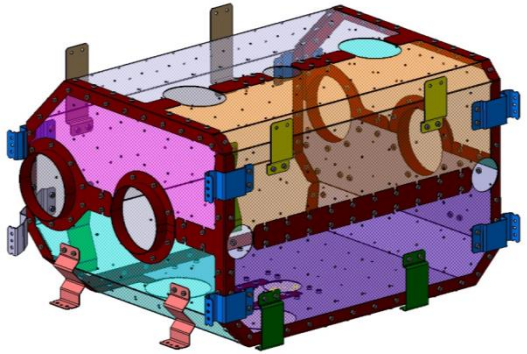
UK Update

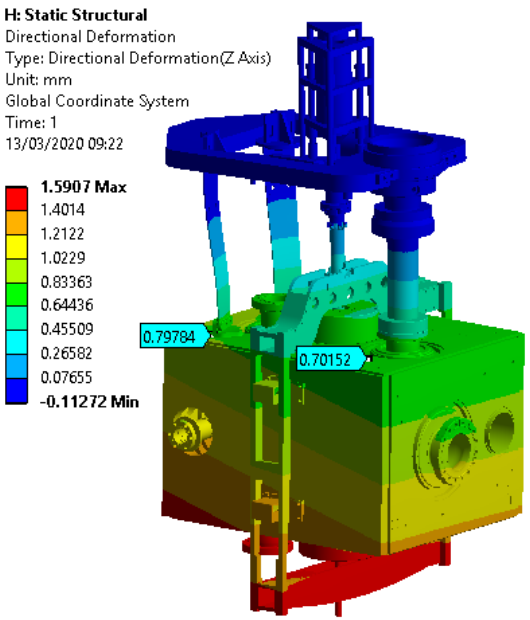
Niklas Templeton on behalf of the UK team

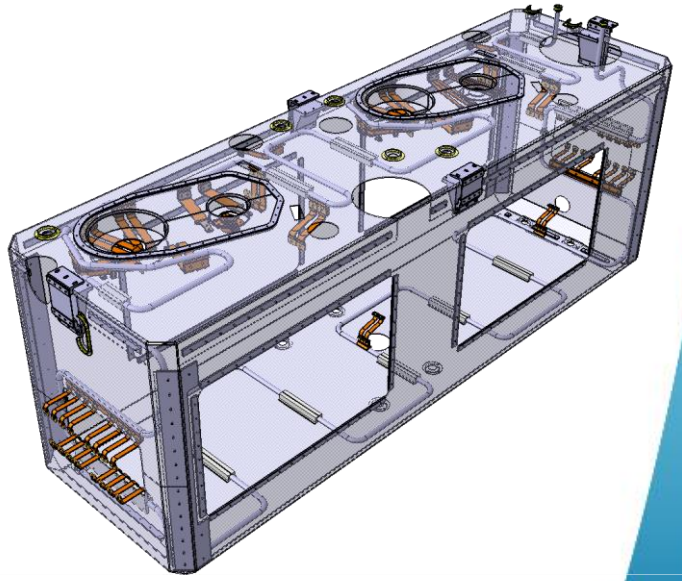
Global CC coordination meeting – Friday 13 March

UK Update

- Cold Magnetic Shields
- Warm Magnetic Shield
- Thermal Screen
- Cavity Support System
- Transport
- OVC Tender & Tooling

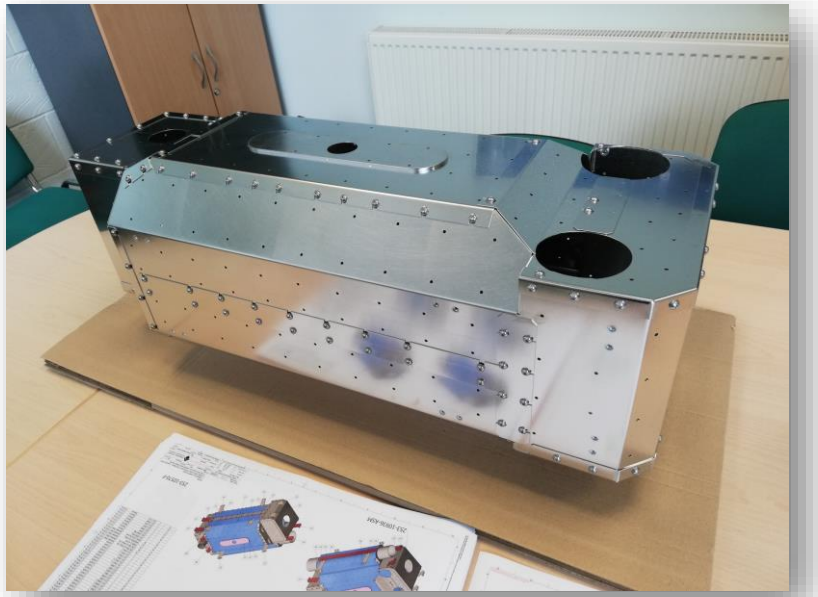






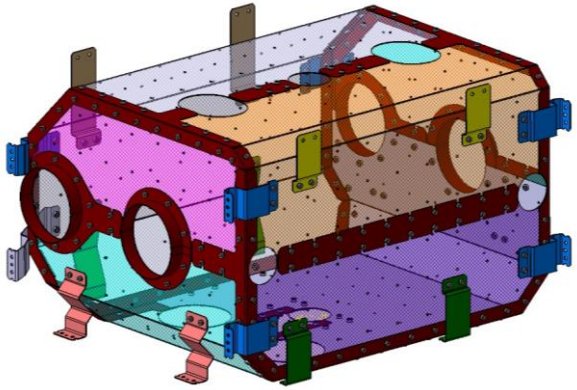
RFD Cold Magnetic Shields

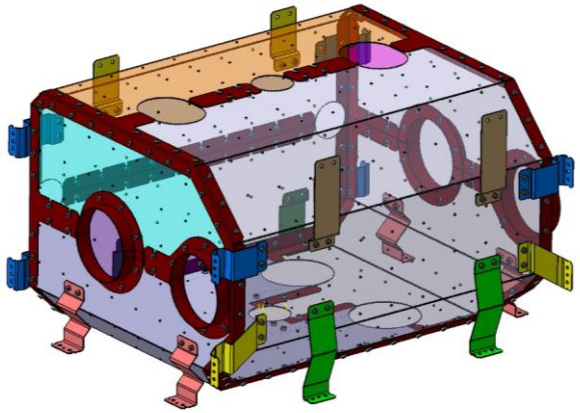
- 2 x RFD SPS cold magnetic shields manufactured by Magnetic Shields LTD
- Factory acceptance visit conducted on 26th of February
- Visual Inspection, Dimensional check & field measurements carried out – All OK
- Initial field measurement results show a shielding factor of up to 100 in the worst case orientation – significant improvement!
- Improved attenuation due to new dry hydrogen furnace



DQW COLD MAGNETIC SHIELD (PRE-SERIES)

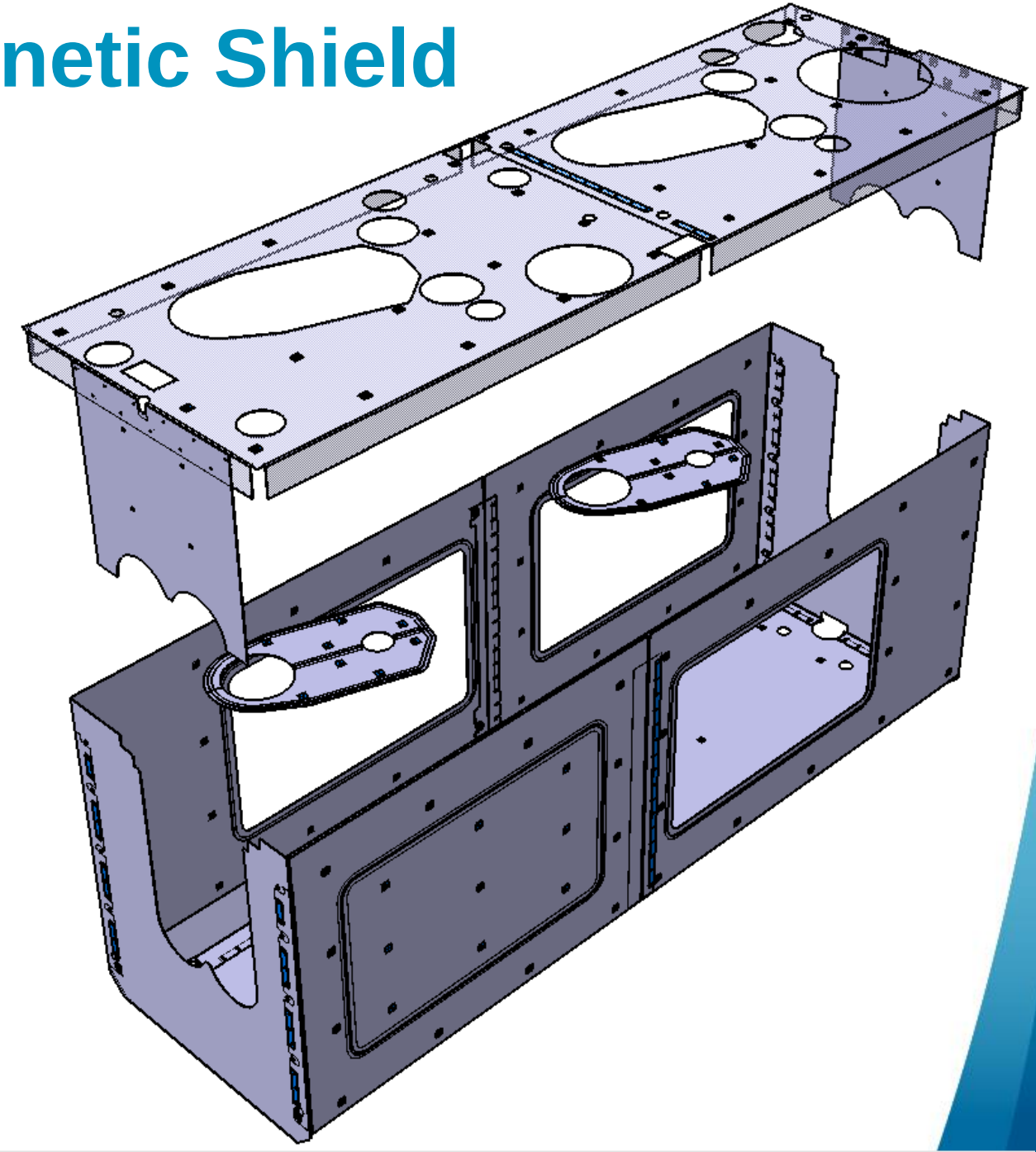
First 2 shields of the pre-series under manufacturing at Magnetic Shields Ltd.





