AMS 02 RADIATORS MASS REDUCTION

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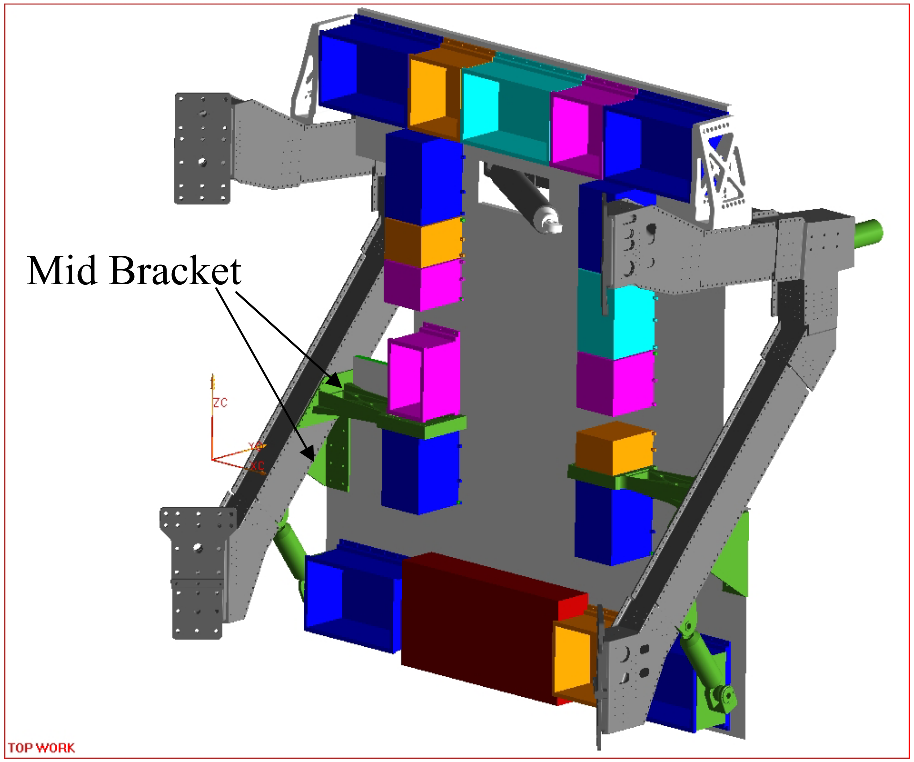
OHB-System

Mid Bracket Design

One of the major design driver is the radiator panel insert load as a result of enforced interface displacements (coupled load analysis)

An approach to reduce the effects of enforced interface displacement is to minimise the contrained DOF's

The current design has:
- 2 x 6 DOF at upper bracket I/F
- 4 x 6 DOF at mid bracket I/F
- 2 x 1 DOF at lower bracket I/F

