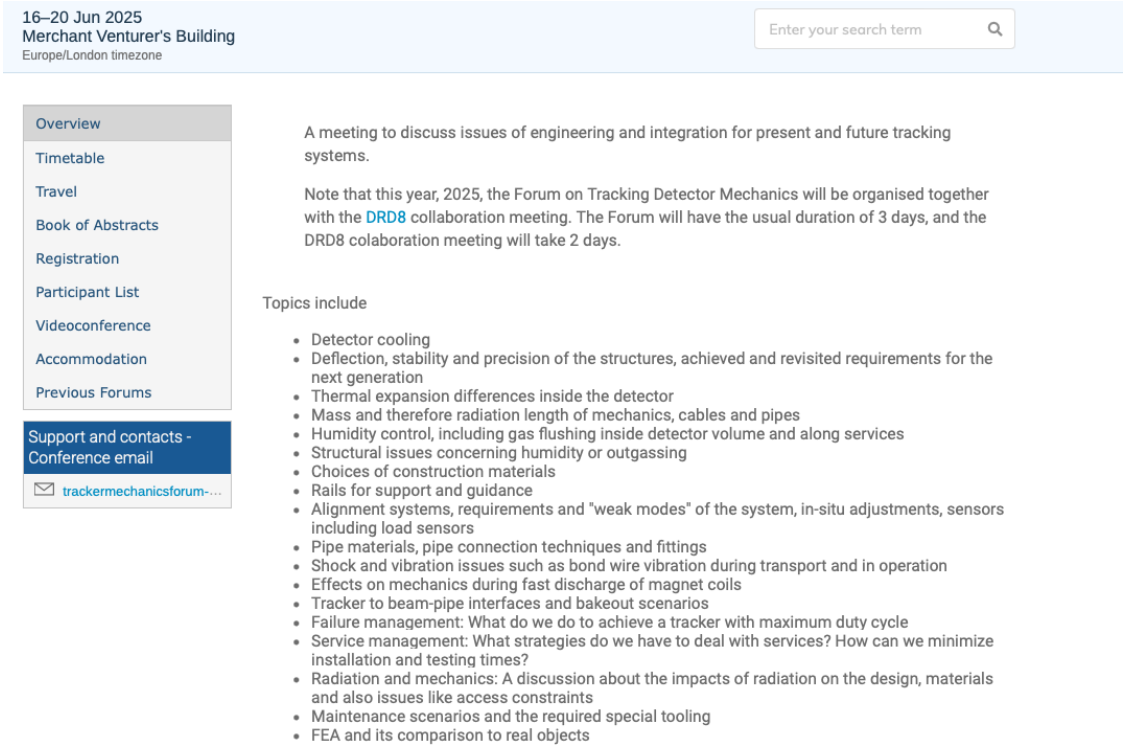
Highlights from the Forum

https://indico.cern.ch/event/1482847/timetable/#20250616.detailed



16–20 Jun 2025
Merchant Venturer's Building
Europe/London timezone

Enter your search term

Overview
Timetable
Travel
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Registration
Participant List
Videoconference
Accommodation
Previous Forums

Support and contacts - Conference email
trackermechanicsforum-...

A meeting to discuss issues of engineering and integration for present and future tracking systems.

Note that this year, 2025, the Forum on Tracking Detector Mechanics will be organised together with the DRD8 collaboration meeting. The Forum will have the usual duration of 3 days, and the DRD8 colaboration meeting will take 2 days.

Topics include

- Detector cooling
- Deflection, stability and precision of the structures, achieved and revisited requirements for the next generation
- Thermal expansion differences inside the detector
- Mass and therefore radiation length of mechanics, cables and pipes
- Humidity control, including gas flushing inside detector volume and along services
- Structural issues concerning humidity or outgassing
- Choices of construction materials
- Rails for support and guidance
- Alignment systems, requirements and "weak modes" of the system, in-situ adjustments, sensors including load sensors
- Pipe materials, pipe connection techniques and fittings
- Shock and vibration issues such as bond wire vibration during transport and in operation
- Effects on mechanics during fast discharge of magnet coils
- Tracker to beam-pipe interfaces and bakeout scenarios
- Failure management: What do we do to achieve a tracker with maximum duty cycle
- Service management: What strategies do we have to deal with services? How can we minimize installation and testing times?
- Radiation and mechanics: A discussion about the impacts of radiation on the design, materials and also issues like access constraints
- Maintenance scenarios and the required special tooling
- FEA and its comparison to real objects

- Lots of ATLAS & CMS talks
- Large focus on CO2 cooling and related challenges

DRD8 Collaboration Meeting

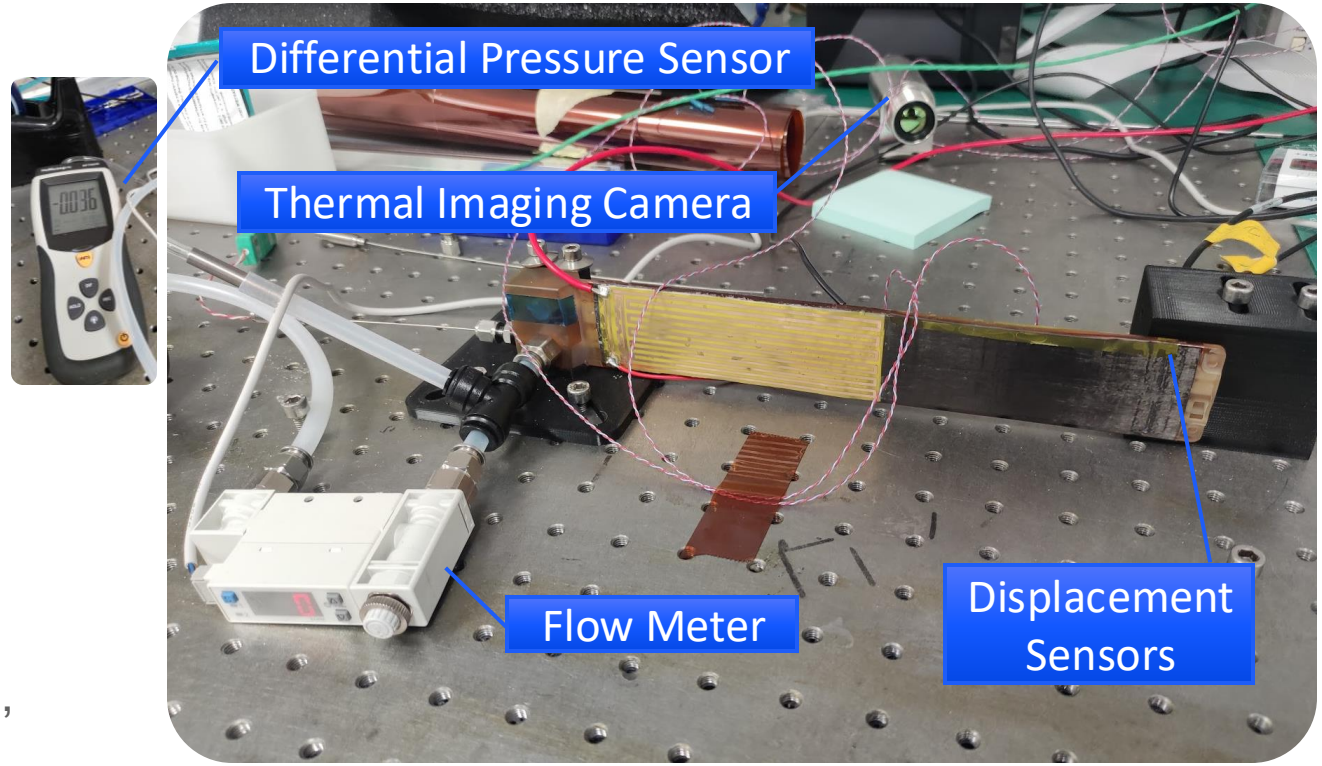
Work Packages:

