## TORCH Prototype and Combined (Volume) RICH2 Feasibility Study Adam Lowe



### **Contents**

### TORCH Prototype Updates

- Frame Design
- Frame Production
  - Side Brace Laminate
  - Side Brace Machining
  - Side Brace Kitting
- <sup>®</sup> Electronics Mount Production
  - 2x Mid Board Supports
  - 1x Upper Board Supports
- Next Steps
- Questions?

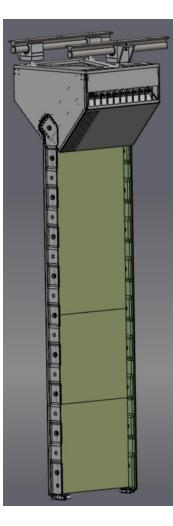
### RICH2/TORCH Integration

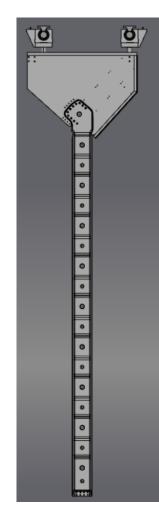
- Re-packaging Ideas
- Integration into the RICH2 Superstructure Options
- Advancing the Concept
- Next Steps
- Open Discussion/Questions

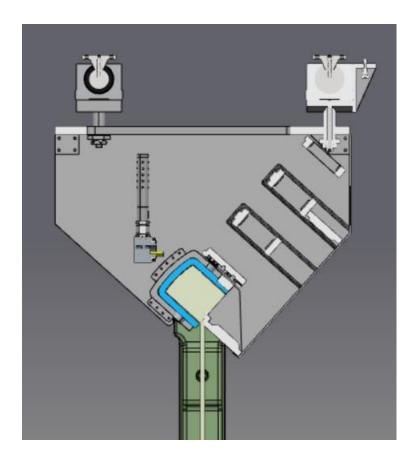


### Frame Design Re-Cap

### Lightweight, minimum material CF frame



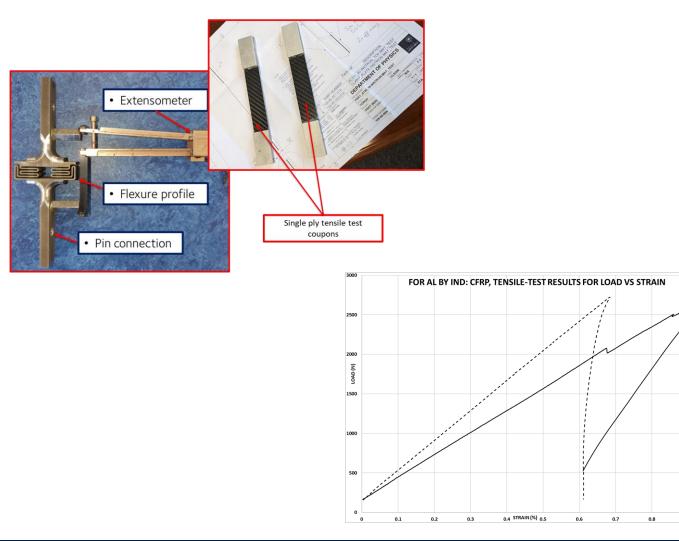






### **Frame Design Re-Cap**

• Full orthotropic FEA of the frame has been carried out with material sample testing to validate





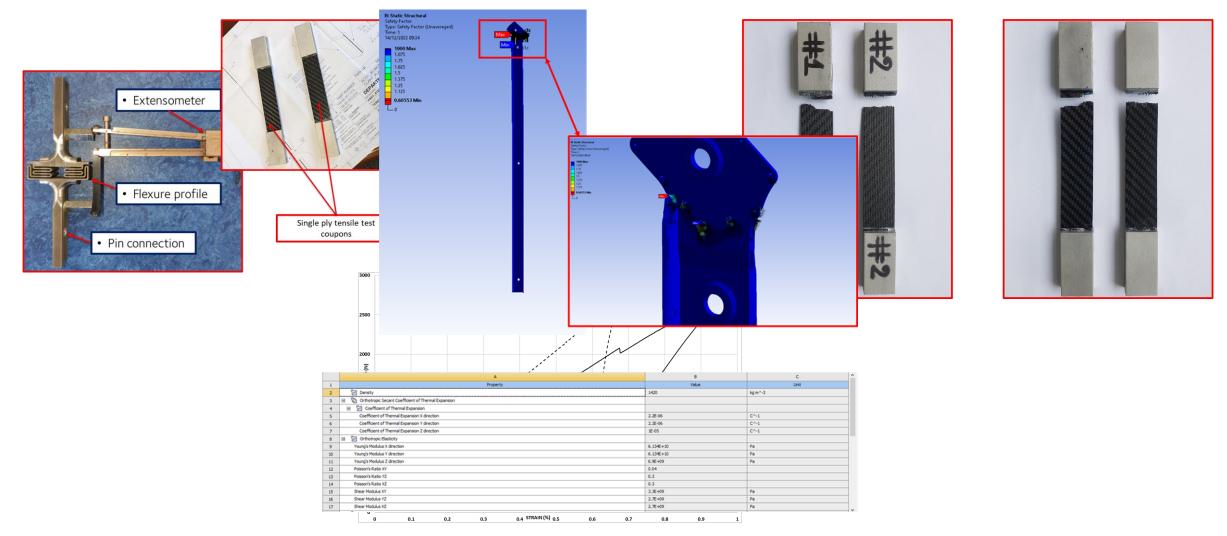
0.9





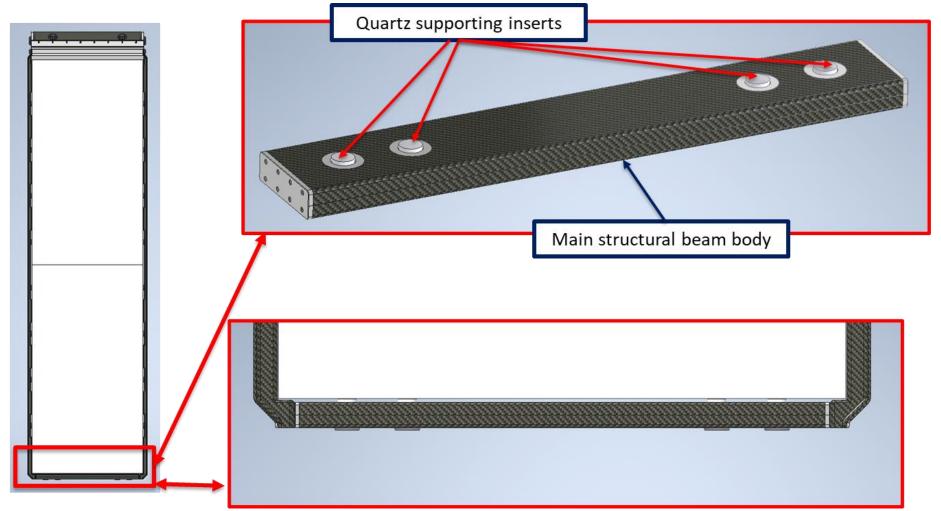
### Frame Design Re-Cap

• Full orthotropic FEA of the frame has been carried out with material sample testing to validate



