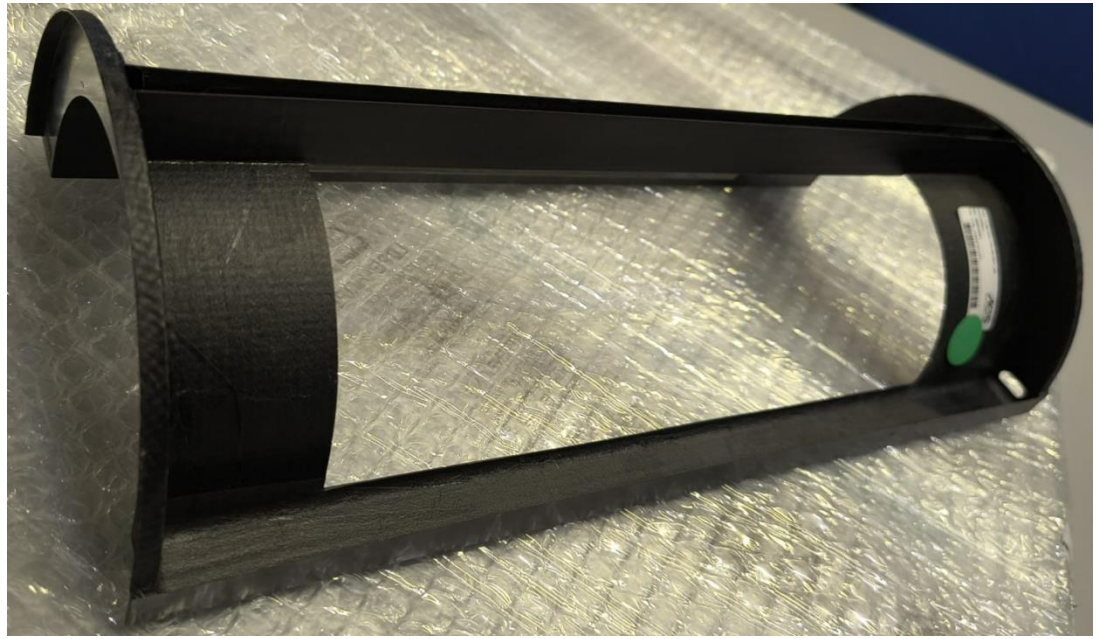
Epic SVT
prototype check and F.E.analysis status

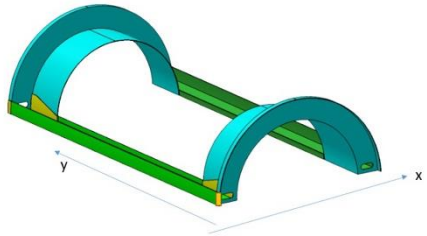
R. Turrisi, M. Benettoni, N. Bez, R.Dima, M. Turcato
INFN PADOVA - Servizio Progettazione Meccanica
May 2026

1° L01 prototype



PROPOSTA LAMINAZIONE
Struttura centrale

SIGLA	DESCRIZIONE	TH [mm]
PWL	C 46 HS40 PW ER450 46% H100	0,05
PW	CC200 ER450 M46J 200gsm 40% 6k Tw	0,2
UD	HM124 ER450 M46J 124gsm 36% 12k UD	0,13



PLY N°	DENOM	Th	A	B	C	D (flangia)
P01	PWL	0,05	X	x		X
P02	PWL	0,05		y	y	X
P03	UD	0,13	X	x		
P04	UD	0,13		Y	Y	
P05	PW	0,2	X	X		X2
P06	PWL	0,05		Y	Y	
P07	UD	0,13		Y	Y	
P08	UD	0,13	X	X		
P09	UD	0,1		Y	Y	