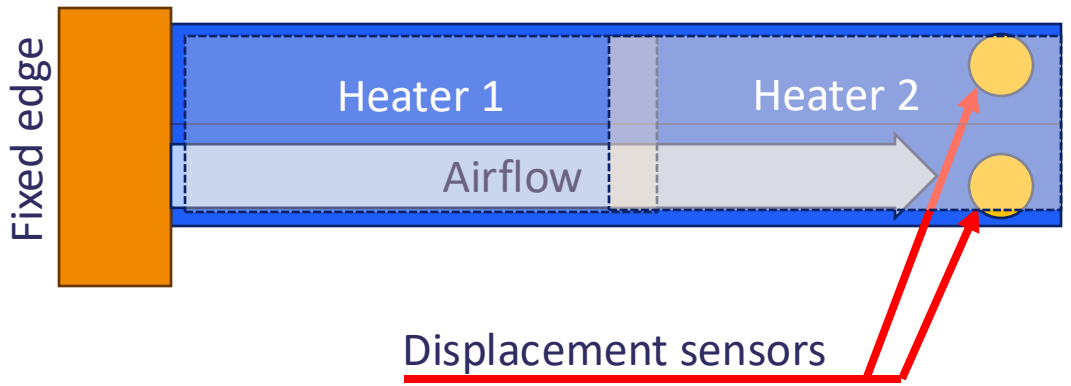
- **WP1: Global system design and integration**
  - Project 1.1: The Vertex Region of Future Particle Physics Experiments
  - Project 1.2: Robots in the HEP Experimental Caverns
- **WP2: Low-mass mechanics and thermal management**
  - Project 2.1: Advanced Mechanical Tracker Structures
  - Project 2.2: Characterisation of Material Properties and Database Development
- **WP3: Detector cooling**
  - Project 3.1: New Evaporative Cooling Fluids and Systems
  - Project 3.2: Microchannel Cooling Substrates
- **WP4: Design and qualification tools**
  - Project 4.1: Extended Reality (XR) Development
  - Project 4.2: Connection of Engineering Design Tools with Physics Simulation Software

Adam Huddart's slides

Test Setup

- Monitor pressure, temperature & displacement
- Staves are cantilever mounted
- Airflow within 1 channel (half) of the quarter stave
- Sensors & Readout
  - Flow meter (up to 100 l/min) + needle valve to adjust flow, flow measurement in DAQ
  - 2 capacitive displacement sensors, in DAQ
  - Pressure sensor (up to 0.350 bar_d) – standalone, no connection to DAQ
  - In-flow thermocouple for coolant temperature monitoring
  - Surface mount thermocouple for thermal imaging camera validation

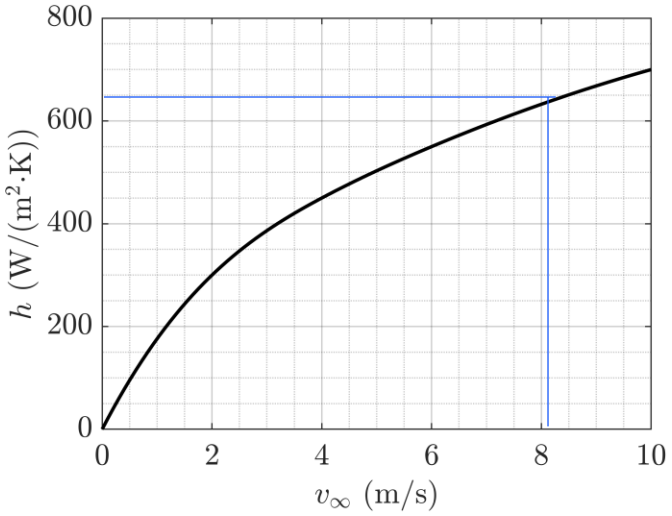


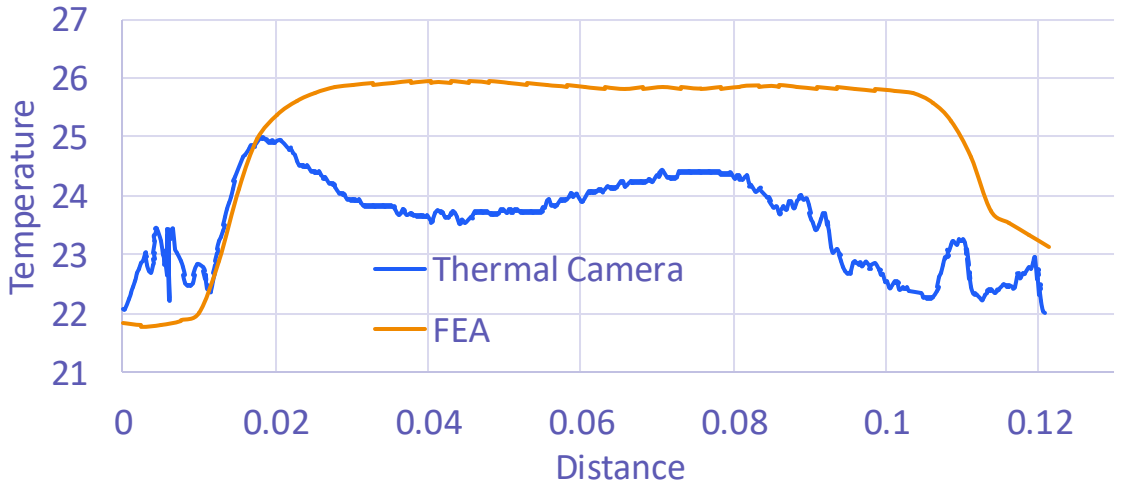


Science and Technology Facilities Council

2D FEA Model vs. Thermal Imaging

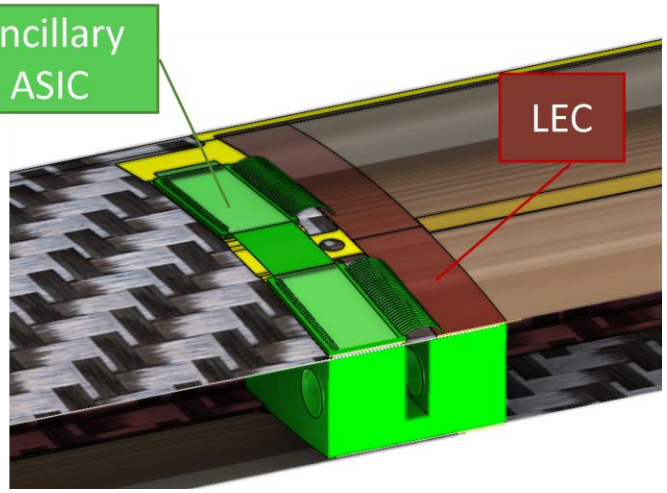
- Internal heat generation in Kapton layer – 50 microns thick
- Convection Coefficients
  - Natural convection - 7 W/m^2 K from external surfaces
  - Forced convection - 48.44 W/m^2 K from internal surfaces
  - Forced convection - 650 W/m^2 K from K9 adjacent surfaces
- Forced convection temperature from 1D model

