AMS02 radiators Mass optimization working group meeting

Debriefing notes

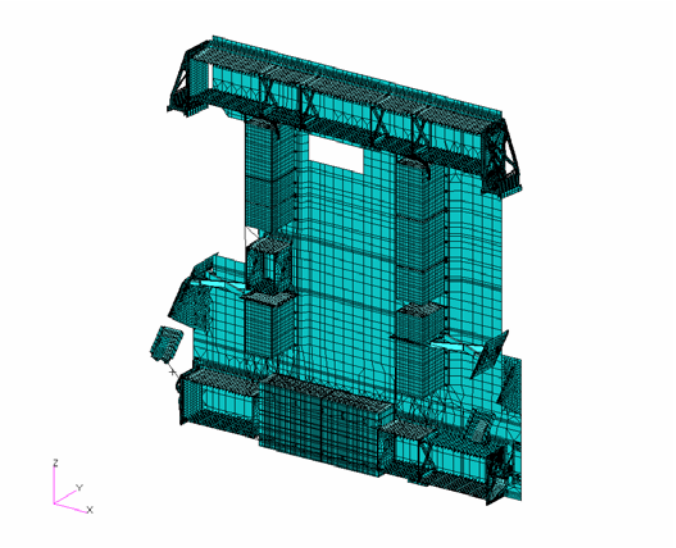
M. Molina

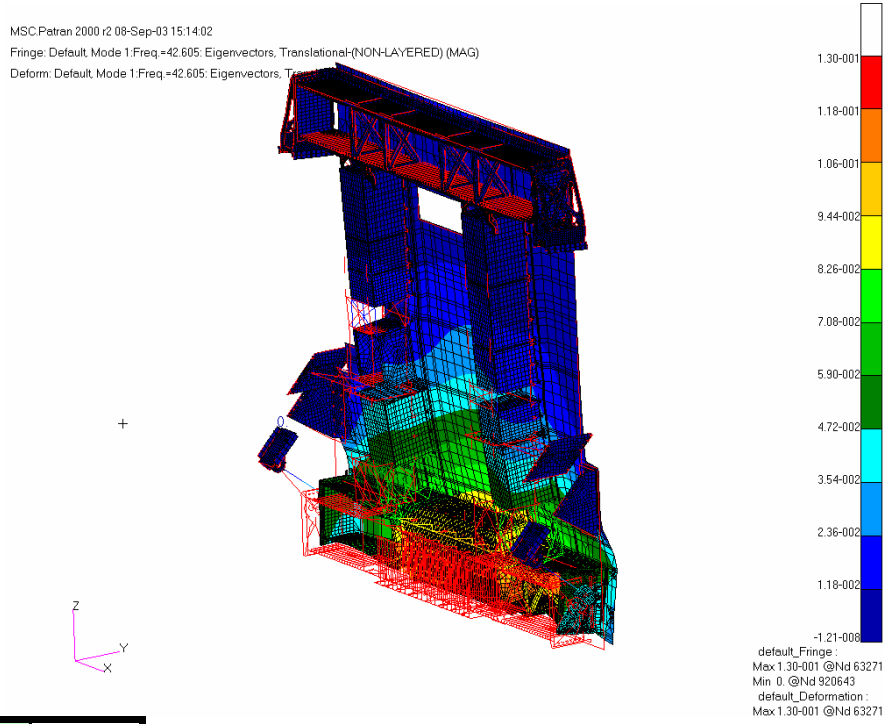
Introduction

- In the following pages the actions coming from the meeting at CERN (01/08/2003) are checked against the activities performed from 04/08/2003 to 19/09/2003
- Conclusions include
  - an agreed procedure for future (structurl) analysis on AMS02 radiators and
  - a check list for next analytical activities

Actions check

- CRATES
  - 1) structural optimization (neglecting thermal)
    - Customized design
  - 2) Specific design (RAM/WAKE)
- RADIATOR
  - 3) Attachment points for the brackets
    - Number
    - Interface area
  - 4) doublers
- TOP BRACKETS
  - 5) Shear plate
- MID BRACKETS
  - 6) Reduce length
  - 7) Outside the radiator
  - 8) TTCS box combination
- MISCELLANEA
  - 9) Modelling techniques
  - 10) Remove “some” brackets





- CRATES walls thickness optimized
- MASS SAVING **7.9 Kg**

Mass [kg]	**287.1**
First Freq. [Hz]	**42.6**

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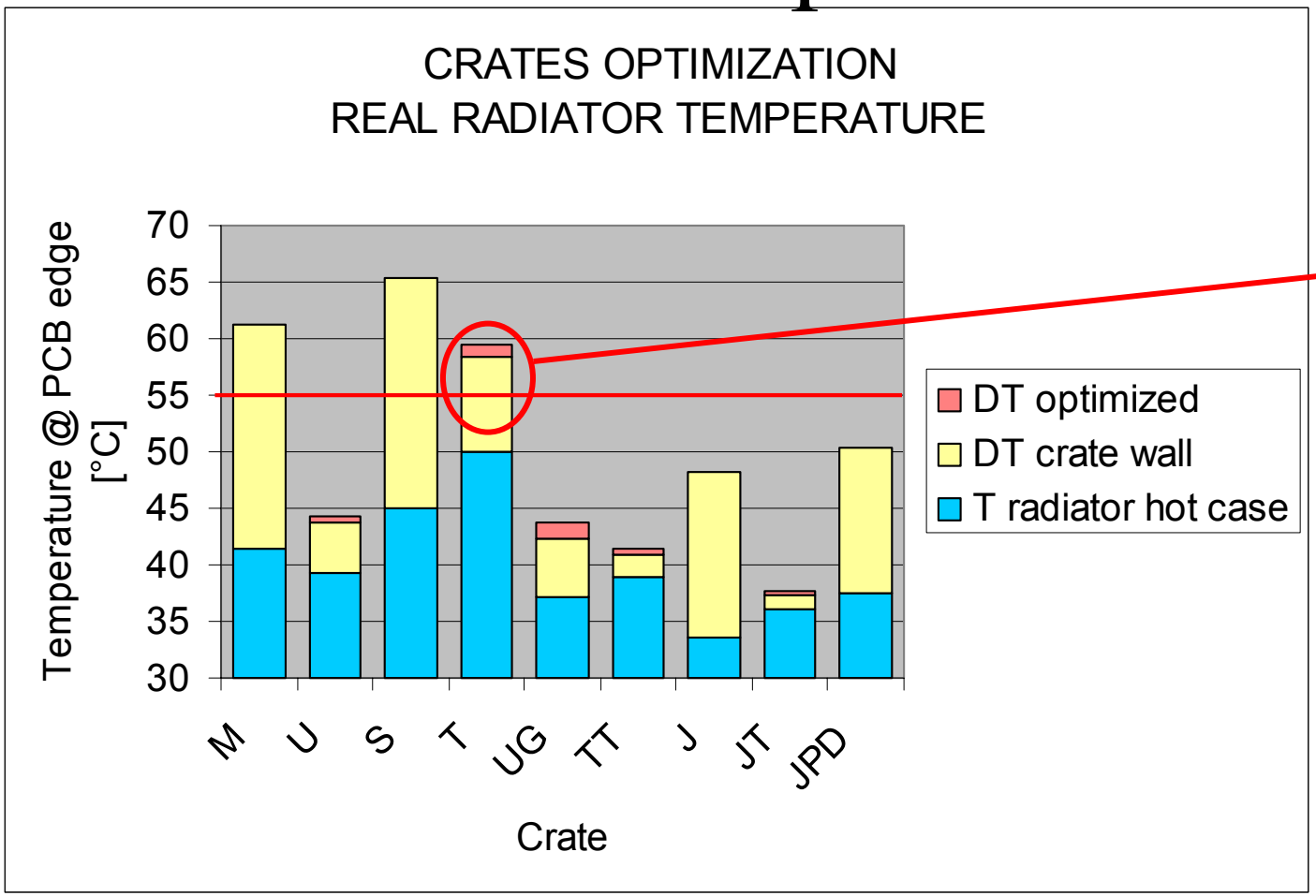
On-orbit temperatures