Warm Magnetic Shield

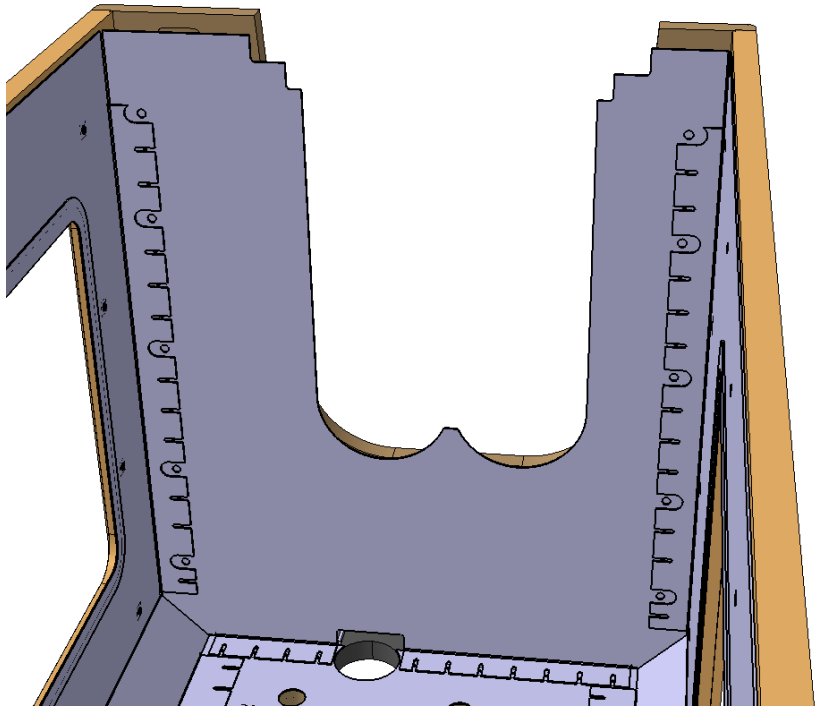
- Global MuMetal Shield @ 300 K
- Thickness = 2 mm (+ 1 mm spacers)
- Lower Assembly Lines OVC as second skin
  - Allows for OVC tolerance up to ±6 mm
- Upper Assembly mounted to Top Plate
- Underlap between Upper & Lower Assemblies
- Assemblies connected via EM gasket/spring fingers
- Mass: 182.7 kg

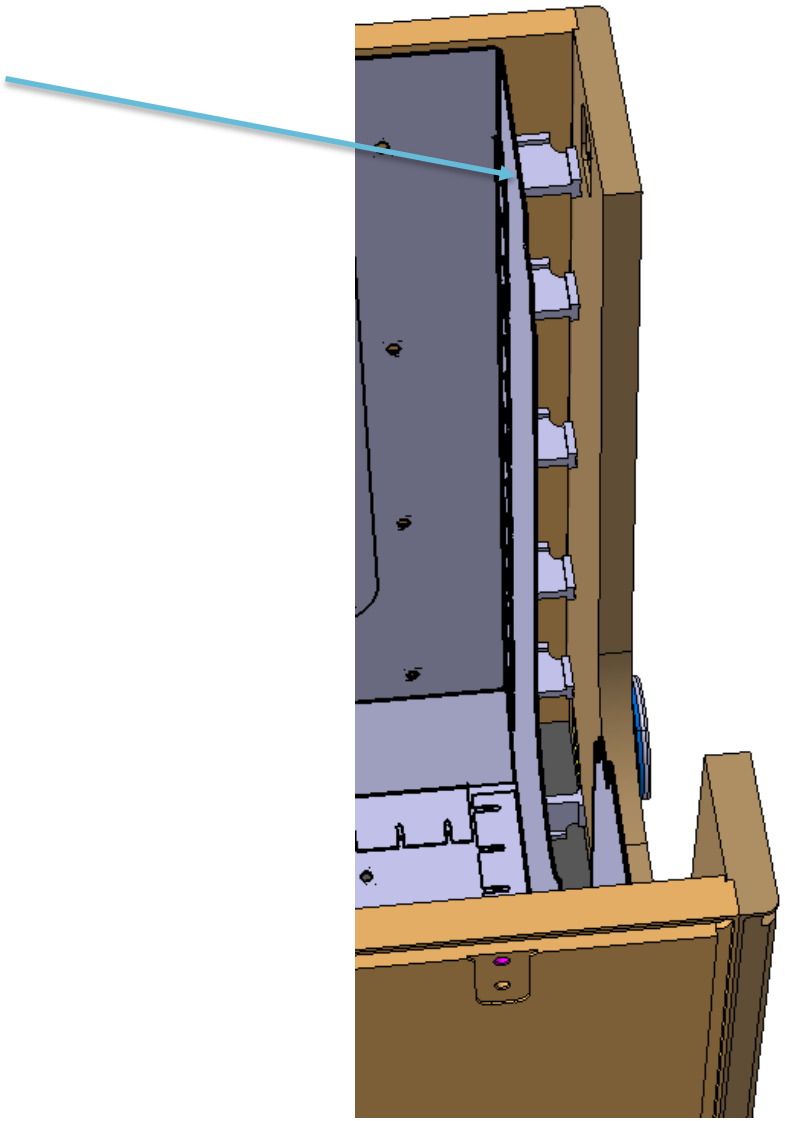


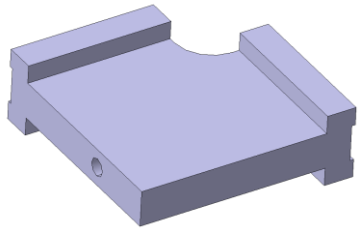
Warm Magnetic Shield

- Proposal to mount end panels off OVC stiffening webs

- Required webs to be modified
  - Remove chamfer
  - Add tapped hole
  - May need to increase thickness from 10 mm

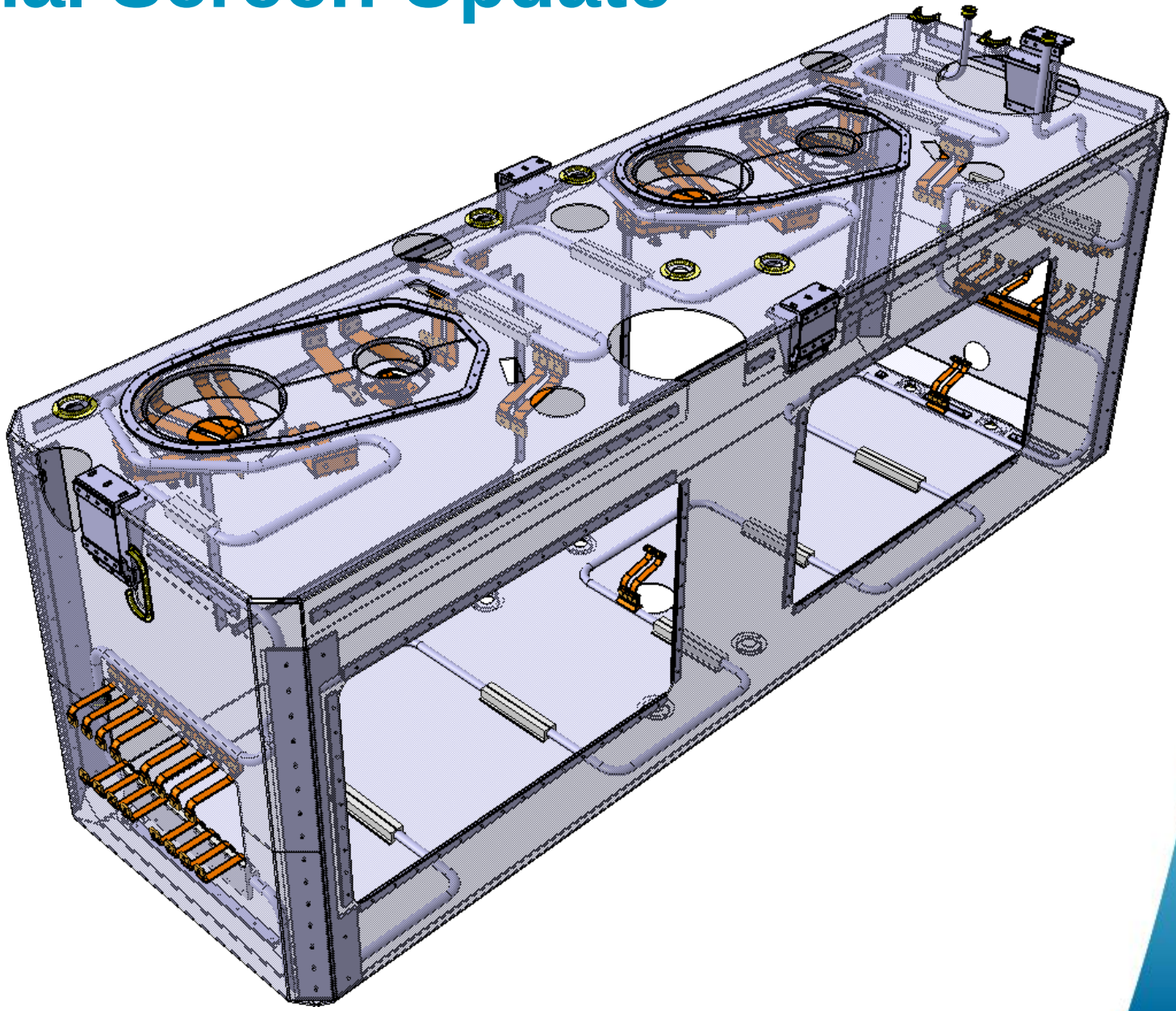






Thermal Screen Update

- Flexure & stiffener design
- Upper cooling circuit
- Lower cooling circuit
- FSI Bottom
- Pipe Transitions
- Thermalisation
- Heat loads taken from *EDMS 2310389*



Thermal Screen Update

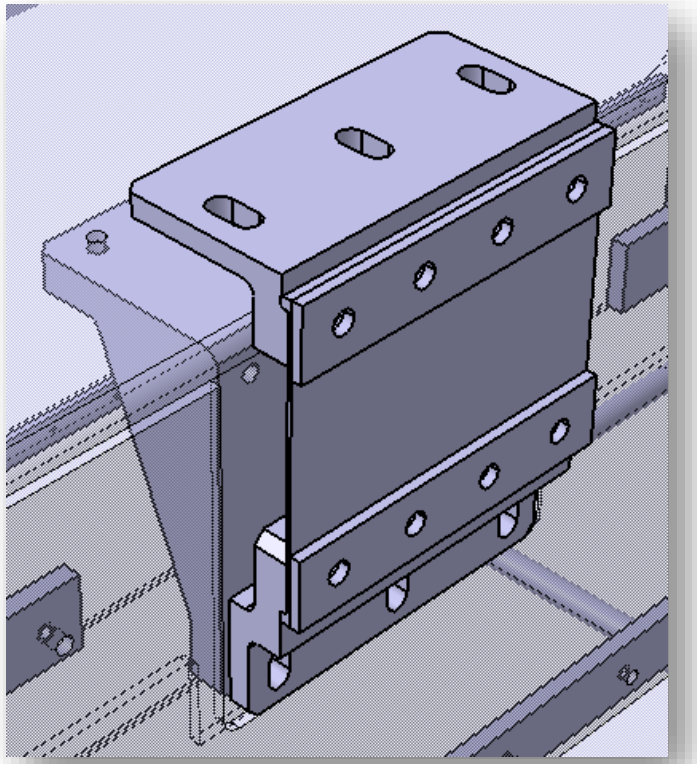
- Flexure & stiffener design updated
  - Machined from bulk
  - Alignment features added