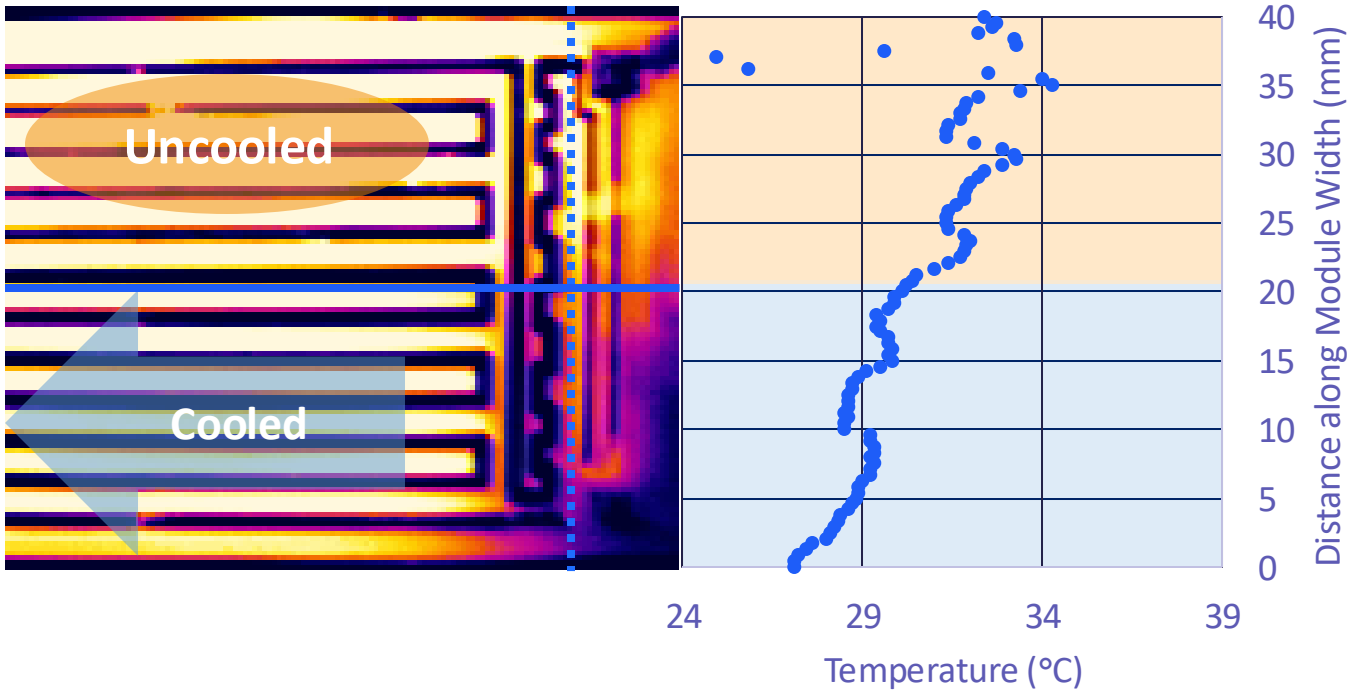




K9 Foam Performance

- Kapton heater issue means LEC & ASIC power are lower than what they will be, making it difficult to evaluate performance
- To compensate for this:
  - Flow velocity reduced to 30 ltr/min
  - Total Module power increased
    - LEC Power – 0.28 W
    - ASIC Power – 0.19 W
- Trace line shown in dotted blue plotted





Science and Technology Facilities Council

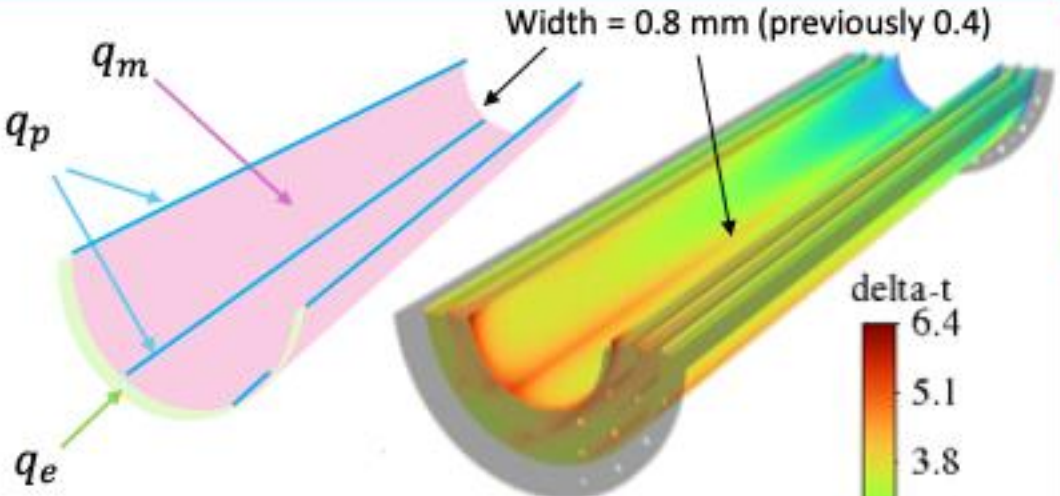
Preparation for mechanics qualification: Thermal

ALICE ITS3 WP5

Updated values of the chip power dissipation are higher than those previously quoted (in the ALICE ITS3 TDR), which requires further investigation.

Massimo Angeletti's slides

CFD analysis of updated power values



Pixel matrix $q_m = 15.6 \frac{mW}{cm^2}$

Readout periphery $q_p = 436.4 \frac{mW}{cm^2}$

Left end-cap $q_e = 791.6 \frac{mW}{cm^2}$

Estimate

- ΔT_pixel_matrix < 7 °C (previously <5 °C)

Experimental evaluation

Dummy layers (heaters)

Stack-up	[µm]
PU protection	10
Copper	5
Kapton	12.5
Glue 10 / Silicon	40
Kapton	12.5