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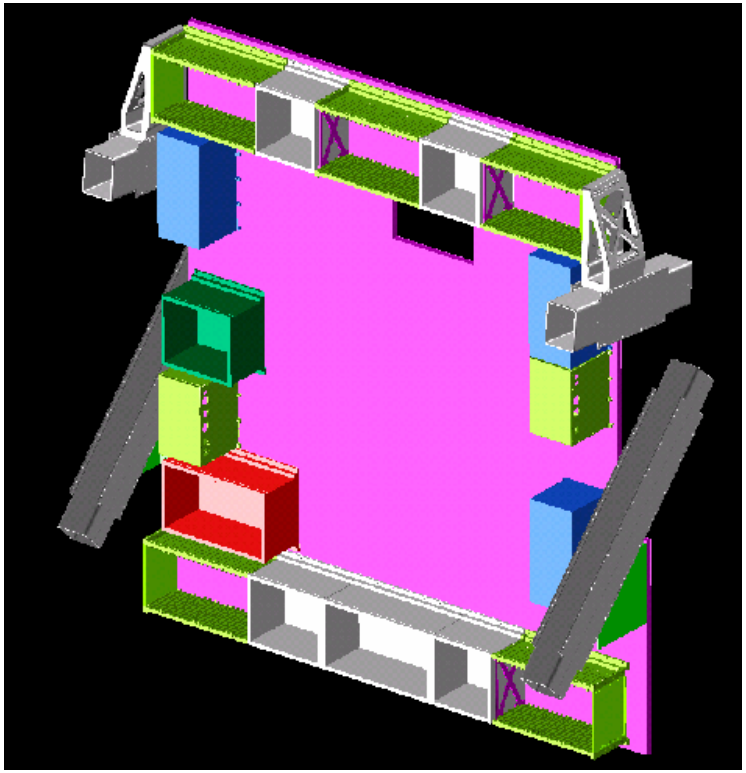
RAM radiator: “squared” crates layout (no more gemini)



Lession learned: framed RAM radiator

- Mass reduction is low due to the small relative mass of the mid brackets compared to the whole system
- Connecting the XPD near the USS
  - bracket compliance is reduced
    - The bracket design could be made more compliant BUT this is critical due to lower envelope available
  - high loads are transferred to radiator
- Interface stiffness changes, new criticalities during next CLA cycle could arise.
- It is mandatory to update boundary conditions with CLA, because fixation point of USS used by LMSO until now is no longer representative

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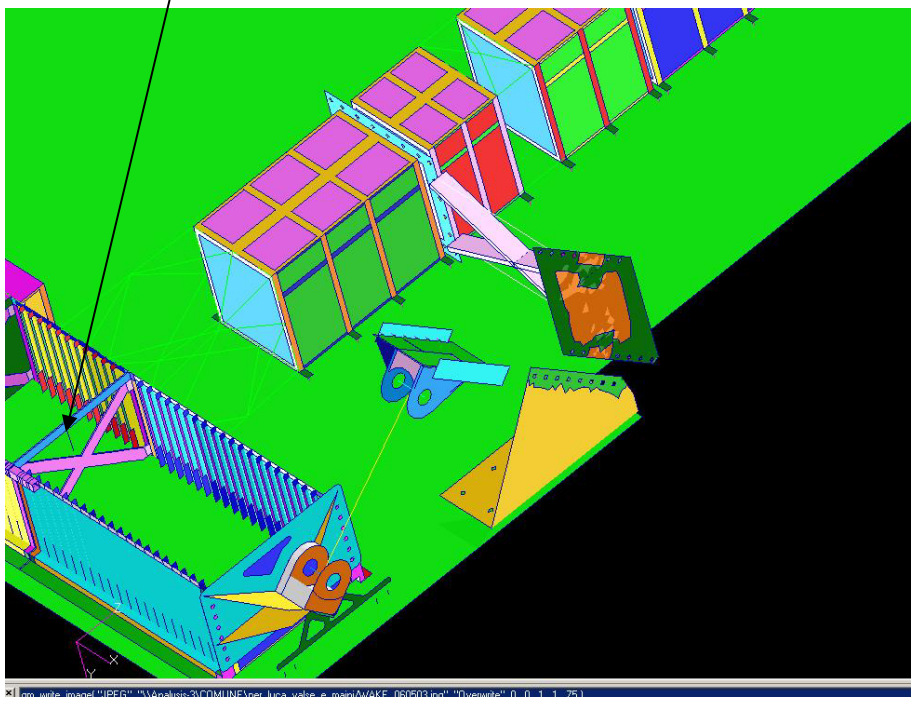
OPTION 2

- Removal of the Mid Z Bracket
- Load cases selection
  - 1011, 1015, 1022, 2023, 2034, 2057