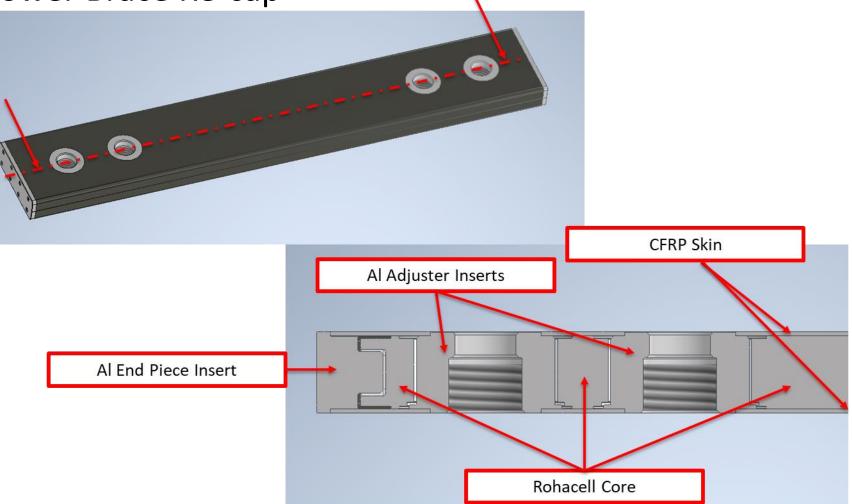


### TORCH Lower Brace Re-cap

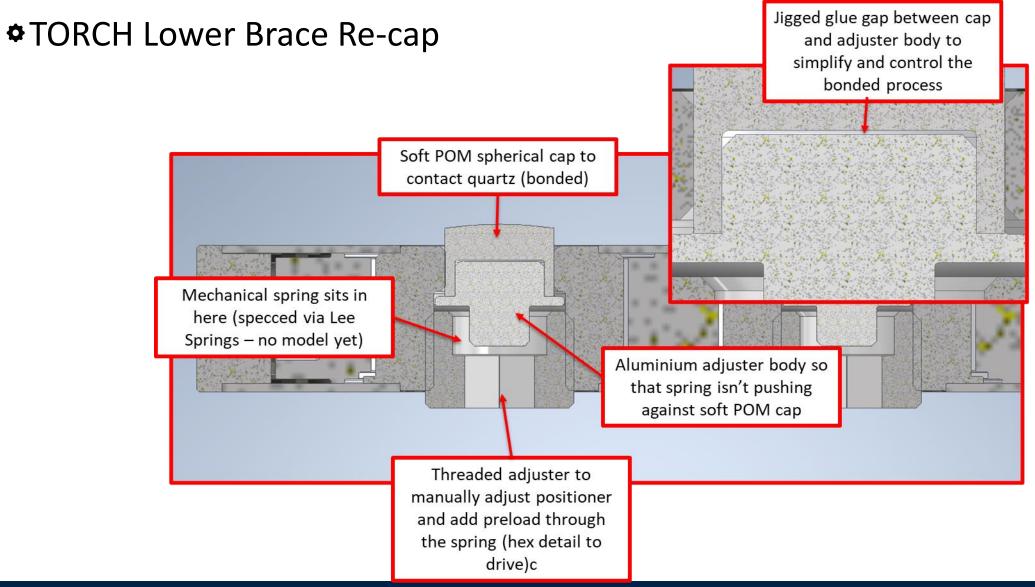




#### TORCH Lower Brace Re-cap

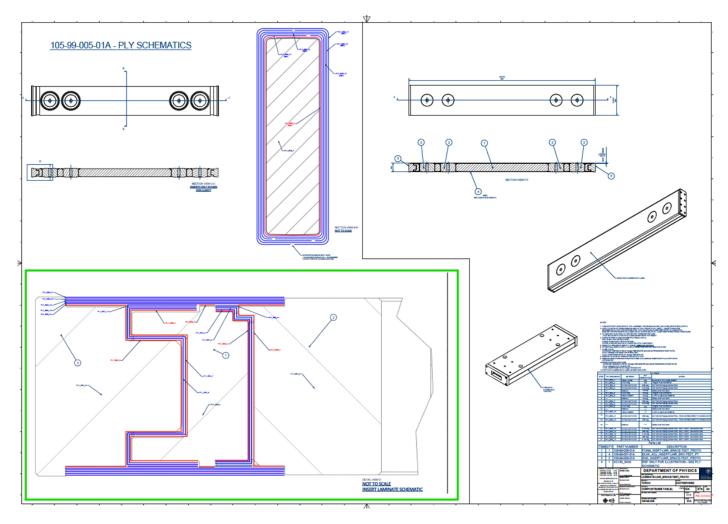




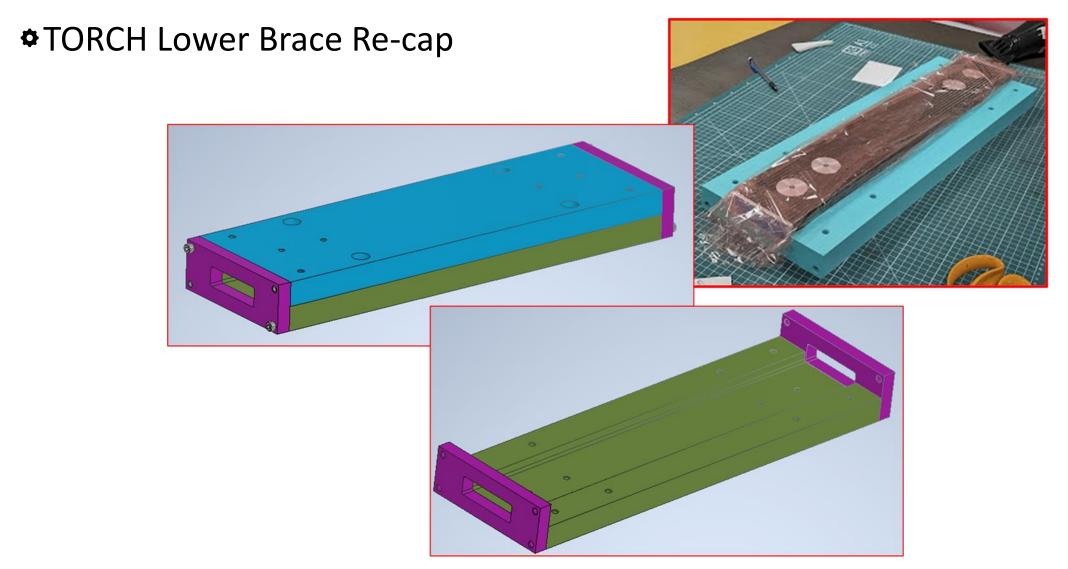




### TORCH Lower Brace Re-cap





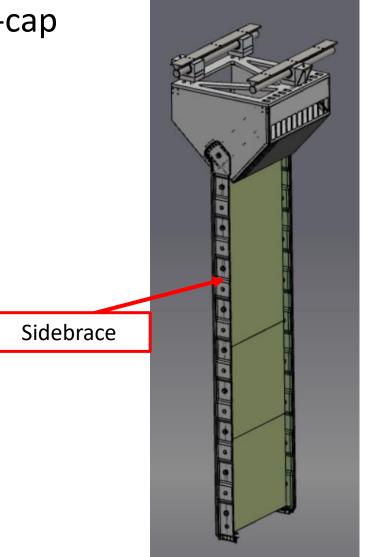




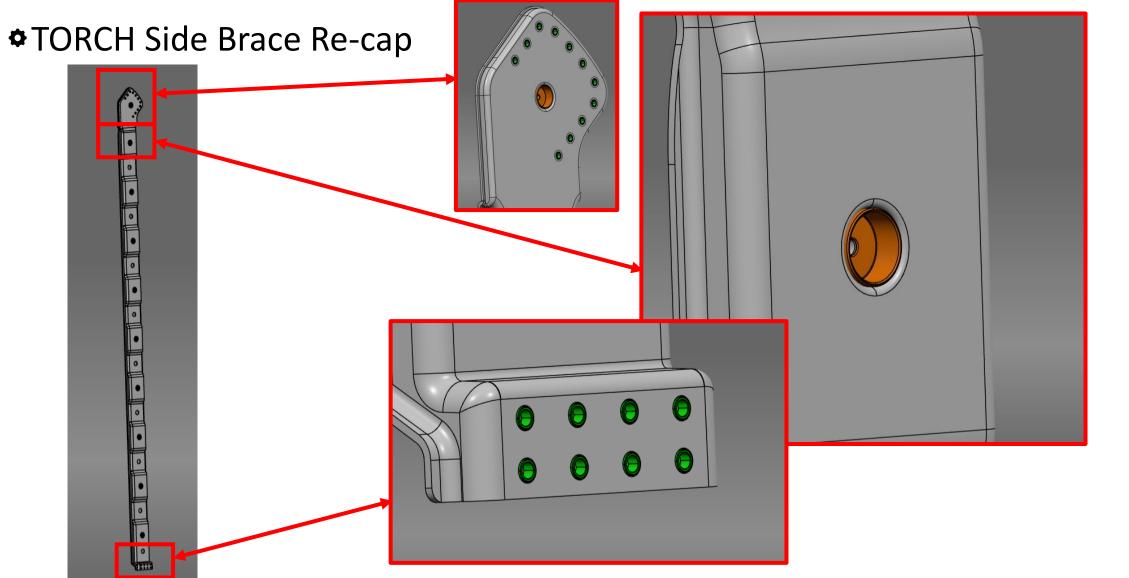
#### TORCH Lower Brace Re-cap



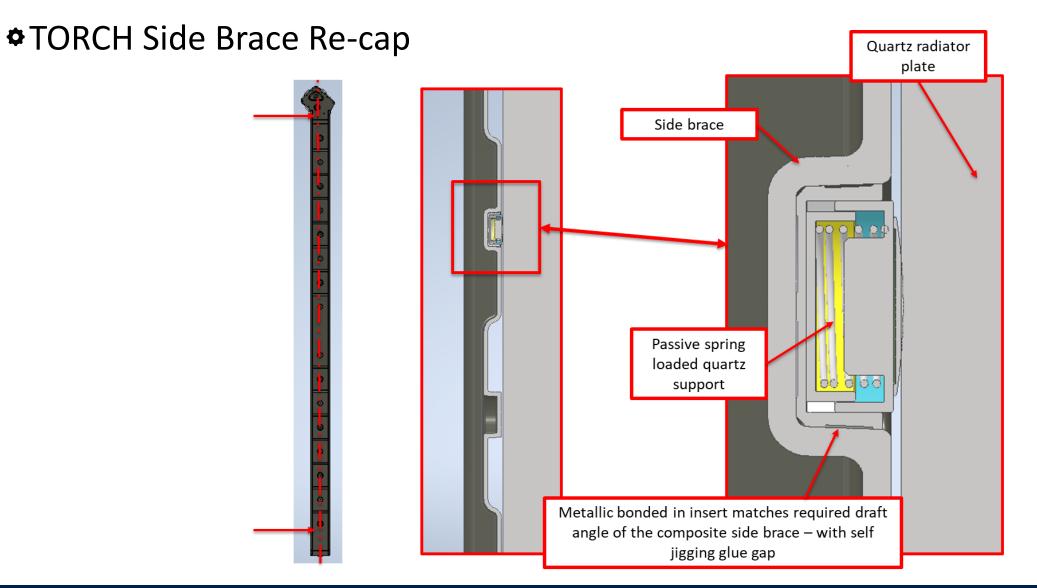




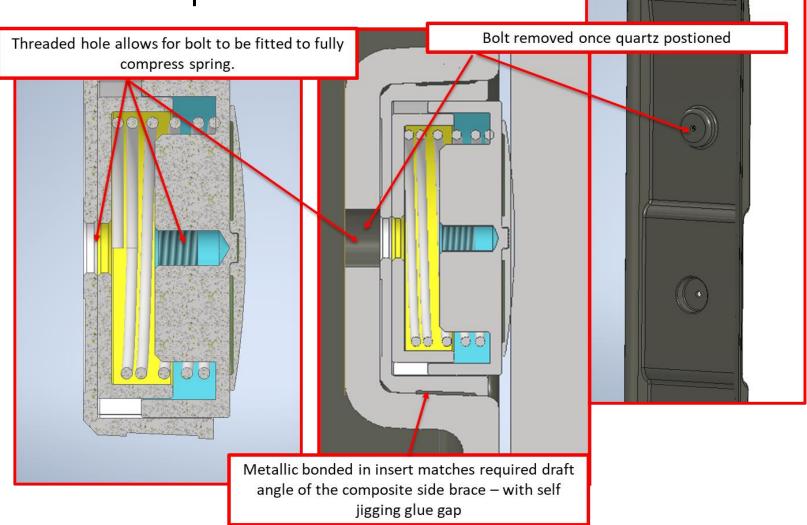




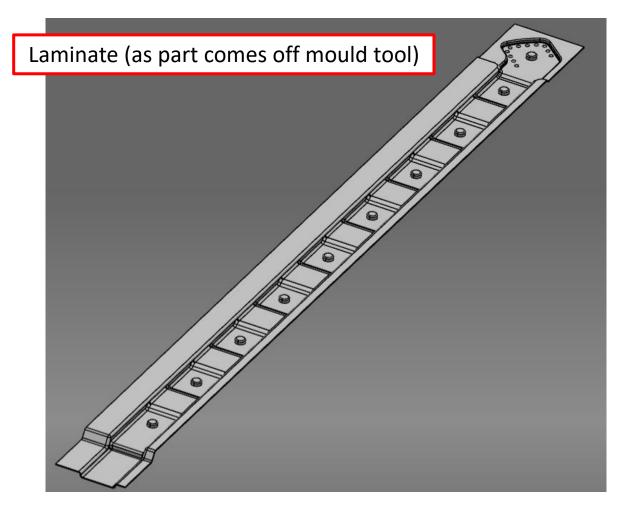


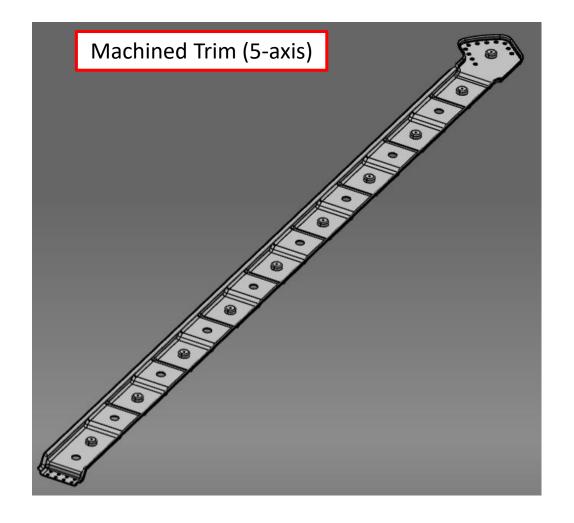




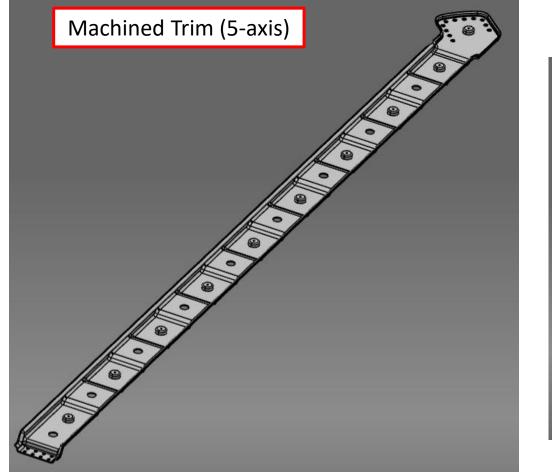


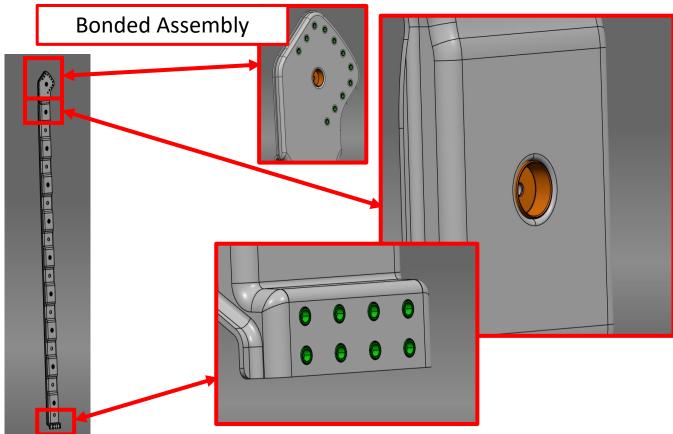








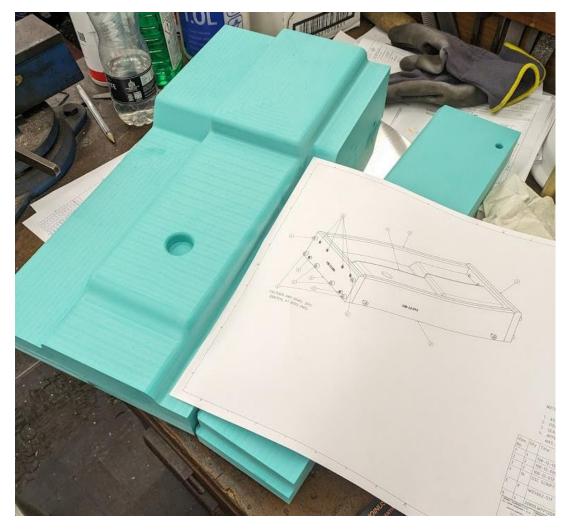






## **Side Brace Tooling**

### Side brace patterns and carbon fiber mould tools fully produced;



# Patterns produced from 'Epoxy block tooling board';

- Easy to machine;
- Cheap;