Total thickness 110-120 µm

@EP-DT-MPT

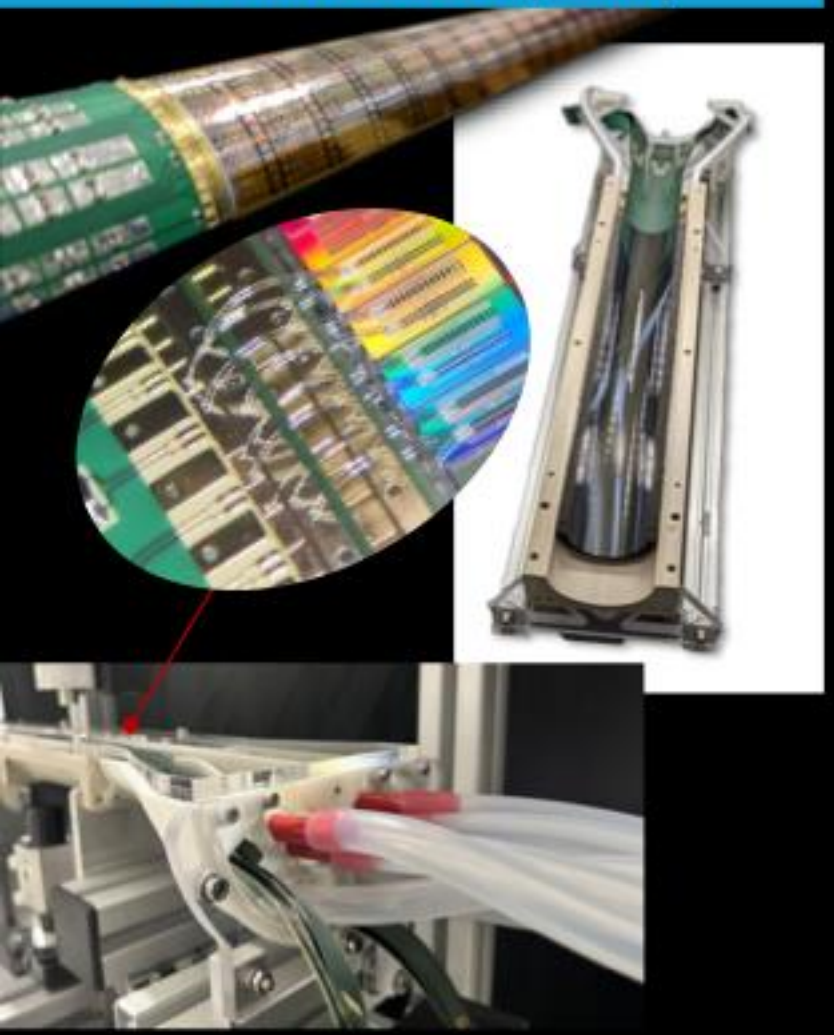
Thermal prototype (BBM6)

@Assembled at INFN Bari

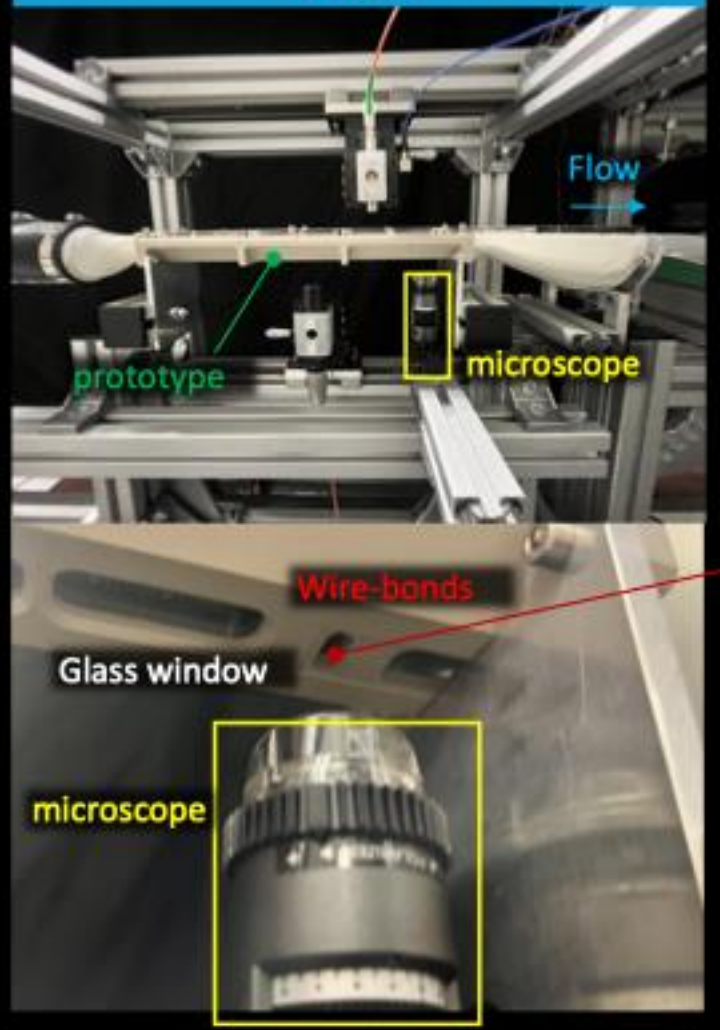
Long term testing: Wire bonds Vs airflow

Purpose: Investigate potential wire-bonding failure due to high air freestream velocities (> nominal 8m/s)

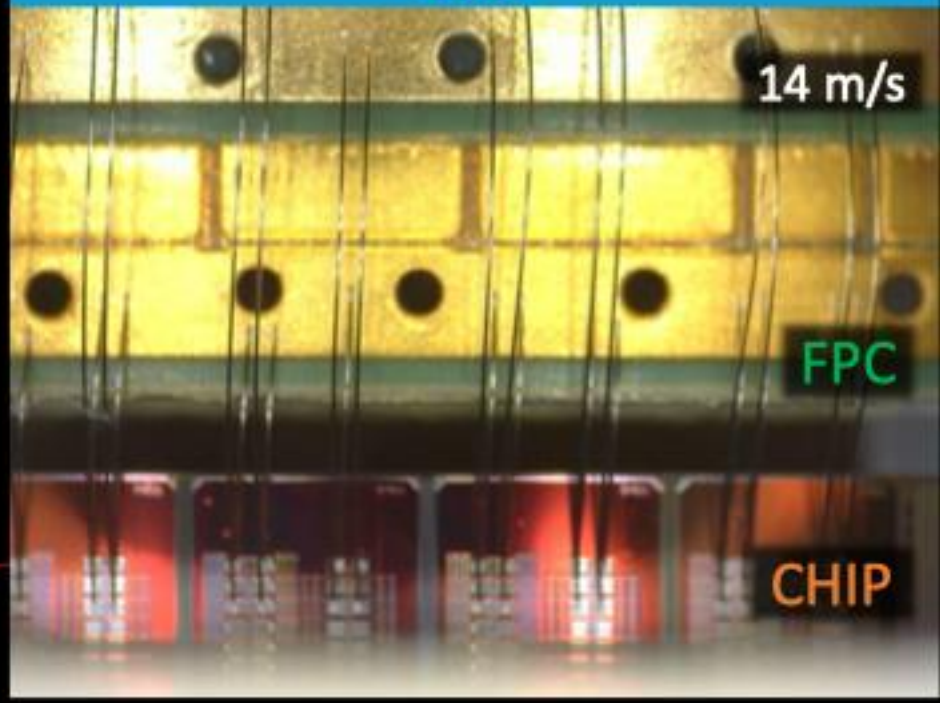
Breadboard model (BBM4)



Setup



Video



No wire bonds failure

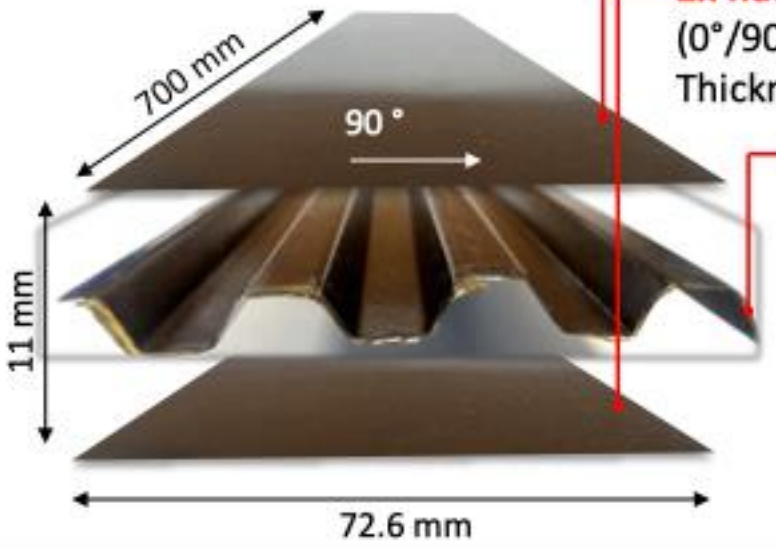
due to aeroelastic stresses
(Air freestream@14m/s)