PLANNING

Name	Measured value	Nominal value	+Tol	-Tol	Deviation	+/-
Cylindricity cyl. Y-	0.3801	0.0000	0.3000	0.0000	0.3801	0.0801
Cylindricity cyl. Y+	0.2280	0.0000	0.3000	0.0000	0.2280	
Cylindricity cyl. Y- Y+	0.4094	0.0000	0.3000	0.0000	0.4094	0.1094
Radius Cylinders						
Radius cyl. INT Y-	62.4851	62.5000	0.1000	0.0000	-0.0149	-0.0149
Radius cyl. INT Y+	62.5445	62.5000	0.1000	0.0000	0.0445	
Radius cyl. EXT Y-	62.9167	63.0000	0.1000	0.0000	-0.0833	-0.0833
Radius cyl. EXT Y+	63.0426	63.0000	0.1000	0.0000	0.0426	
Dist. Plane_TOP to center_cyl_Y-	0.2990	0.5000	0.2000	0.0000	-0.2010	-0.2010
Dist. Plane_TOP to center_cyl_Y+	0.4029	0.5000	0.2000	0.0000	-0.0971	-0.0971
Parallelism Planes Y+Y- ext	0.4092	0.0000	0.0000	0.0000	0.4092	0.4092
Perpend Plane Y- ext_axis	0.2773	0.0000	0.0000	0.0000	0.2773	0.2773
Perpend Plane Y-+ext_axis	0.2830	0.0000	0.0000	0.0000	0.2830	0.2830
Flatness Plane top X-	0.4607	0.0000	0.0000	0.0000	0.4607	0.4607
Flatness Plane top X+	0.4587	0.0000	0.0000	0.0000	0.4587	0.4587
Flatness Plane TOP	0.5046	0.0000	0.0000	0.0000	0.5046	0.5046
Flatness Plane Y- ext	0.1862	0.0000	0.0000	0.0000	0.1862	0.1862
Flatness Plane Y+ ext	0.1422	0.0000	0.0000	0.0000	0.1422	0.1422
Dist. 354	353.9612	354.0000	0.1000	-0.1000	-0.0388	

Combination of M46J (435 Gpa) unidirectional and woven plies
General thickness ~ 0.5 mm
Weight 66g

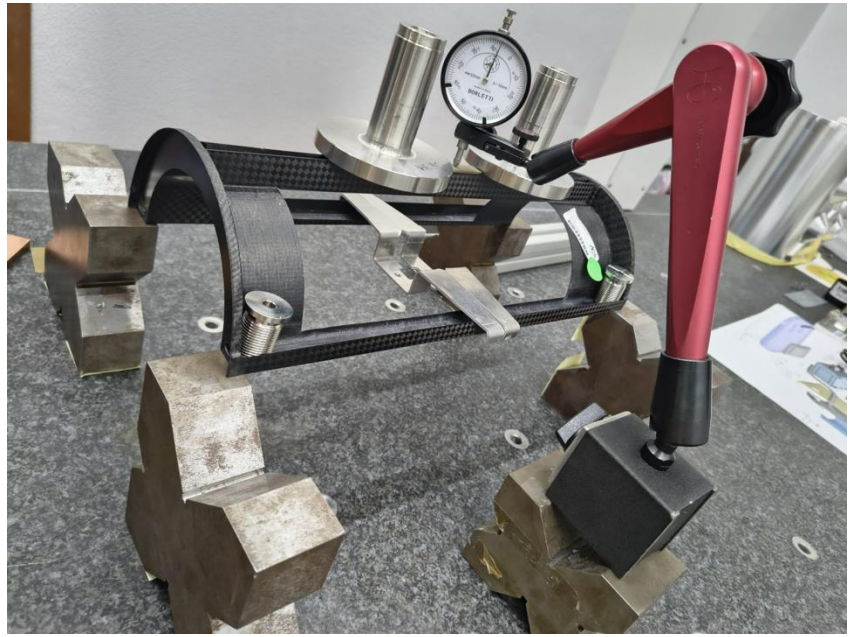
Measured with CMM, some non-conformities addressed to supplier:

- Inner radii smaller instead larger wrt nominal (by a few 10um)
- Cylindricity deviation up to ~ 0.4 mm
- Side longerons straightness/flatness deviation up to ~ 0.5 mm
- Seem minor non-conformities that can be recovered with next batch

