

Upscaling of in-situ Automated Fiber Placement with LM-PAEK – from Panel to Fuselage

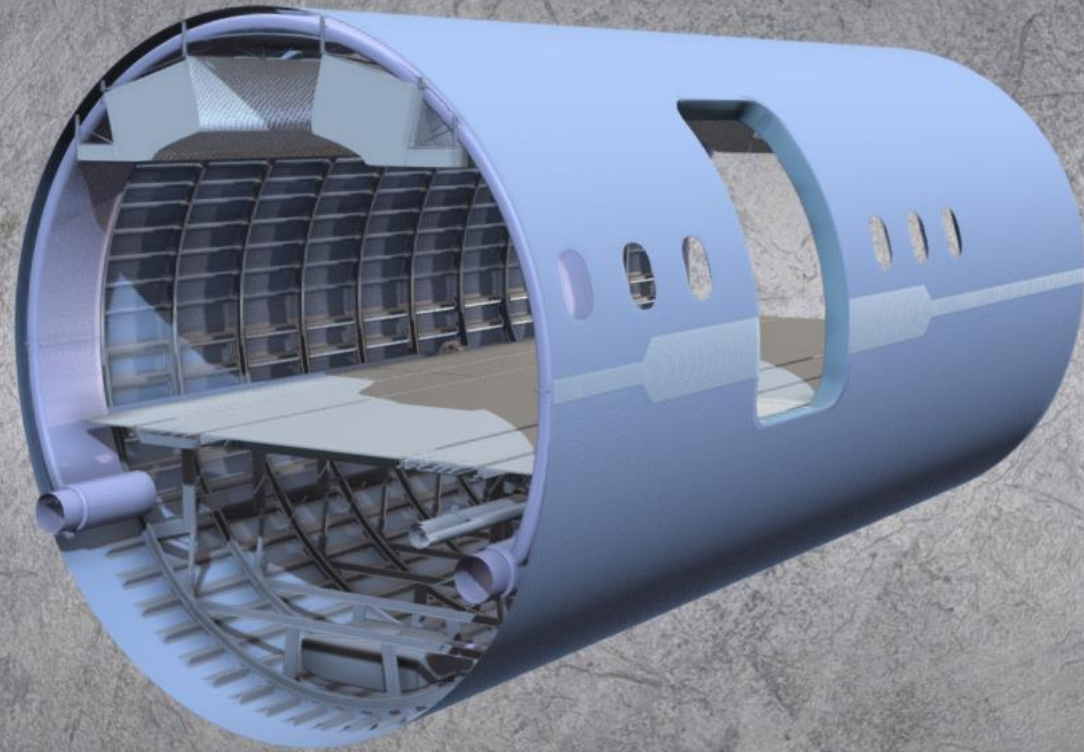
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German Aerospace Center (DLR) Augsburg