>3 months testing

Air-cooling option for Outer Tracker: Concept

CFRP corrugated sandwich panel

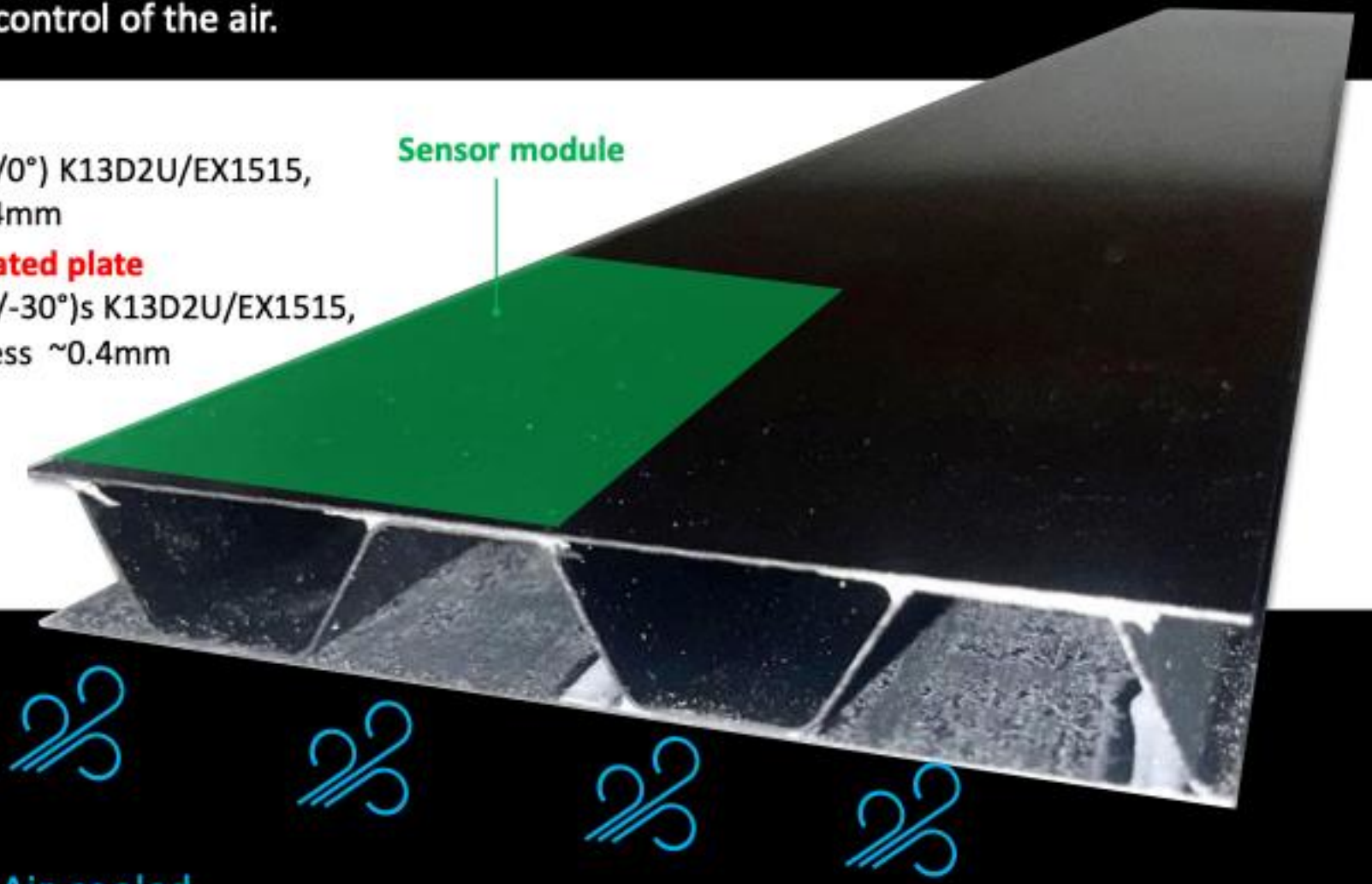
Air-cooling and structural support fully integrated (Material budget contribution of the mechanics <0.5%X_0), enabling a reliable and efficient regulation and control of the air.



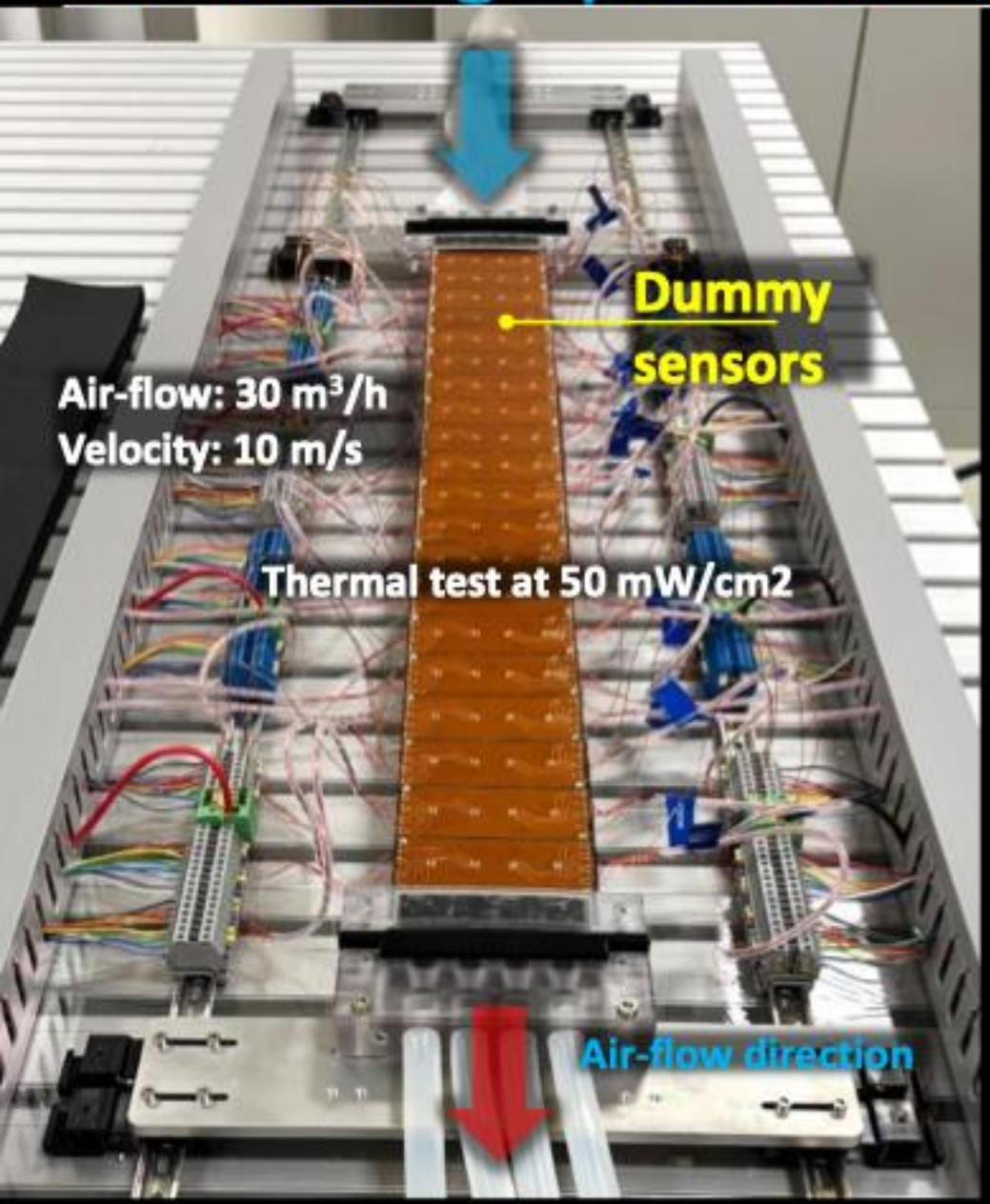
2x flat plates
(0°/90°/0°/90°/0°) K13D2U/EX1515,
Thickness ~0.4mm