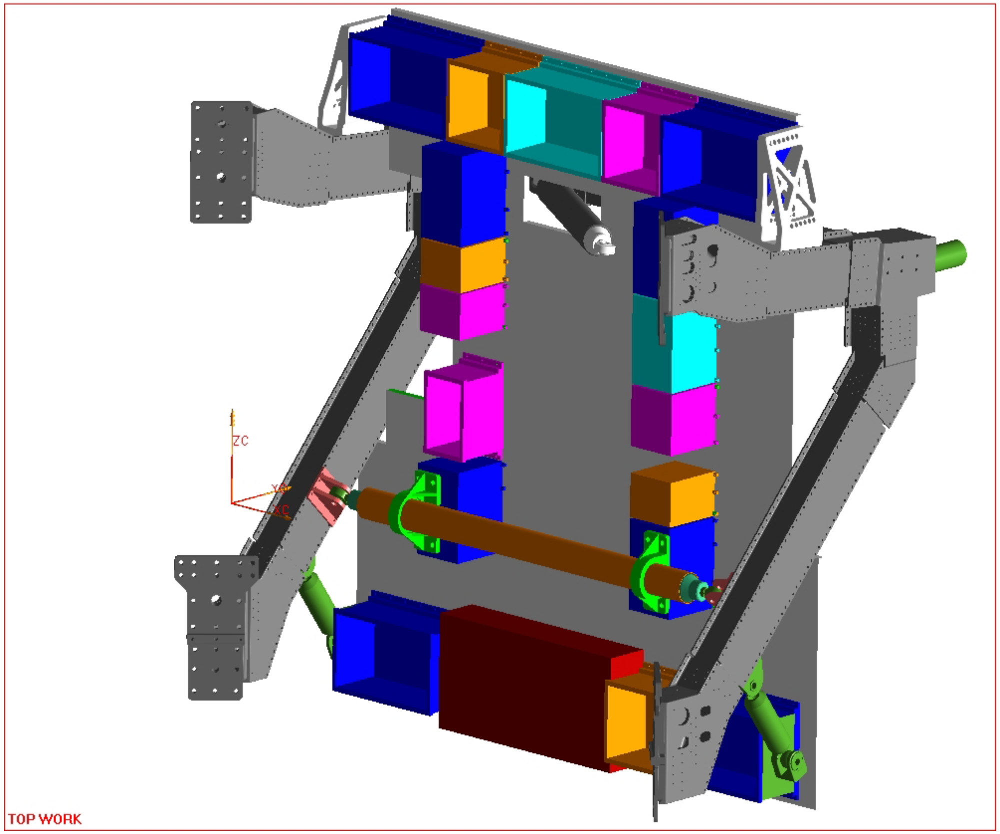


Mid Bracket Design

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

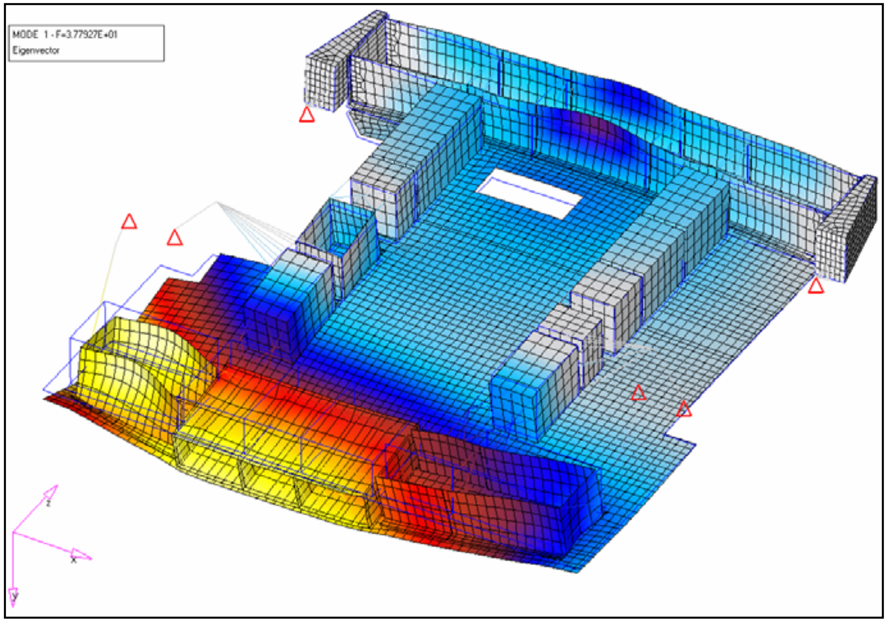
The alternate design has:
- 1 x 6, 1 x 5 DOF at upper bracket I/F
- 1 x 3, 1 x 2 DOF at mid bracket I/F
- 2 x 1 DOF at lower bracket I/F