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Knowledge for Tomorrow





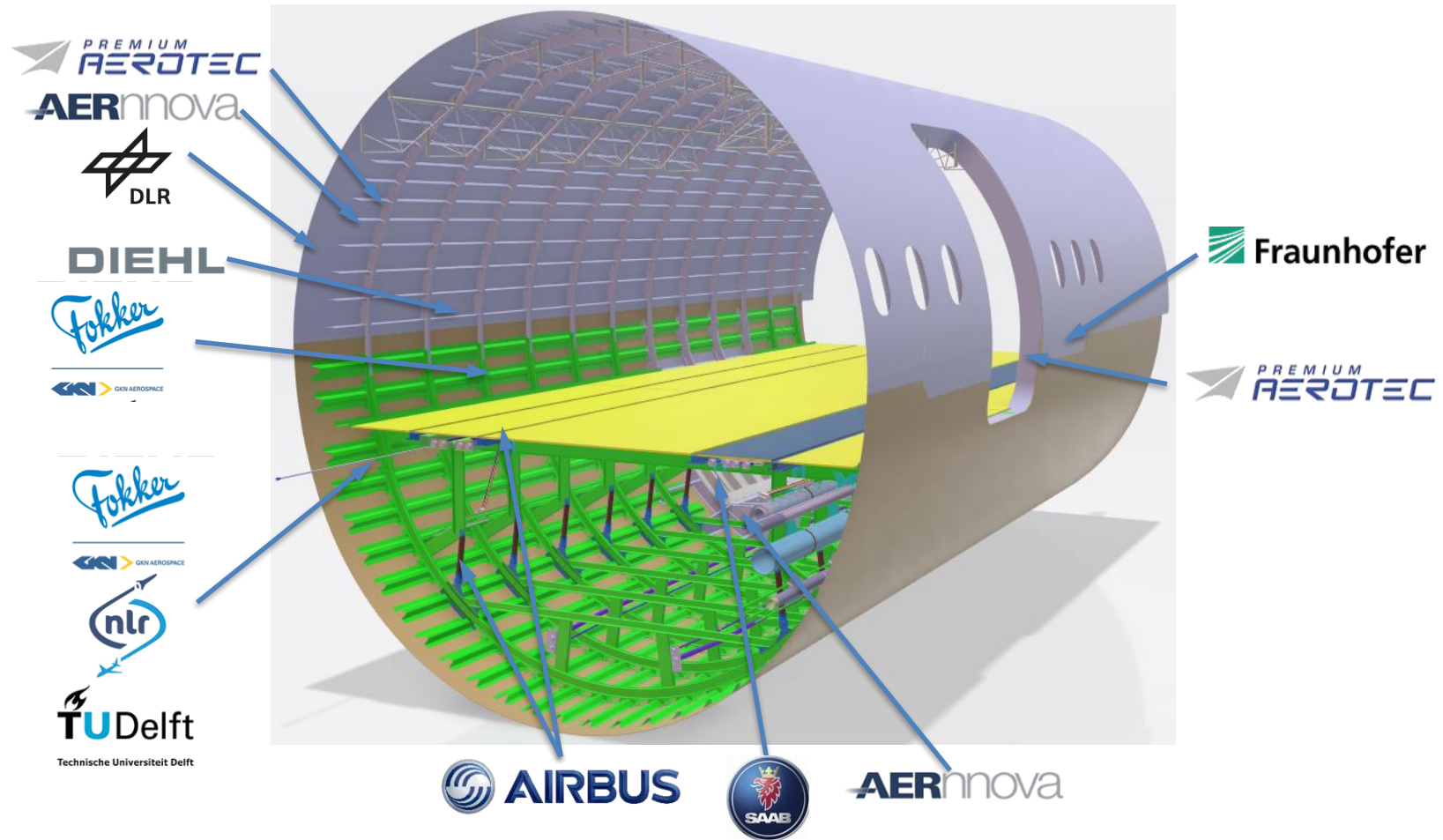
World's largest thermoplastic composite structure

The Multifunctional Fuselage Demonstrator (MFFD) project

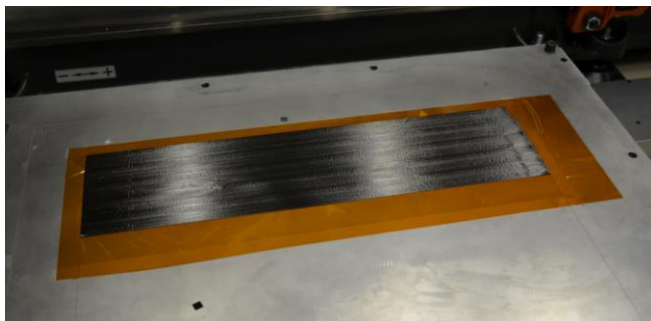
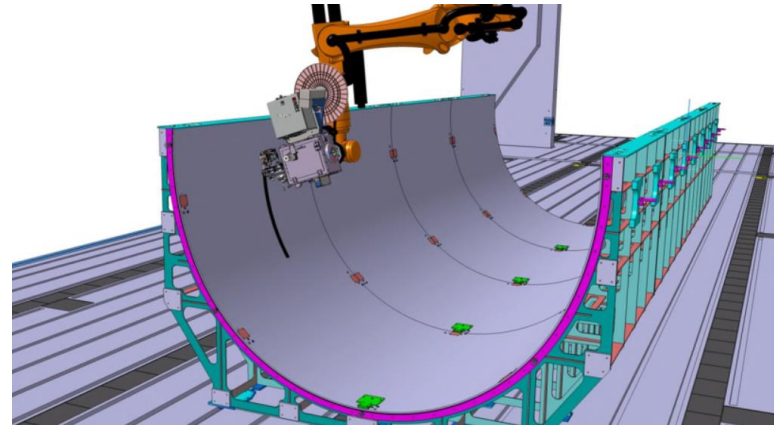
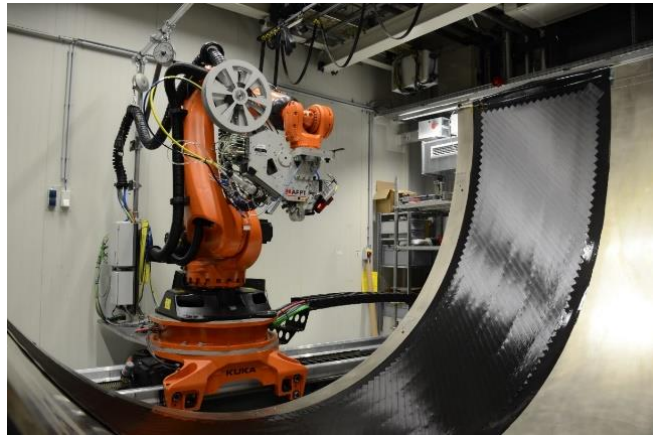
Advantages of a thermoplastic fuselage:

- No size limitations due to oven / autoclave
- Short / no curing time
- Weldability

 This project was funded by the European Union



From panel to fuselage



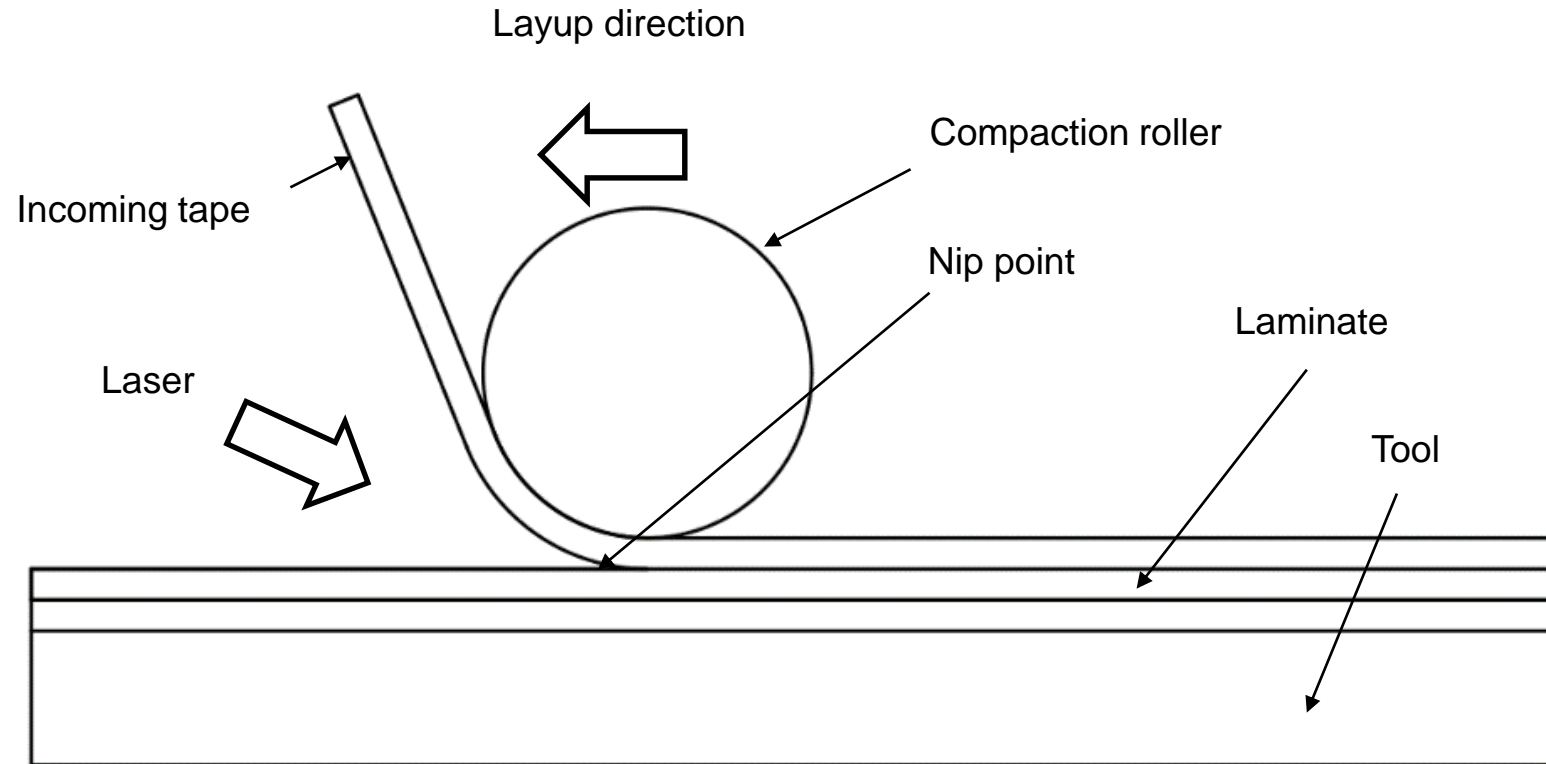
●
2020:
Pre-trials

●
2021:
Test shell
(length: 1 m, diameter: 4 m)