Quick load test to verify CF bulk Young modulus / stiffness

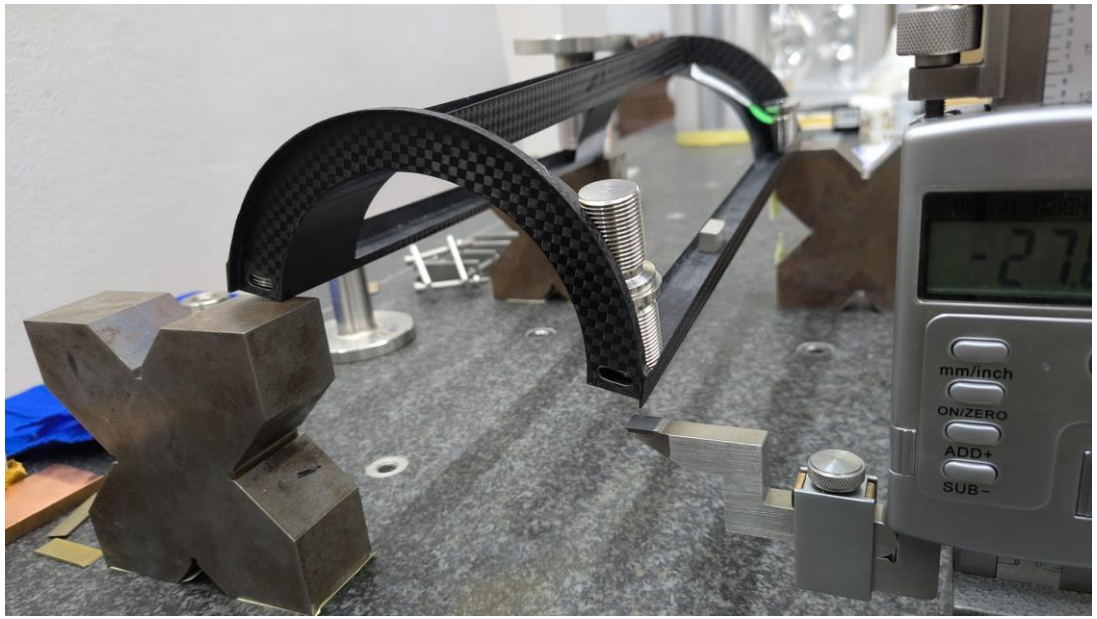
Load test on:
- Side longerons deflection =>
from FEA => E~147 GPa
(wrt M46J 436GPax0.6 fiber fraction ~261? GPa)

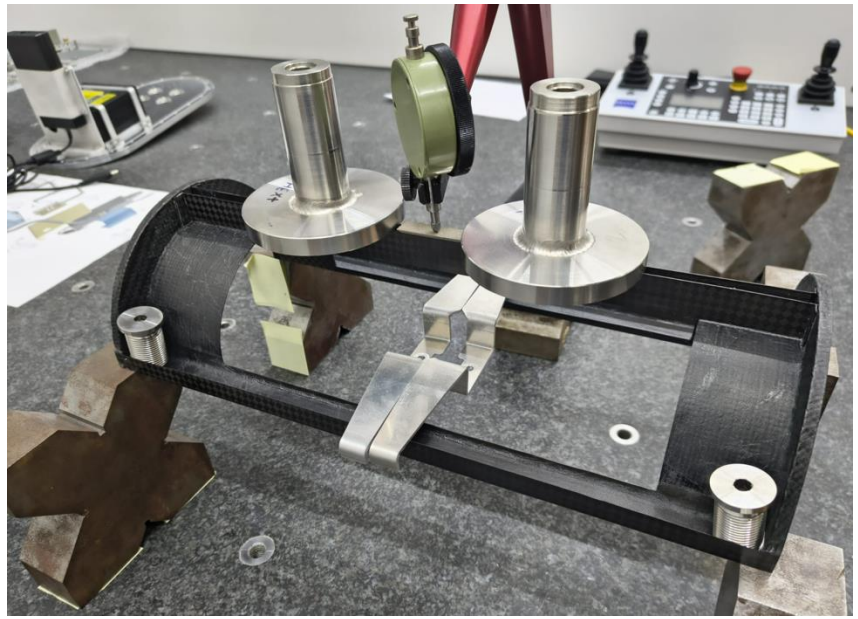
force N	deformation low wing um	um/N	deformation high wing um	um/N
2.2	85.0	38.2	50.0	22.5
3.4	130.0	38.4	70.0	20.7
4.2	180.0	42.7	85.0	20.2



- Top longeron deflection:
2 steel cylinder @ pitch13 cm ~0.07mm/15.2N ~ 4.6 um/N (still to be compared to FEA)
1 steel brick at middle ~0.17 mm/27.1N ~6.3 um/N (still to be compared to FEA)

