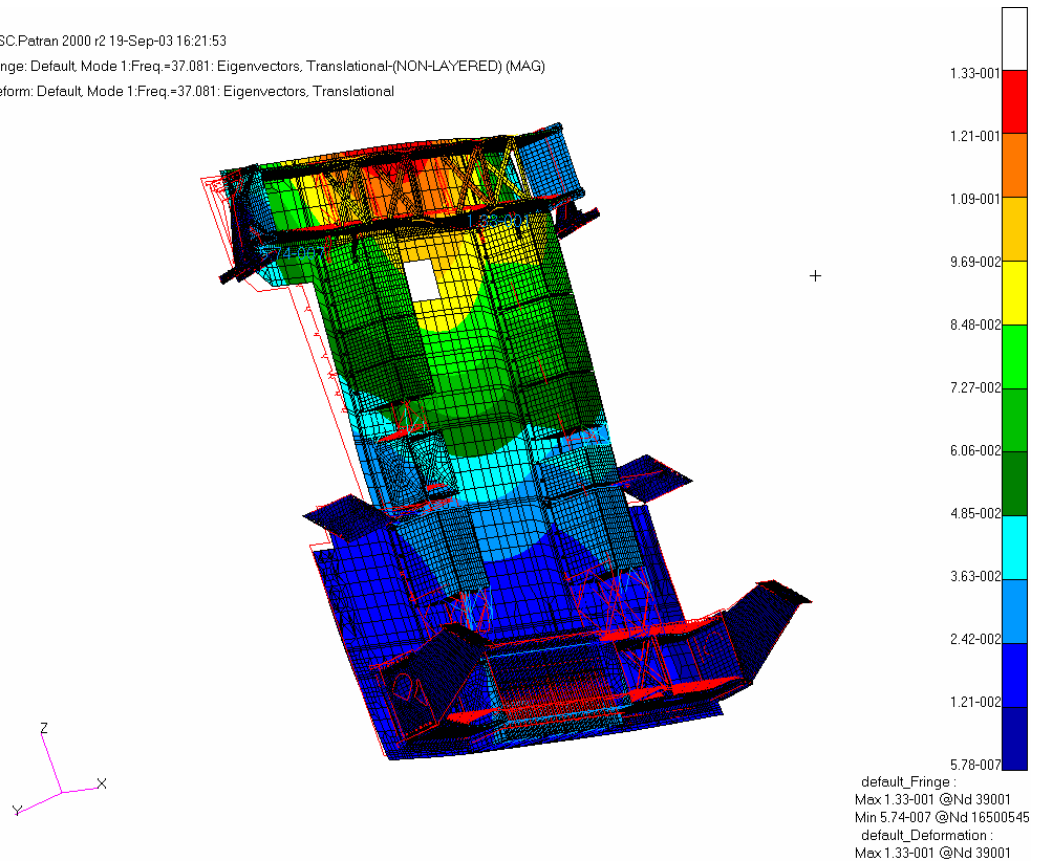
**37.6 kg**      Total mass: 257.4  
Target mass: 249.5



# OPTION 7 - frequency

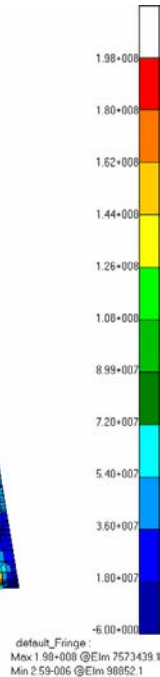
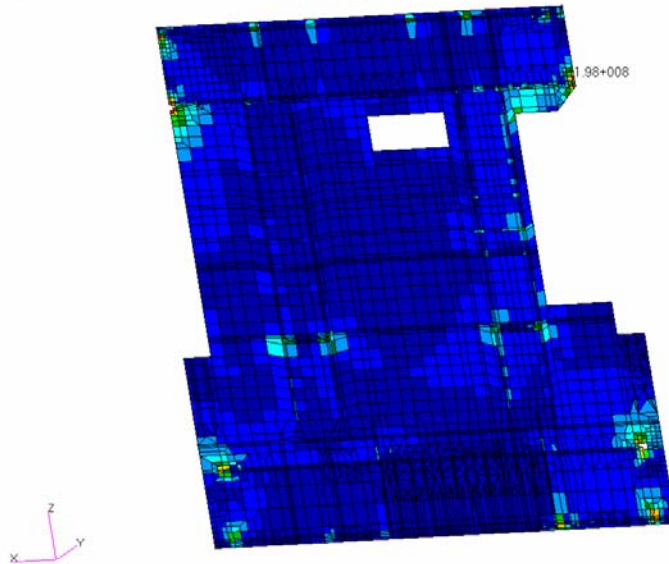
MSC.Patran 2000 r2 19-Sep-03 16:21:53  
Fringe: Default, Mode 1:Freq.=37.081: Eigenvectors, Translational(NON-LAYERED) (MAG)  
Deform: Default, Mode 1:Freq.=37.081: Eigenvectors, Translational

Mass [kg]	257.4
First Freq. [Hz]	37.1

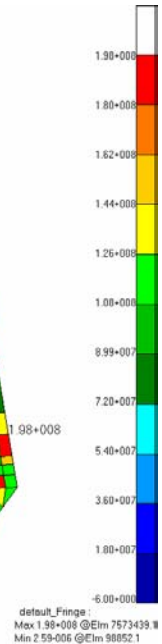
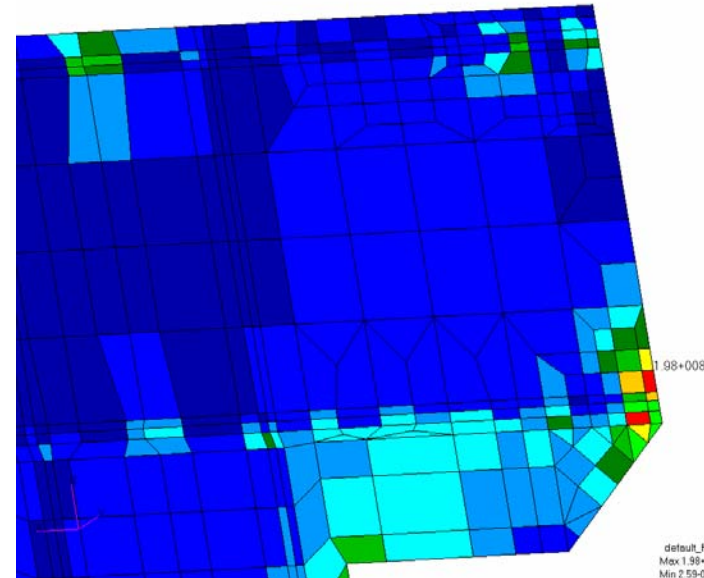