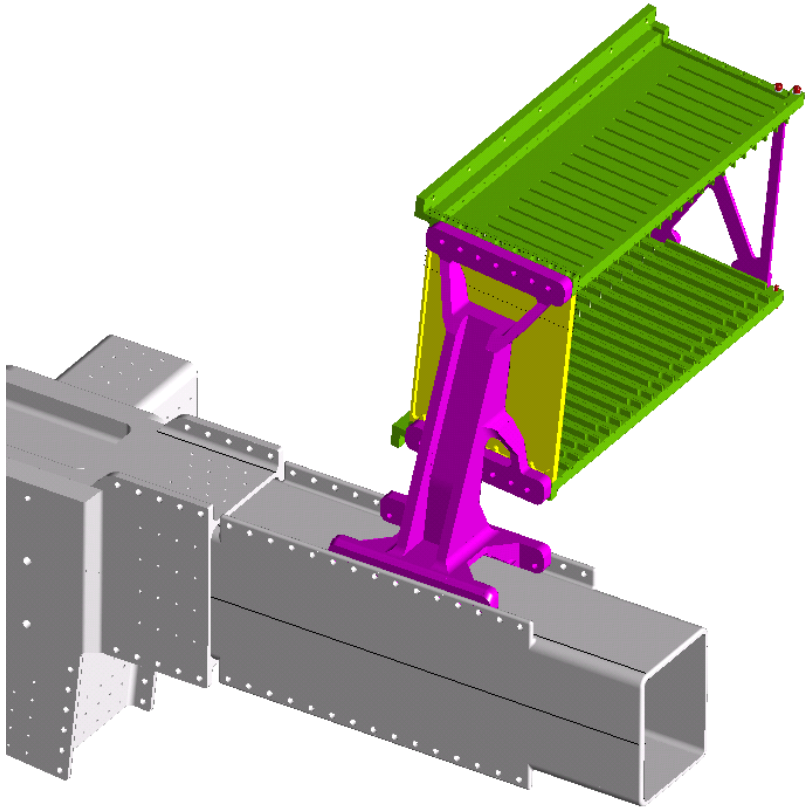


CONCLUSIONS

- "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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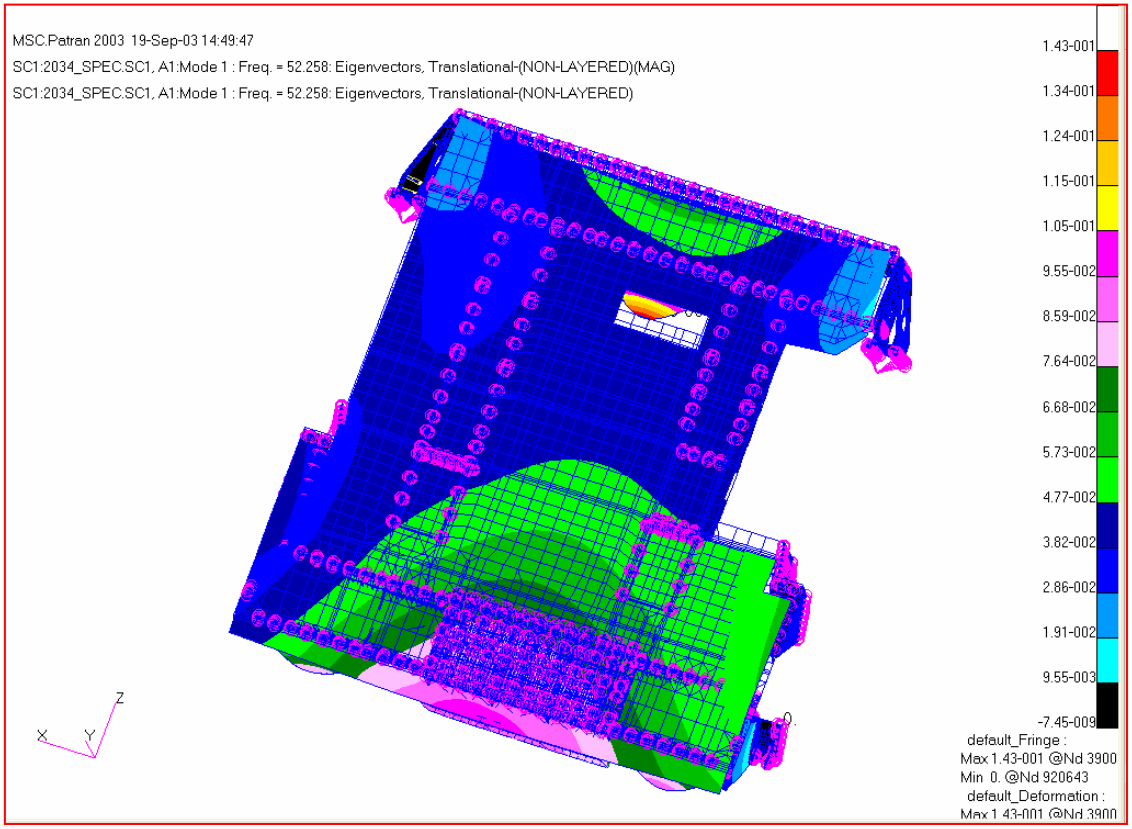

Option 1: top bracket, no change, radiator locally 2mm doubler
mid bracket, without Z bracket
bottom bracket, plate connection instead of rod

F1=52.258 Hz

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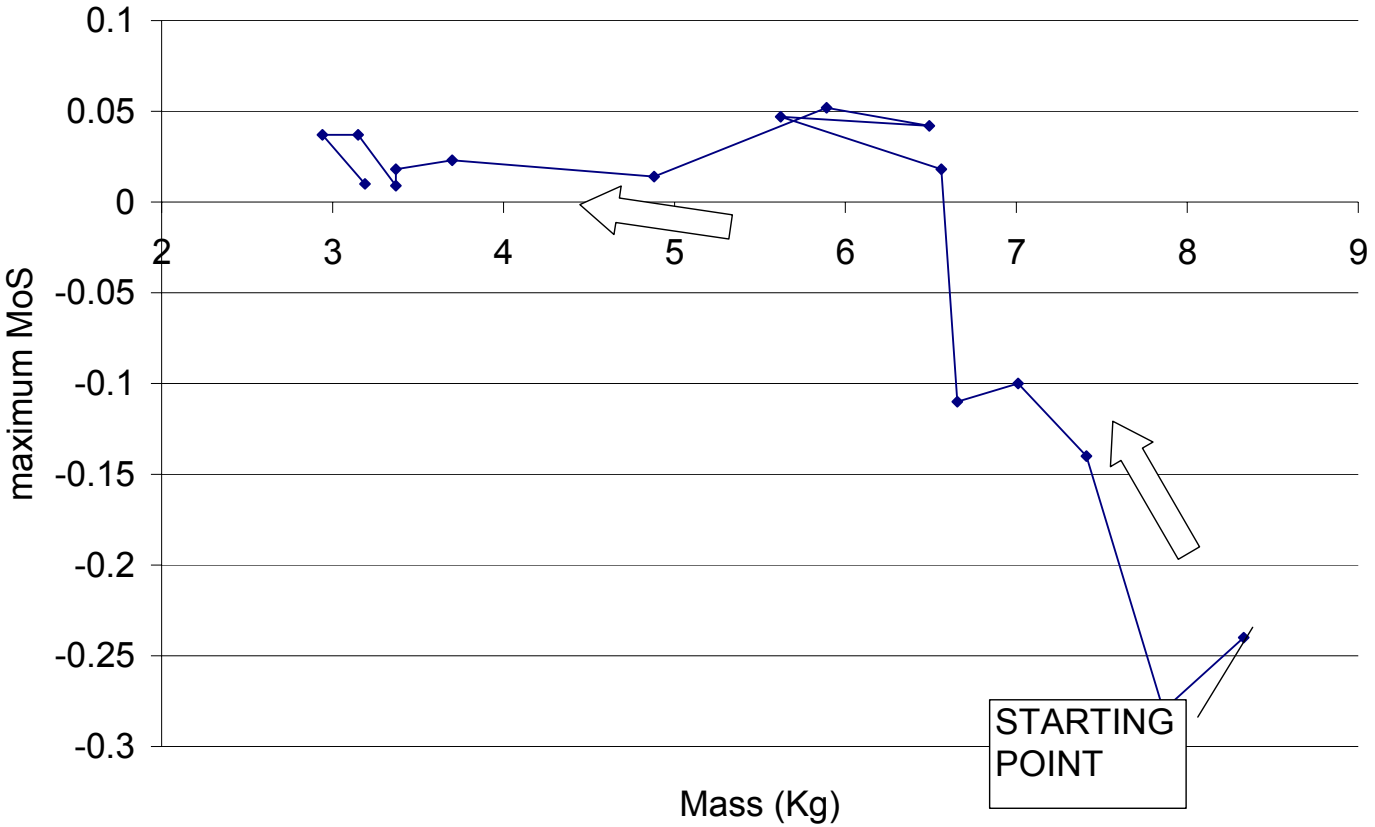
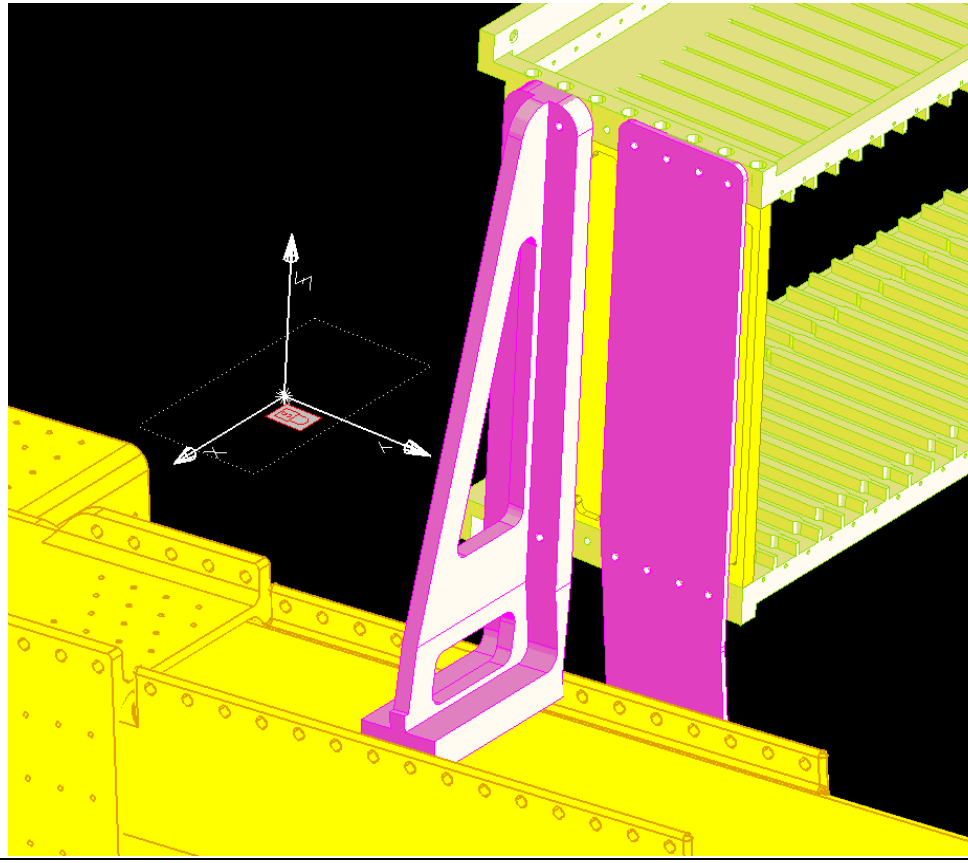
Top bracket optimization sequence