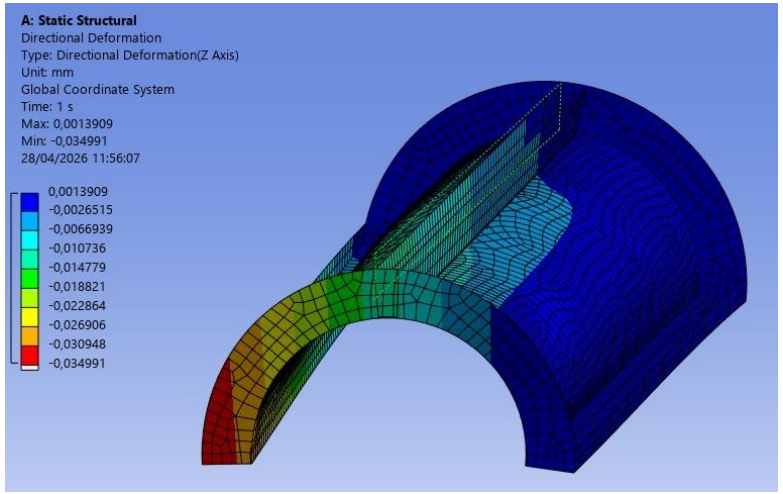
- Torque: frame support on 3 points, load on 4th one
~0.8N: 12-15mm; ~1.6N: 21-24 mm ~ 14-17 mm/N (still to be compared to FEA)
=> *torsional stiffness very poor*

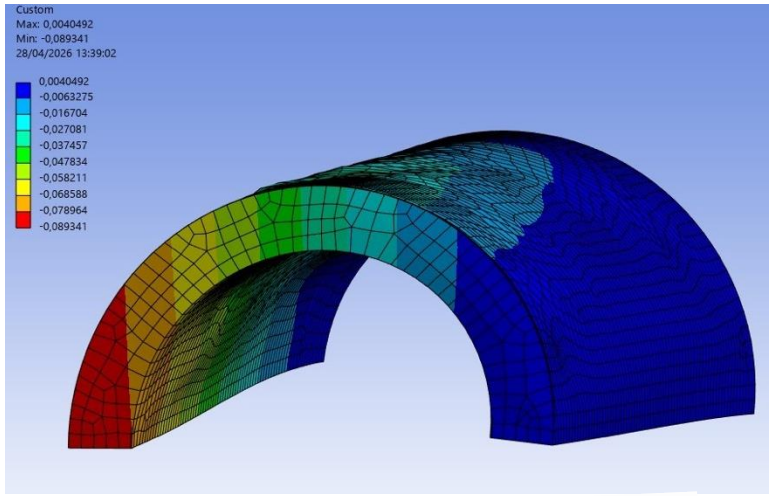




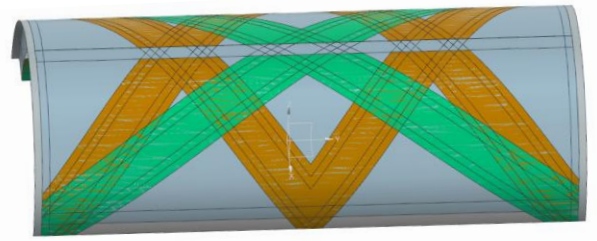
Simulations in progress to increase torsional stiffness

		shell thickness				
		0.50	0.20	0.10	0.05	
		um				
As built (simplified)		287.00	287.00	287.00	287.00	
Shell inner single piece	Resulting sag fraction	0.48	0.59	0.64	0.68	top longeron negligible
2 shell cyl IN&OUT closed		**0.12**	**0.20**	0.30	0.40	top longeron negligible
Shell OUT & top longeron		0.44	0.50	0.52	0.57	
Shell OUT no TOP longeron		0.53	0.60	0.63	0.66	
Closed/tubular longherons 0.5 mm		0.52	0.52	0.52	0.52	
Closed Longerons + Shell IN			0.38			
Spirals reinforcem.		???	???	???	???	





Double shell => closed hollow/tubular section most efficient
Top/middle longeron ~ negligible in case of monolithic shell(s)
Other more elaborated solution to be considered (“elicoidal” reinforcement)
But in any case ….. material budget going to increase!