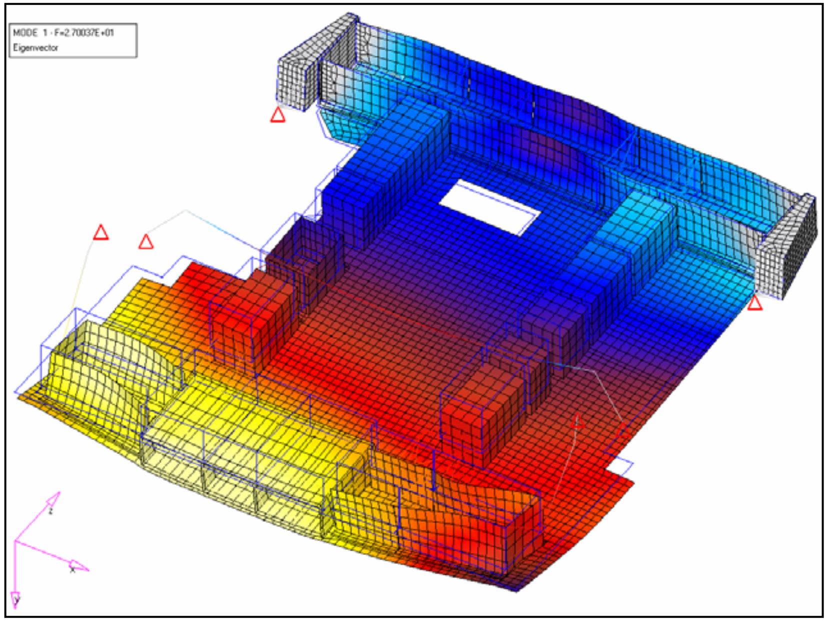
Mid Bracket Design

Natural Frequency

Current Design: f_1 = 37.7 Hz



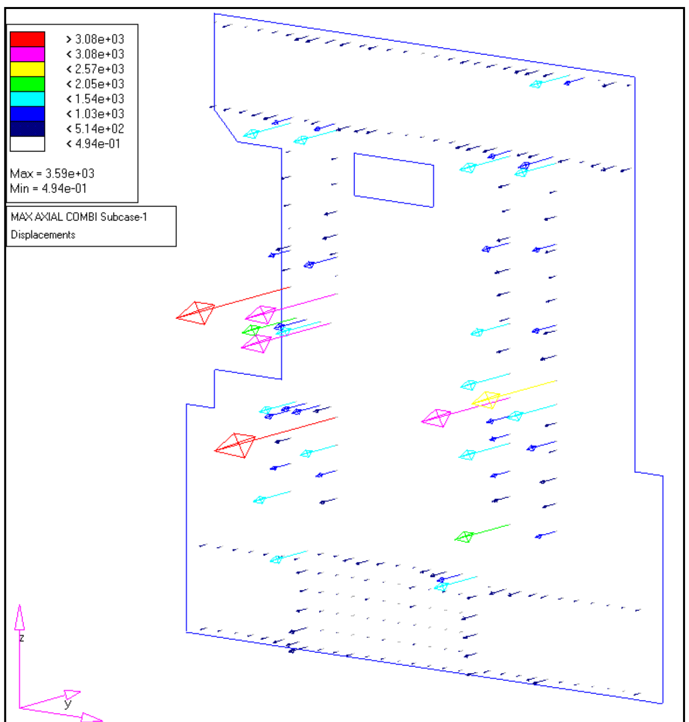
Alternate Design: f_1 = 27.0 Hz



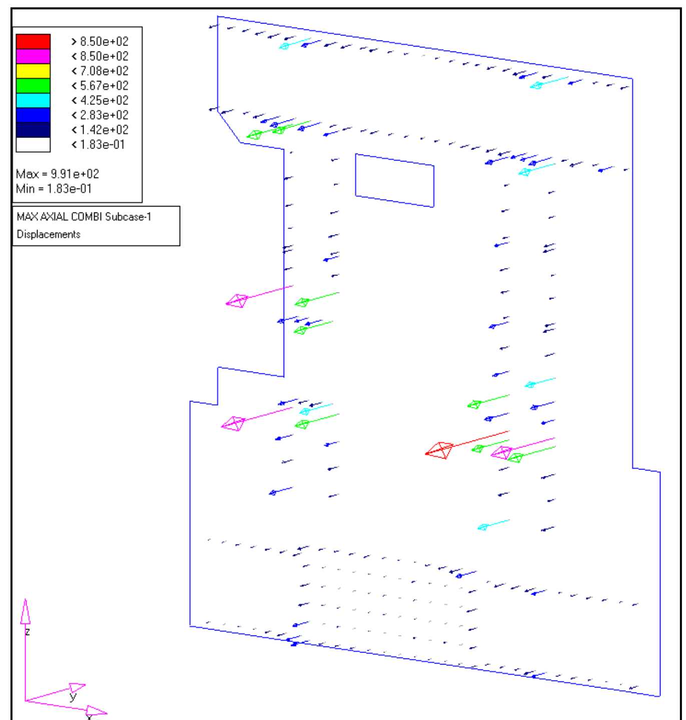