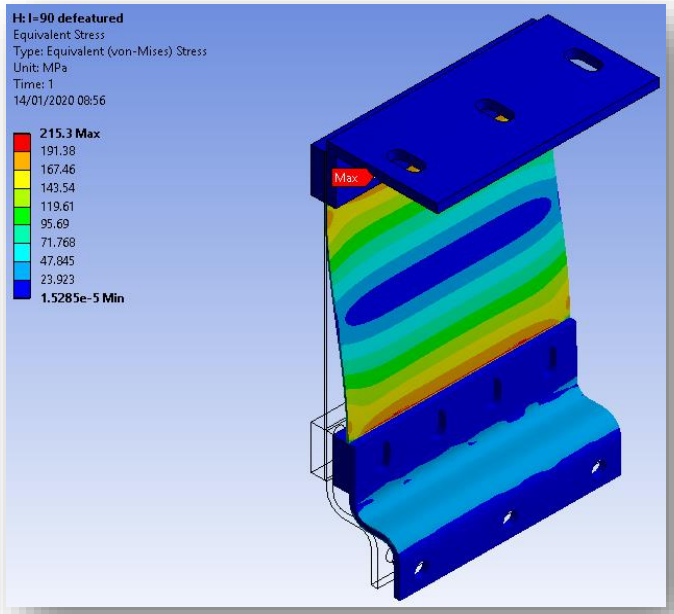
- Max Lateral Displacement: 1.6 mm
- Lateral Flexure Length: 47 mm

- Max Longitudinal Displacement: 5.1 mm
- Longitudinal Flexure Length: 90 mm

- Design Stress < 240 MPa

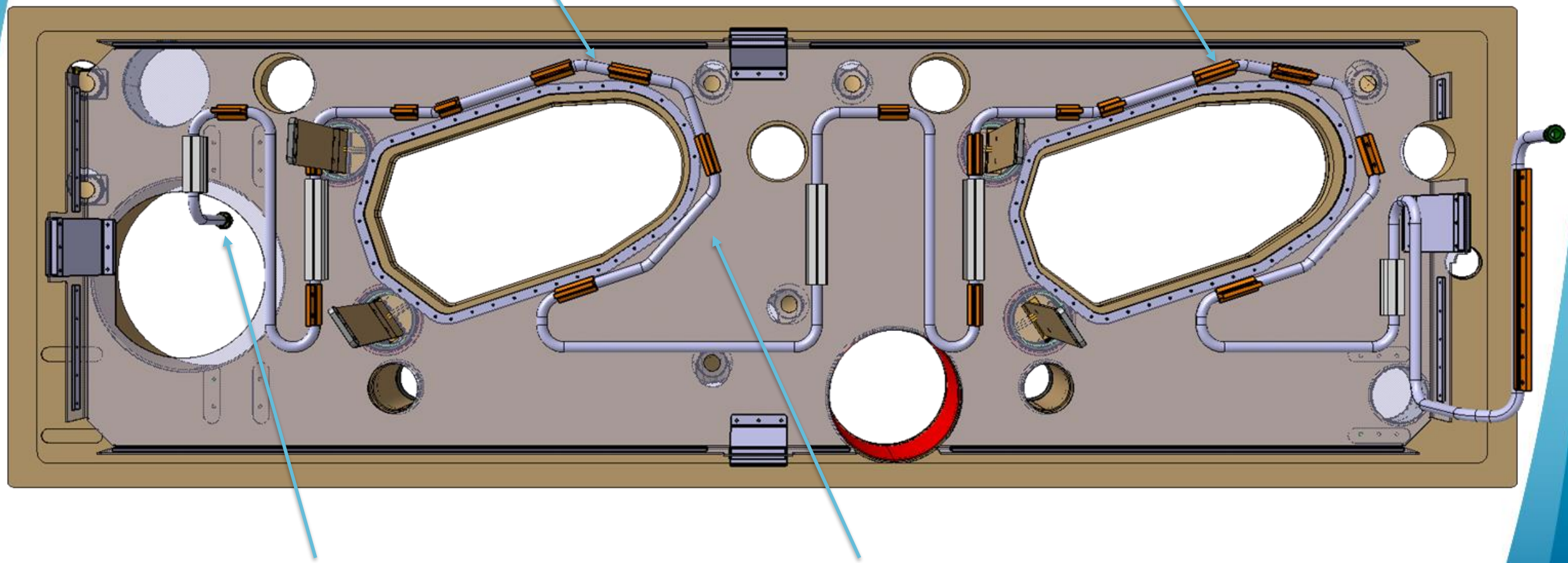
- Total Heat Leak Estimate (4 brackets): 6.3 W



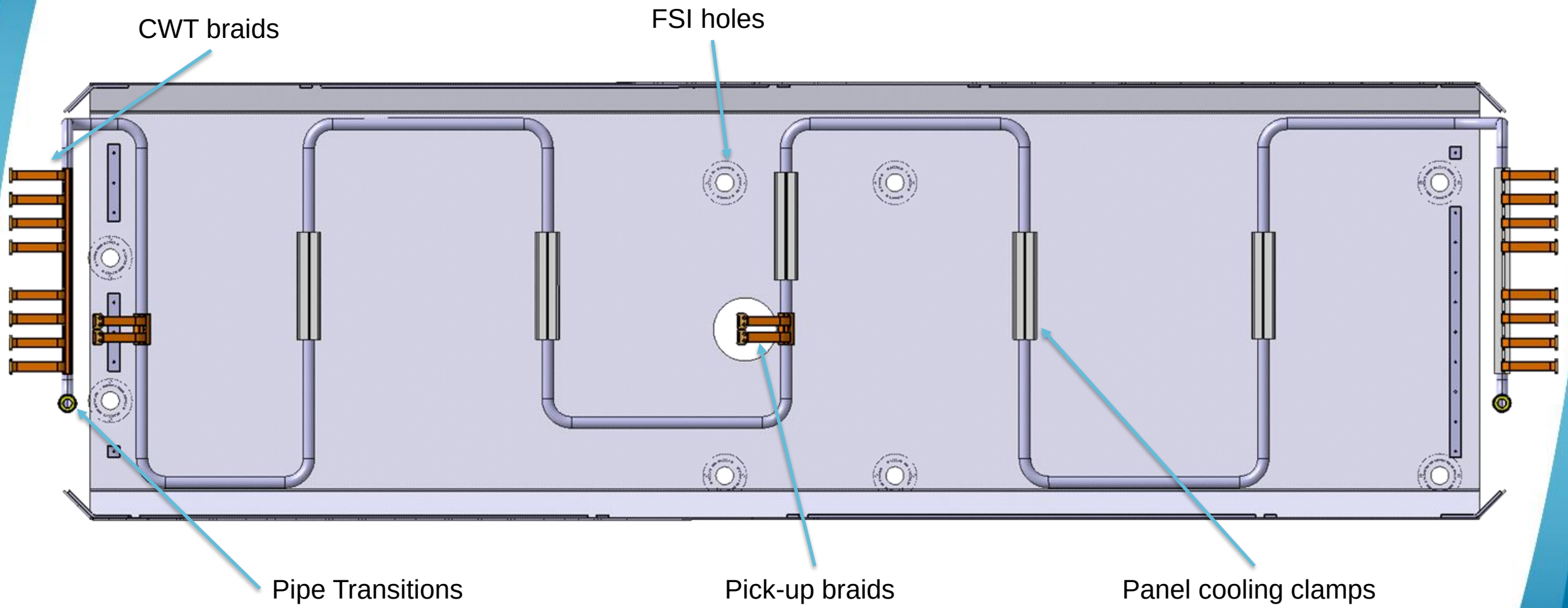


Flexure Geometry Longitudinal		
Length	90	mm
Width	100	mm
Thickness	1	mm
Second Moment of Area, I	8.33	mm^4
Section Modulus, Z	16.67	mm^3
Flexure Displacement		
Maximum Screen Length	2440	mm
$(L_{293}-L_{40})/L_{293}$	0.417	%
Max Flexure Displacement	5.1	mm
Material Young's Modulus, E	1.10E+11	Pa
Force Required, W	76.8	
Max Stress, S	**207.3**	MPa