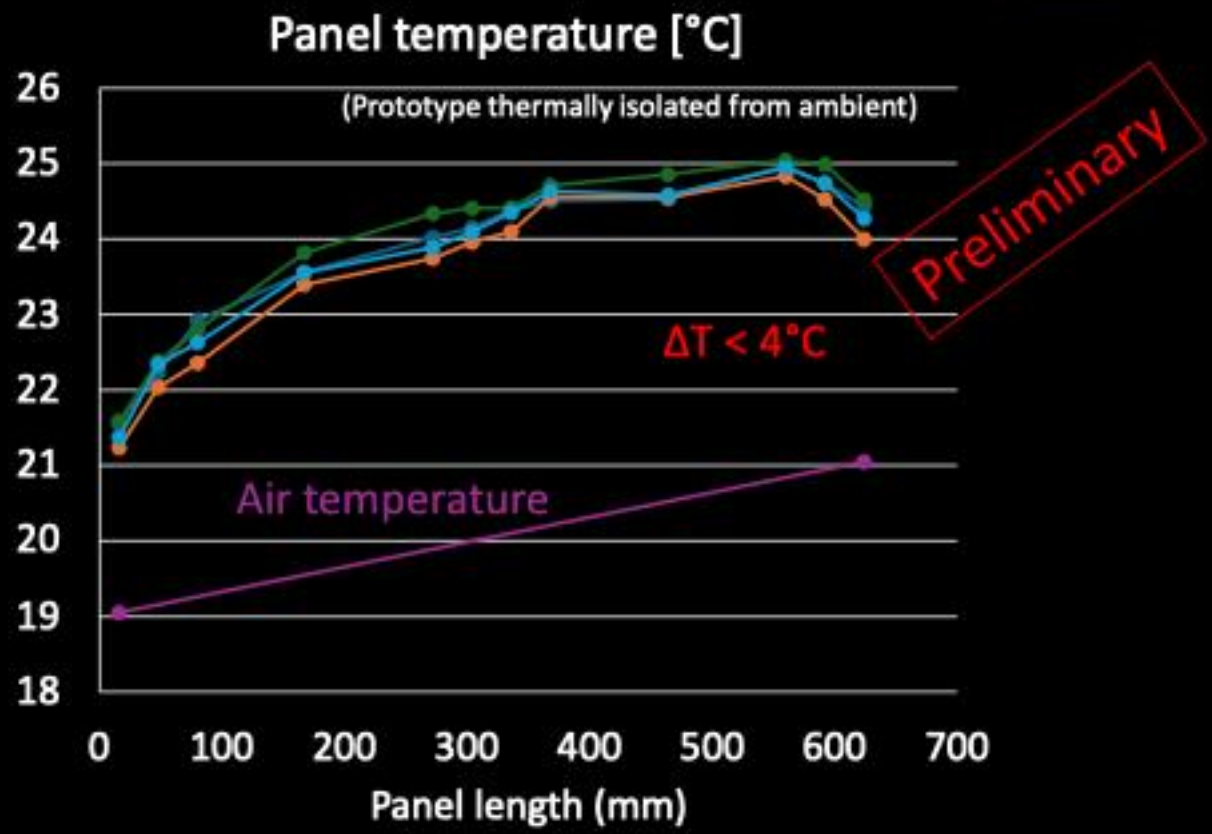
Corrugated plate
(0°/30°/-30°)s K13D2U/EX1515,
Thickness ~0.4mm

K_{xx}, K_{yy} >200 W/mK; K_{zz} >1.3 W/mK



Air-cooling option for Outer Tracker: Thermal

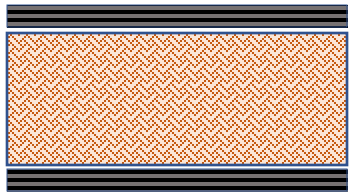




Preliminary thermal test shows panel & air temperature increases along the length:
ΔT of the panel < 4 °C
ΔT of the air < 2 °C

What is BTST ? A quick recap

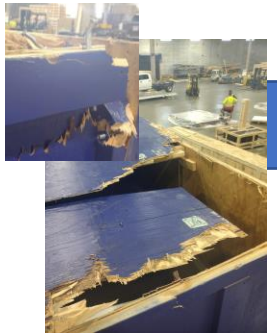
- BTST supports the Barrel Timing Layer (BTL) and the Tracker: BTL Tracker Support Tube
  - Total weight BTST + detectors + services: ~ 5000kg
- Sandwich structure with honeycomb core and two face sheets on either side bonded to it
  - Structure is 5.3m long; 2382mm ID, 2442mm OD
  - 2mm face sheets +26mm core
  - ~600kg self weight + 1800kg BTL detector
- Two Tracker support rails:
  - 5.3m long (or 2.65m x 2); ~100x20mm cross section
  - Solid CFRP laminate with pultruded rod
  - Support ~**2500kg** tracking detector
- Two BTST End Rings:
  - ”Tongue & Groove” 50 mm titanium inserts each end interspersed with 25 mm solid CFRP end ring to distribute loads
- BTL inserts and support rails
  - 1400 inserts for attaching 38 BTL rails to the BTST inner surface



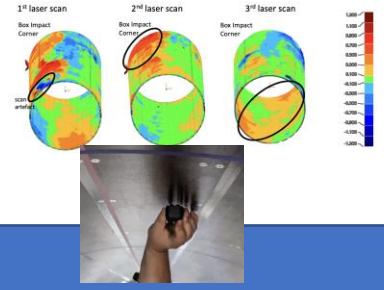
Facesheet = 2mm thick
HoneyComb = 26mm thick
Facesheet = 2mm thick

Details on the geometry and materials used are in back up slides.