Mid Bracket Design

Sandwich Insert max. Axial Load

Current Design:
max. insert axial load $F_{amax} \approx 3600$ N



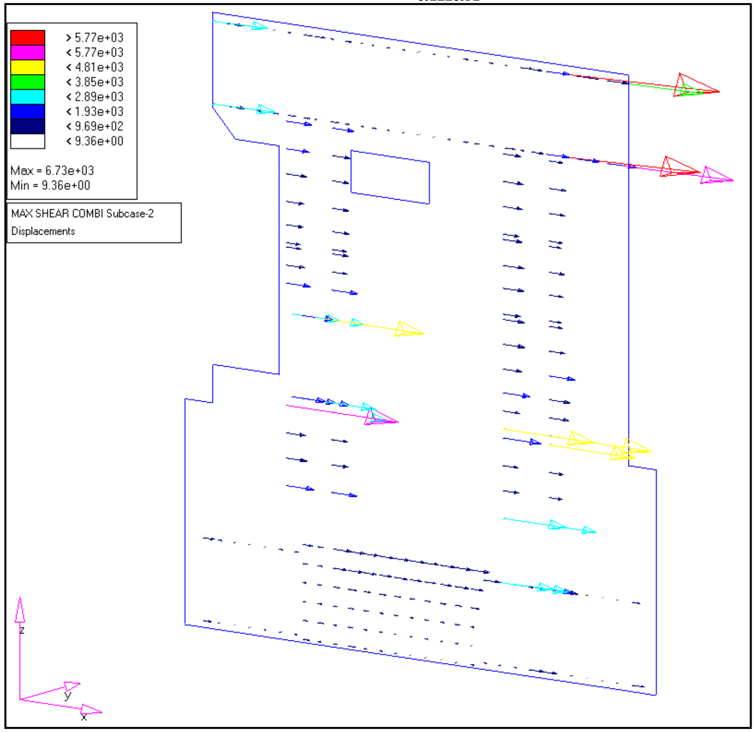
alternate Design:
max. insert axial load $F_{amax} \approx 1000$ N