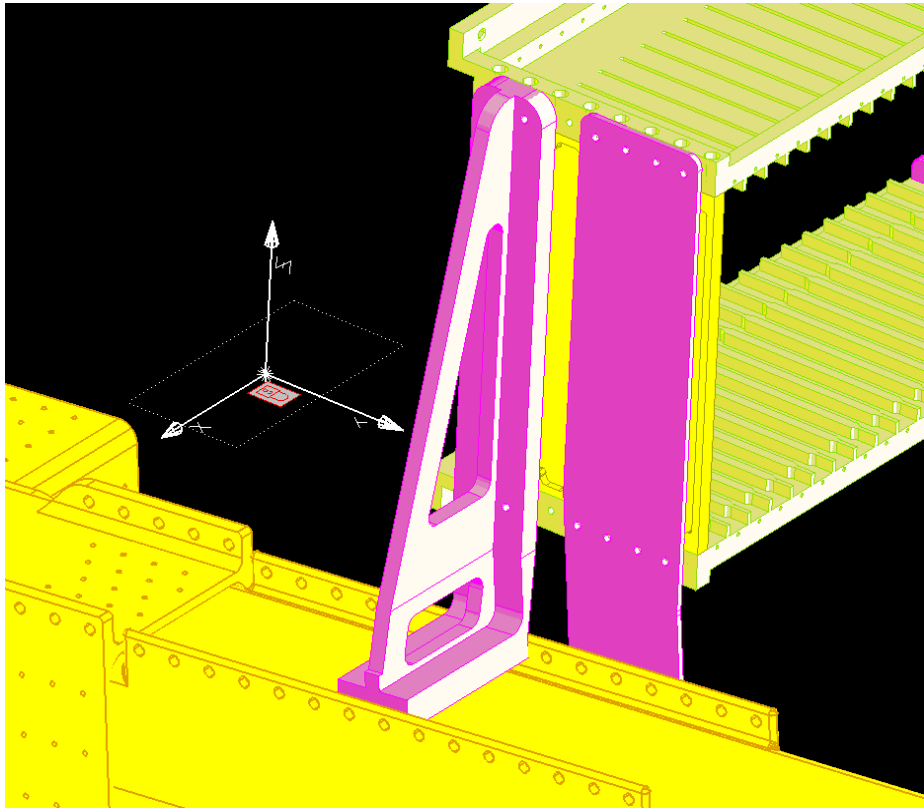
UPPER BRACKET splitted in 2 parts comments

- The load in the XZ plane (radiator plane) is reacted by the rib of bracket A. The load is then transferred to the bracket A flange, that needs to be, in turn, thickened.
- Due to the thicker (stiffer) flange, the bracket A withstands also the forces out of the radiator plane, making therefore uneffective the action of bracket B.



UPPER BRACKET splitted in 2 parts comments

- Moreover, bracket A stiffness makes higher stresses in the junction bracket-to-crate
- Finally, bolts are loaded with higher forces
- CONCLUSION= It is not effective to split the upper bracket in two parts.



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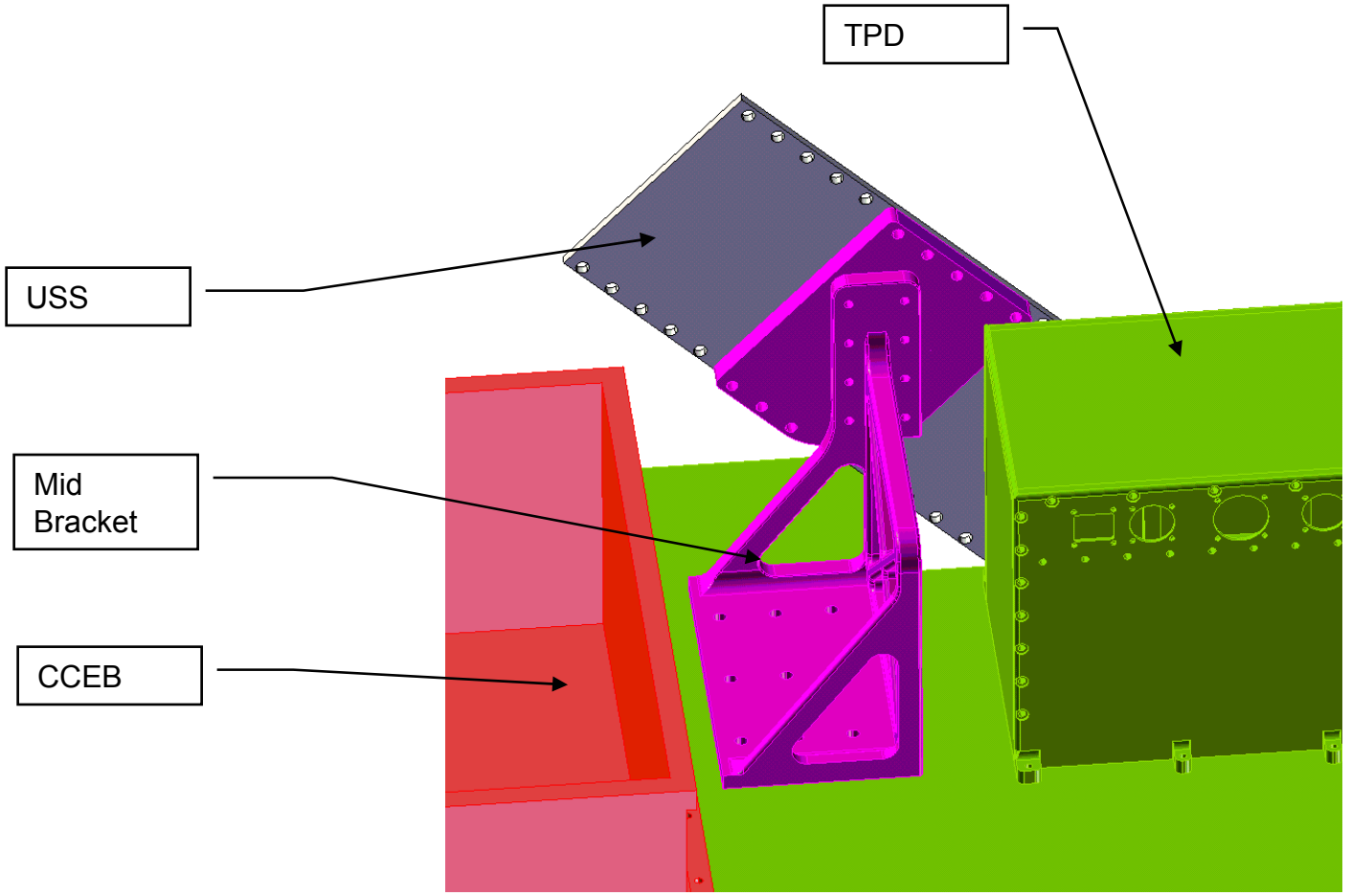
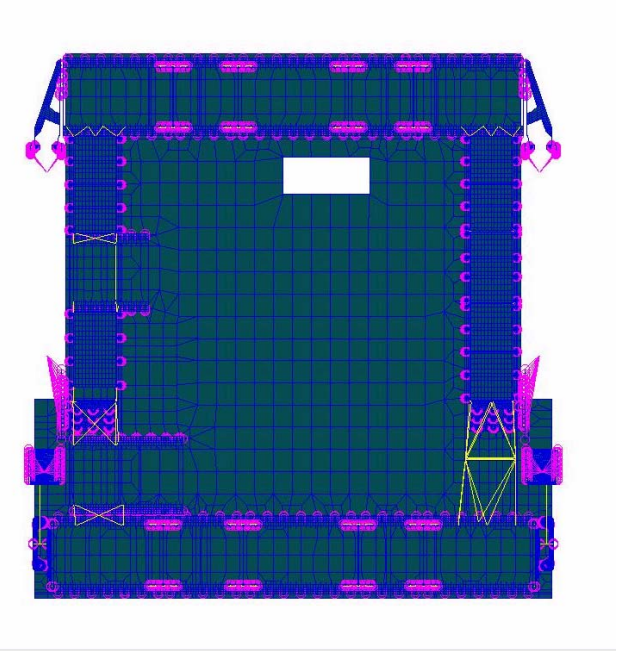
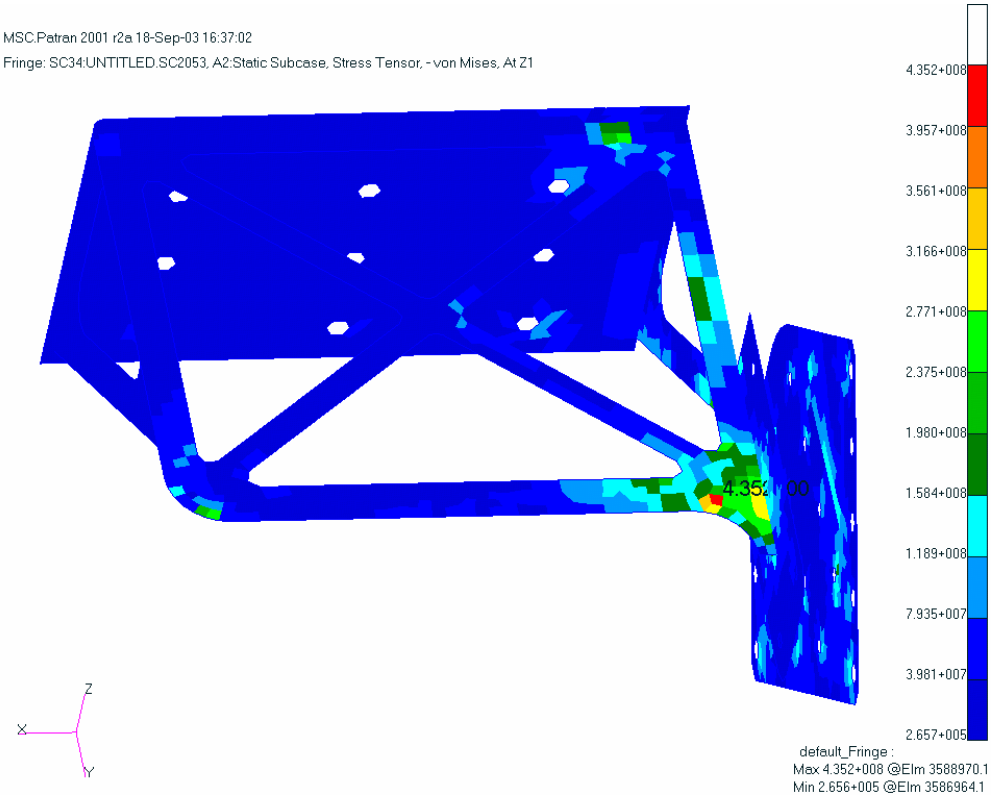
"Short" mid bracket design