●
2022:
Full-size demonstrator
(length: 8 m, diameter: 4 m)

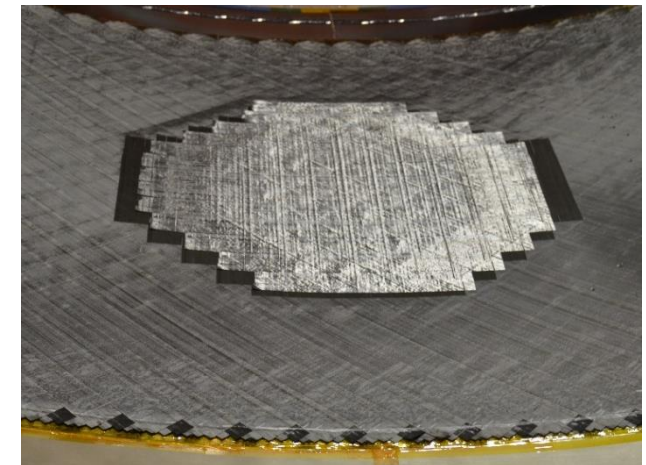
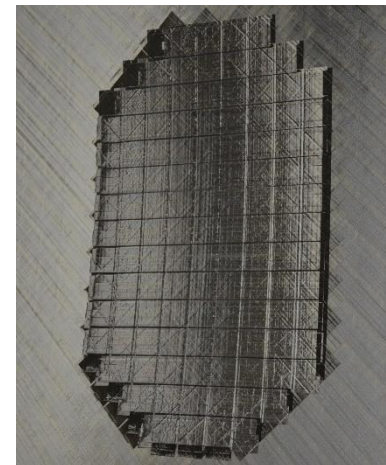
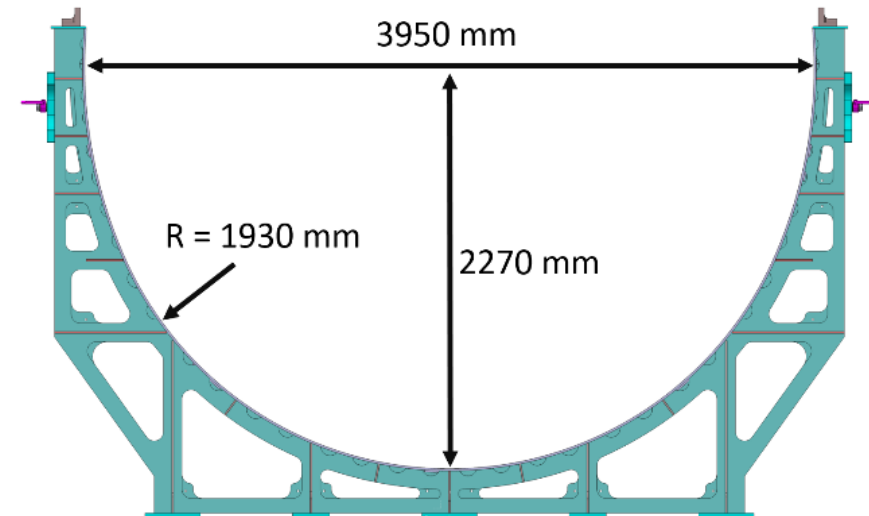
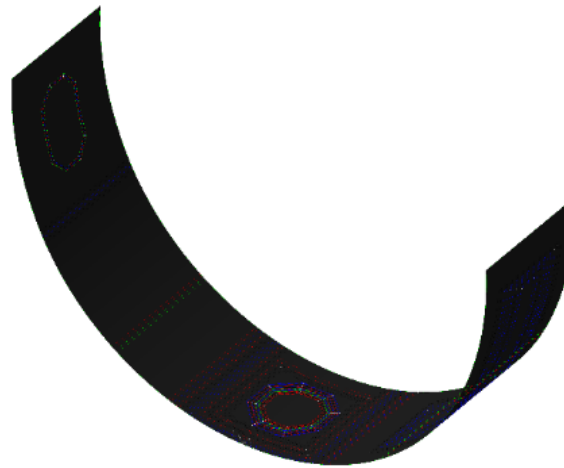