Thermal Screen Upper Assembly

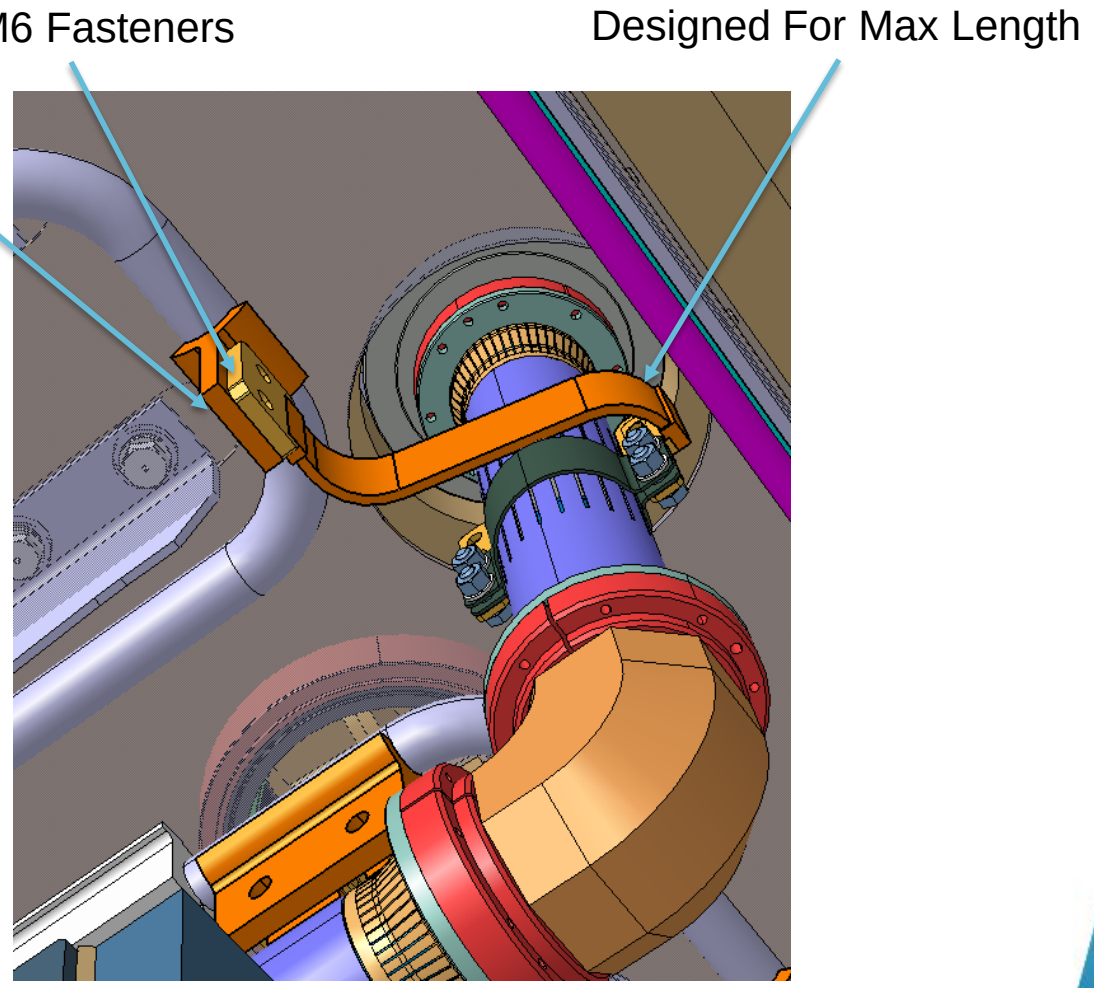


Thermal Screen Lower Assembly



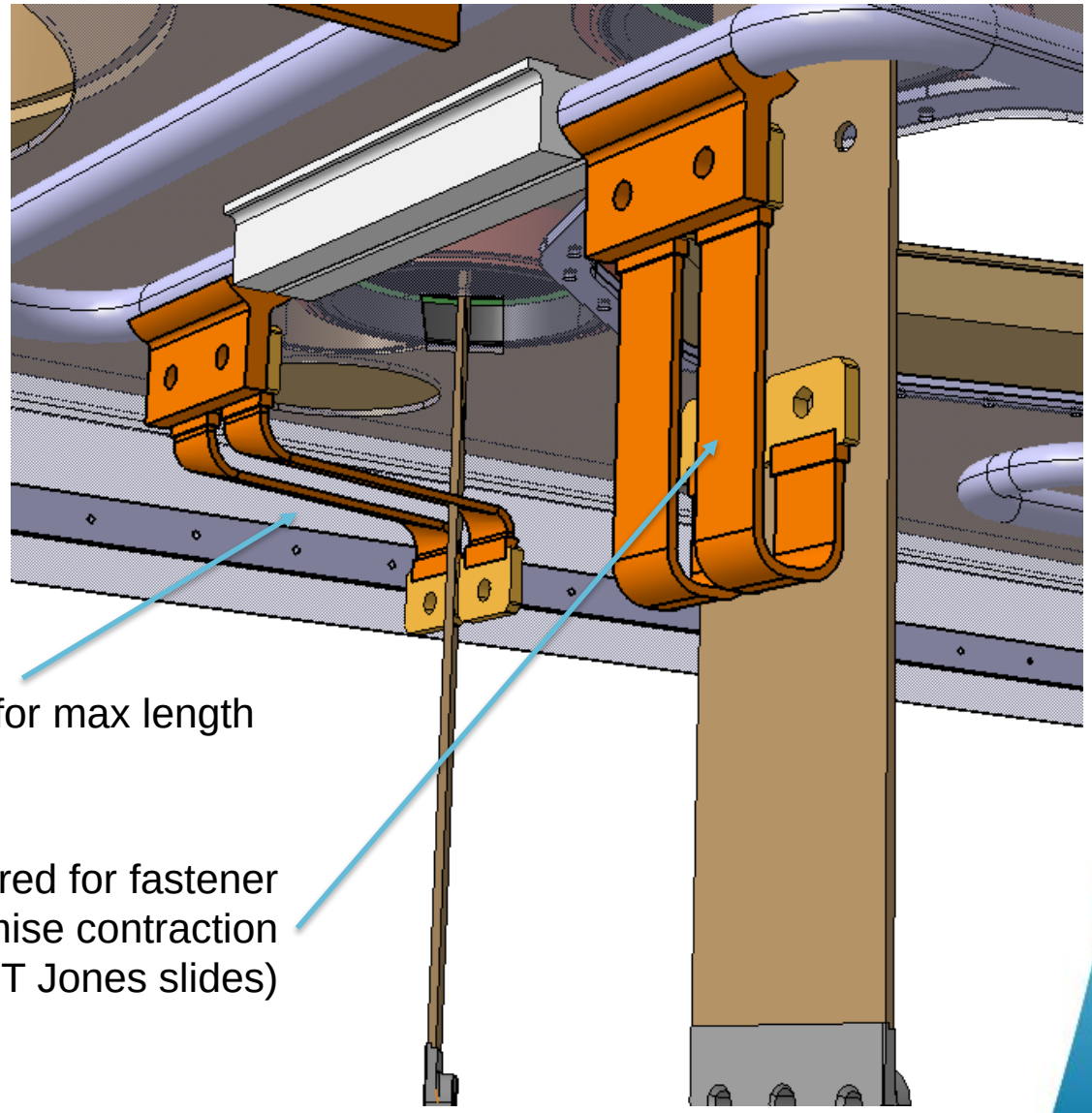
Thermalisation VHOM

- Heat Load to 80 K
  - Static: 7.8 W
  - Dynamic: 11.8 W
- No Braids: 4
- Heat Load / Braid: 4.9 W
- Braid Length: 130 mm
- Braid CSA: 40 mm^2 ← *Increased compared to DQW*
- Braid dT: 18.4 K



Thermalisation Blades

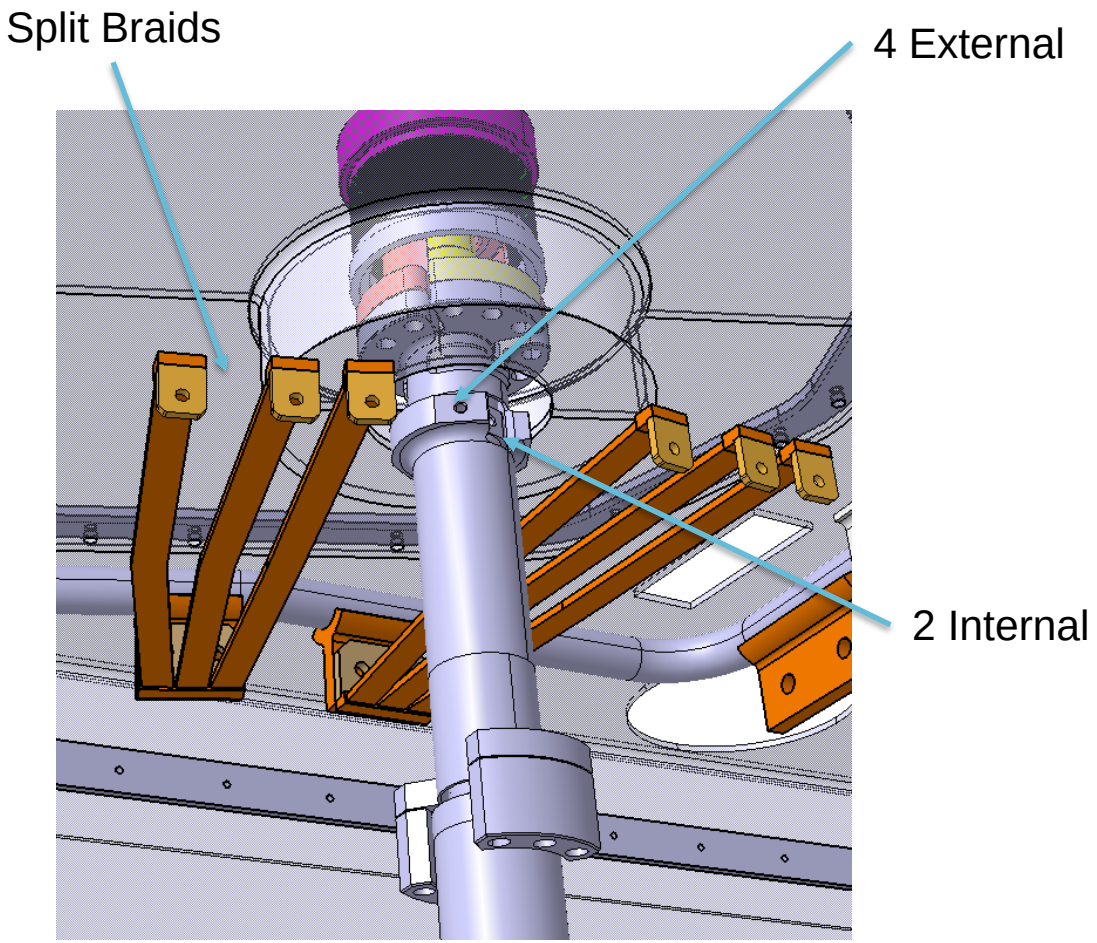
- Heat Load to 80 K: 20 W
- No Braids: 8
- Heat Load / Braid: 2.5 W
- Braid Length: 160 mm
- Braid CSA: 40 mm^2
- Braid dT: 11.6 K