## OPTION 7 – SKINS STATUS

MSC.Patran 2000 r2 19-Sep-03 15:35:51  
Fringe: SC1004LN1004\_A1.Static Subcase, Stress Tensor, - von Mises, Layer 4



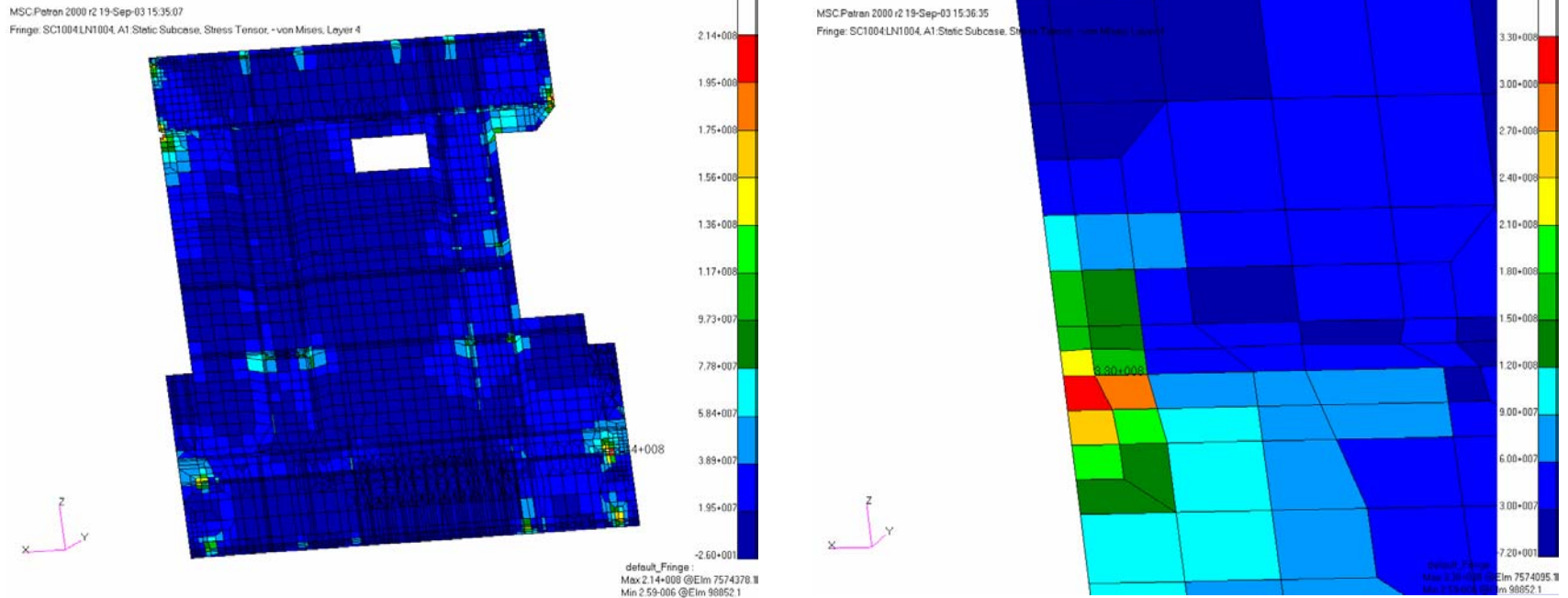
MSC.Patran 2000 r2 19-Sep-03 15:35:51  
Fringe: SC1004LN1004\_A1.Static Subcase, Stress Tensor, - von Mises, Layer 4



SKINS	
MPa	MoS
<b>198</b>	<b>0.08</b>

This value of stress is obtained removing, from the view, some elements connected with the rigid MPC. The maximum value of stress obtained from the FEM was 480 MPa; for the analysis of the removed elements see the PANEL INSERT analysis, next slide.