Thermoplastic in-situ AFP



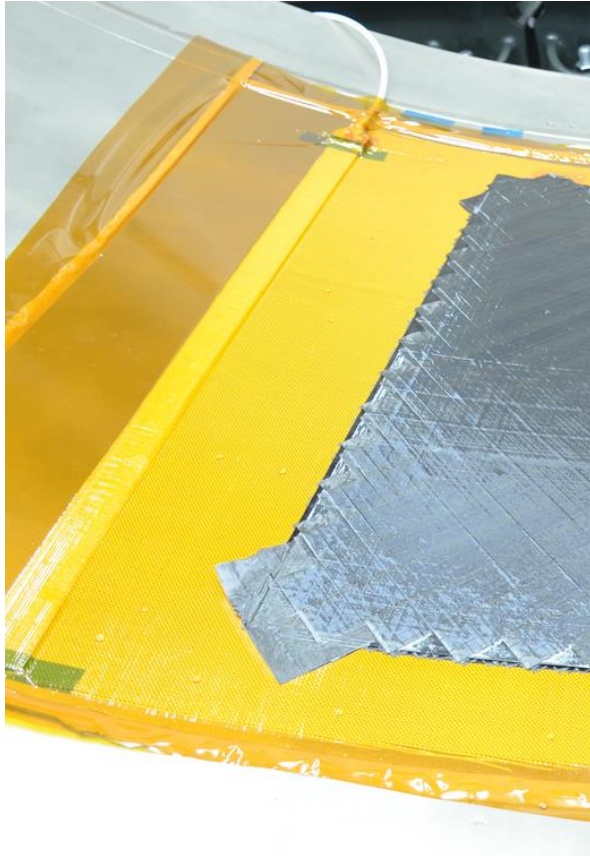
Design

- 98 plies
- 9986 m of LM-PAEK tape
- Angles: 0°, 45°, 90°, 135°
- Estimated weight: 38 kg
- Reinforcements:
 - Rectangular patch
 - Octagonal antenna patch
 - Octagonal center patch