Thermalisation Tuner – Option 1

Split Braid Option

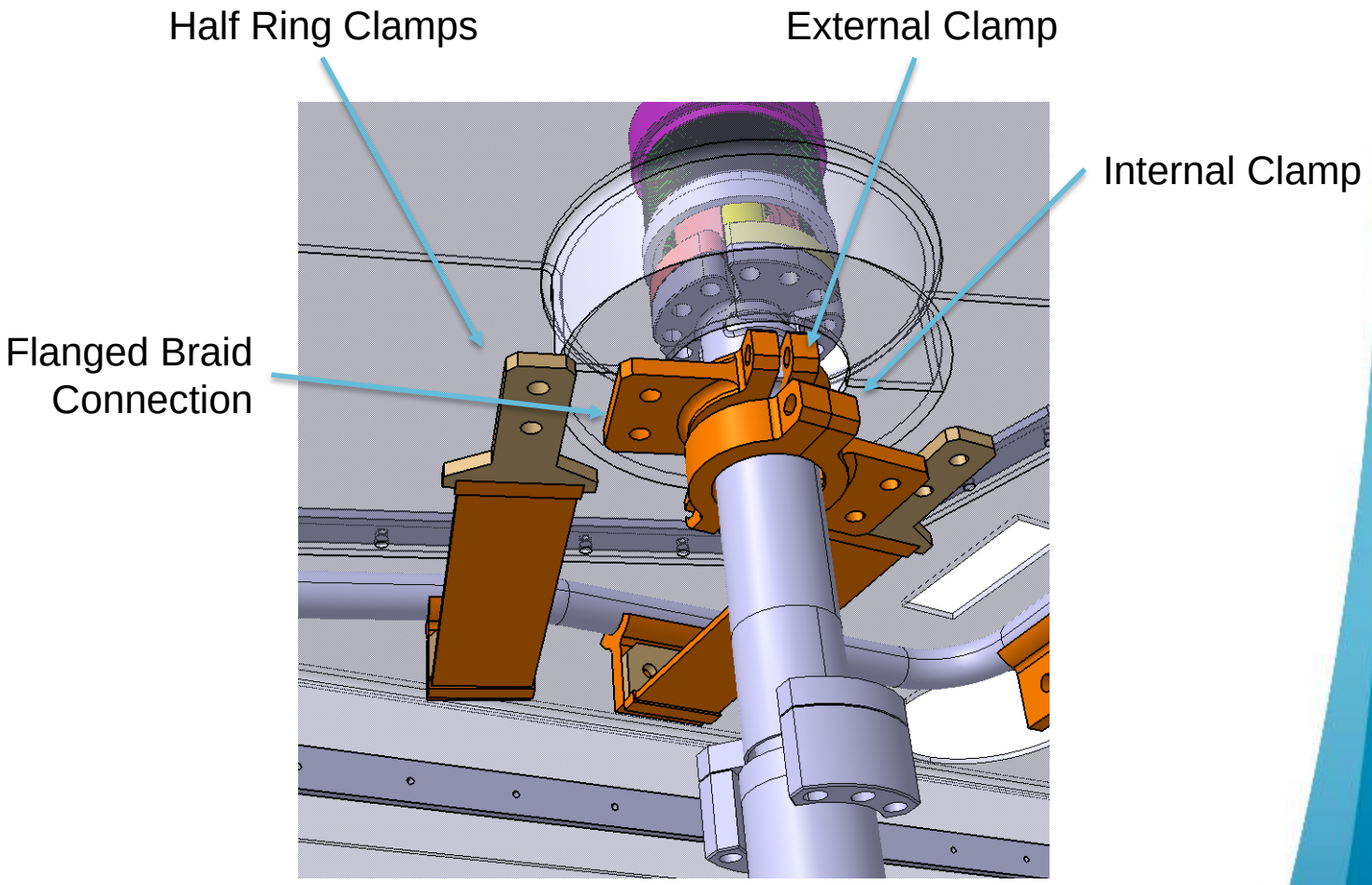
- Heat Load to 80 K: 7.3 W
- No Braids: 12
- Heat Load / Braid: 0.6 W
- Braid Length: 220 mm
- Braid CSA: 16 mm^2
- Braid dT: 9.7 K



Thermalisation Tuner – Option 2

Half Ring Clamp Option

- Heat Load to 80 K: 7.3 W
- No Braids: 4
- Heat Load / Braid: 1.8 W
- Braid Length: 150 mm
- Braid CSA: 40 mm^2
- Braid dT: 7.9 K



Thermalisation FPC

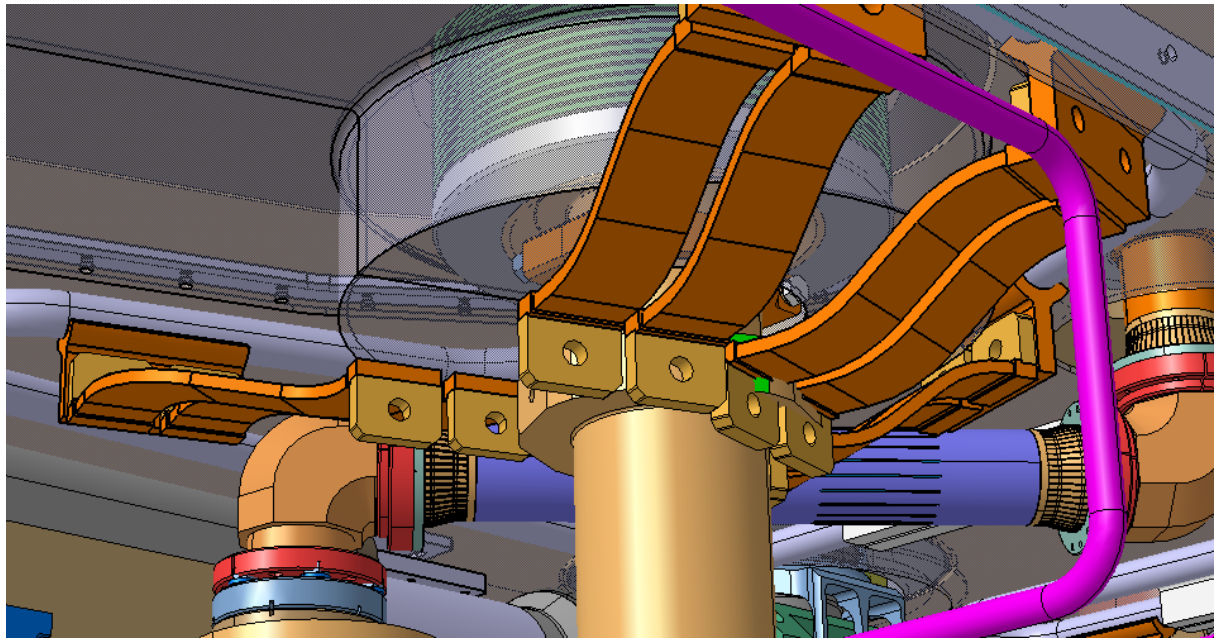
- Heat Load to 80 K
  - Static: 56 W
  - Dynamic: 65.2 W

Worst case SPS operation

- No Braids: 16
- Heat Load / Braid: 7.6 W
- Braid Length: 200 mm
- Braid CSA: 75 mm^2