## OPTION 7 – SKINS STATUS

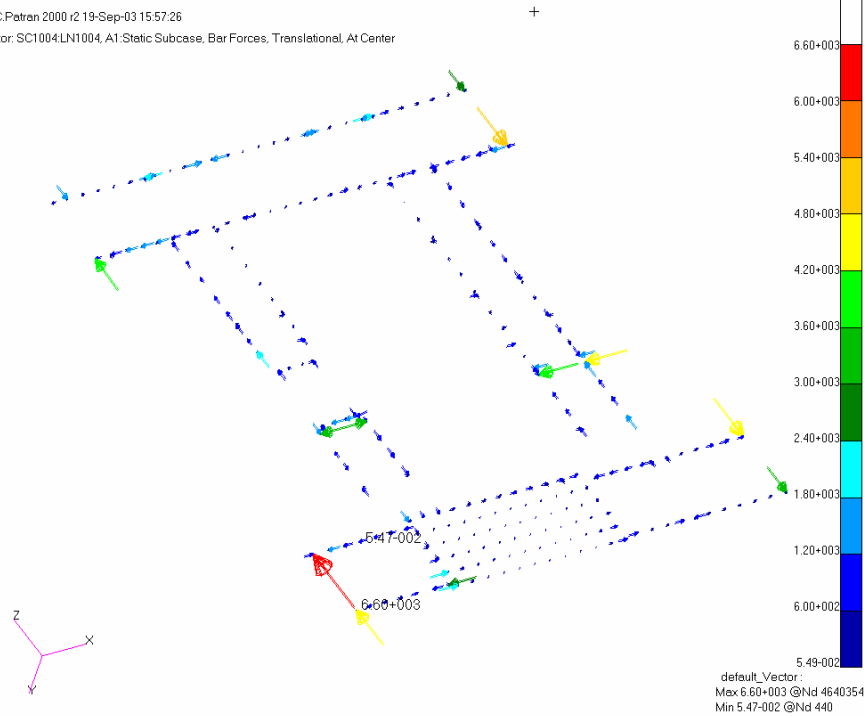


SKINS	
MPa	MoS
<b>198</b>	<b>0.08</b>

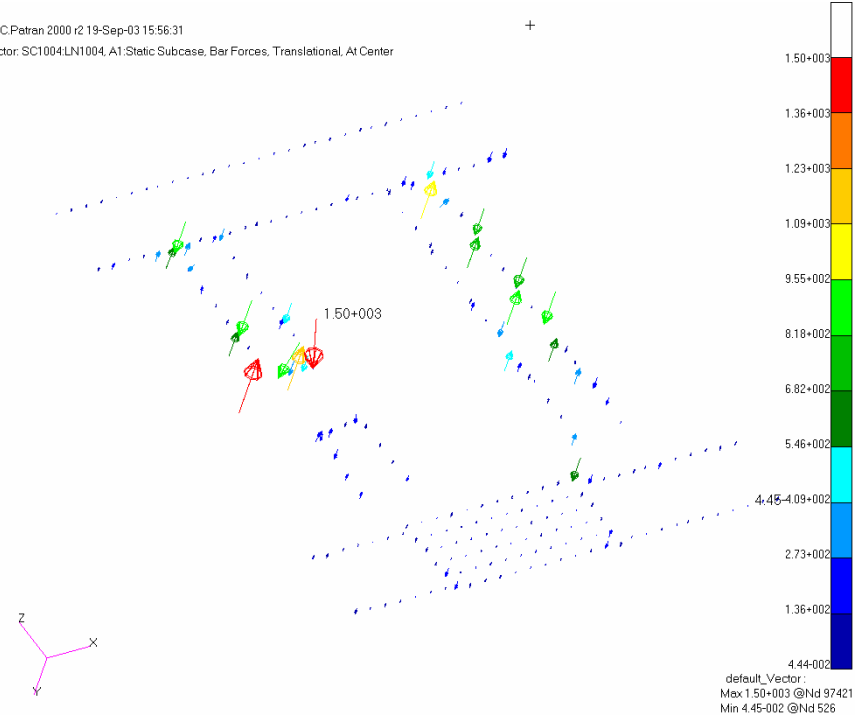
This value of stress is obtained removing, from the view, some elements connected with the rigid MPC. The maximum value of stress obtained from the FEM was 480 MPa; for the analysis of the removed elements see the PANEL INSERT analysis, next slide.

## OPTION 7 - PANEL INSERT STATUS

MSC.Patran 2000 r2 19-Sep-03 15:57:26  
Vector: SC1004.LN1004, A1:Static Subcase, Bar Forces, Translational, At Center



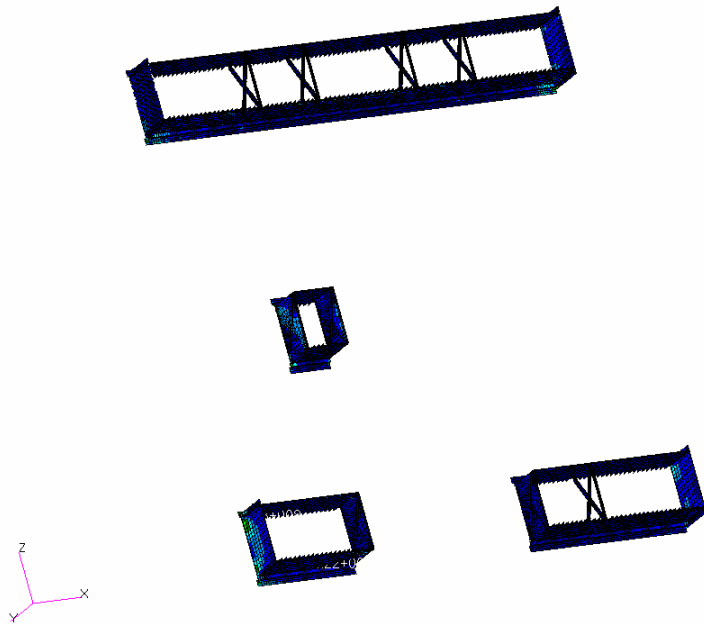
MSC.Patran 2000 r2 19-Sep-03 15:56:31  
Vector: SC1004.LN1004, A1:Static Subcase, Bar Forces, Translational, At Center



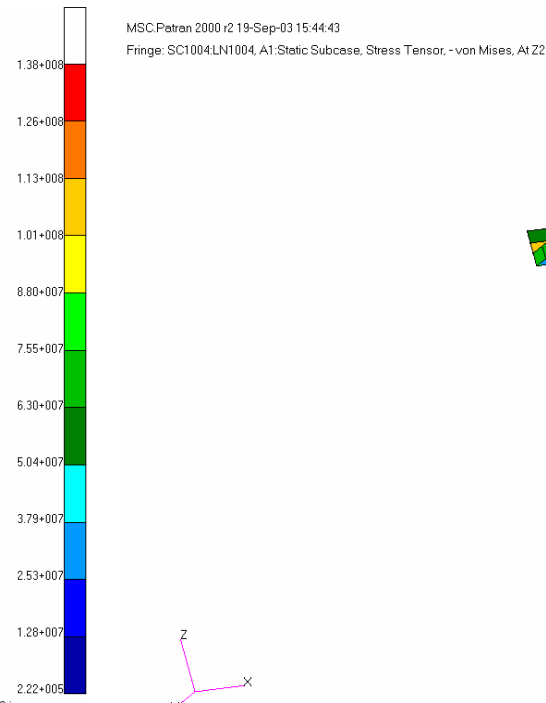
PANEL INSERT		
AXIAL [N]	SHEAR [N]	MIN MoS (AX,SH)
1500	6600	-0.79

## OPTION 7 - CRATES STATUS

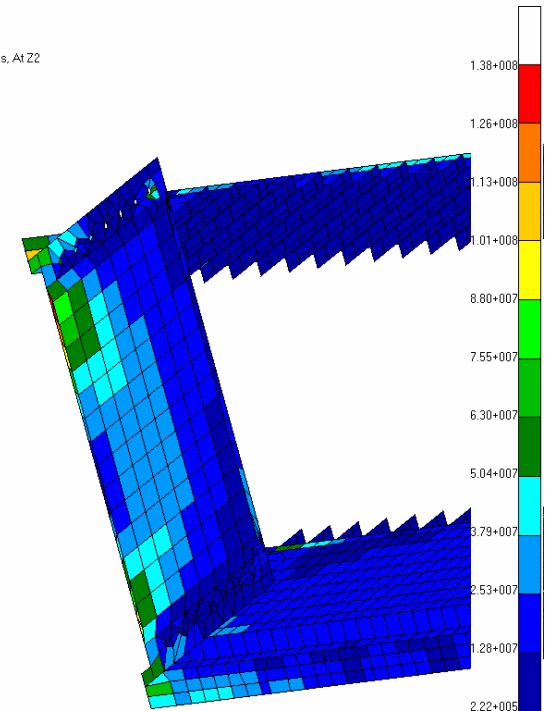
MSC.Patran 2000 r2 19-Sep-03 15:44:43  
Fringe: SC1004.LN1004, A1:Static Subcase, Stress Tensor, -von Mises, At Z2



default\_Fringe :  
Max 1.38+008 @Elm 2522112.1  
Min 2.22+005 @Elm 40258.1



MSC.Patran 2000 r2 19-Sep-03 15:44:43  
Fringe: SC1004.LN1004, A1:Static Subcase, Stress Tensor, -von Mises, At Z2