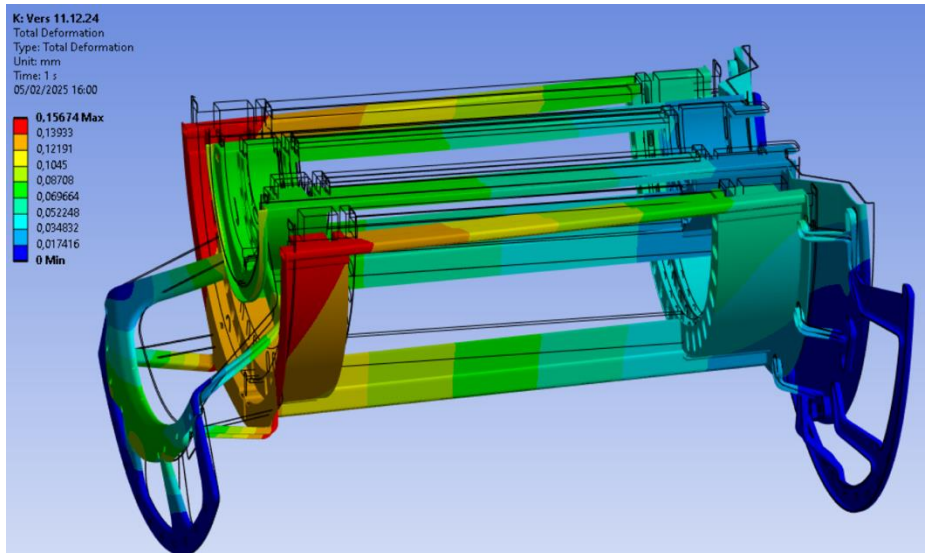
Prototype to be used/tested @ INFN Bari to assess torsional stiffness requirement to define modification

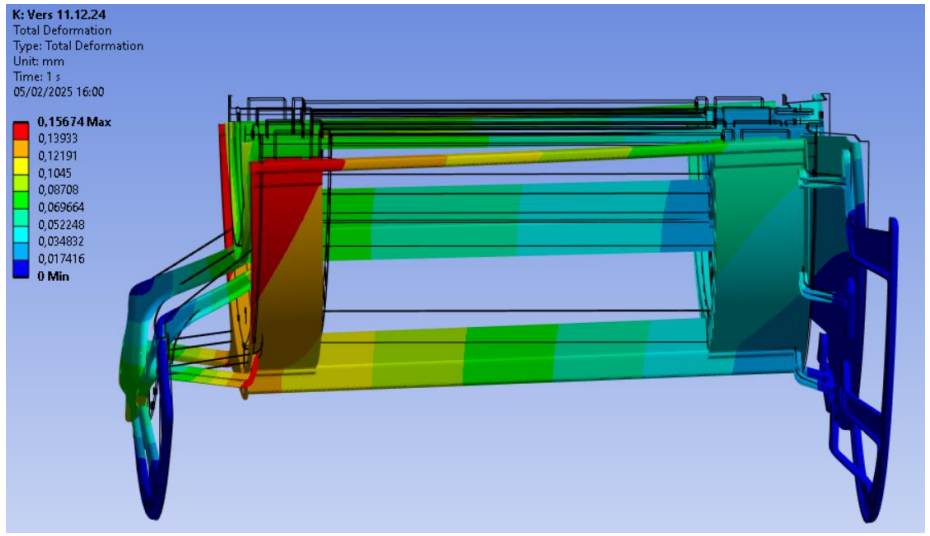
Thank you
Spare slides

Preliminary static structural simulations

Initial attempt: uniform thickness 1 mm, Isotropic material E=50GPa, overall gravity load ~ 16N

(includes 50% contingency)