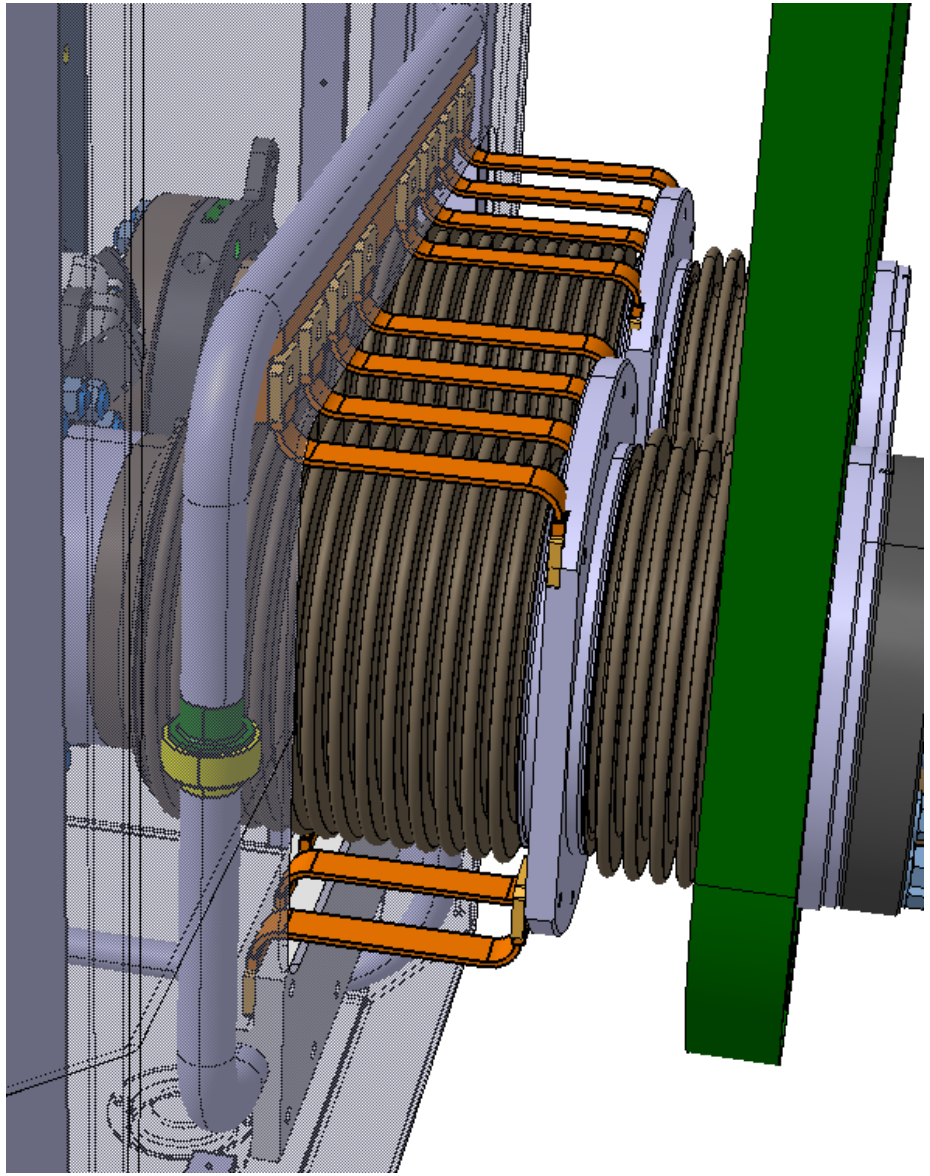
Increased compared to DQW

- Braid dT: 23.4 K



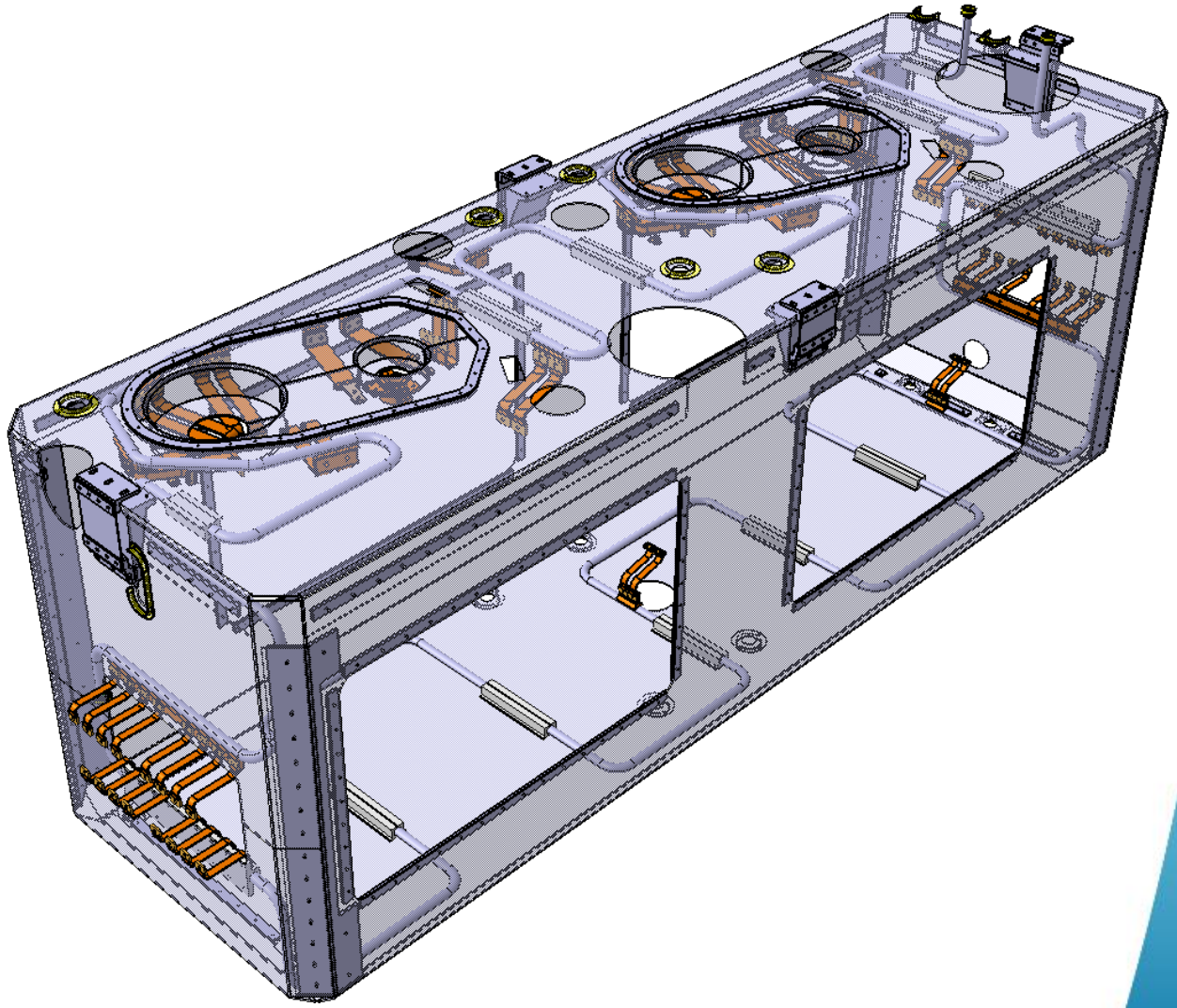
Thermalisation CWT

- Heat Load to 80 K: 41.2 W
- No Braids: 32
- Heat Load / Braid: 1.3 W
- Braid Length: 120 mm
- Braid CSA: 16 mm^2
- Braid dT: 11.2 K



Thermalisation Summary

RFD	Heat Load 80 K (W)	No. Braides, n	A (mm2)	L (mm)	dT (K)
CWT	41.2	32	16	120	11.2
Support Blades	20	8	40	160	11.6
FPC	121.2	16	75	200	23.4
Tuner	7.3	4	40	150	7.9
VHOM	19.6	4	40	130	18.4
Pick Up	19.6	4	40	130	18.4
HHOM	TBD	-	-	-	-
Instrumentation	10	-	-	-	-
Screen Flexures	6.3	-	-	-	-
Radiation	30	-	-	-	-
	275.2				

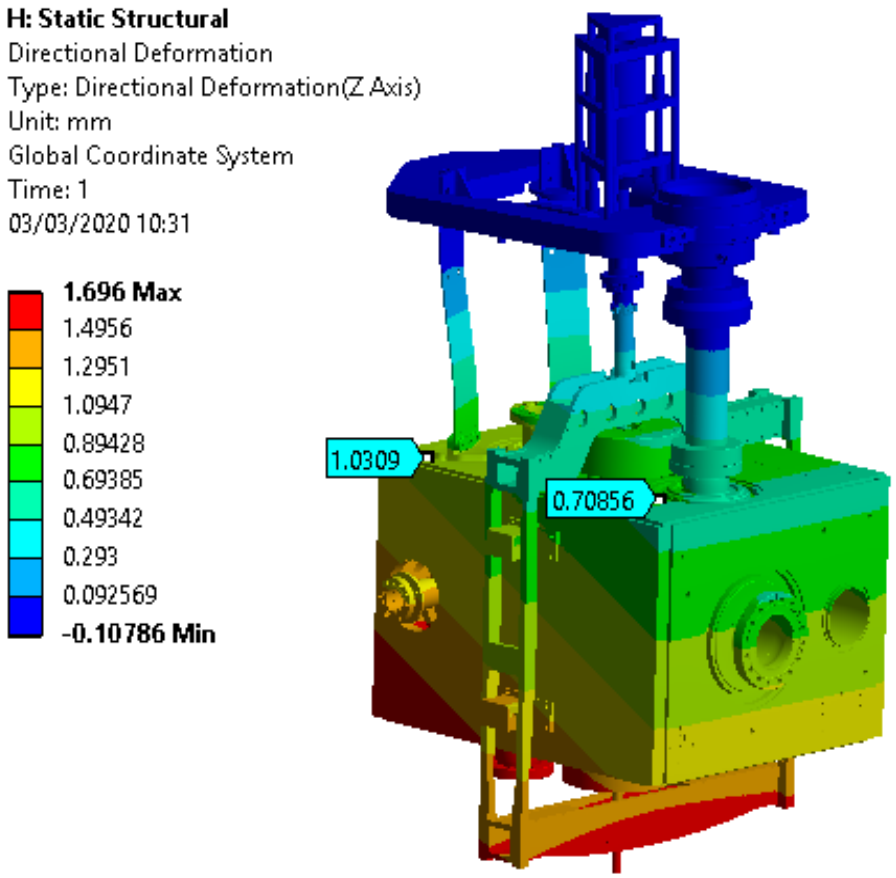


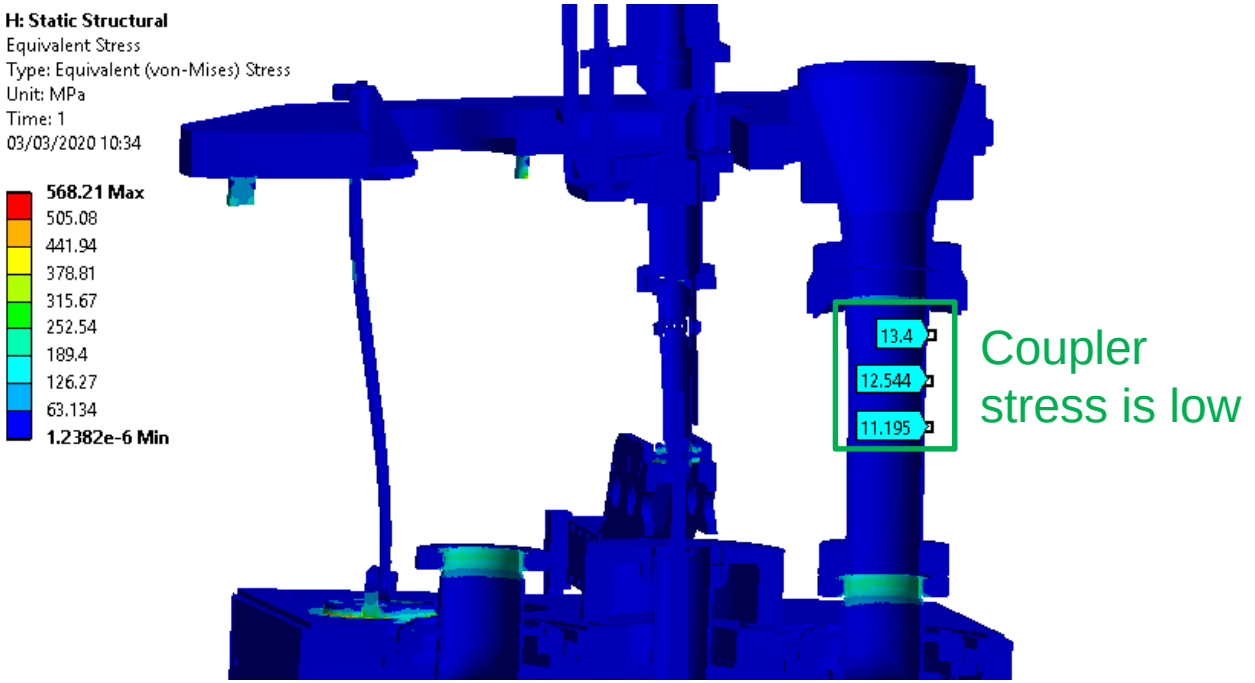
Blade Thermalisation Study

Thomas Jones

Blade thermalisation

Situation on DQW

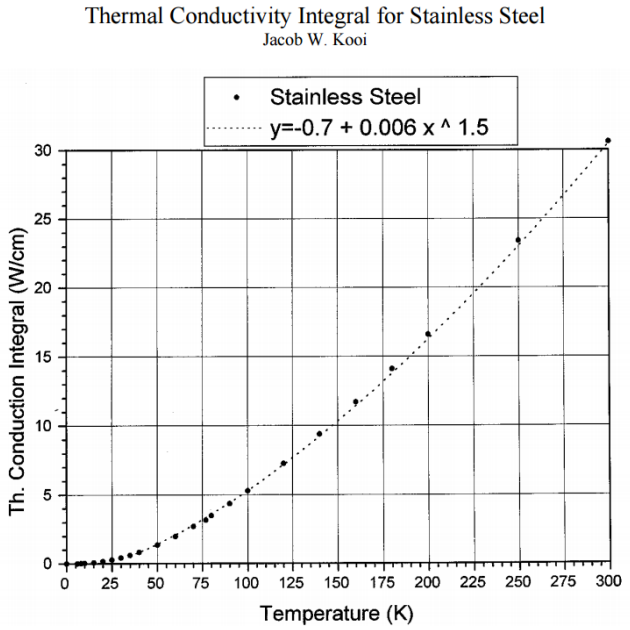




Coupler stress is low

- Heat leak to 2K from hand calculation and FEA 0.3W per blade, 1.2W total.
- In reality, observed a higher value to 2K and lower to the 80K. This was true for all static heat leak with an intermediate intercept.
- Suggests thermal intercepts could be improved.