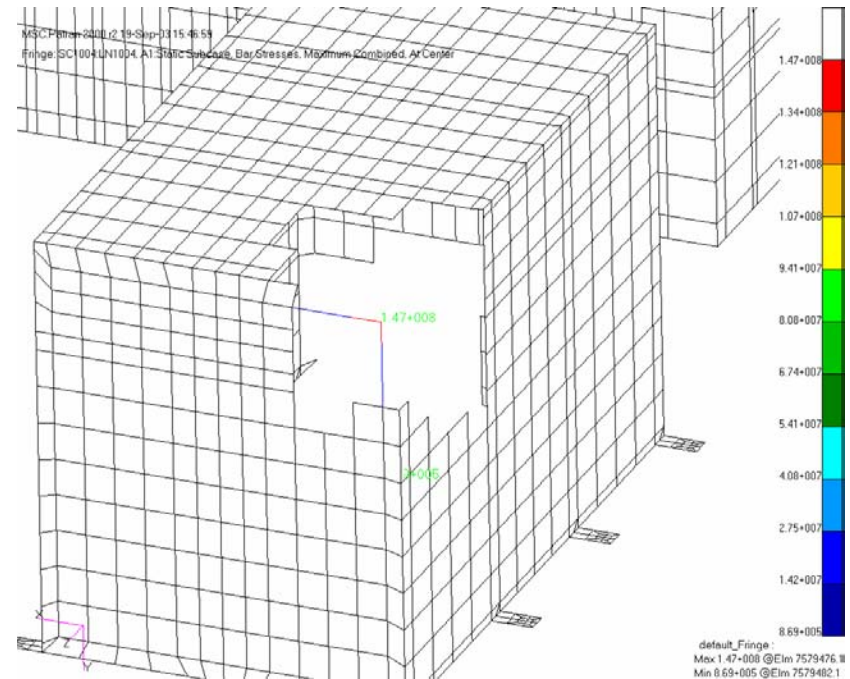
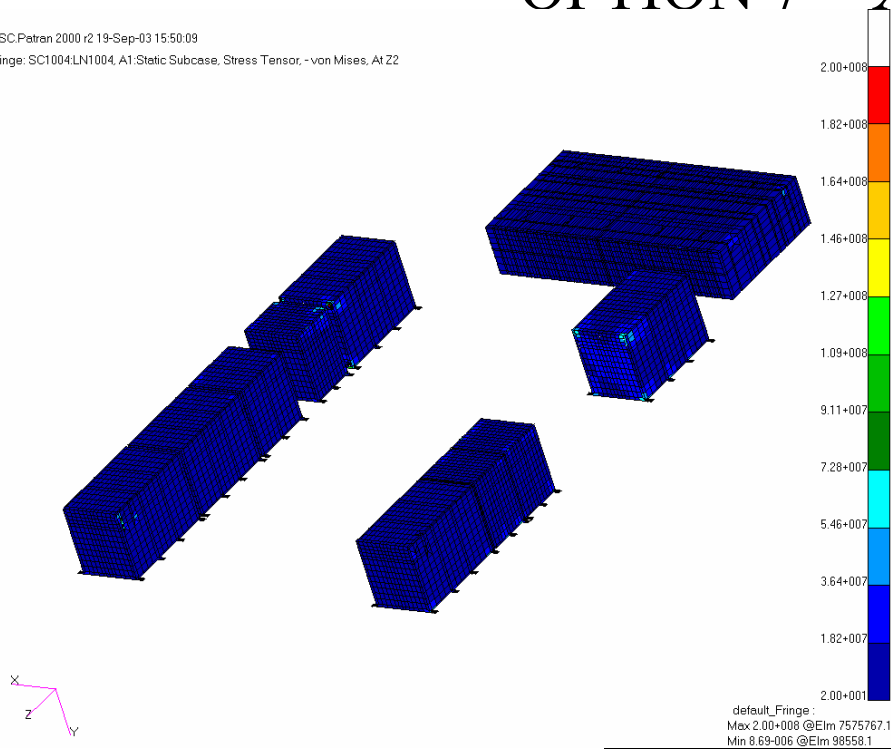