MID BRACKET





MID BRACKET	
MPa	MoS
435	-0.49

Worst LC over 128

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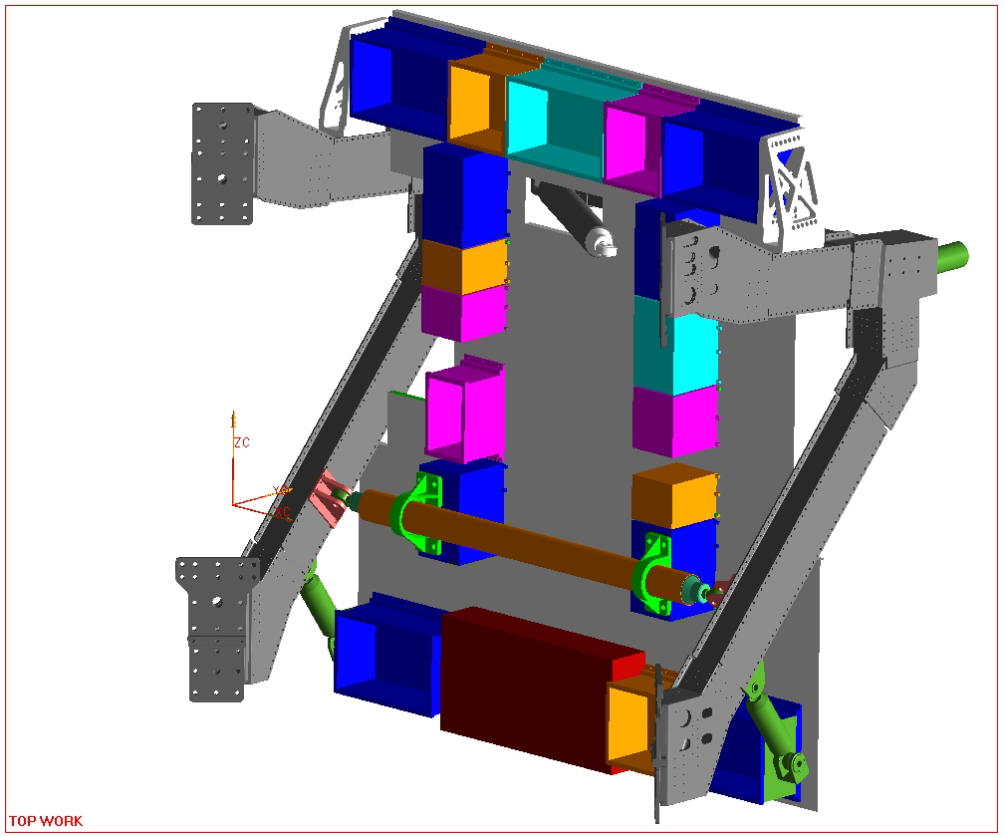
Mid Bracket Design

Alternate mid bracket design:

- A tube integrated between the USS bars with sperical bearing at both ends
- Two clamps attachted to the crates forming the interface to the tube
- Additionally one of the upper brackets is released in x-direction

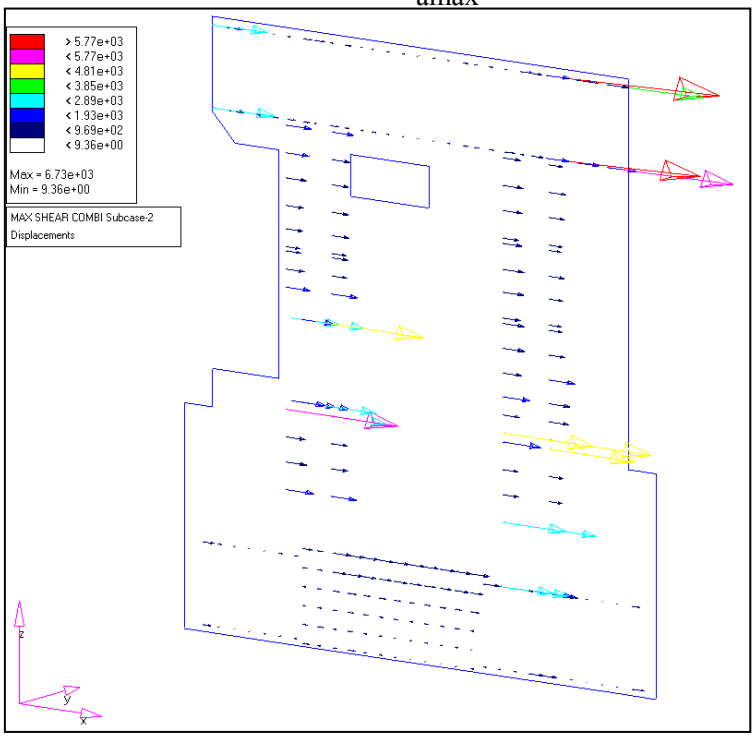
The alternate design has:
- 1 x 6, 1 x 5 DOF at upper bracket I/F
- 1 x 3, 1 x 2 DOF at mid bracket I/F
- 2 x 1 DOF at lower bracket I/F