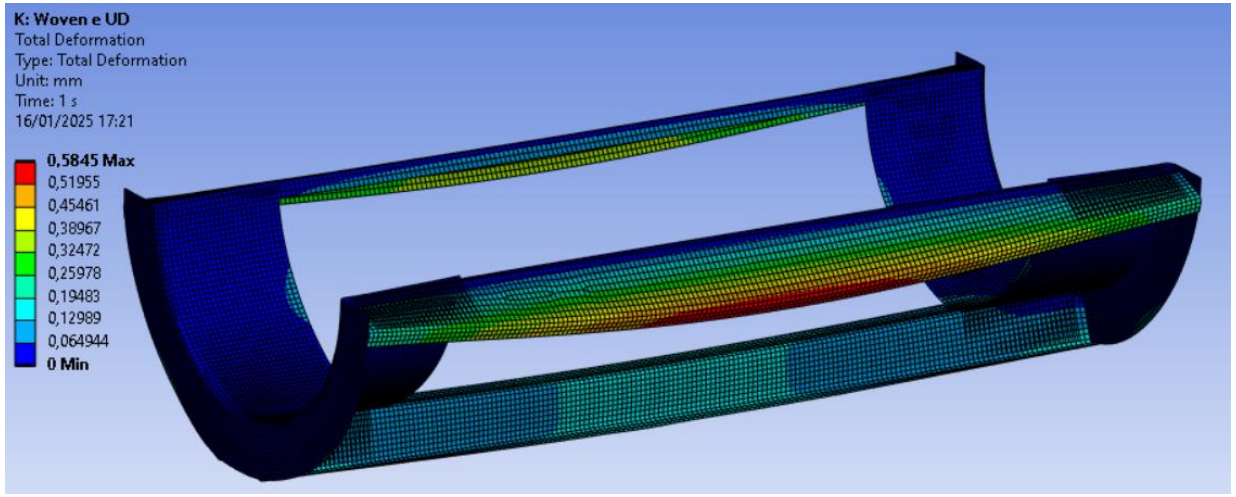




2nd iteration:

FEA of simplified L1 layer only, assuming:

- Arcs composed by orthotropic CF woven E=61 GPa
- Beams composed by unidirectional CF E_l=121 Gpa, E_t= 8.6 GPa
- Shell elements thickness 0.2 mm on the “sensor half-cylinder”



E.g. L2 supports to increase stifness …

Work in progress to refine geometry and FEA models to minimize deformation / displacement of sensors, with minimal amount of structure mass