default\_Fringe :  
Max 1.38+008 @Elm 2522112.1  
Min 2.22+005 @Elm 40258.1

CRATE	
MPa	MoS
138	0.623

## OPTION 7 - XPD STATUS

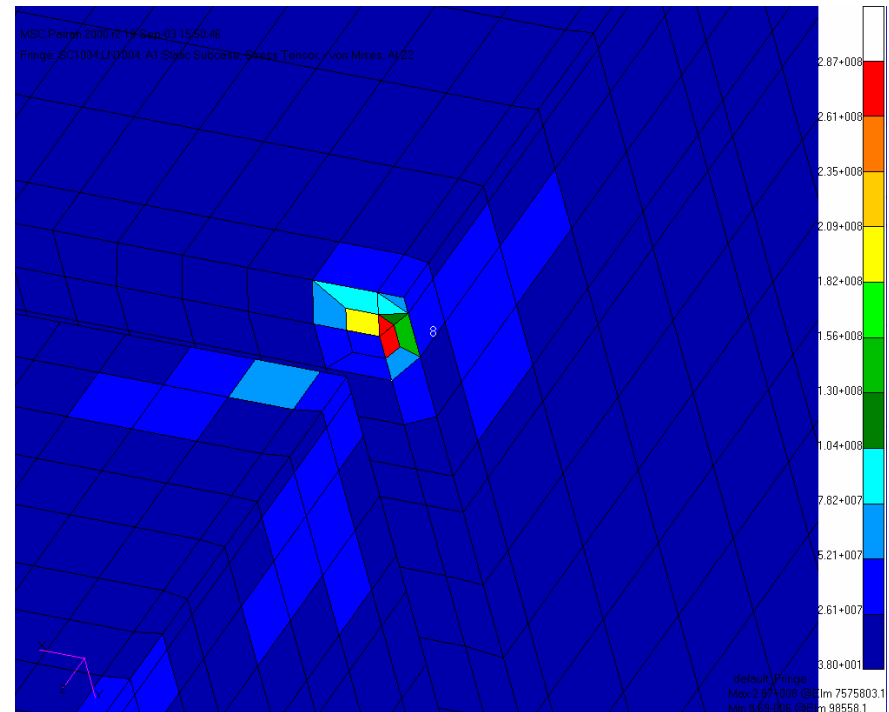
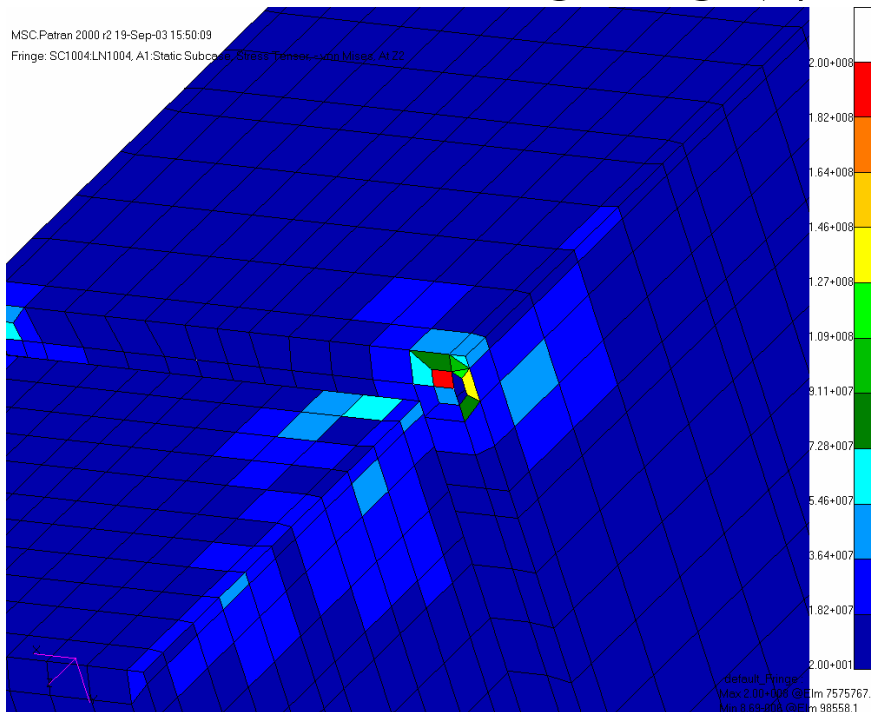
MSC.Patran 2000 r2 19-Sep-03 15:50:09  
Fringe: SC1004:LN1004, A1:Static Subcase, Stress Tensor, -von Mises, At Z2



XPD	
MPa	MoS
<b>200</b>	<b>0.12</b>

This value of stress is obtained removing, from the view, some elements connected with the rigid MPC. The maximum value of stress obtained from the FEM was 275 MPa.

## OPTION 7 - XPD STATUS



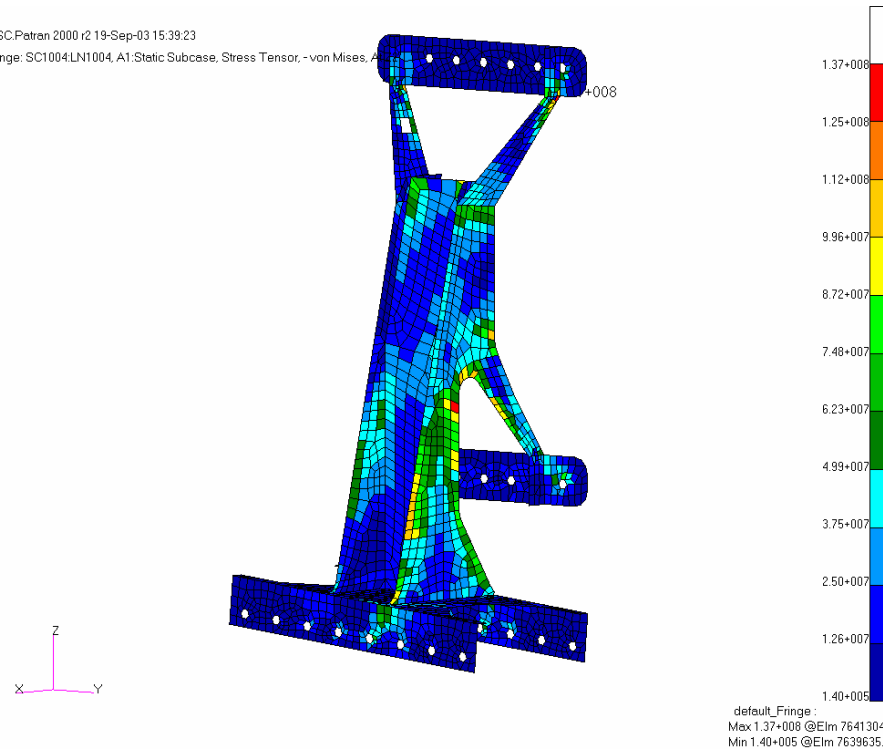
XPD	
MPa	MoS
<b>200</b>	<b>0.12</b>

This value of stress is obtained removing, from the view, some elements connected with the rigid MPC. The maximum value of stress obtained from the FEM was 275 MPa.