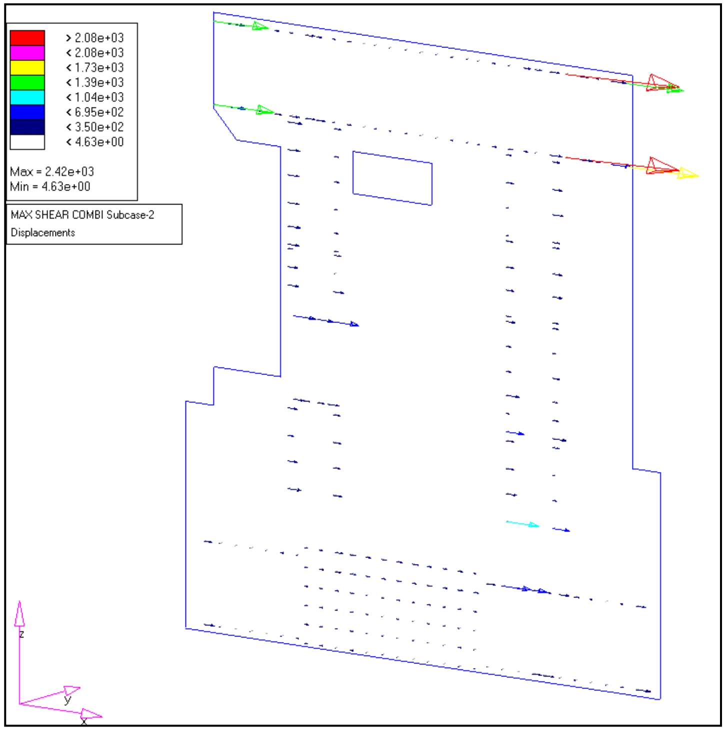
Mid Bracket Design

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



Mid Bracket Design

Mid Bracket Mass Estimate

Current Design:
$m_{total} \approx 19$ kg (from FE-Model)

Alternate Design: Aluminum
$m_{tube} \approx 6$ kg
$m_{brackets} \approx 5$ kg
$m_{total} \approx 11$ kg

Mass saving: ≈ 8 kg

Alternate Design: CFRP
$m_{tube} \approx 4$ kg
$m_{brackets} \approx 3$ kg
$m_{total} \approx 7$ kg

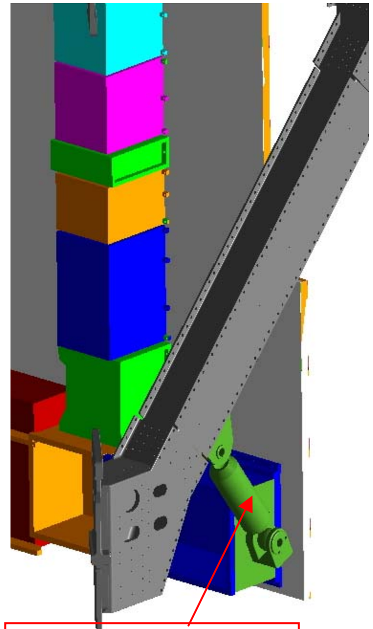
Mass saving: ≈ 12 kg

Mass Reduction of Lower Bracket (ROD)

Current Design				
Material / Safety Factor	Material		-	7075
	youngs module	E	N/mm^2	71000
	ultimate strength	σu	N/mm^2	414
	yield strength	σy	N/mm^2	324
	Safety Factor ultimate	ju	-	2,00
	Safety Factor yield	jy	-	1,25
	Density	rho	kg/mm^3	2,80E-06
Geometry	total length	l_k	mm	354
	tube length	l_{tube}	mm	194
	outer Diameter	Da	mm	80
	inner Diameter	Di	mm	70
	cross section	A	mm^2	1178
	moment of inertia	I	mm^4	832031
	max compression force	Fc	N	20000
Strength	Tube stress	σ_c	N/mm^2	17,0
	Margin of Safety ultimate	Msu	-	11,2
	Margin of Safety yield	Msy	-	14,3
Buck	critical buckling force	F_{buck}	π^2*E*I/lk^2	4652551
	Margin of Safety buckling	Msb	-	115
	Mass of Tube (2x)	m_t	kg	1,280