First ply adhesion

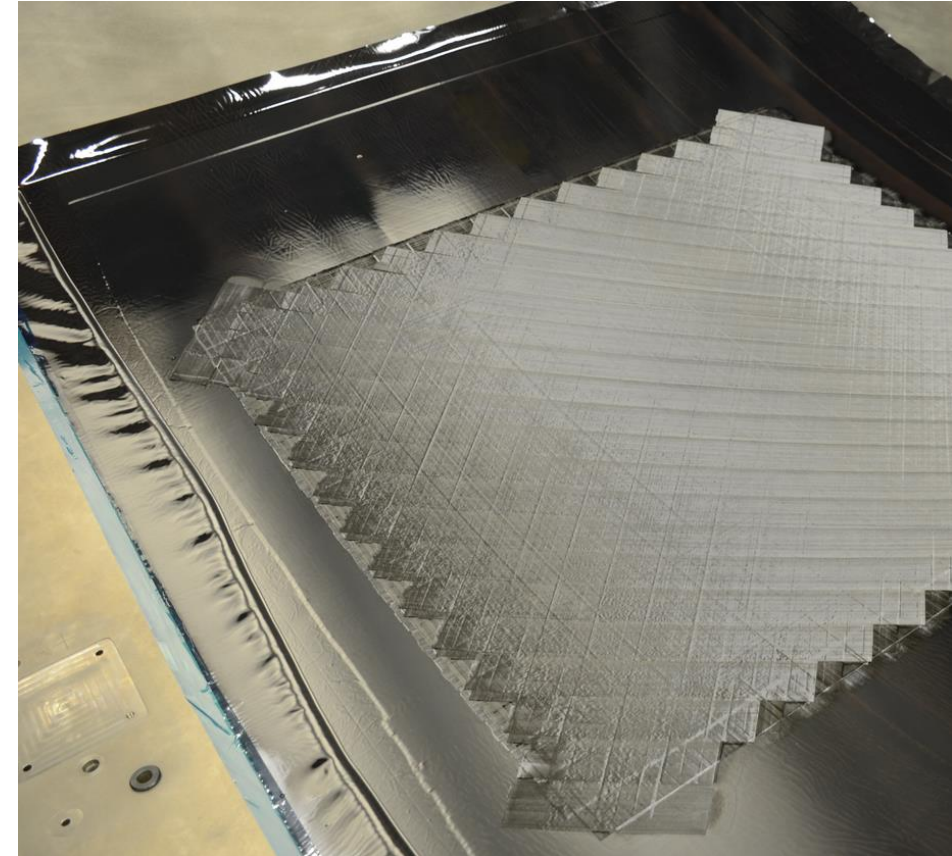
Polyimide foil



Resin foil



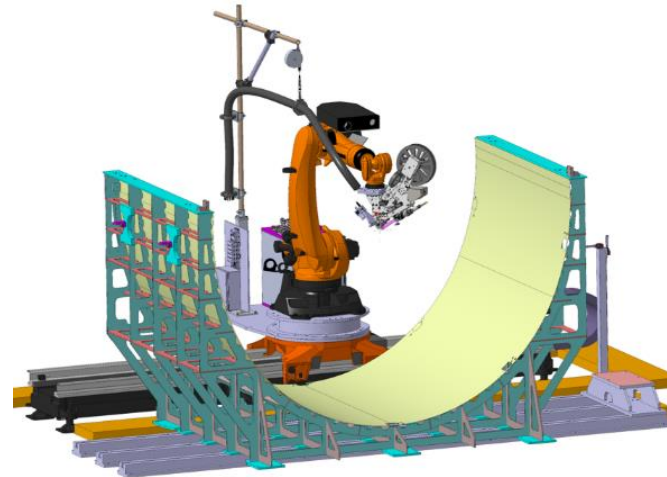
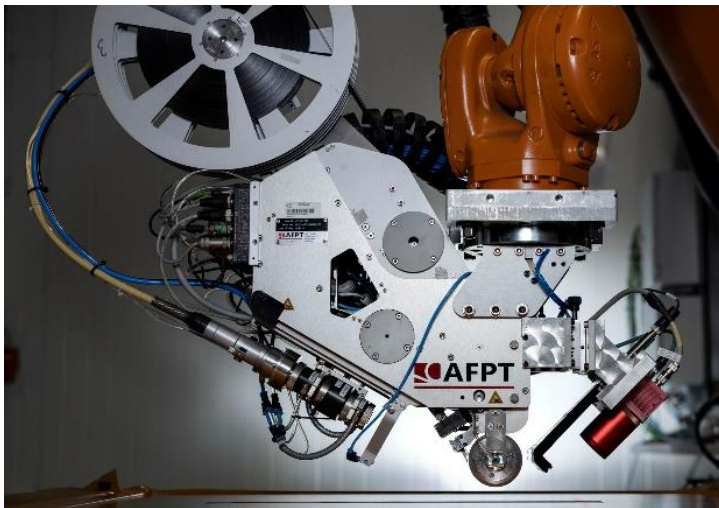
Lightning strike protection (LSP) foil



Full Scale T-AFP Manufacturing

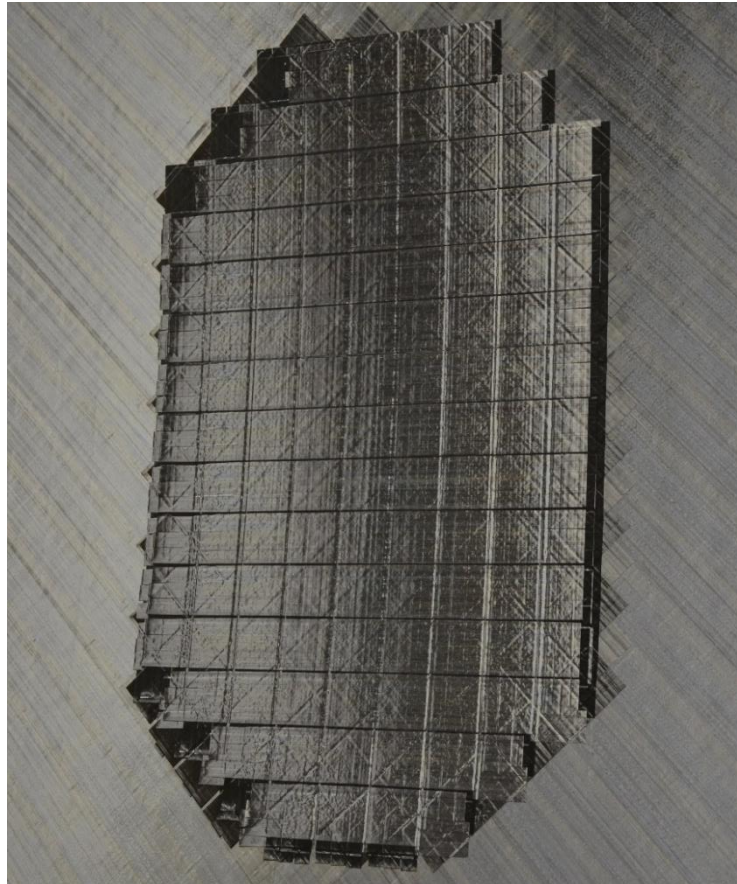
Setup:

- Multi Tow Lay-up Head (MTLH) by AFPT
- Three ½" tapes
- Heat source: 6 kW IR laser
- Lay-up speed: 7.5 m/min