- Does not inhibit pre-preg cure;
- Mould tools produced from a tooling grade pre-preg carbon fiber;
  - Matched CTE with the final component;
  - Tough and re-usable tool;
  - Lower cure temperature than component pre-preg (hence less thermal expansion difference between pattern and mould tool) – OR SO WE HOPED!;



### Side Brace Laminate

• First side brace laminate was produced in the 3m autoclave at Brick Kiln Composites (Banbury);





### Side Brace Laminate - Measurement

• The laminate was put on the large 1600mm 5 axis mill at Oxford to be quasi-CMM inspected;

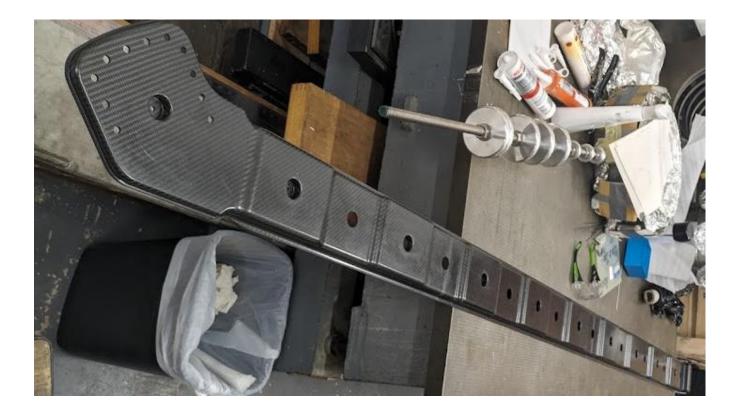






## Side Brace Machining

Machining op successful without inducing any twisting or bending;

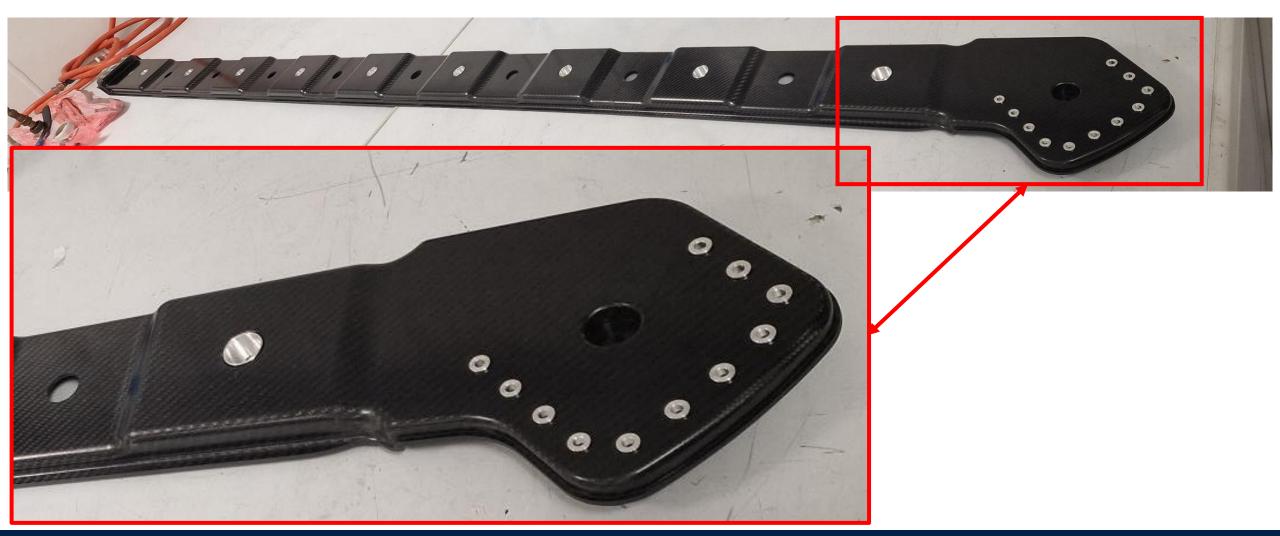






## Side Brace Bonding

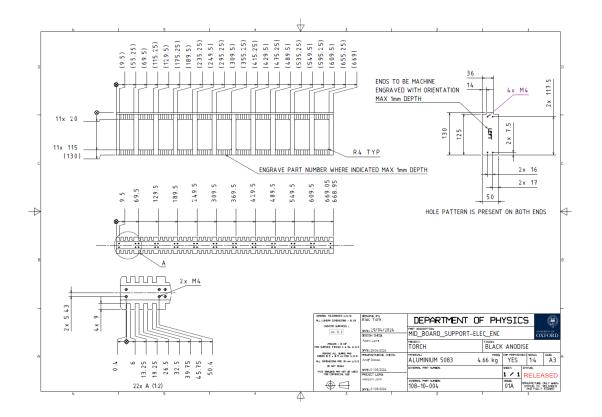
### Full bonding op of metallic inserts into sidebrace completed;