Alternative 1 (reduced tube cross section)				
Material / Safety Factor	Material		-	7075
	youngs module	E	N/mm^2	71000
	ultimate strength	σu	N/mm^2	414
	yield strength	σy	N/mm^2	324
	Safety Factor ultimate	ju	-	2,00
	Safety Factor yield	jy	-	1,25
	Density	rho	kg/mm^3	2,80E-06
Geometry	total length	l_k	mm	354
	tube length	l_{tube}	mm	194
	outer Diameter	Da	mm	25
	inner Diameter	Di	mm	22
	cross section	A	mm^2	111
	moment of inertia	I	mm^4	7676
	max compression force	Fc	N	20000
Strength	Tube stress	σ_c	N/mm^2	180,6
	Margin of Safety ultimate	Msu	-	0,15
	Margin of Safety yield	Msy	-	0,44
Buck	critical buckling force	F_{buck}	π^2*E*I/lk^2	42921
	Margin of Safety buckling	Msb	-	0,07
	Mass of Tube (2x)	m_t	kg	0,120

Alternative 2 (CFRP Tube)				
Material / Safety Factor	Material		-	CFRP
	youngs module	E	N/mm^2	100000
	ultimate strength	σu	N/mm^2	700
	yield strength	σy	N/mm^2	N/A
	Safety Factor ultimate	ju	-	2,00
	Safety Factor yield	jy	-	1,25
	Density	rho	kg/mm^3	1,60E-06
Geometry	total length	l_k	mm	354
	tube length	l_{tube}	mm	194
	outer Diameter	Da	mm	25
	inner Diameter	Di	mm	23
	cross section	A	mm^2	75
	moment of inertia	I	mm^4	5438
	max compression force	Fc	N	20000
Strength	Tube stress	σ_c	N/mm^2	265,3
	Margin of Safety ultimate	Msu	-	0,32
	Margin of Safety yield	Msy	-	N/A
Buck	critical buckling force	F_{buck}	π^2*E*I/lk^2	42829
	Margin of Safety buckling	Msb	-	0,07
	Mass of Tube (2x)	m_t	kg	0,047



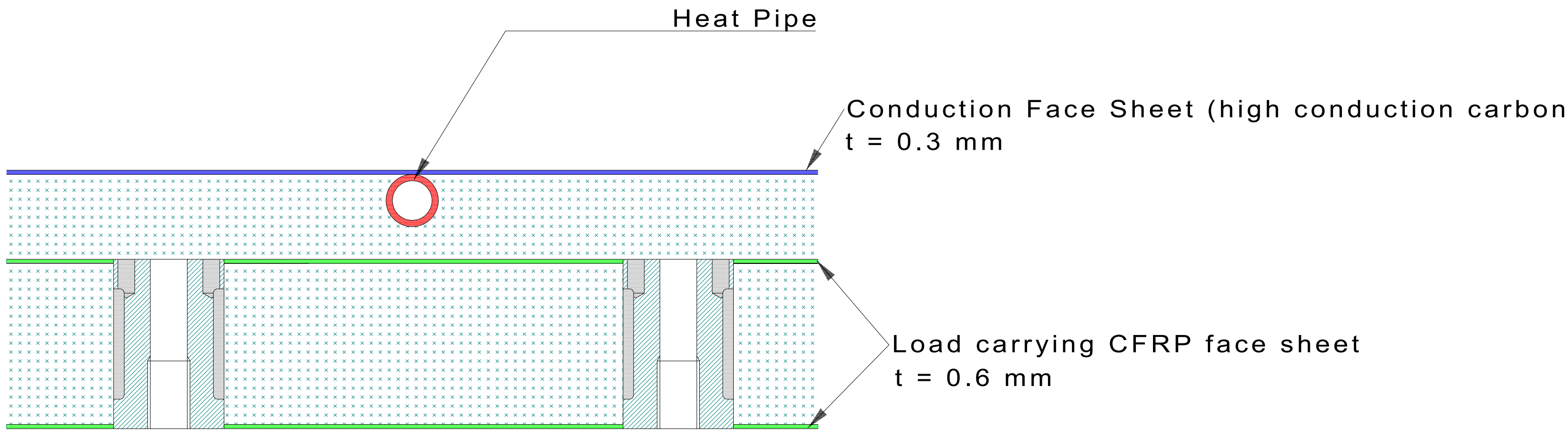
Lower Bracket Rod

1. Rod tube made of Aluminum with reduced cross section could safe a mass of ~ 1.1 kg
2. Rod tube made of CFRP with an additional reduction of cross section saves ~ 1.2 kg