Improvements for RFD



K_{dt} 300K to 80K =	27.43	W/cm
K_{dt} 80K to 10K =	3.6	W/cm
K_{dt} 10K to 2K =	0.1	W/cm

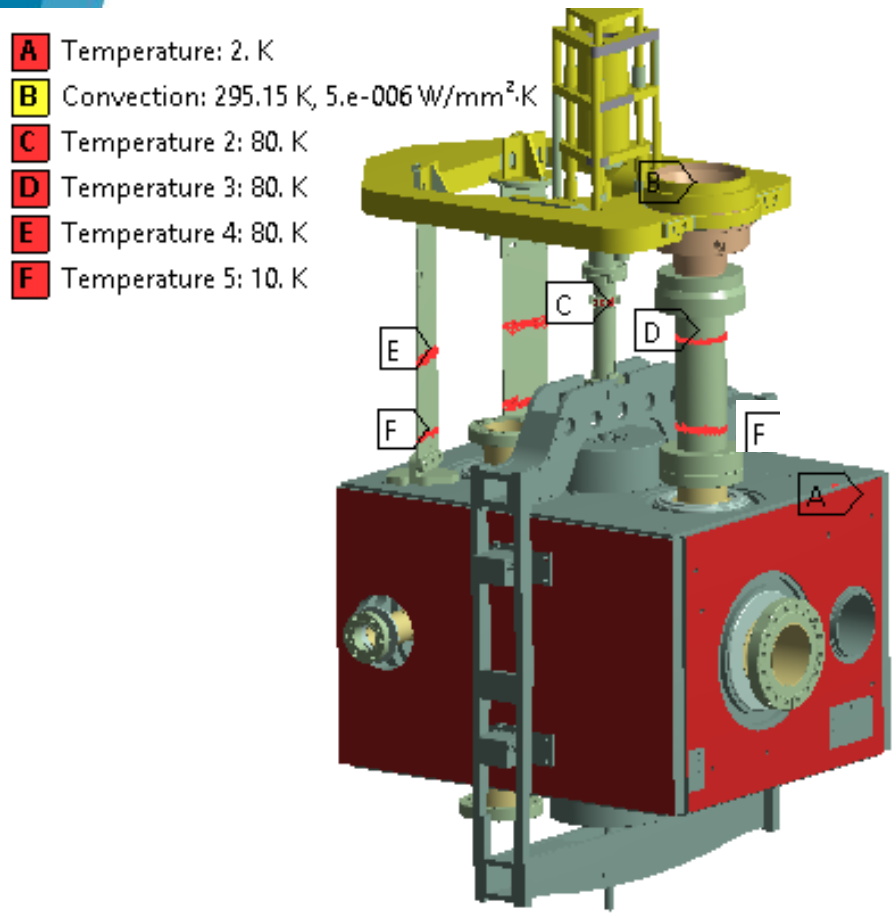
Thermal contraction of Stainless Steel from FNAL ES371110

$Q = (K_{dt}A)/X$ i.e. integral value already contains ΔT

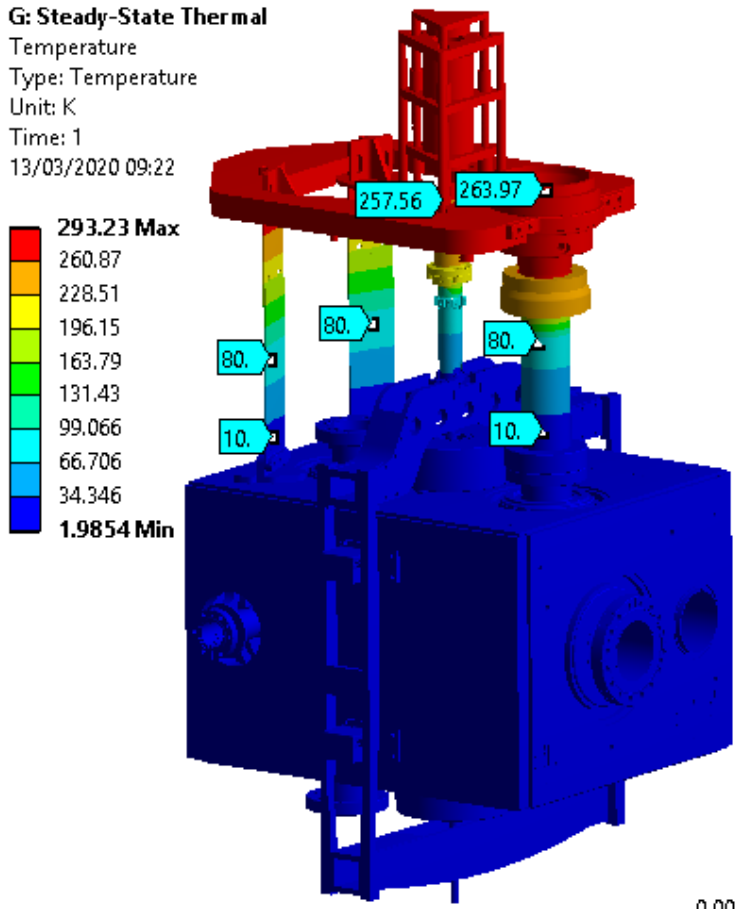
Blade total length (cm) =	34	Inputs	24	= Coupler Total Length (cm)
Width of blade (cm) =	7.5		6.2	= Coupler ID (cm)
Thickness of blade (cm) =	0.3		6.8	= Coupler OD (cm)
Length 300K to 80K (cm) =	20		4.5	= Length 300K to 80K (cm)
Length 80K to 10K (cm) =	8.5		14	= Length 80K to 10K (cm)
Length 10K to 2K (cm) =	5.5	Calculated	5.5	= Length 10K to 2K (cm)
Cross sectional area (cm^2) =	2.25		6.13	= Cross Sectional Area (cm^2)
Q from 300K to 80K (W)=	3.09		37.34	= Q from 300K to 80K (W)
Q from 80K to 10K (W)=	0.95		1.58	= Q from 80K to 10K (W)
Q from 10K to 2K (W)=	0.04		0.11	= Q from 10K to 2K (W)
Contraction 300K to 80K (from room temp) (mm) =	0.34		0.076	= Contraction 300K to 80K (from room temp) (mm)
Contraction 80K to 10K (from room temp) (mm) =	0.26		0.42	= Contraction 80K to 10K (from room temp) (mm)
Contraction 10K to 2K (from room temp) (mm) =	0.17		0.17	= Contraction 10K to 2K (from room temp) (mm)
Total contraction (mm) =	0.76		0.67	= Total contraction (mm)
Difference	**0.09**	**mm**		

- Suggest to move thermal intercept further down to ~200mm from room temperature point.
- Include an intercept to the 4K-20K circuit on each blade to minimise heat to 2K.
- If possible increase the number of fasteners per thermal strap to 2. With the aim to increase redundancy and contact pressure.

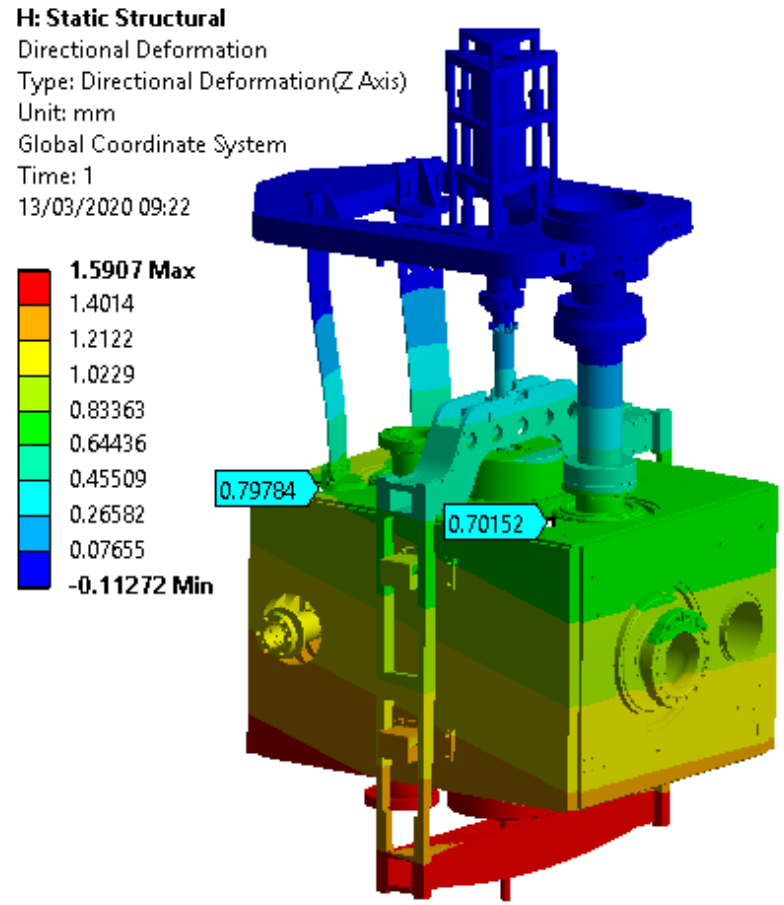
FEA



- Intercepts at Hand Calc positions
- Gravity applied
- Room temperature applied as convection to see potential ‘ice’ regions



- Temperature results show heaters required on coupler and tuner



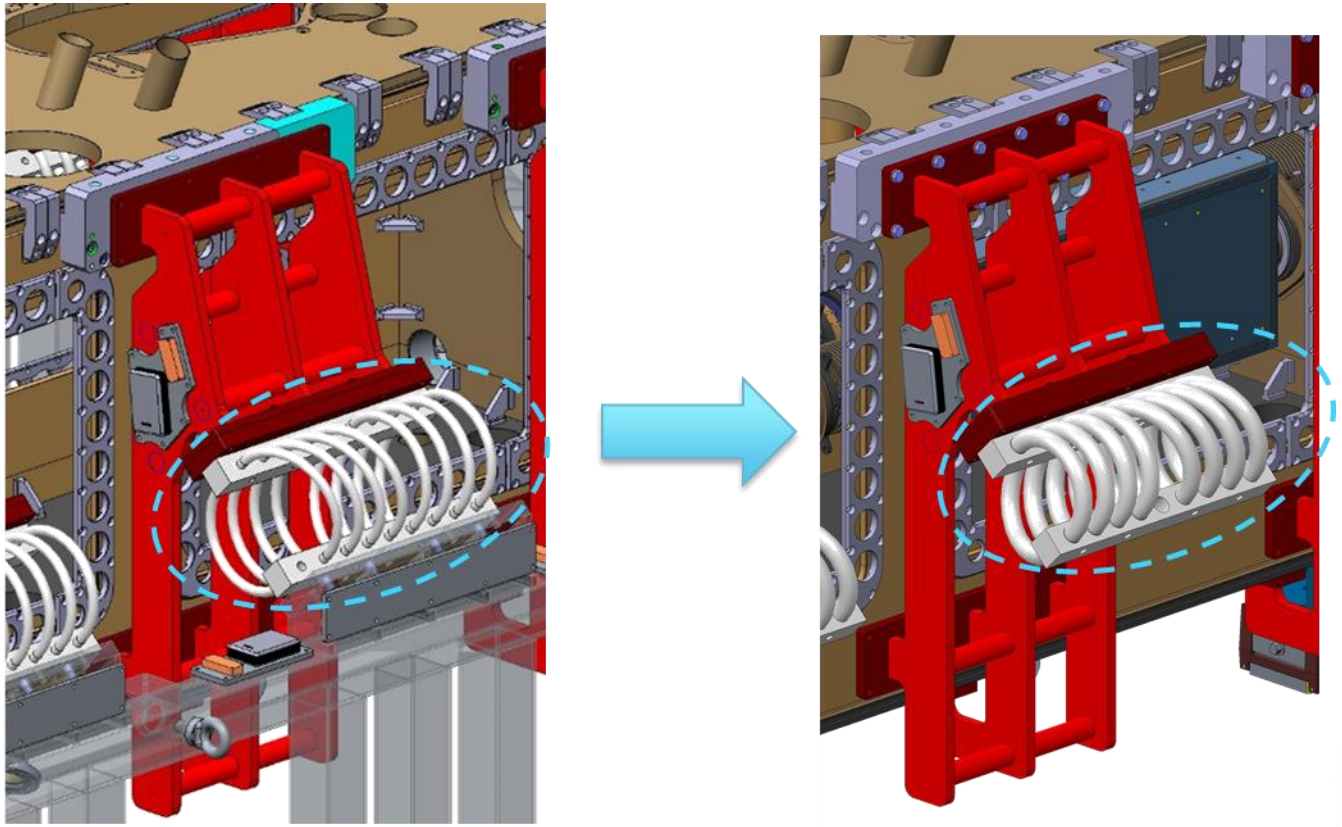
- Vertical deformation results in agreement with hand calc.
- ~0.1mm difference in contraction.