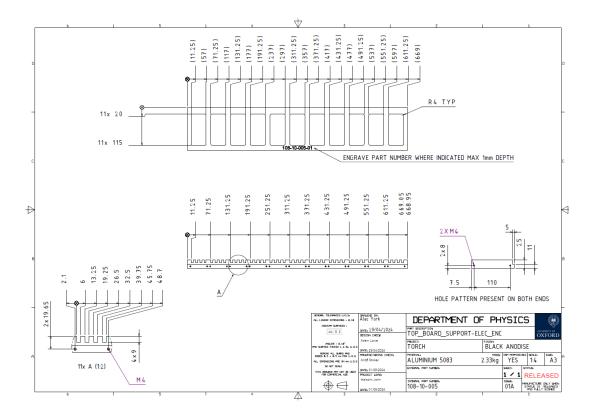




### **Electronic Boards Detailed**

Mid and upper board supports fully detailed and manufactured;



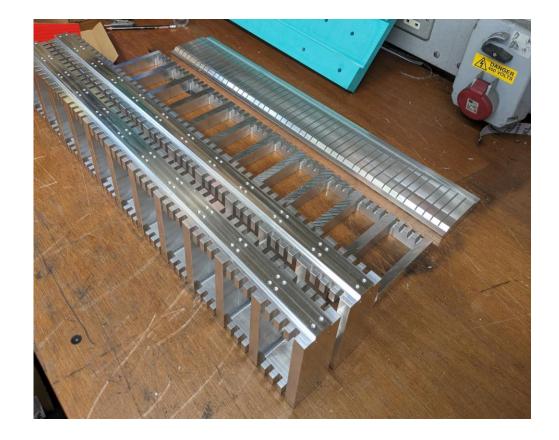




## **Electronic Board Supports Manufactured**

• Board supports fully manufactured and co-ordinate measured on machined – full CMM inspection pending.







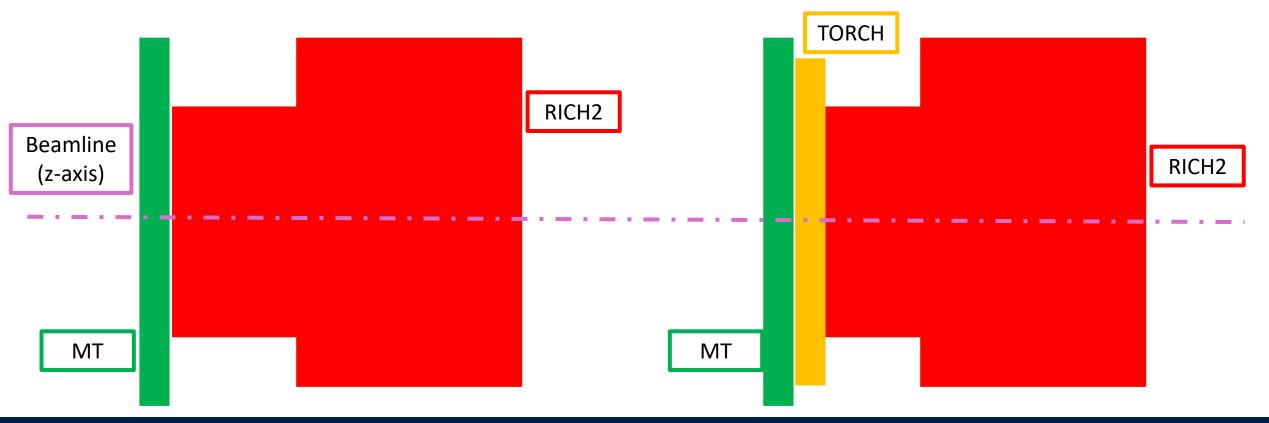
## **TORCH Prototype Build Plan**

Board supports fully manufactured and co-ordinate measured on machined – full CMM inspection pending.