In this presentation

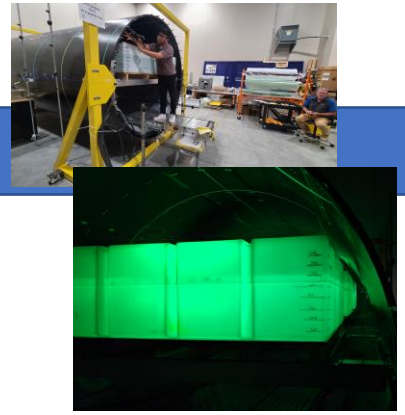


June 2024: road Transport incident

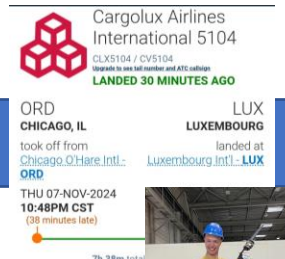


2.5 months of visual, laser and ultrasonic inspection

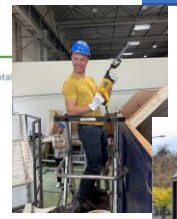
2 weeks of loading tests + technical review



2 weeks of box modifications



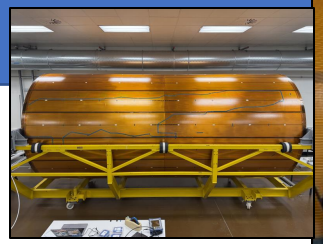
Received at CERN Nov 2024

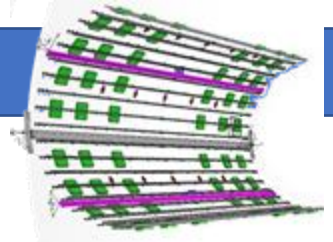


2024

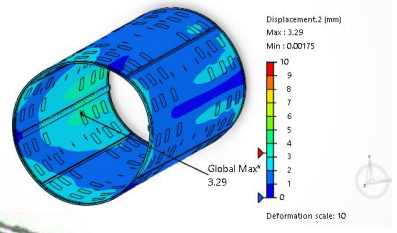
Heating foil glueing

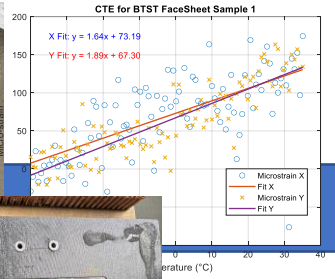
Feb 2025: Identifying dis-bond with ultrasonic scanning

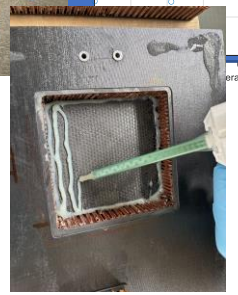




FEA for repair strategies







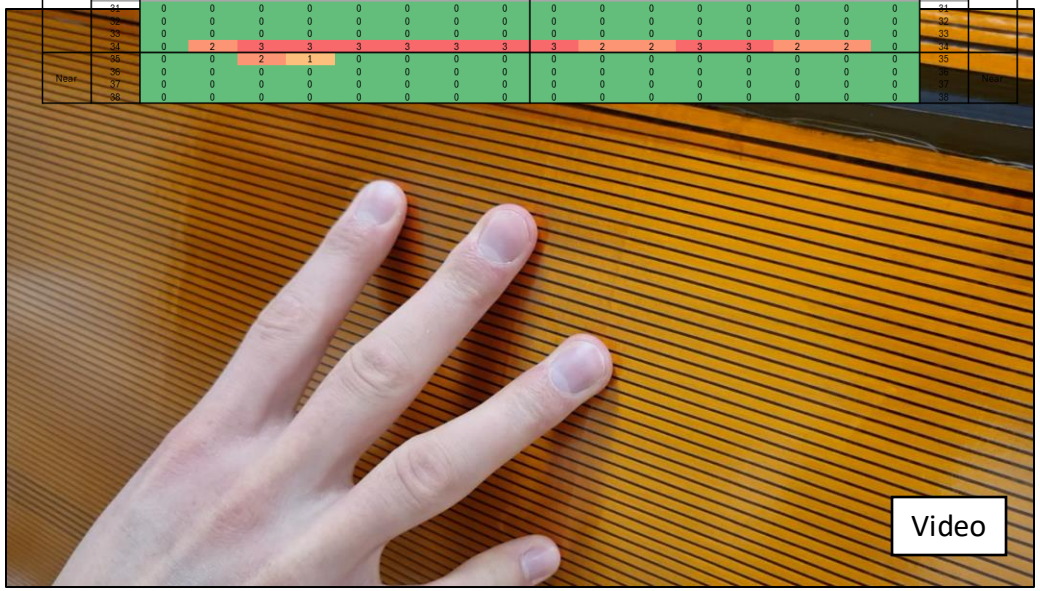
2025

Repair steps and test strategies

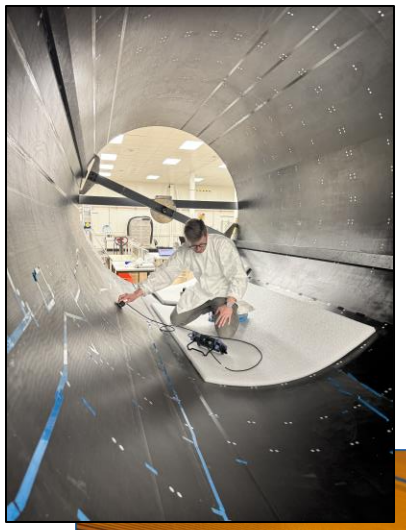
Ultrasonic inspection for dis-bond identification

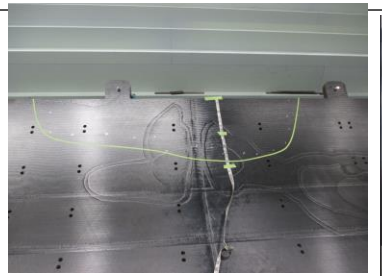
3.3.2025 -4.3.2025_BTST outside

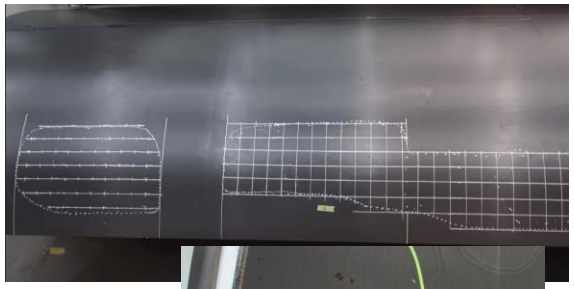
Quadrant	Plus Z	8	7	6	5	4	3	2	1	-1	-2	-3	-4	-5	-6	-7	-8	Minus Z	Quadrant
	39, 40, 1	Rail								Rail								39, 40, 1	
Near	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	Near
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	5	
	6	0	0	0	0	3	2	3	3	3	0	0	3	0	0	0	0	6	
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	
Top	10	Virtual coordinate								Virtual coordinate								10	Top
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	
	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	
	14	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	14	
	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	16	
	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	
	18	0	0	1	0	0	0	0	1	1	2	2	2	2	1	0	1	18	
Far	19, 20, 21	Rail								Rail								19, 20, 21	Far
	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	
	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	
	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	
	25	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	
	26	3	3	3	3	3	3	3	3	2	0	0	0	0	0	0	0	26	
	27	3	3	3	3	3	3	3	3	2	1	0	0	0	0	0	0	27	
	28	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	0	28	
	29	1	1	1	1	2	2	2	2	3	3	3	3	3	3	3	0	29	
Bottom	30	Virtual coordinate								Virtual coordinate								30	Bottom
	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	
	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	
	34	0	2	3	3	3	3	3	3	3	2	2	3	3	2	2	0	34	
	35	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	35	
Near	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36	Near
	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	
	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	