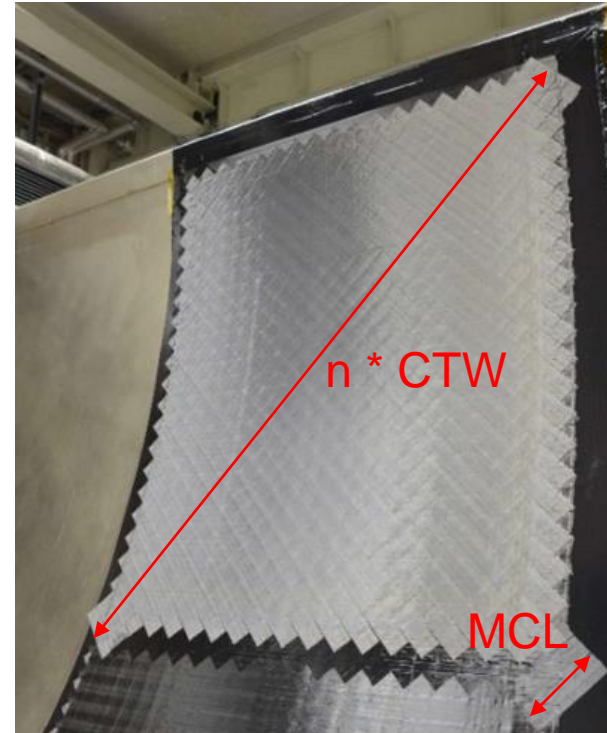
Gap Design Strategies

Inclusion of dispersed gaps



Zero gap/overlap strategy with adjustment of the ply geometry

- Determine consolidated tow width (CTW)
- Determine minimum cut length (MCL)
- Design ply