ID Task Mode	Task Name	Predecessors	Baseline Duration	Baseline Start Baseline Finish % Con	nplete Actual Duration		Actual Duration	Start Finish							
Mode			Duration		Duration		Finsh		1	la com	la casa				
0					<b>20</b> 40 41				Qtr 1, 2024 Dec Jan F	Feb Mar Apr May	Qtr 3, 2024 Qtr 4, 2024 Jun Jul Aug Sep Oct	Nov Dec			
1 =	TORCH MEG Schedule Guarz Proourement		181 days? 2 days	Thu 04/01/24 Thu 12/09/24 35% Thu 04/01/24 Fri 05/01/24 100%	70.12 da 2 days	Thu 04/01/24 Thu 04/01/24	NA 158 days? Fri 06/01/24 2 days	Thu 04/01/24 Mon 0 Thu 04/01/24 Fri 06/0	0/24						
5 <b></b> , 6 <b></b> ,	Decign		161 days	Thu 04/01/24 Thu 01/08/24 38%	82.34 days	Thu 04/01/24	NA 182 days	Thu 04/01/24 Fri 16/0							
V =	Prototype		48 days	Thu 04/01/24 Mon 11/03/24 100%			Mon 11/03/24 48 days	Thu 04/01/24 Mon 11							
5 🗸 🔫	Optics Frame v1 Focussing Block Mount_FBM_v2_Design		18 days	Thu 04/01/24 Mon 29/01/24 100% Tue 30/01/24 Pri 16/02/24 0%	18 days 0 days		Mon 29/01/24 18 days	Thu 04/01/24 Mon 29 Tue 30/01/24 Pri 16/0		_					
4 5	Side Brace_LHS_SB_v2_Design (As draw) & RHS (As mirror)		11 days	Mon 19/02/24 Mon 04/03/24 0%	0 days	NA	NA 11 days	Mon 19/02/24 Mon 04		<b>`</b>					
18 <b></b> 24 <b></b> 30 <b></b>	Electronics Housing		151 days	Thu 04/01/24 Thu 01/08/24 37%	60.15 days	Thu 04/01/24	NA 162 days	Thu 04/01/24 Pri 16/0							
1 🗸 🛋	Electronics Design Requirements Electronics Housing Design Review	34,37,40,43	7 days	Thu 04/01/24 Fri 12/01/24 100%	7 days	Thu 04/01/24	Fri 12/01/24 7 days	Thu 04/01/24 Fri 12/0 Fri 19/04/24 Fri 19/0							
2 🗸 🔫	Nounting Rails and Interface	34,37,40,43	1 day 106 days	Thu 04/01/24 Thu 30/05/24 29%	1 day 41.52 days	Thu 04/01/24	NA 143 days	Thu 04/01/24 Mon 22	4	1 '					
	Cooling		151 days	Thu 04/01/24 Thu 01/08/24 100%	86 days	Thu 04/01/24	Thu 02/05/24 86 days	Thu 04/01/24 Thu 02/	<u>ــــــــــــــــــــــــــــــــــــ</u>		·				
• = •	MCP Mounting		126 days	Thu 04/01/24 Thu 27/06/24 12%	18.89 days	Thu 04/01/24	NA 158 days	Thu 04/01/24 Mon 12	4						
	Chassis Bond Jig/Exo Skeleton		81 days 92 days	Thu 08/02/24 Thu 30/05/24 27% Thu 04/01/24 Pri 10/05/24 18%	43.29 days 23.8 days	Thu 04/01/24	NA 162 days NA 131 days	Thu 04/01/24 Pri 16/0 Thu 04/01/24 Thu 04/							
->	Manufacturing		181 days?	Thu 04/01/24 Thu 12/08/24 30%	60.06 days	Thu 04/01/24	NA 198 days?	Thu 04/01/24 Mon 07							
V =	Planning		10 days	Pri 15/03/24 Thu 28/03/24 100%	10 days	Mon 19/02/24	Fri 01/03/24 10 days	Mon 19/02/24 Fri 01/0		±_			4.C. davas	Wed 20/40/24	Mad 20/44/24
× =	Prototype 109-99-027-01A-LAMINATE-SIDE_BRACE-TEST_PROTO		50 days 40 days	Thu 15/02/24 Wed 24/04/24 74% Thu 15/02/24 Wed 10/04/24 10%	74.42 days	Thu 15/02/24	NA 100 days Thu 06/06/24 81 days	Thu 15/02/24 Wed 03 Thu 15/02/24 Thu 05/					16 days	Wed 30/10/24	Wed 20/11/24
	109-99-027-01A-LAMINATE-SIDE_BRACE-TEST_PROTO 109-99-031-01A-PASSIVE_INSERT-6_BRACE-TEST_P (12 off)		40 days 20 days	Thu 15/02/24 Wed 10/04/24 100% Wed 05/03/24 Tue 02/04/24 40%	81 days 8 days	Thu 23/05/24	NA 20 days	Thu 15/02/24 Thu 06/ Thu 23/05/24 Wed 19							
Image: Section 1.1 Image: Section	108-99-034-01A-INSERT-SIDE_TO_LWR_BRC-TP (20 off)	13	20 days	Fri 08/03/24 Thu 04/04/24 100%	11 days	Thu 23/05/24	Thu 06/06/24 11 days	Thu 23/05/24 Thu 06/							
📅 🤜	109-99-032-01A-ASSY_BOND-SIDE_BRACE-TEST_PROTO	14,56,57,55	10 days	Thu 11/04/24 Wed 24/04/24 0%	0 days	NA	NA 10 days	Thu 20/06/24 Wed 03		*			d alarma	March 20140/24	March 20/40/24
-,	Test Beam Option Frame Electronics Housing		56 days? 70 days	Thu 04/01/24 Thu 21/03/24 0% Fri 31/05/24 Thu 05/09/24 28%	0 days 30.47 days	NA Pri 03/05/24	NA 56 days?	Thu 04/01/24 Thu 21/ Pri 03/05/24 Mon 30					1 day	Wed 30/10/24	Wed 30/10/24
	Cooling	_	70 days 20 days	Fri 02/08/24 Thu 05/09/24 28%	30.47 days 13.53 days	Pri 03/05/24	NA 107 days NA 29 days	Fri 03/05/24 Moh 30 Fri 03/05/24 Wed 12					-		
	108-10-006 - Air InCooling Electronics Support	38	3 days	Fri 02/08/24 Tue 06/08/24 0%	0 days	NA	NA 3 days	Fri 03/05/24 Tue 07/		-	· -				
	109-10-004 - Small board support		20 days	Fri 02/08/24 Thu 29/08/24 48%	14 days	Fri 03/05/24	NA 29 days	Fri 03/05/24 Wed 12					Charles and	Thus DATA DOM:	Ella matra atra a
-	108-10-008 - Top electronics support 108-10-005 - Half small board support	38	20 days 20 days	Fri 02/08/24 Thu 29/08/24 48%	14 days	Pri 03/05/24	NA 29 days	Pri 03/05/24 Wed 12 Pri 03/05/24 Wed 12					2 days	Thu 31/10/24	Fri 01/11/24
	MCP Mounting	38	20 days 30 days	Pri 02/08/24 Thu 29/08/24 48%	14 days	NA	NA 29 days	Pri 03/05/24 Wed 12 Tue 13/08/24 Mon 23			- <u> </u>				
	Chassis		3 days	Fri 31/05/24 Tue 04/06/24 0%	0 days	NA	NA 3 days	Mon 19/08/24 Wed 21	14						
=5	Mounting Rails and Interface		5 days	Pri 31/05/24 Thu 06/06/24 0%	0 days	NA I	NA 5 days	Tue 23/07/24 Mon 29							
-5	Nock Assembly and testing - Electronics Housing Bond Jig/Exo Skeleton	74,79,88,81	5 days	Fri 30/08/24 Thu 05/09/24 0% Mon 29/04/24 Tue 30/07/24 0%	0 days 0 days	NA	NA 5 days NA 67 days	Tue 24/09/24 Mon 30 Fri 05/07/24 Mon 07/			₩ <b>-</b>		3 days	Mon 04/11/24	Wed 06/11/24
	Mock Full Assembly - TBOF + EH + P	59,50,73	67 days 5 days	Fri 05/09/24 Thu 12/09/24 0%	0 days	NA NA	NA 5 days	Tue 01/10/24 Mon 07/					o aayo		
	Manufacturing Complete		0 days	Thu 12/09/24 Thu 12/09/24 0%	0 days	NA	NA D days	Mon 07/10/24 Mon 07/	4		\$ 07/10				
-,	Tecting		178 days	Thu 04/01/24 Mon 08/08/24 62%	128.8 days	Thu 04/01/24	NA 207 days	Thu 04/01/24 Fri 18/1						The second second	
- = ✓ =	Prototype Instron Coupon 1		75 days 1 day	Thu 04/01/24 Wed 17/04/24 33% Thu 04/01/24 Thu 04/01/24 100%	38.67 days		NA 116 days Thu 04/01/24 1 day	Thu 04/01/24 Thu 13/ Thu 04/01/24 Thu 04/			- P		3 days	Thu 07/11/24	Mon 11/11/24
	Instron Coupon 2		1 day	Thu 04/01/24 Thu 04/01/24 100%	1 day		Thu 04/01/24 1 day	Thu 04/01/24 Thu 04/					~ ~~,~		
V =	Lower Brace v1		1 day	Thu 04/01/24 Thu 04/01/24 100%	1 day	Thu 04/01/24	Thu 04/01/24 1 day	Thu 04/01/24 Thu 04/							
	Lower Brace_Tensile_Testing		1 day 5 days	Thu 04/01/24 Thu 04/01/24 0%	0 days	NA	NA 1 day	Thu 04/01/24 Thu 04/ Pri 07/06/24 Thu 13/							
-,	109-99-027-01A_Testing (Side Brace v1) Electronics Assembly Testing and Commissioning	51	5 days 101 days	Mon 22/04/24 Mon 09/09/24 93%	109.26 days	Mon 22/04/24	NA 5 days NA 118 days	Mon 22/04/24 Wed 02		∽			7 days	Tue 12/11/24	Wed 20/11/24
	Bond Testing		9 days	Wed 31/07/24 Mon 12/08/24 0%	0 days	NA	NA 9 days	Tue 08/10/24 Fri 18/1						The second second second second	
V =	Proto TORCH disassembly (At CERN)		39 days	Mon 12/02/24 Thu 04/04/24 100%	39 days	Mon 12/02/24	Thu 04/04/24 39 days	Mon 12/02/24 Thu 04/							
-	Guartz Bonding at CERN		184 days 184 days	Mon 08/01/24 Thu 19/09/24 63% Mon 08/01/24 Thu 19/09/24 77%	143.46 days	Mon 08/01/24	NA 228 days NA 217 days	Mon 08/01/24 Wed 20 Mon 08/01/24 Tue 05/				-			
V 3	Pre-Bonding Logistics Quartz Manufacture and Shioping	4	184 days 55 days	Mon 08/01/24 Thu 19/09/24 77% Mon 08/01/24 Pri 22/03/24 100%	166.47 days	Mon 08/01/24 Mon 08/01/24	NA 217 days Pri 22/03/24 55 days	Mon 08/01/24 Tue 05/ Mon 08/01/24 Fri 22/0							
	Quartz Sign Off	122	1 day	Mon 25/03/24 Mon 25/03/24 100%	1 day		Mon 25/03/24 1 day	Mon 25/03/24 Mon 25	4						
V =	Booking Facilities at CERN		0 days	Thu 08/02/24 Thu 08/02/24 100%			Thu 08/02/24 0 days	Thu 08/02/24 Thu 08/		08/02					
V =	Facilities booked at CERN (period reserved)		0 days	Thu 08/02/24 Thu 08/02/24 100% Fri 13/09/24 Thu 19/09/24 0%	0 days 0 days	Thu 08/02/24	Thu 08/02/24 0 days	Thu 08/02/24 Thu 08/ Tue 08/10/24 Mon 14	•	08/02					
-, -,	Shipping Optics Frame to CERN Shipping Electronics Enclosure to CERN	99	5 days 5 days	Pri 13/09/24 Thu 19/09/24 0% Thu 22/08/24 Wed 28/08/24 0%	0 days 0 days	NA	NA 5 days NA 5 days	Tue 08/10/24 Mon 14 Wed 30/10/24 Tue 05/			Σ				
	Shipping Bond Jig to CERN	112	7 days	Tue 13/08/24 Wed 21/08/24 0%	0 days	NA	NA 7 days	Mon 21/10/24 Tue 29/							
=,	Bonding at CERN (+1 ws ENG)		16 days	Thu 22/08/24 Thu 12/09/24 0%	0 days	NA	NA 16 days	Wed 30/10/24 Wed 20			_	-			
=,	Bonding prep Dry run alignment	118,128	1 day	Thu 22/08/24 Thu 22/08/24 0%	0 days	NA	NA 1 day	Wed 30/10/24 Wed 30 Thu 31/10/24 Pri 01/1	*		·   · · +				
	Dry run alignment Adhesive application	130	2 days 3 days	Fri 23/08/24 Mon 26/08/24 0% Tue 27/08/24 Thu 29/08/24 0%	0 days 0 days	NA	NA 2 days	Thu 31/10/24 Pri 01/1 Mon 04/11/24 Wed 05			1 1 1				
	Cure time	132	3 days	Fri 30/08/24 Tue 03/09/24 0%	0 days	NA	NA 3 days	Thu 07/11/24 Mon 11			<b>1</b> 1				
	Optical sign off testing	133	7 days	Wed 04/09/24 Thu 12/09/24 0%	0 days		NA 7 days	Tue 12/11/24 Wed 20	14			↓			
i 📅 🤜	TORCH-RICH Feacibility study		93 days	Wed 20/03/24 FH 26/07/24 10%	9.3 days	Wed 20/03/24	NA 93 days	Wed 20/03/24 Pri 26/0							
							Page 1								
						r	age :								

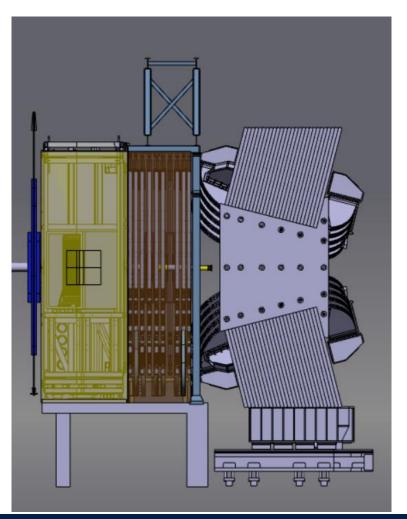


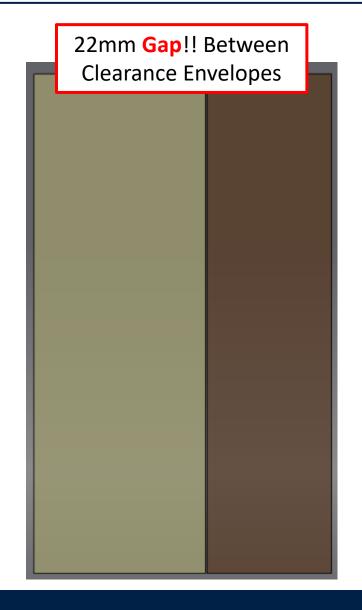
Motivation isto occupy the same volume of space (overall envelope) as RICH2.