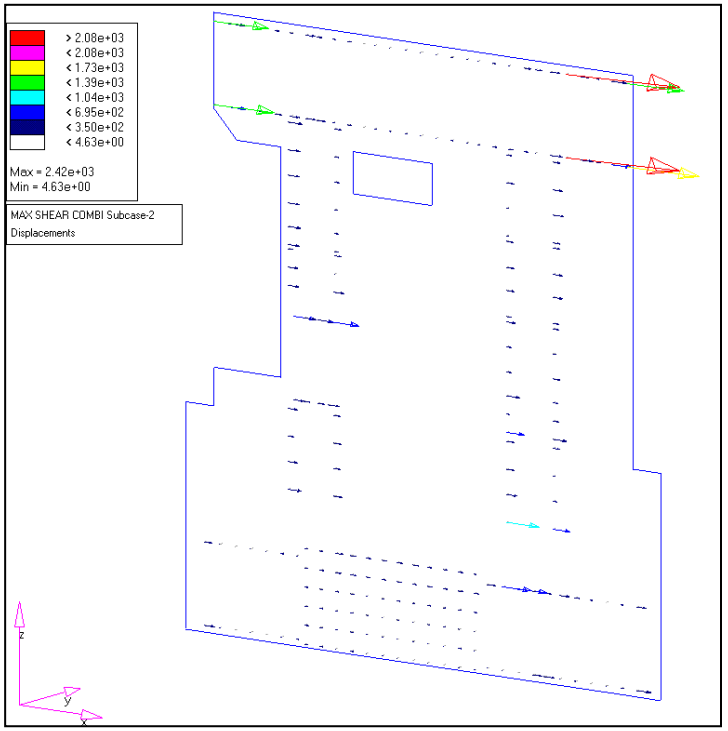
Mid Bracket Design

Sandwich Insert max. Shear Load

Current Design:
max. insert shear load $F_{amax} \approx 6700$ N



alternate Design:
max. insert shear load $F_{amax} \approx 2400$ N



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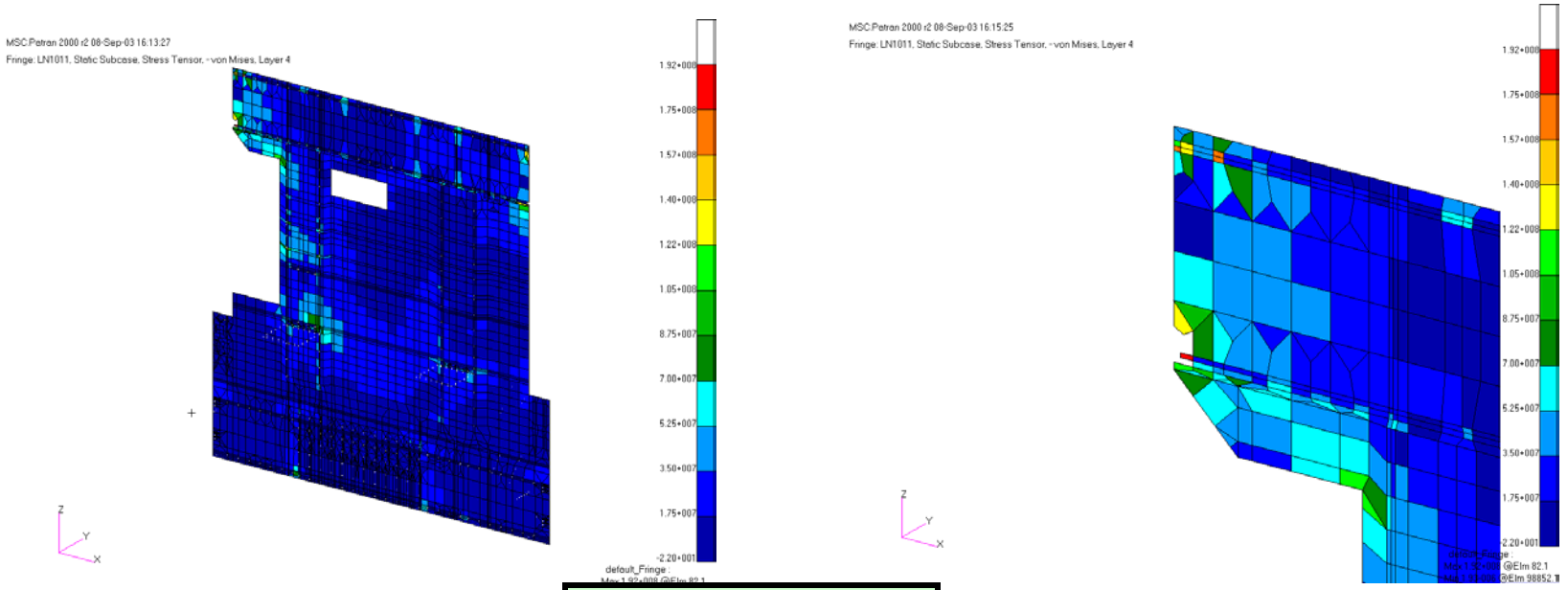
  - 11) Titanium Bracket

OPTION 2 – SKINS STATUS



SKINS	
MPa	MoS
192	0.11

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 383 MPa; for the analysis of the removed elements see the PANEL INSERT analysis, next slide.