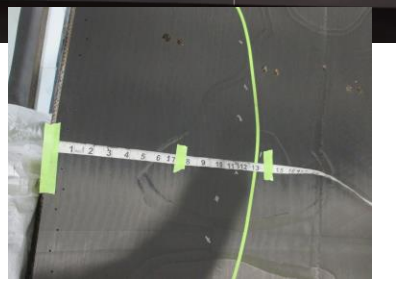


Recording of the cracking sound on 28.2.2025, discovered after gluing the last heating foil

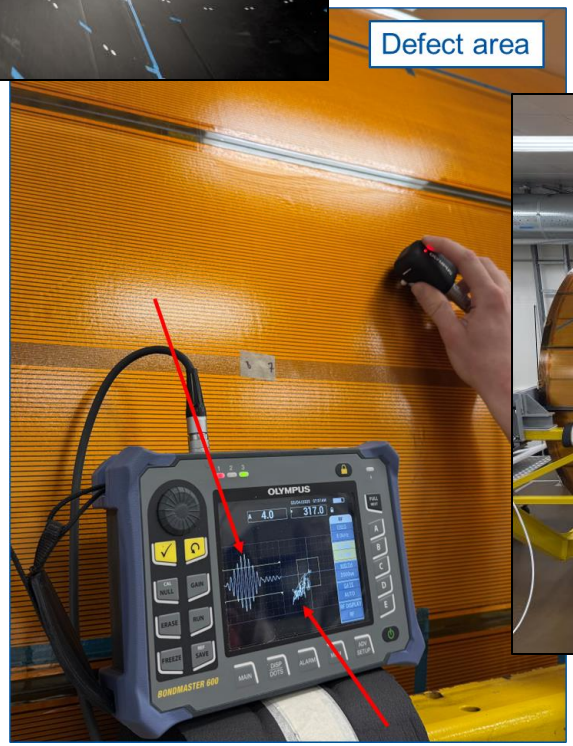


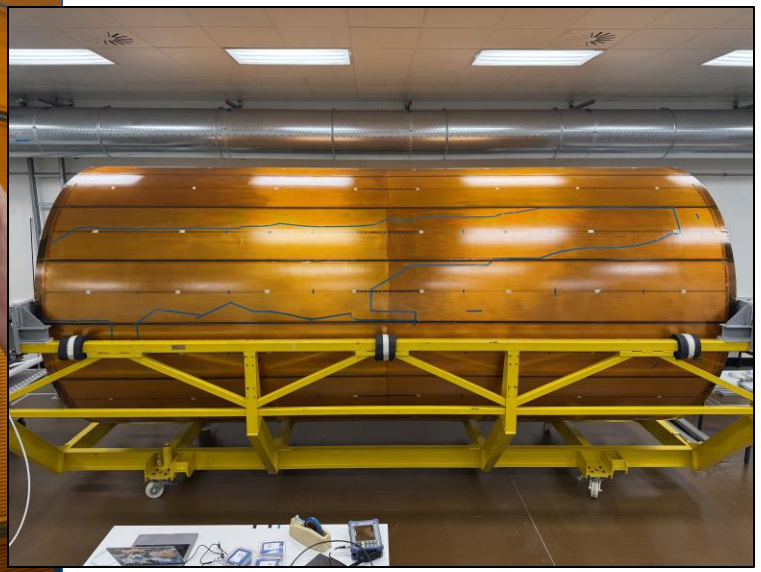




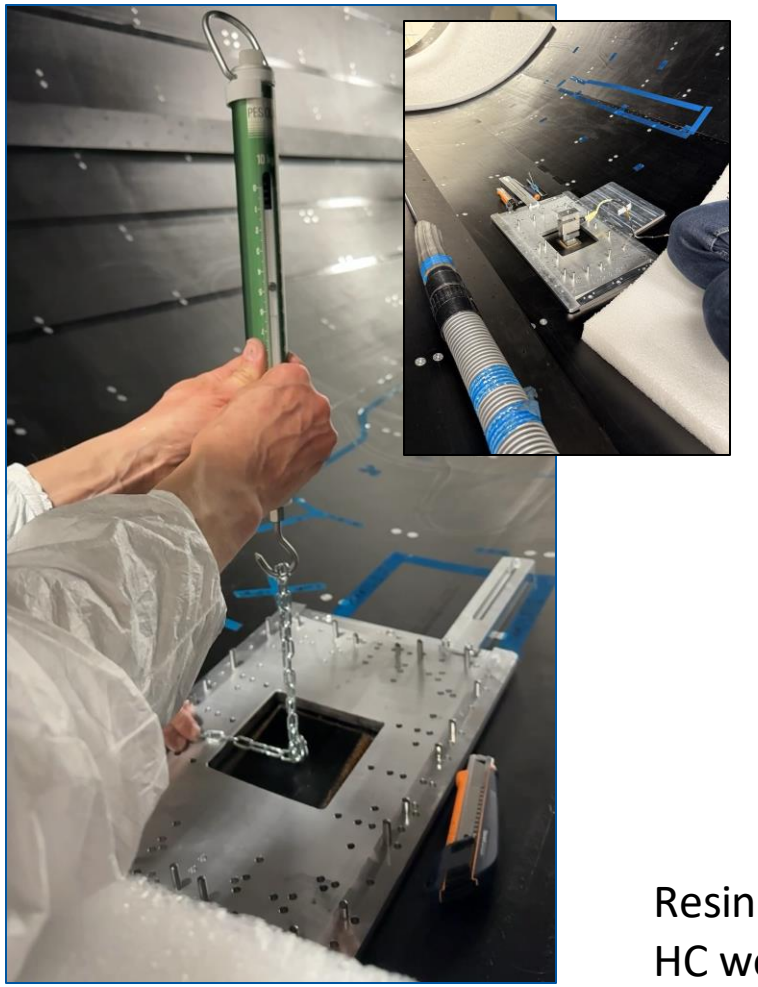


Disbond repairs at the vendor during BTST manufacturing





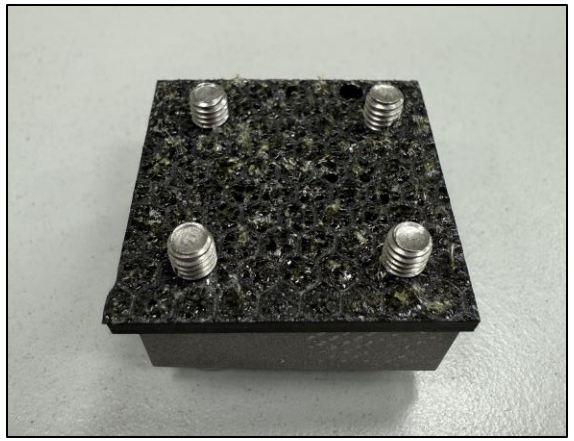
Flatwise tensile pull test for facesheet to honeycomb (HC) adhesion



Flatwise tensile pull on the BTST, failure at 50N

Resin fillets for bonding to HC weak

Dis-bond failure observed in BTST and curved panel samples



Normally expected failure in HC

Flat material characterization panel samples fail at 1400N +/- 15% (expected failure range)

Curved panel for BTST samples fail at 800N +/- 20% (lower than expected)

BTST samples fail at 100N or lower