### Current concept states;







## Current concept states; 22mm Gap Between es If you no longer **go for a gap** that exists, you are no longer a **racing driver**. Ayrton Senna MCLAREN INTERNATIONAL <u> 부</u> 부

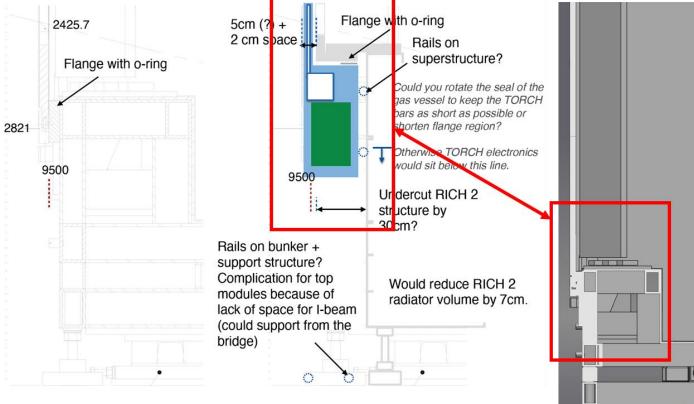


## Current concept states; 22mm Gap Between es If you no longer go for a gap that exists, you are no longer a PHYSICIST OF ENGINEER Ayrton Senna MCLAREN INTERNATIONAL **H** <u> 부</u> 부



## **RICH2/TORCH Integration – Skinny is Key**

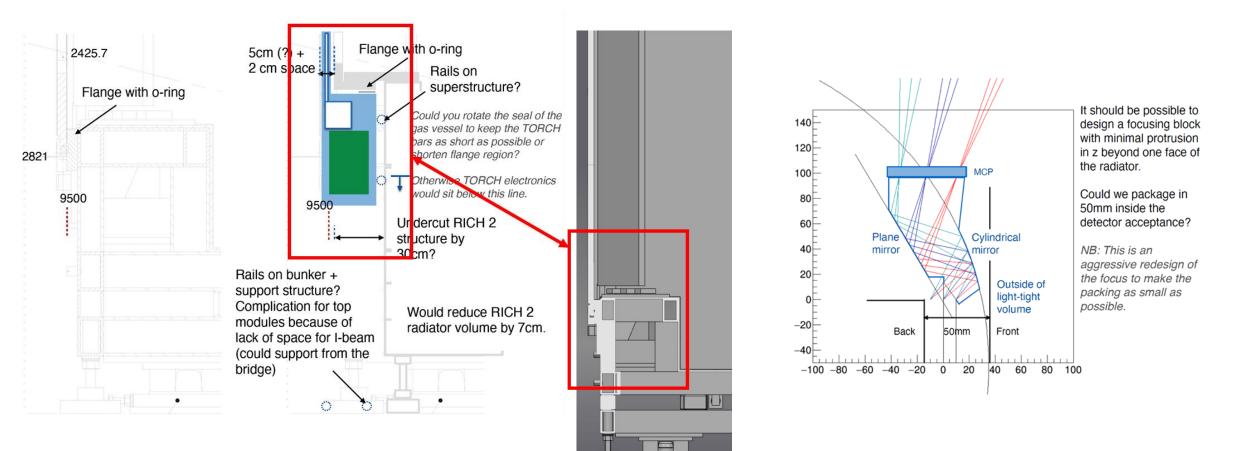
In order to successfully integrate into any space in this region of the experiment it becomes obvious that slimming down the sub-detector as much as pos:





## **RICH2/TORCH Integration – Focussing Block Change for V-Elec**

### In order to accommodate this design, a focussing block re-design is required





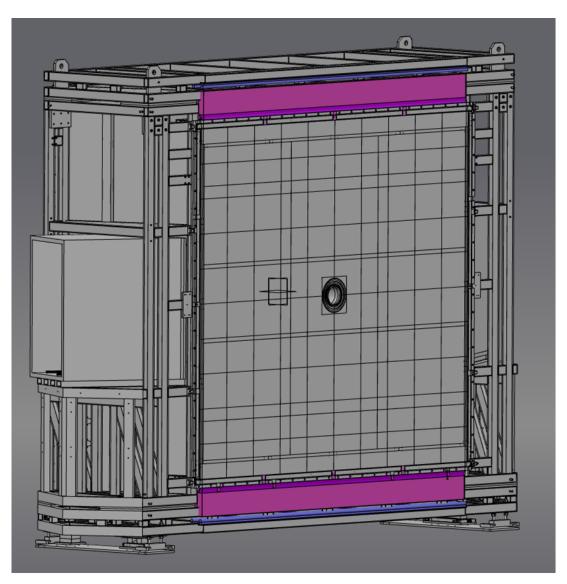
## **RICH2/TORCH Integration – Integration Strategies**

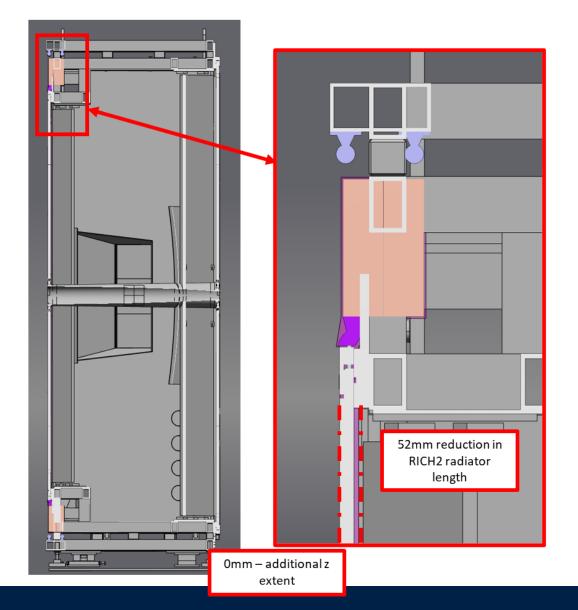
Several different TORCH design strategies have been investigated;

- Inimal/Zero RICH2 Impact (at the expense of additional Z-volume); RULED OUT
- Zero additional Z-volume (at the expense of RICH2 structure); Preferred
- Halfway house requiring minimised compromise from both RICH2 and Sci-Fi; RULED OUT
- <sup>®</sup> Differing electronic layouts for all of the above options; Under Consideration



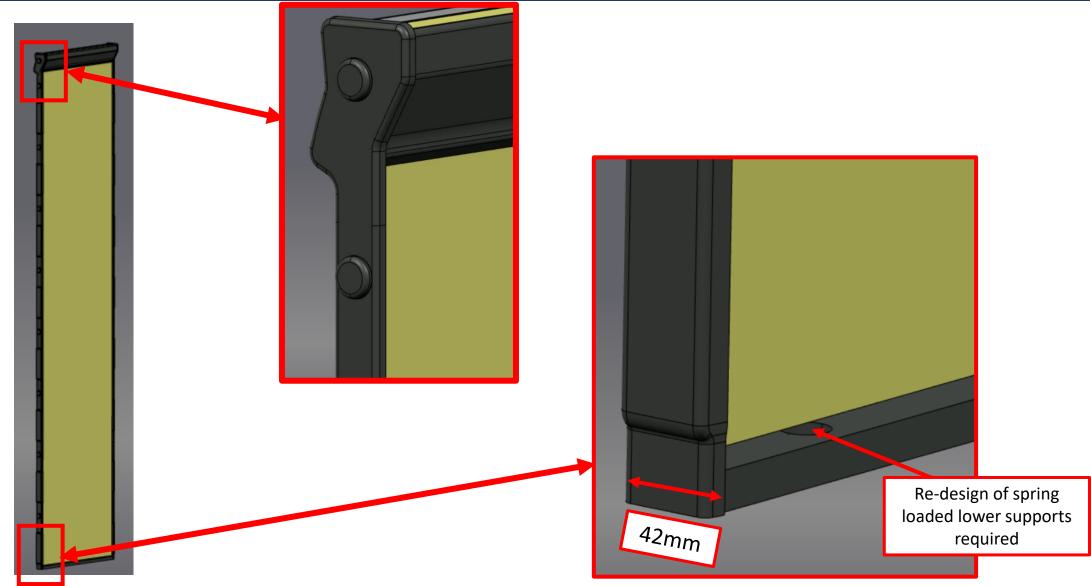
## **RICH2/TORCH Integration – PREFERRED SOLUTION – 1b)**





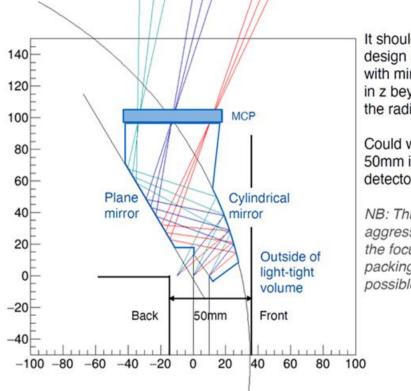


### **RICH2/TORCH Integration – Advancing the TORCH Frame**





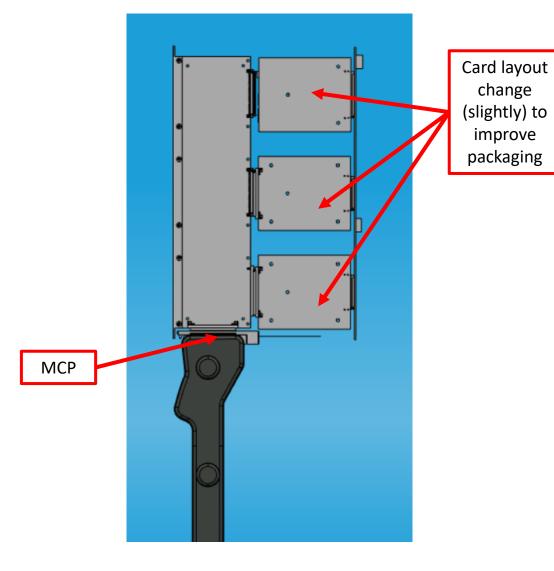
### **RICH2/TORCH Integration – Adapting the Electronics**



It should be possible to design a focusing block with minimal protrusion in z beyond one face of the radiator.

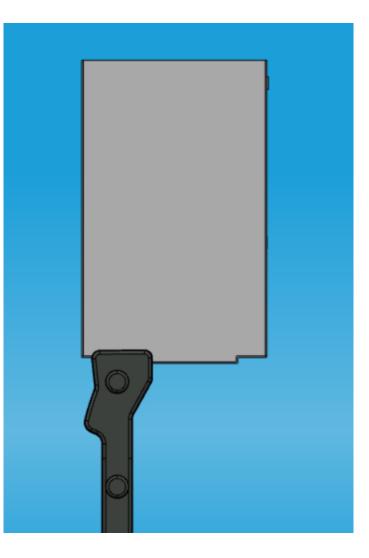
Could we package in 50mm inside the detector acceptance?

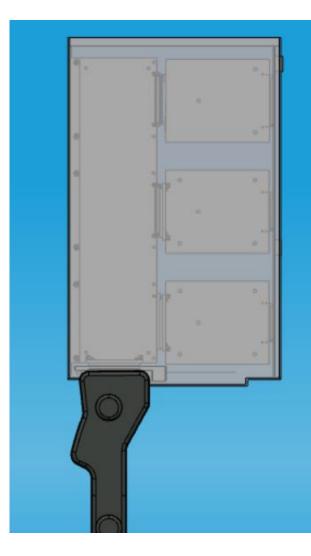
NB: This is an aggressive redesign of the focus to make the packing as small as possible.