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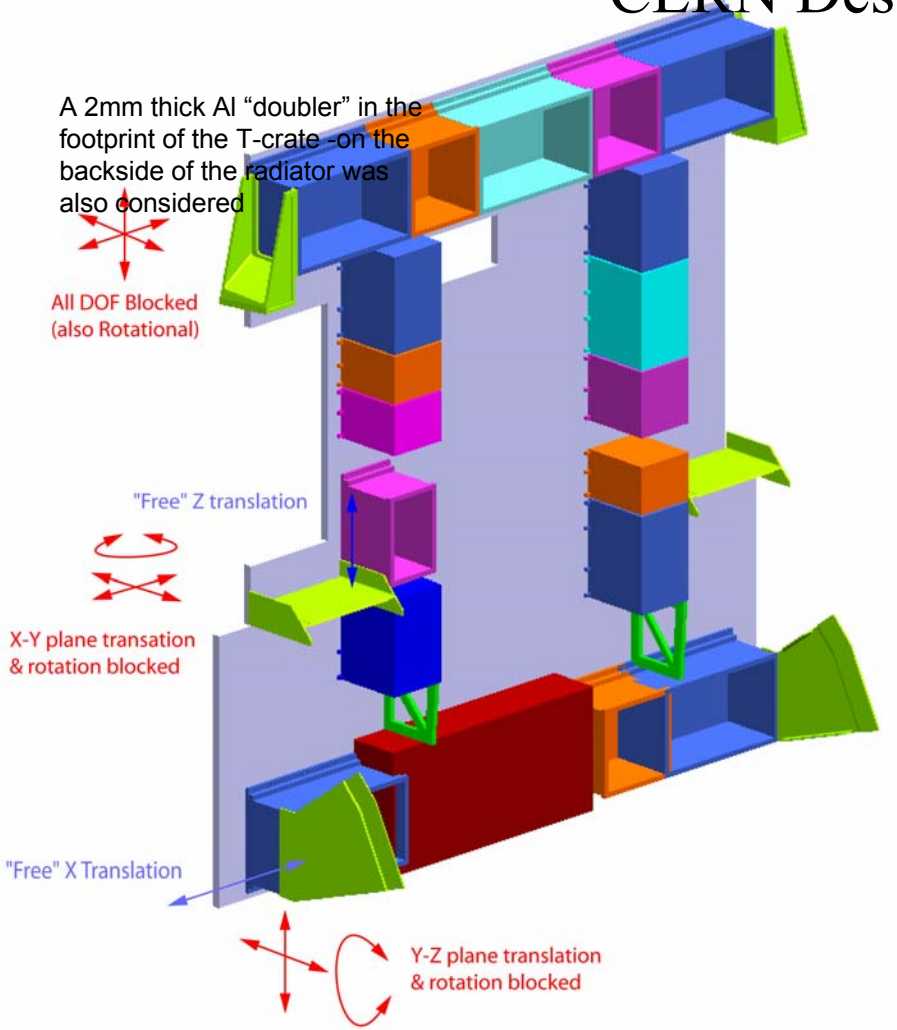
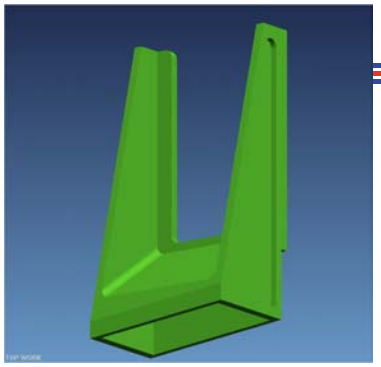
CERN Design Idea

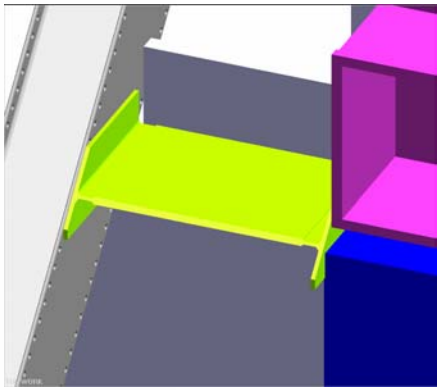




Top bracket

As shown:~2.1 Kg + bolts

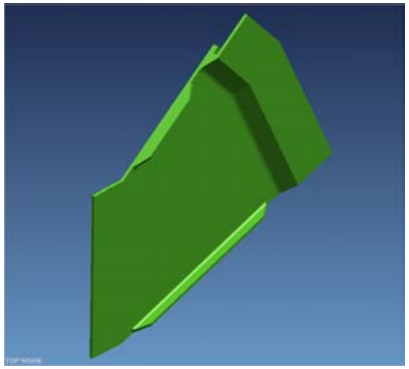
FEM results indicate a lighter option might be possible



Mid bracket

More detailed design in work

? Kg



Lower plate

As shown:

~2 Kg + bolts

All brackets need a more detailed design & more analysis!

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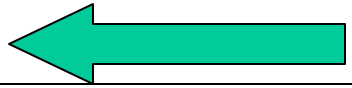
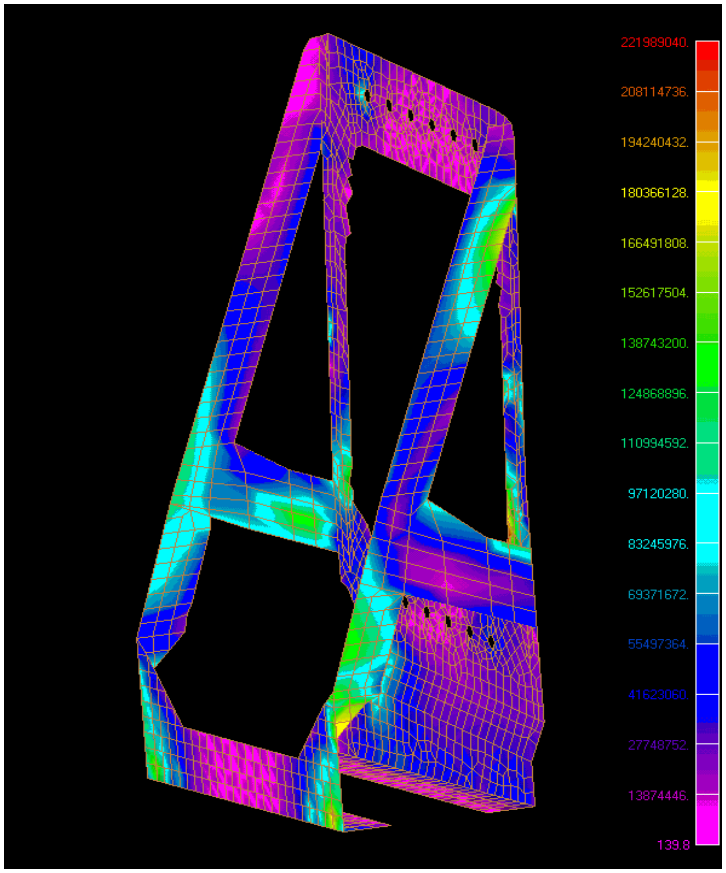
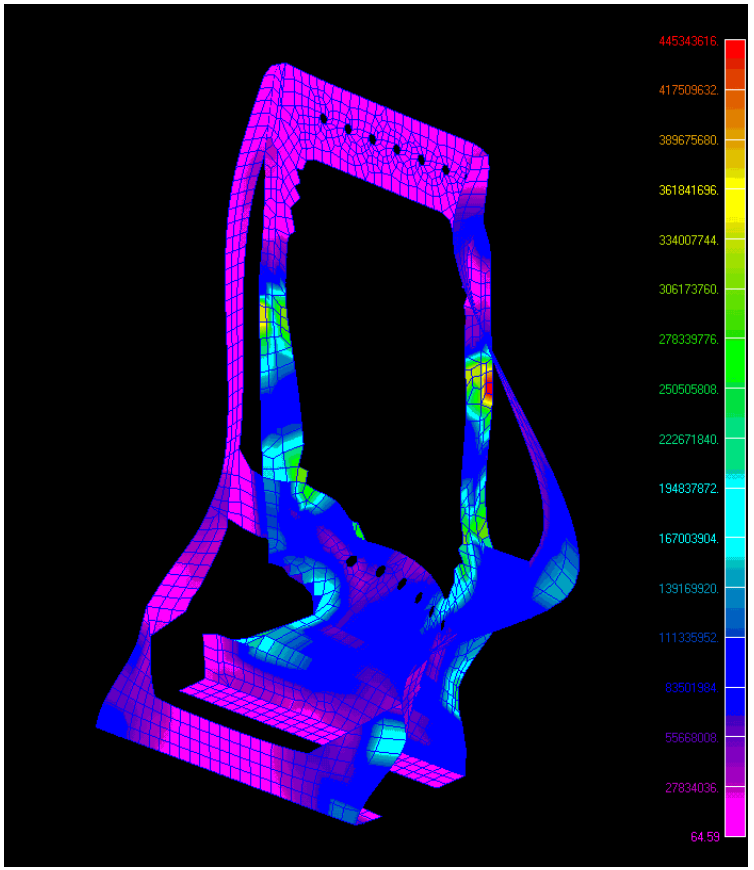


Upper bracket comparison (equal MoS)