## OPTION 7 - TOP BRACKET STATUS

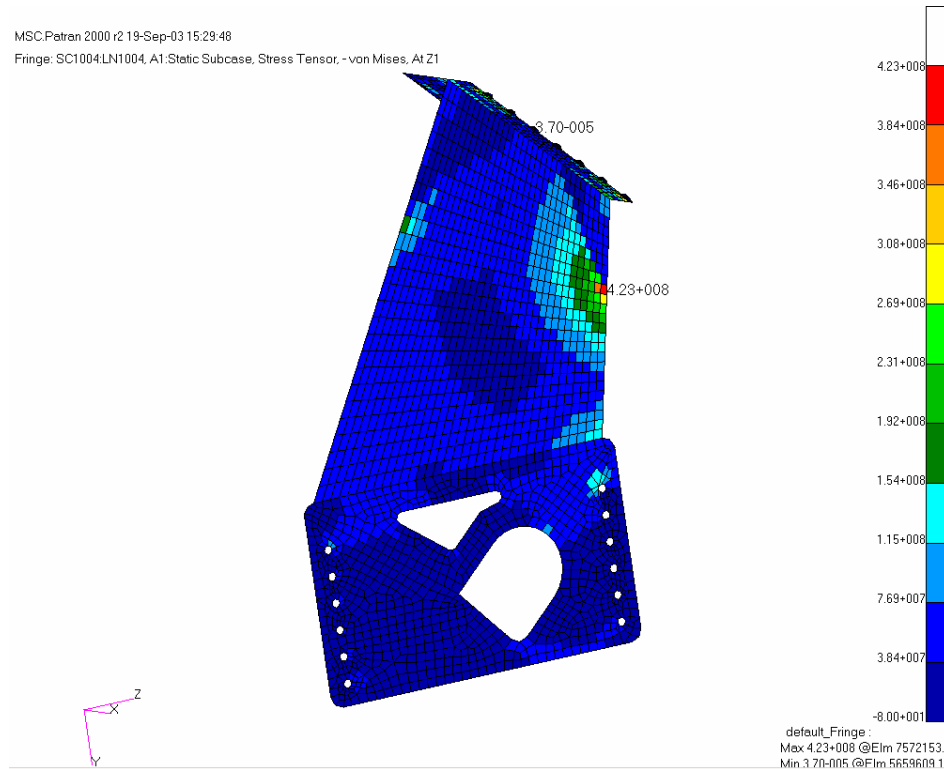
MSC.Patran 2000 r2 19-Sep-03 15:39:23

Fringe: SC1004LN1004, A1.Static Subcase, Stress Tensor, - von Mises, A



TOP BRACKET	
MPa	MoS
137	0.635

## OPTION 7 - LOWER BRACKET STATUS

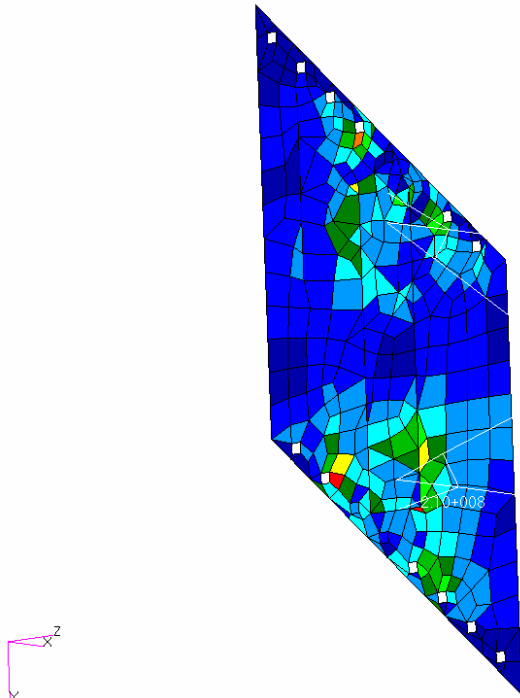


LOWER BRACKET	
MPa	MoS
423	-0.47

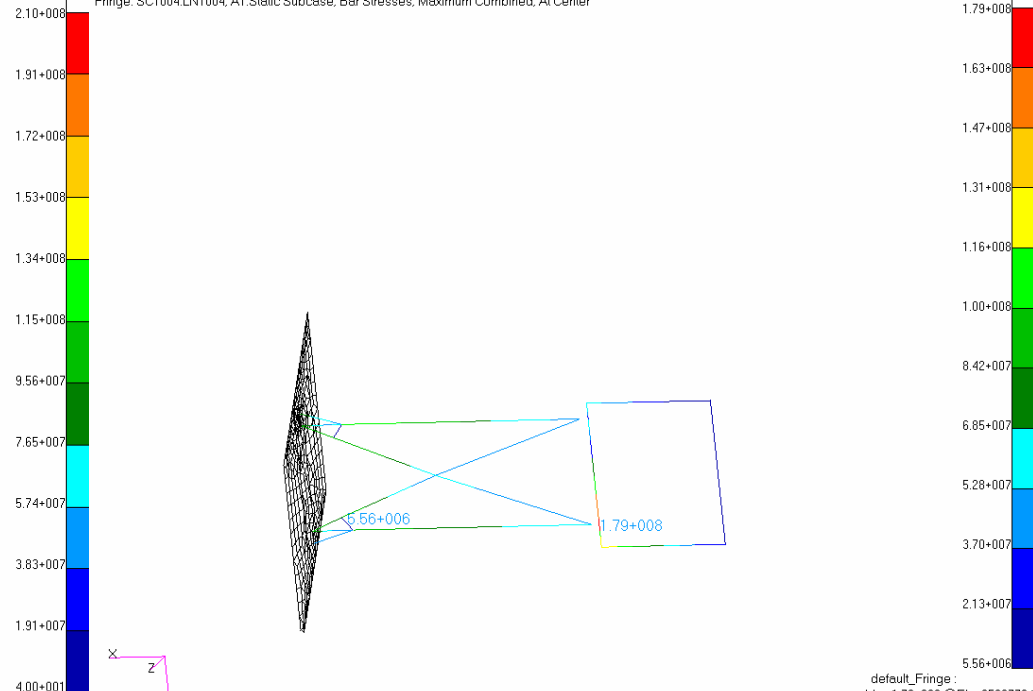
## OPTION 7 - MID BRACKET STATUS

MSC.Patran 2000 r2 19-Sep-03 15:31:55

Fringe: SC1004.LN1004, A1:Static Subcase, Stress Tensor, -von Mises, At Z2



MSC.Patran 2000 r2 19-Sep-03 15:32:10  
Fringe: SC1004.LN1004, A1:Static Subcase, Bar Stresses, Maximum Combined, At Center



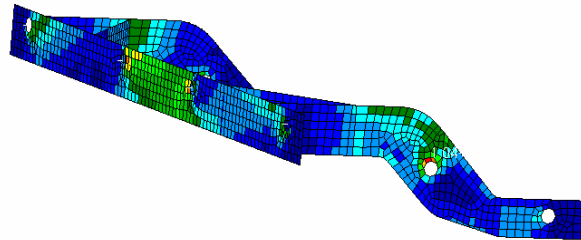
default\_Fringe:  
Max 2.10+008 @Elm 2520742.1  
Min 5.97-006 @Elm 2521299.1