Further mass reduction can be realized when smaller spherical bearing are used:

- MS14103-06 with inner diameter of 9.5 mm instead of 35 mm (Fu-radial = 60.000 N)
- Additionally bracket dimension could be reduced significantly in this case

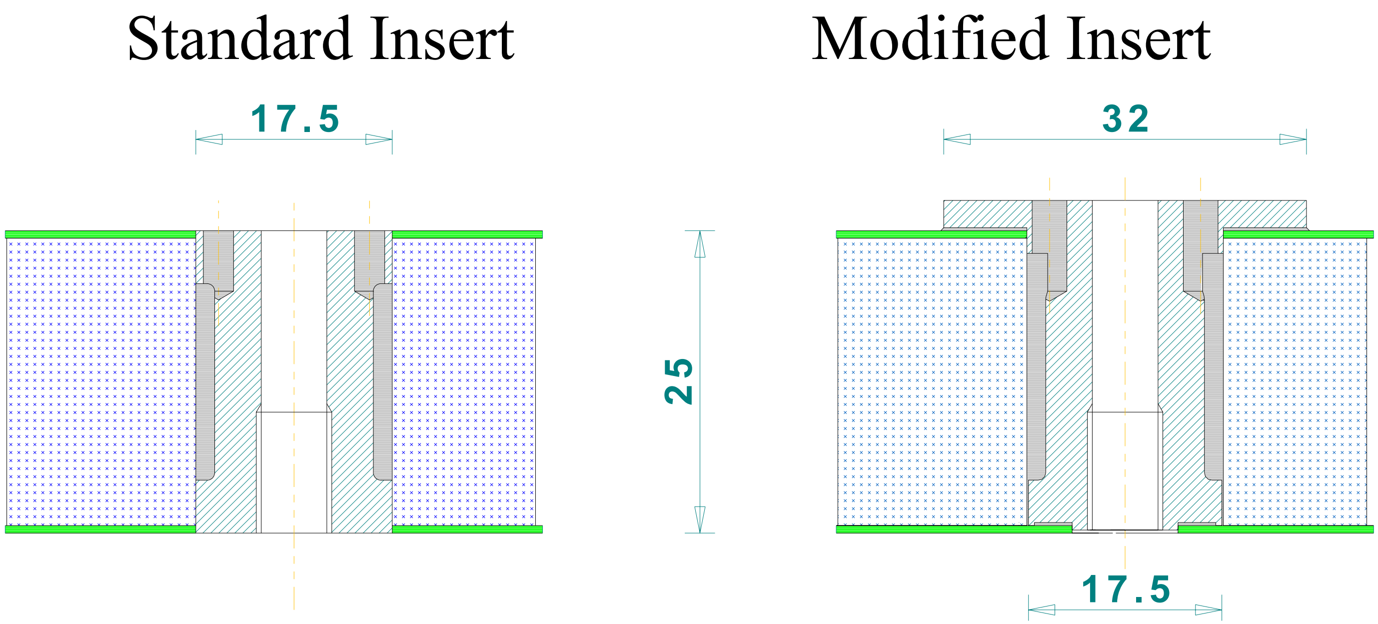
Mass Reduction Zenith Radiator



- 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

Sandwich Inserts



Allowable load from
ESA PSS-03-1202
- PSS = 1000 N
- QSS = 2800 N

Allowable load to be determined by detailed analysis and/or test

For a smaller insert (M5)
we measured:

PSS = 2800 N
QSS: not tested

Conclusion:
Using the modified insert, we can increase the load carrying capability significantly. In order to perform a relyable analytical verification, static tests should be carried out beforehand.