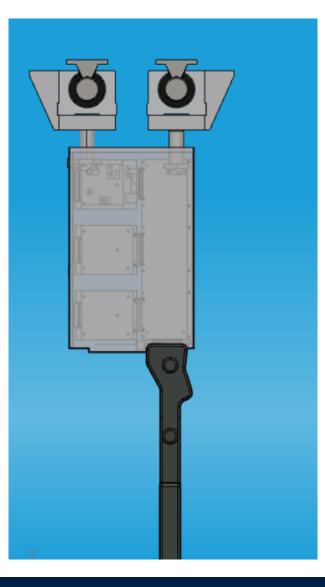
### **RICH2/TORCH Integration – Assuming an Electronics Housing**







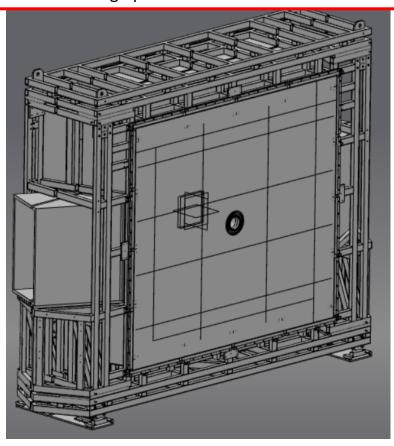
## **RICH2/TORCH Integration – Repurposing current TORCH mount**

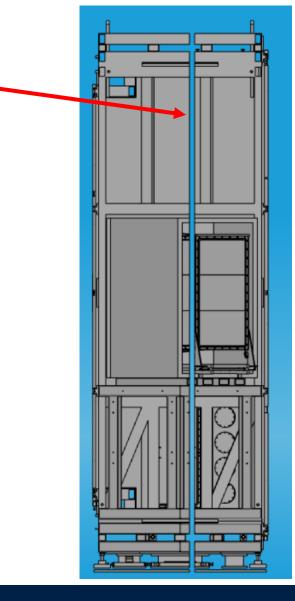




# **RICH2/TORCH Integration – RICH2 Radiator Length Reduction**

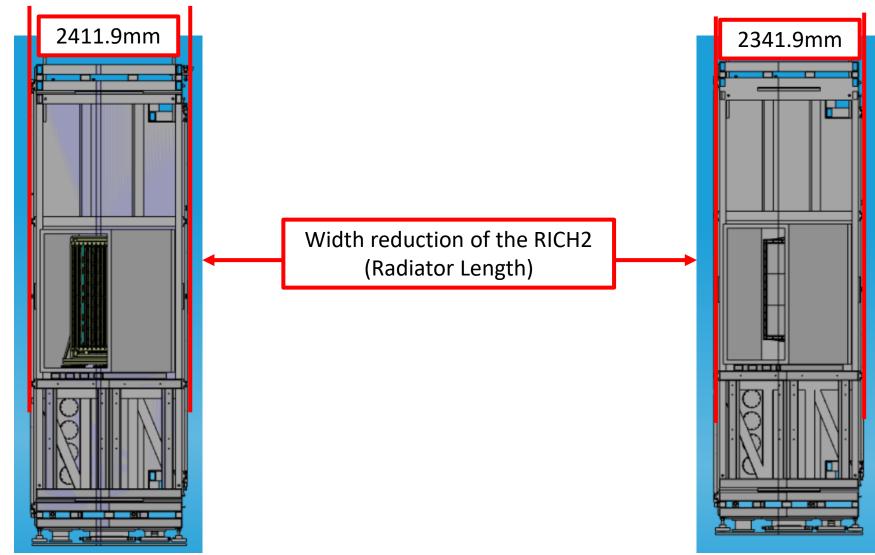
Suggestion would be to remove ~70mm from the centre of the RICH chamber/structure and 'stitch back together' from a design point of view – **NOT LITERALLY!** 