COMPARISON DATA

- Aluminium solution

Mass : 3.195 Kg
Max stress : 222 N/mm^2
MoSy: 0.44
MoSu: 0.01
freq: 32.2 Hz

- Titanium solution 2

Mass : 0.96 Kg
Max stress : 445 N/mm^2
MoSy: 0.55
MoSu: 0.07
freq: 24.1 Hz*

*Buckling analysis has not been done

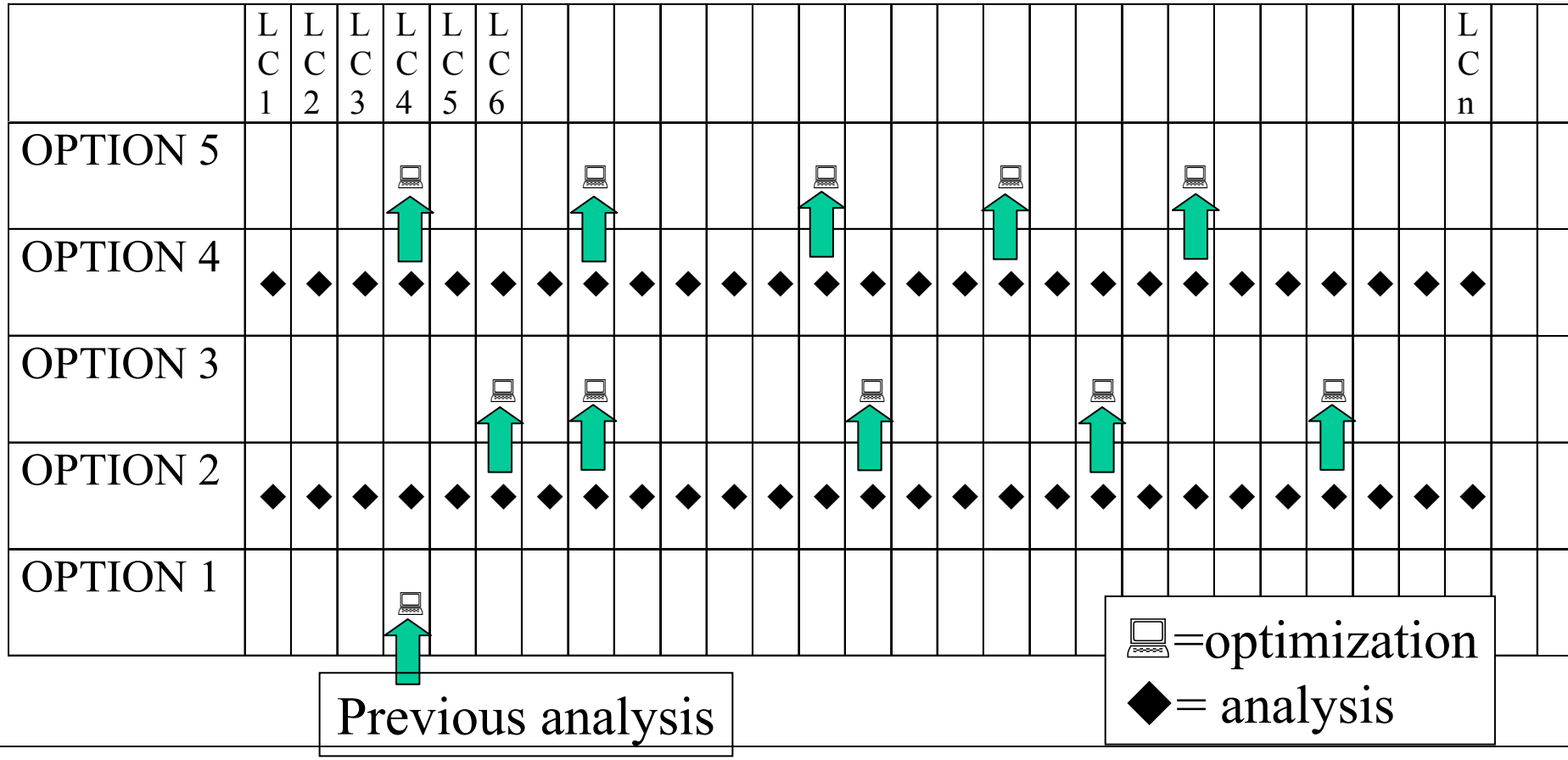
Comments on titanium brackets

- Titanium brackets, when optimized, are very light but
  - are too soft, and therefore provide a first frequency of the radiator very low (24 Hz)
  - ribs 1 mm thick can show local buckling instability problems
- In conclusion, titanium option will be no more considered

Conclusions

LOAD CASES AND OPTIONS

(how many cases are representative?)



Procedure for future analysis

- All 128 load cases must be considered at the same time
- Format results as per following table

Configuration number	Mass [kg]	Mass saving reached [kg]	First Freq. [Hz]	LOAD CASE	MaxVM\MAXCOMBStress and force													
					SKINS		CRATES		XPD		intercrate LINKS		TOP BRACKET		MID BRACKET		Lower ROD	
					MPa	MoS	MPa	MoS	MPa	MoS	MPa	MoS	MPa	MoS	MPa	MoS	MPa	N
BASELINE 1	334.6	0	51															

- Propose insert design to withstand loads calculated

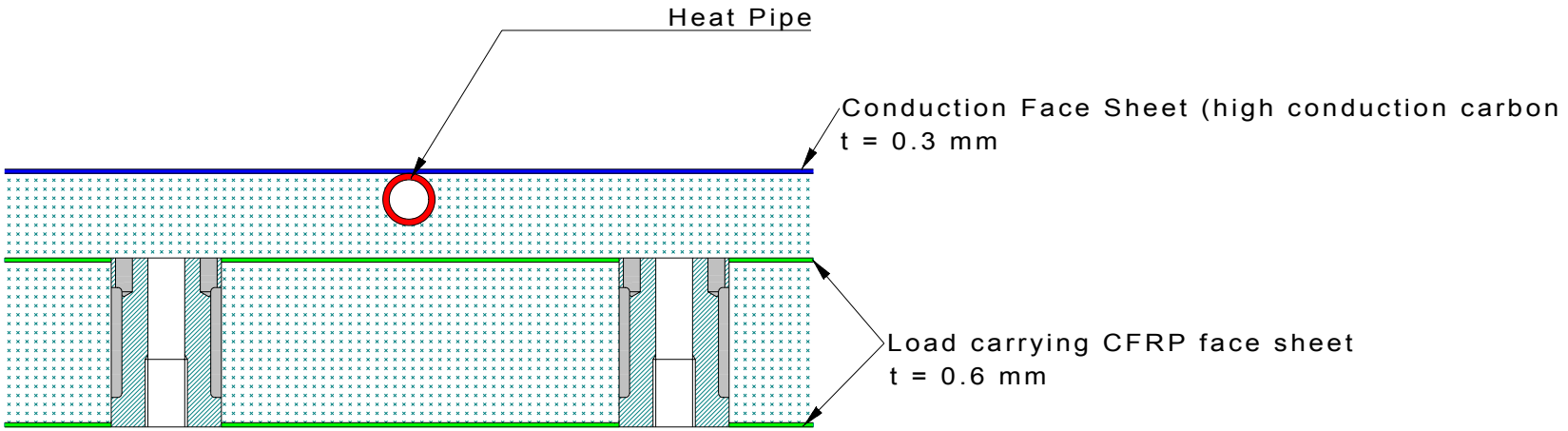
CONCLUSIONS - Check list

Parameter	Expected value	Actual value
MoS Inserts loads	>=0 (see table, prev. Page) <= 4000 N (TBC by OHB)	
Mass	WAKE 267 Kg RAM 255 Kg (TBC by CGS))	
Frequency	Best >50Hz Acceptable 30-50 Hz	

Other options: zenith radiator (see next slide)

Additional mass saving: carbon fiber zenith radiator

Mass Reduction Zenith Radiator



- Current design with aluminum face sheets

- Alternative design with CFRP face sheets could safe a mass of ~10 kg
  Detailed Analyses (thermal and structural) are required

Open points

- Still TBD when new results from LMSO are needed from the CLA (Coupled Load Analysis)
  - Discussion planned before end of September in dedicated telecon