Transport Tooling

Edward Jordan

Wire Rope isolator change

- Supplier expressed concern with the static preload on the isolator - from the self weight of the module.
  - A common rule of thumb is to allow a maximum of 20mm static deflection on the isolator
  - The proposed configuration had 26mm static deflection
- A second supplier offered an isolator with thicker diameter
  - Static deflection of 11mm



Impact of isolator change

- The new isolator will only withstand a drop height of 300mm,
  - Previous target was 460mm
- This new value of 300mm still adheres to MIL-STD-810H
  - “Realistic variations to the default values provided in Tables 516.8-IX thru 516.8-XI may be permitted when justified; e.g. large/complex systems in which specific handling considerations are identified in the LCEP may supersede the default levels provided.” ***pg. 516.8-32***
- Vertical Natural frequency increased from 3hz to 4.75hz

OVC Tender & Tooling

Carlos Granjeiro

1st OUTER VACUUM VESSEL PROCUREMENT

Lancaster University

Further Competition for

Purchase of an
Outer Vacuum Vessel Prototype
for Hi-Lumi Crab Cavities

10 Companies showed interest:

3 proposals received

All proposals refused for not being able to comply with requirements

Activity	Date
Issue of Further Competition documentation	Monday 20 January 2020
Return of Tender documentation	Friday 14 February 2020 at 12 am
Post Submission Clarifications/Negotiations	From Friday 14 February 2020
Contract Award Date	Monday 24 February 2020

Closure date was extended 1 week (21 February) (requested by several companies because of material availability)

HiLumi HL-LHC PROJECT

2nd OUTER VACUUM VESSEL PROCUREMENT

Lancaster University

Further Competition for

Purchase of an
Outer Vacuum Vessel Prototype
for Hi-Lumi Crab Cavities

Activity	Date
Issue of Further Competition documentation	Friday 28 February 2020
Return of Tender documentation	Thursday 26 March at 12 am
Post Submission Clarifications/Negotiations	From Friday 27 March 2020
Contract Award Date	Wednesday 3 April 2020

Changes from previous Tender:

- RELAXATION OF THE NORM (CERN SPEC EDMS 1429406 V1.0) replaced by EN 10028-7 + EN 10216-5 + EN 10217-7 + EN 10253-4
- 2 Grades of Stainless Steel Allowed (1.4404 and 1.4435)
- Cobalt content ≤ 0.3% by mass

8 Companies showed interest

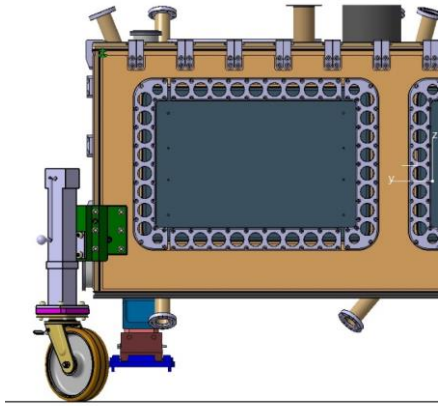
6 were deemed able to compete

2 Already dropped off (before 1.4404 extension)

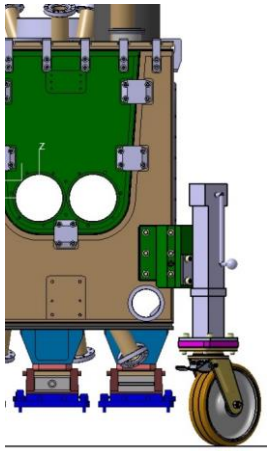
Remaining companies (1 Spain, 2 UK and 1 Italy)
(3 are the same of the previous competing bids)

HiLumi HL-LHC PROJECT

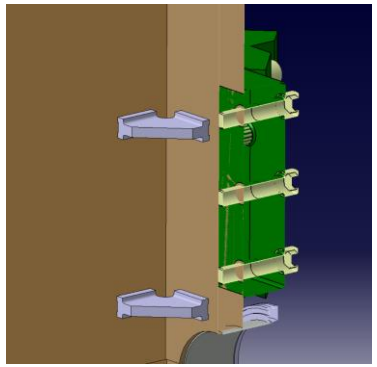
OUTER VACUUM VESSEL TOOLING



Tooling for workshop transfer: Castor wheel with jacking system

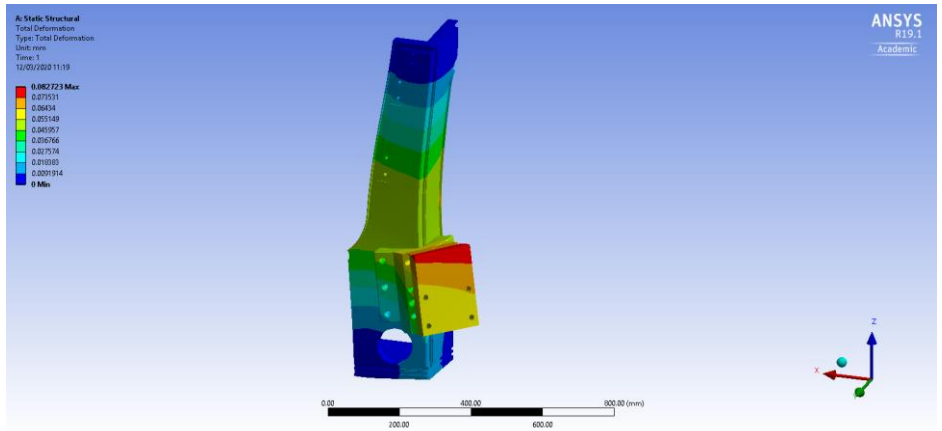


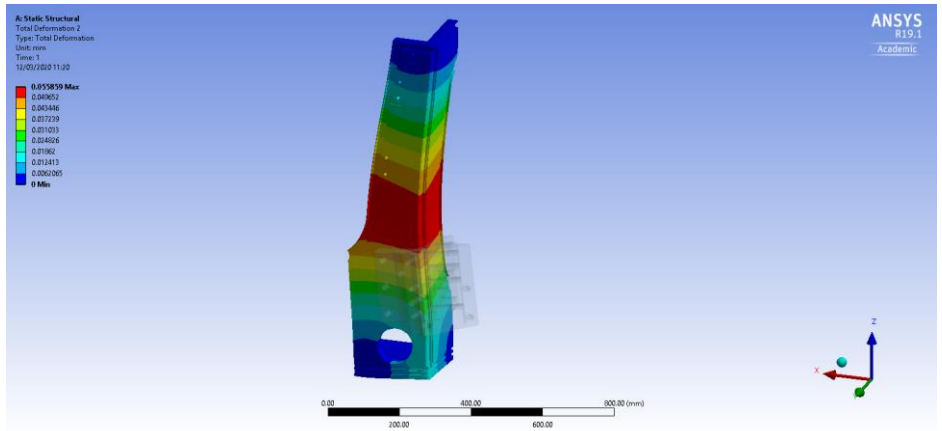
Will attach directly on the corners of the OVC using bolts and pins.



It could be considered to introduce a new inner reinforcement in the region to stiffen the area

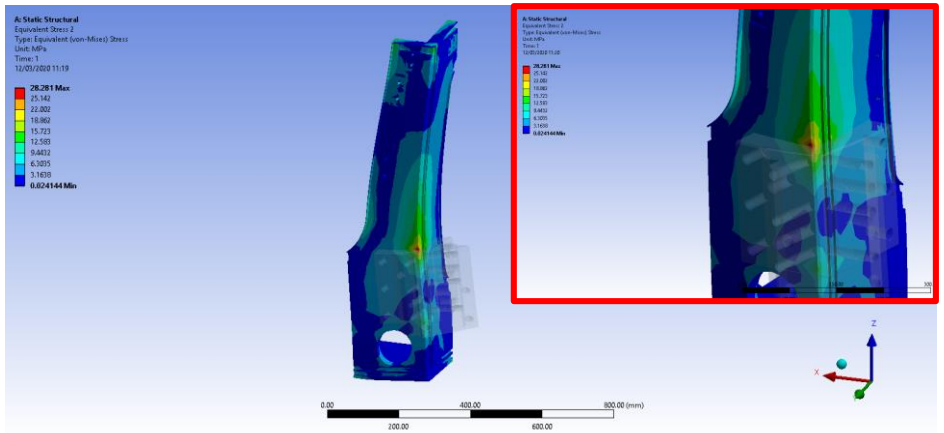
OUTER VACUUM VESSEL TOOLING





- OVC: 1.4435 , Interface: Aluminium
- Force 2500 kg
- Supports: Fixed top and bottom only
- Deflection: 0.056 mm (Real deflection will be lower)
- Stress: 28 MPa (15 MPa on the weld region)

Minimal distortion and stress even in a very conservative validation



Additional Slides

	SPS operation					SPS operation				
	Static					*Dynamic 5 MV (40 kW FPC)*				
	2 K bath	*comments*	10 K intercept	**80 K intercept**	*comments*	**2 K bath**	*comments*	10 K intercept	**80 K intercept**	*comments*
Radiation	3.4	*(from DQW)*		30	*(from DQW)*	-			-	-
CWT [2]	5.8		-	41.2		0			0	-
Supports [3]	1.1 0.3	*cavity support* *No He lines support* *(from DQW)*		20 - 5.2	*cavity support* *No He lines support* *(from DQW)*	-			-	-
FPC [4]	5.3			56		8.2			65.2	
VHOM lines	0.7	*design changes ongoing*		7.8		3.4			11.8	
VHOM antennas [5]	-			-		0.3			-	-
HHOM lines	2.7	*design changes ongoing*		-		7			TBD	
HHOM antennas [5]	-			-		0.7			-	-
Pickup lines	2.7	*(from HHOM)*		7.8	*(from VHOM)*	7	*(from HHOM)*		11.8	*(from VHOM)*
Pickup antennas [5]	-			-		0	*around 0*		-	-
Tuner [5]	0.9			7.3		-			-	-
Instrumentation	2.3	*(from DQW)*		10	*(from DQW)*	-			-	-
He level sensor [6]	0.2			0.5	*most conservative*	-			-	-
Cryo safety device [7]	0.7			4.5		-			-	-
Beam screen [XX]		*TBC*		TBC		TBC			TBC	*TBC*
Beam	-			-		0.5			-	-
Cavity [7], [8]	-			-		23.1			-	-
	Static					*Dynamic*				
TOTAL (temporary)	26.1			190.3		50.2			88.8	