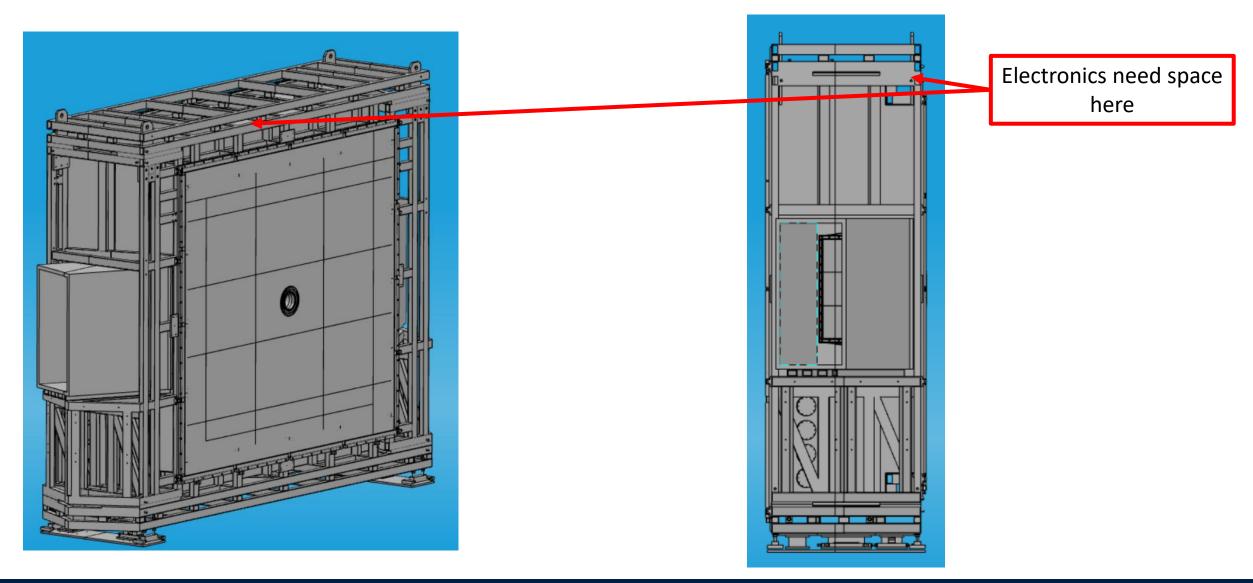


## **RICH2/TORCH Integration – RICH2 Radiator Length Reduction**



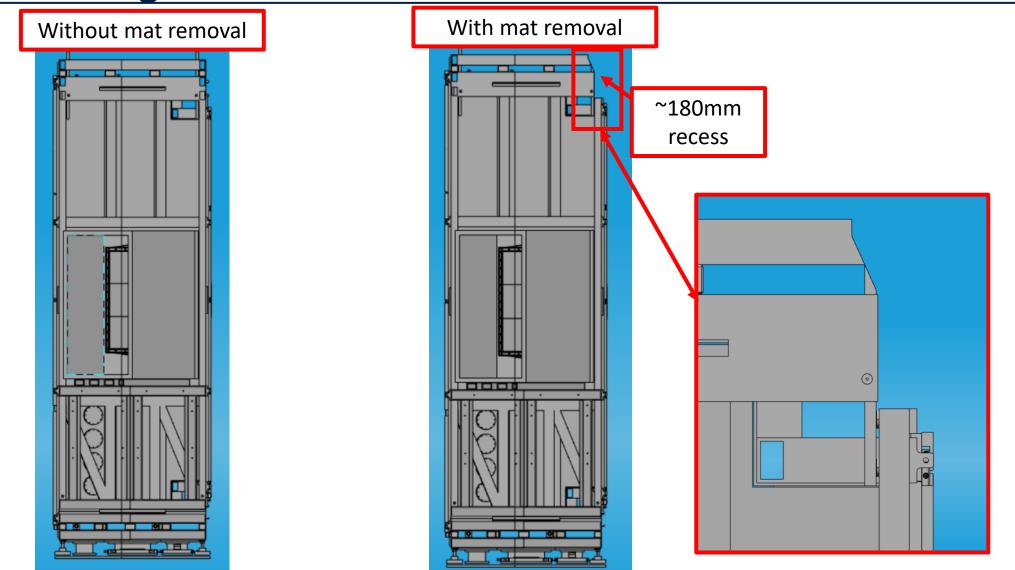


## **RICH2/TORCH Integration – RICH2 Frame Modification**



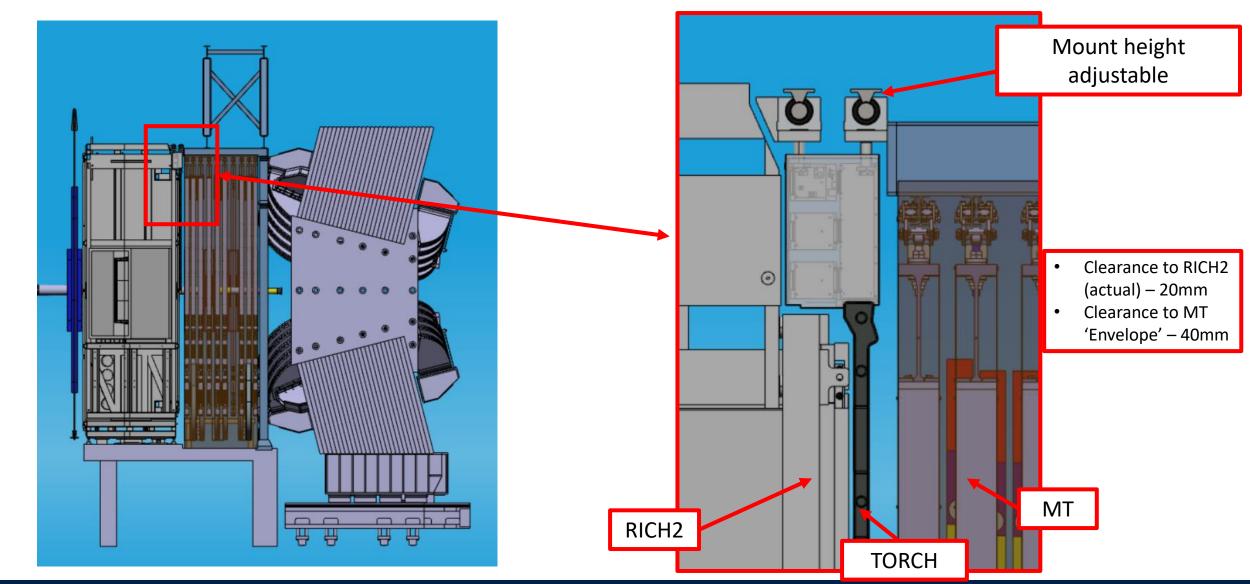


## **RICH2/TORCH Integration – RICH2 Frame Modification**





### RICH2/TORCH Integration – All of this creates (just showing 1 upper TORCH module)....





## Next Steps;

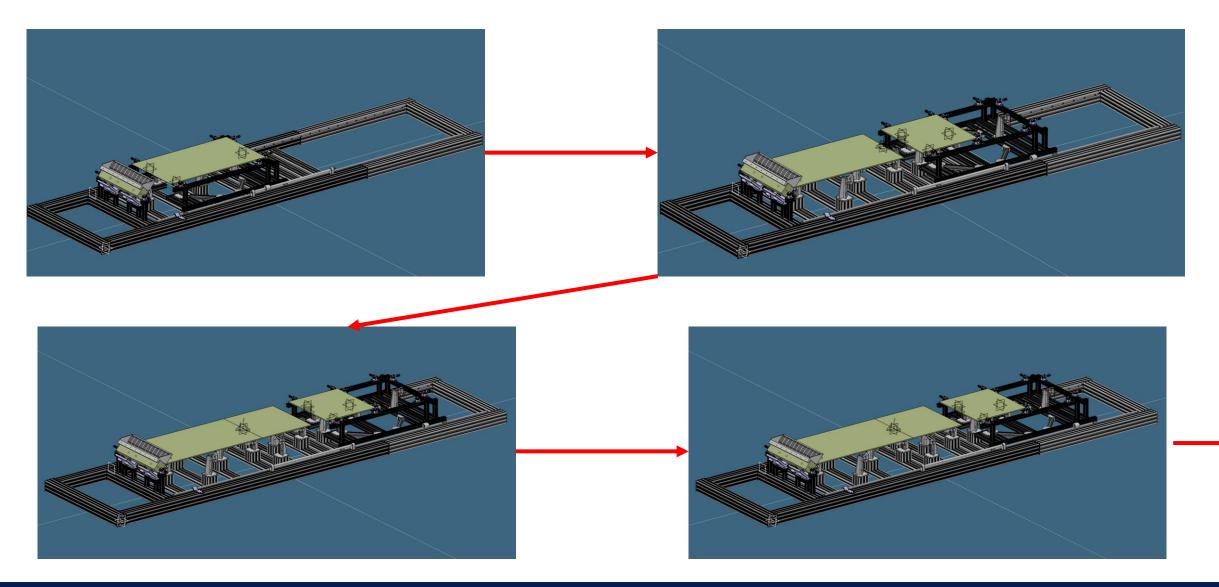
- Full detector design;
- Beampipe clearance consideration;
- Module Integration;
- Further evolve design with RICH2 and MT team to identify where there may be space issues.





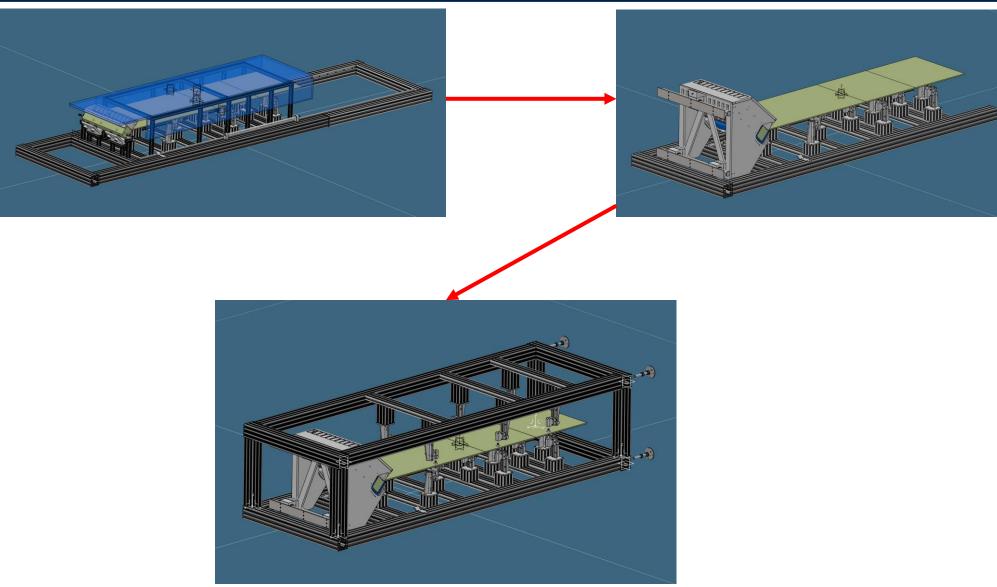


## **Bond Jig and Exo-Skeleton**



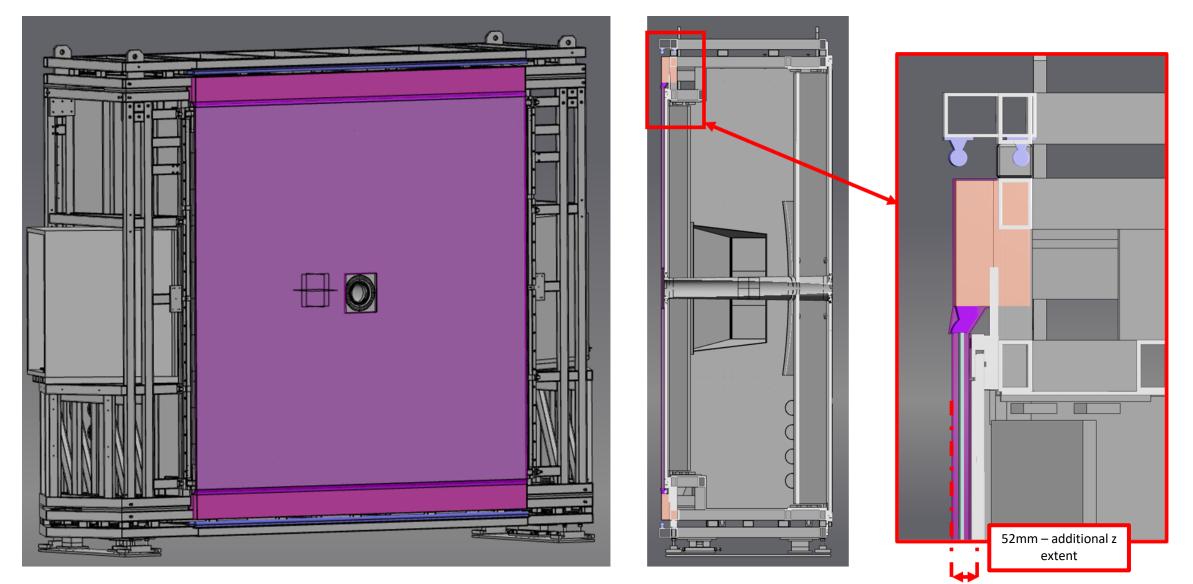


## **Bond Jig and Exo-Skeleton**



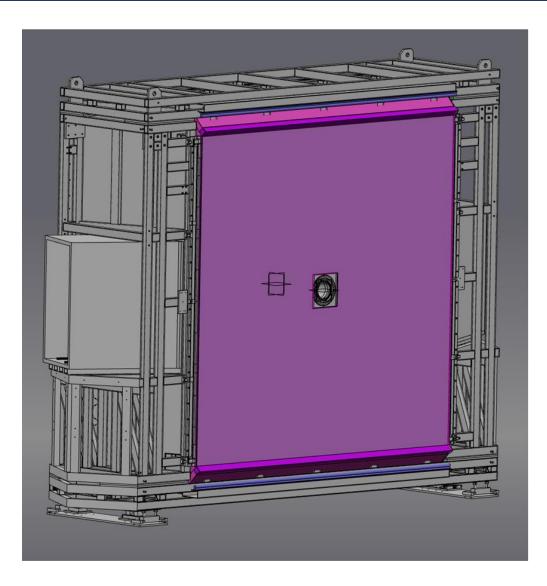


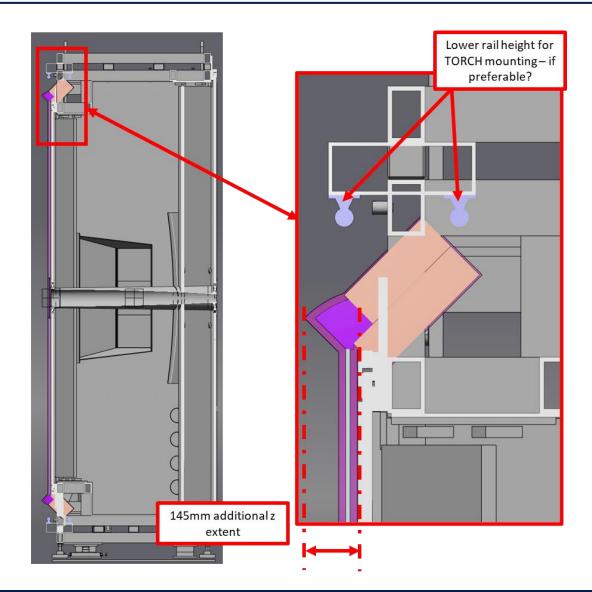
## **RICH2/TORCH Integration – Option 1a) Minimal RICH2 Impact**





### **RICH2/TORCH Integration – Option 2a) Minimal RICH2 Impact (Angled Electronics)**







#### **RICH2/TORCH** Integration – Option 2b) Minimal RICH2 Rad Length Reduction (Angled Electronics)