default\_Fringe:  
Max 1.79+008 @Elm 2522776.1  
Min 5.56+006 @Elm 2522705.1

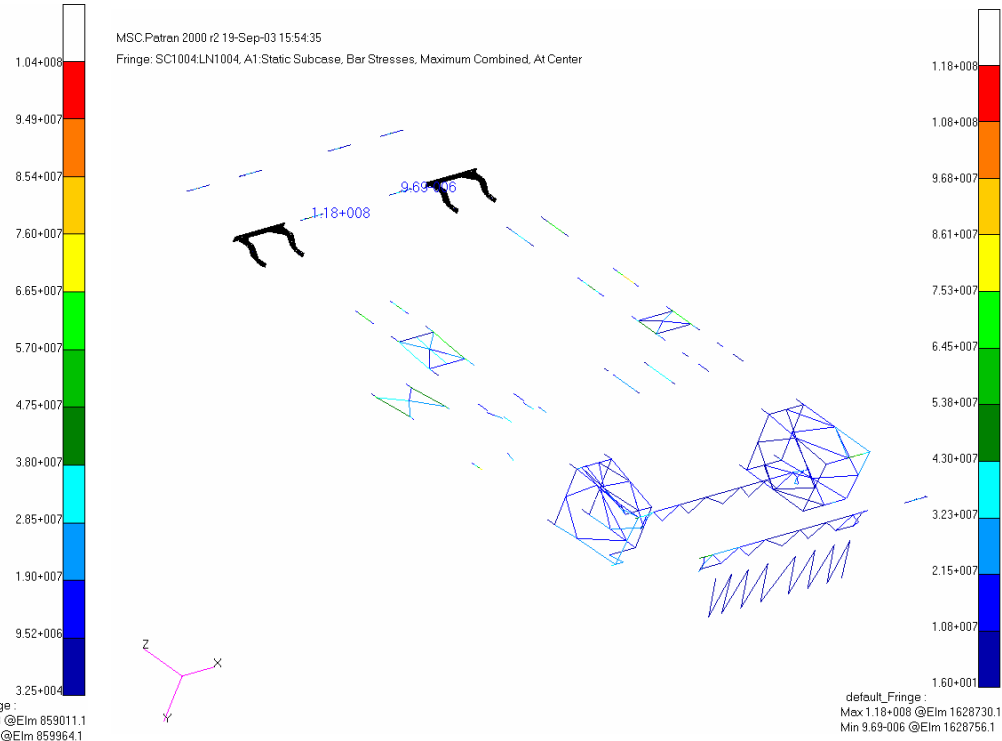
MID BRACKET	
MPa	MoS
205	0.09

## OPTION 7 - INTERCRATE LINKS STATUS

MSC.Patran 2000 r2 19-Sep-03 15:53:46  
Fringe: SC1004LN1004, A1:Static Subcase, Stress Tensor, - von Mises, At Z1



MSC.Patran 2000 r2 19-Sep-03 15:54:35  
Fringe: SC1004LN1004, A1:Static Subcase, Bar Stresses, Maximum Combined, At Center



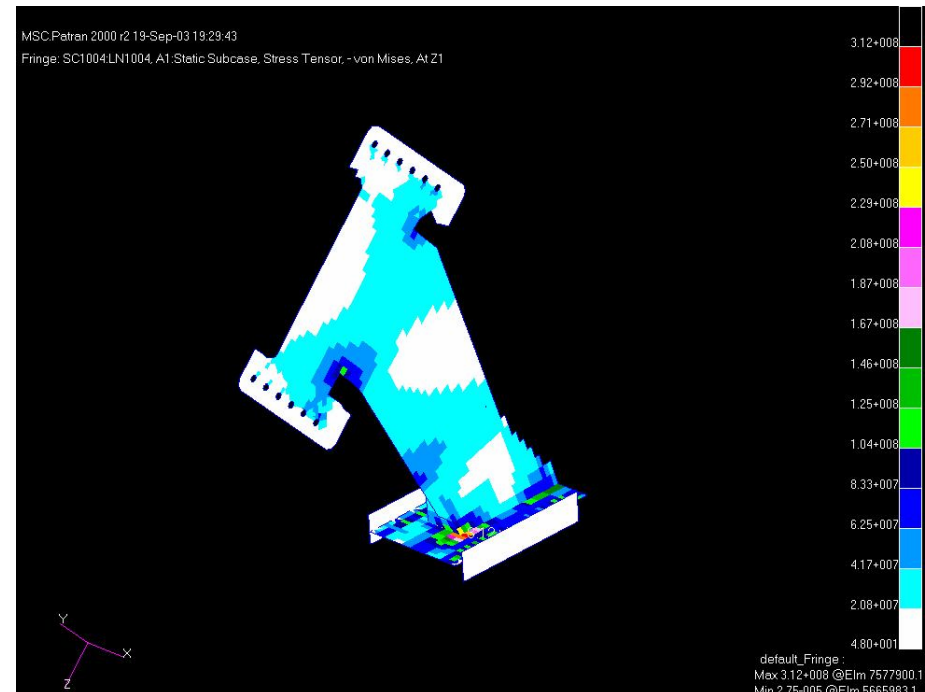
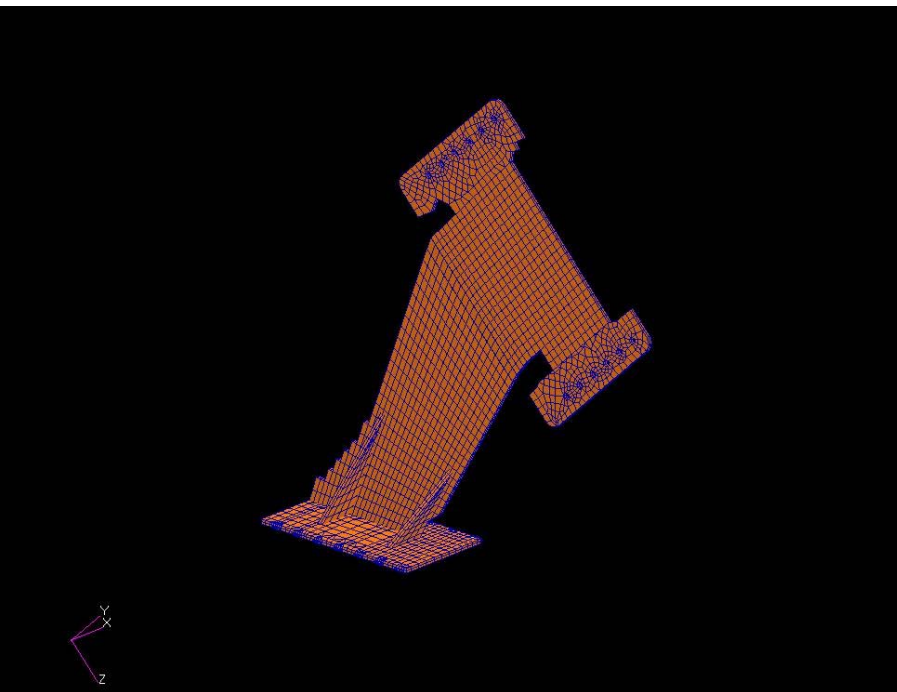
intercrate LINKS	
MPa	MoS
118	0.9