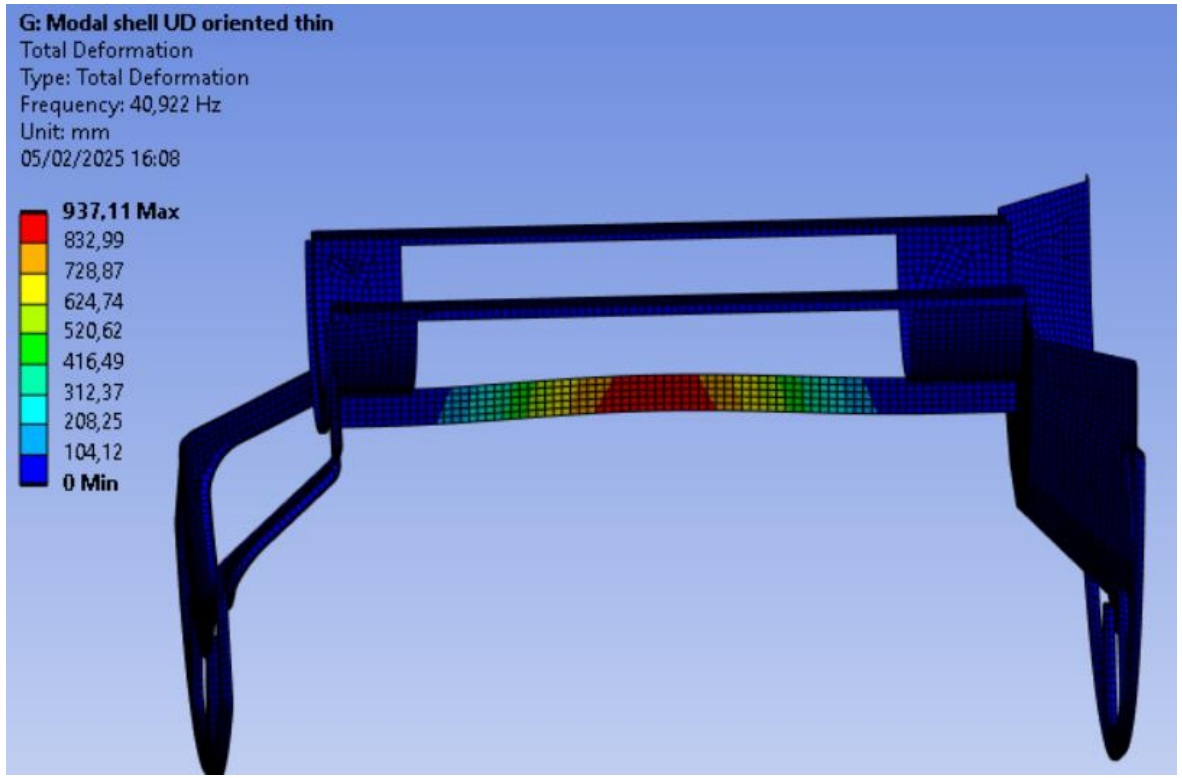
Preliminary modal simulations

- Arcs composed by orthotropic CF woven E=61 GPa
- Beams composed by unidirectional CF E_l=121 Gpa, E_t= 8.6 GPa
- Shell elements thickness 0.4 mm on the “sensor half-cylinder”
- Shell elements thickness 0.6 mm on the support “cones”

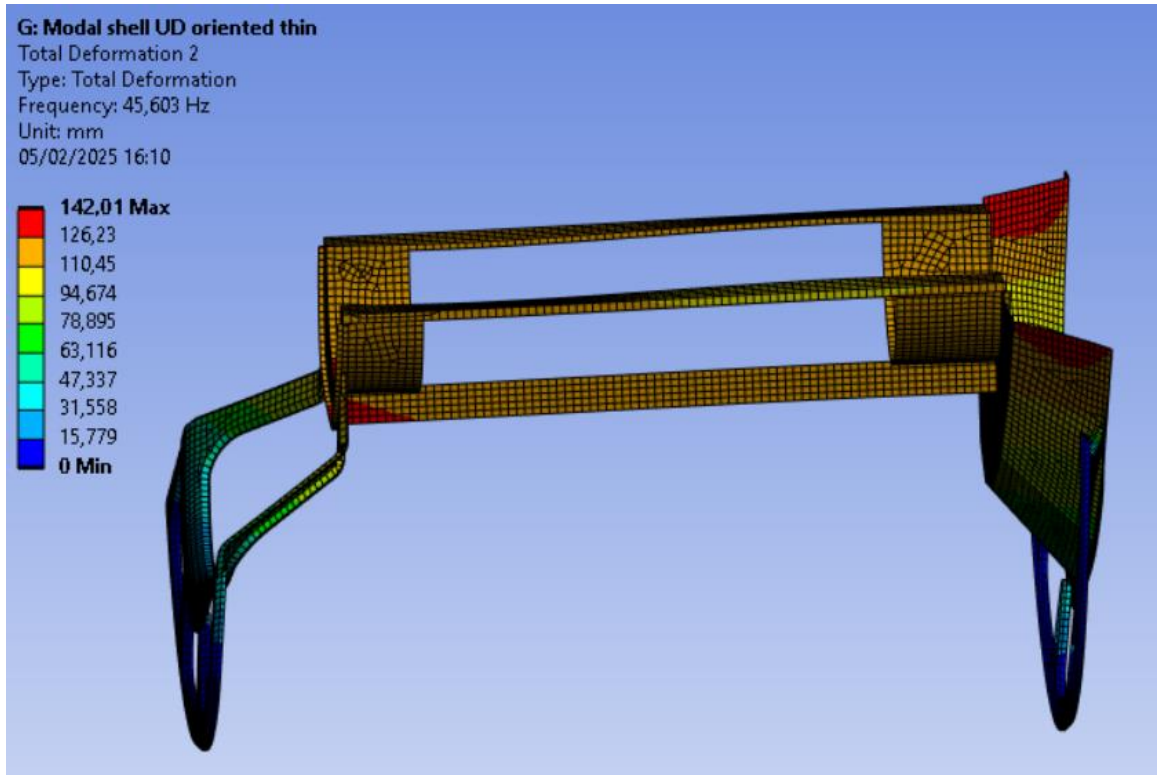
Tabular Data

	Mode	Frequency [Hz]
1	1.	40,922
2	2.	45,603
3	3.	64,792
4	4.	95,922
5	5.	99,269
6	6.	103,24

1st mode: bottom beam deflection …



2nd mode: axial oscillation (along Z)



Work in progress to refine geometry and FEA models to
design stiffer as possible structure, high natural frequencies, with minimal amount of structure mass