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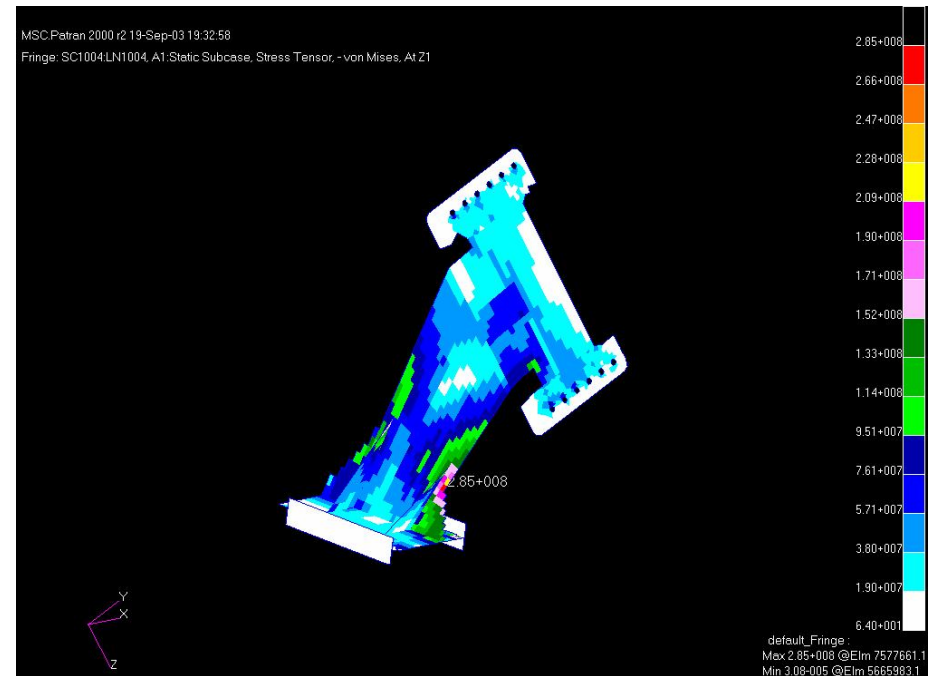
# Comments on Option 7

- Bottom bracket is now out the allowable stress range
- Local stress concentration has been analyzed in the following

# OPTION 8: redesign of bottom plate

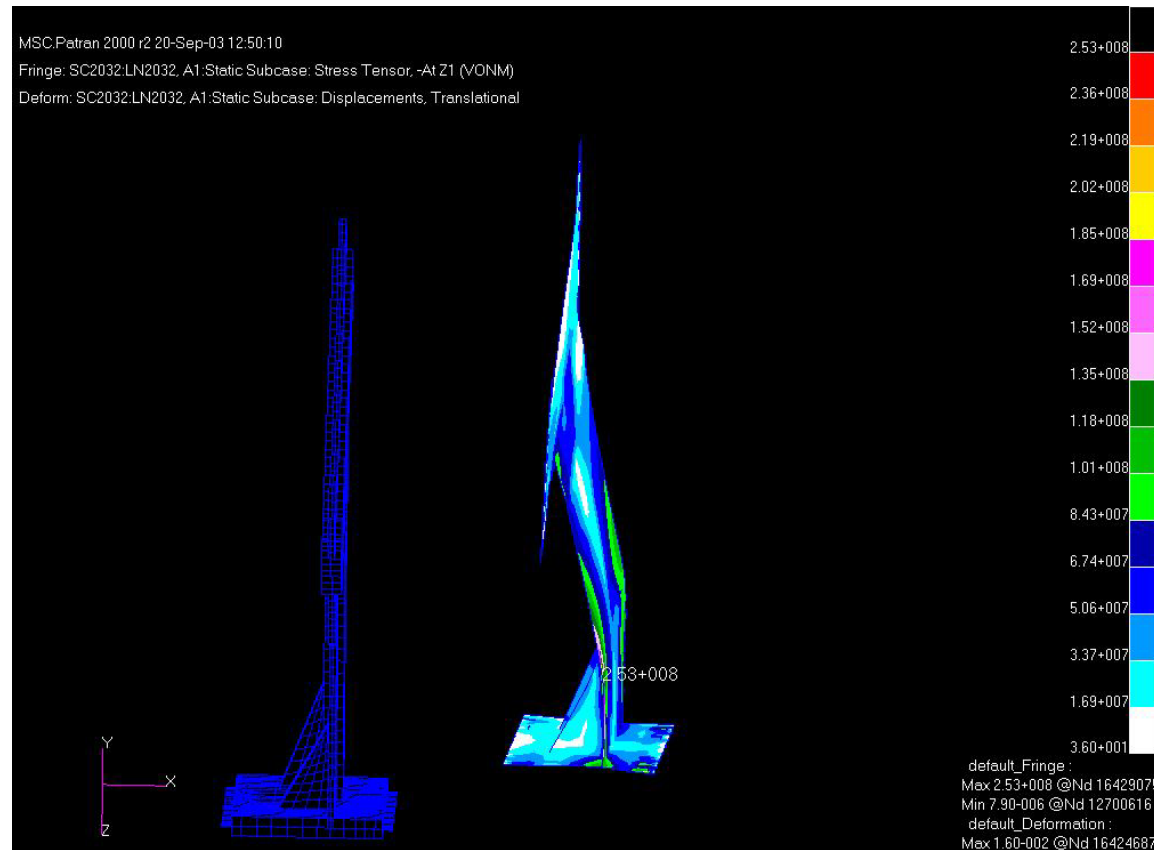


# Option 8



Maximum Stress = 285 MPa

# Option 8: lower plate out-of-plane deformation



# Conclusions on wake radiator

- Starting point was a weight of the radiator ‘system’ (TCS + electronics) of about 295 Kg (45 Kg overweight)
- Structural optimization has reduced the mass
- A radiator ‘system’ weight in the range  
 $257 \text{ Kg} \div 269 \text{ Kg}$   
(overweight 8 Kg  $\div$  20 Kg)

Results in a feasible structural design, pending inserts final and detailed design

COFFEE  
BREAK,  
PLEASE!!!

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# Load cases used for wake radiator optimization

- Starting point
  - All
- Option 1-4
  - 1011 1015 1022 2023 2034 2057
- Option 6
  - All
- Option 7-8
  - 1016 1030 1032 1036 1049 1063
  - 2004 2016 2031 2032 2036 2040 2049