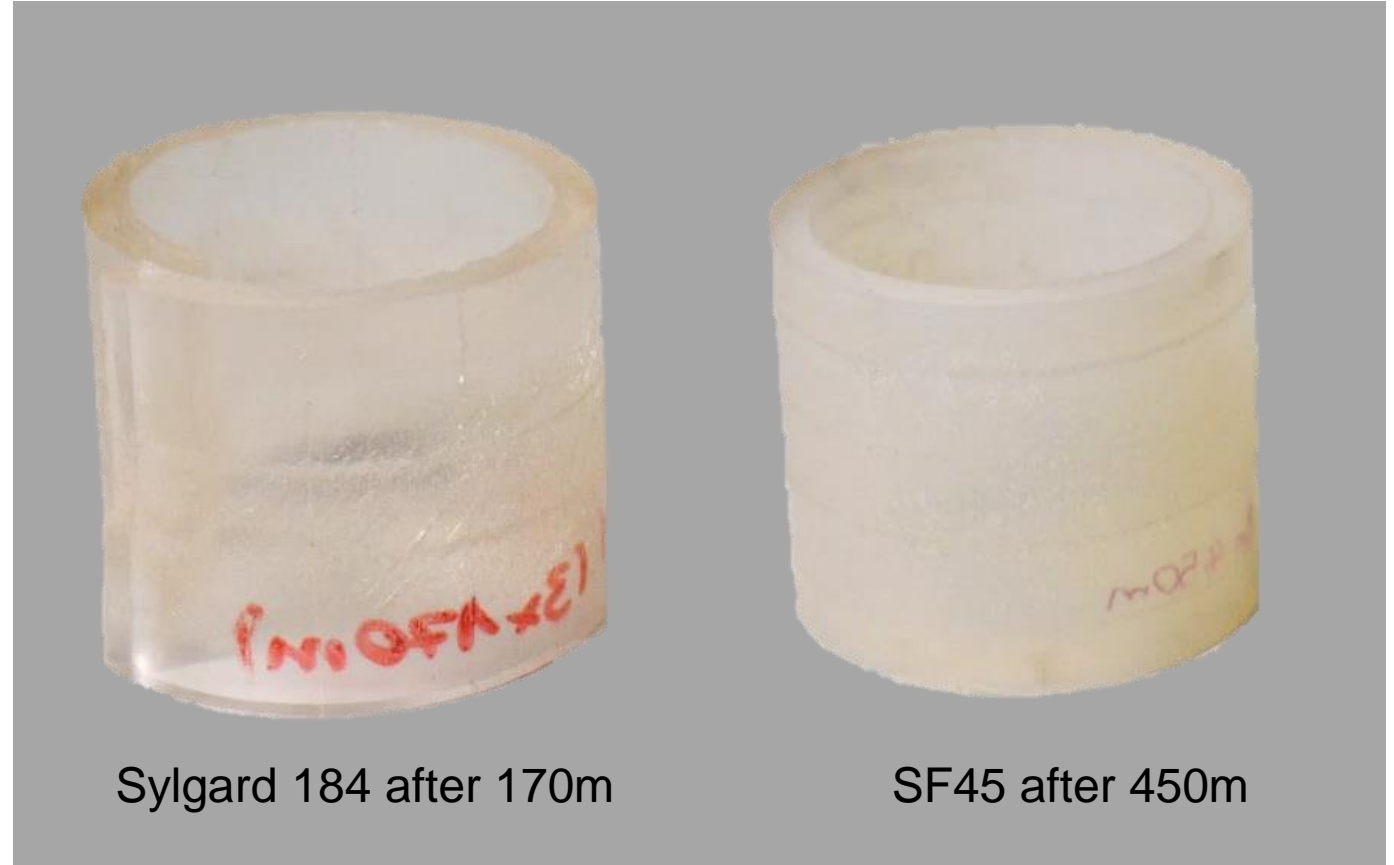


TC1225 LM-PAEK
7.5 m/min
500°C
3 x 1/2" tapes
→ CTW = 41.3 mm

MTLH by AFPT
→ MCL = 150 mm

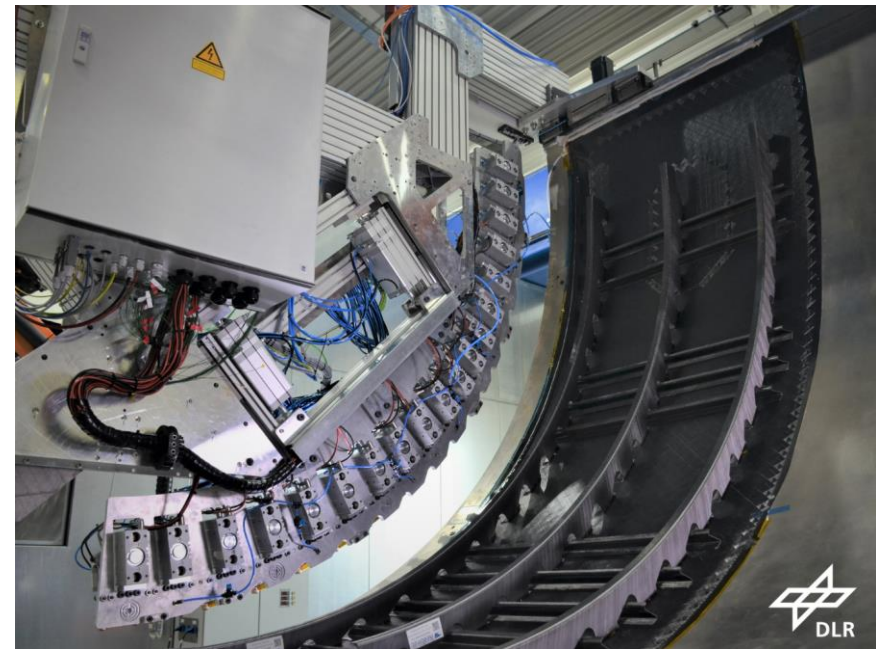
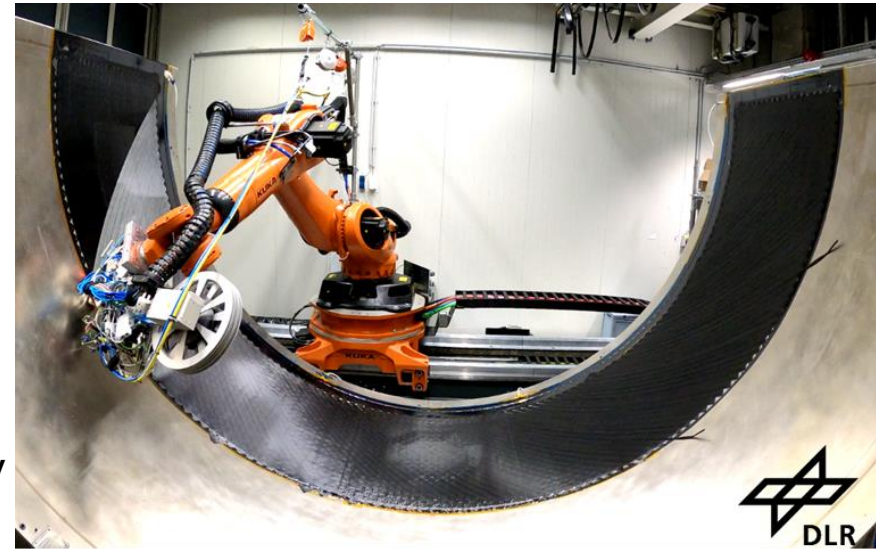


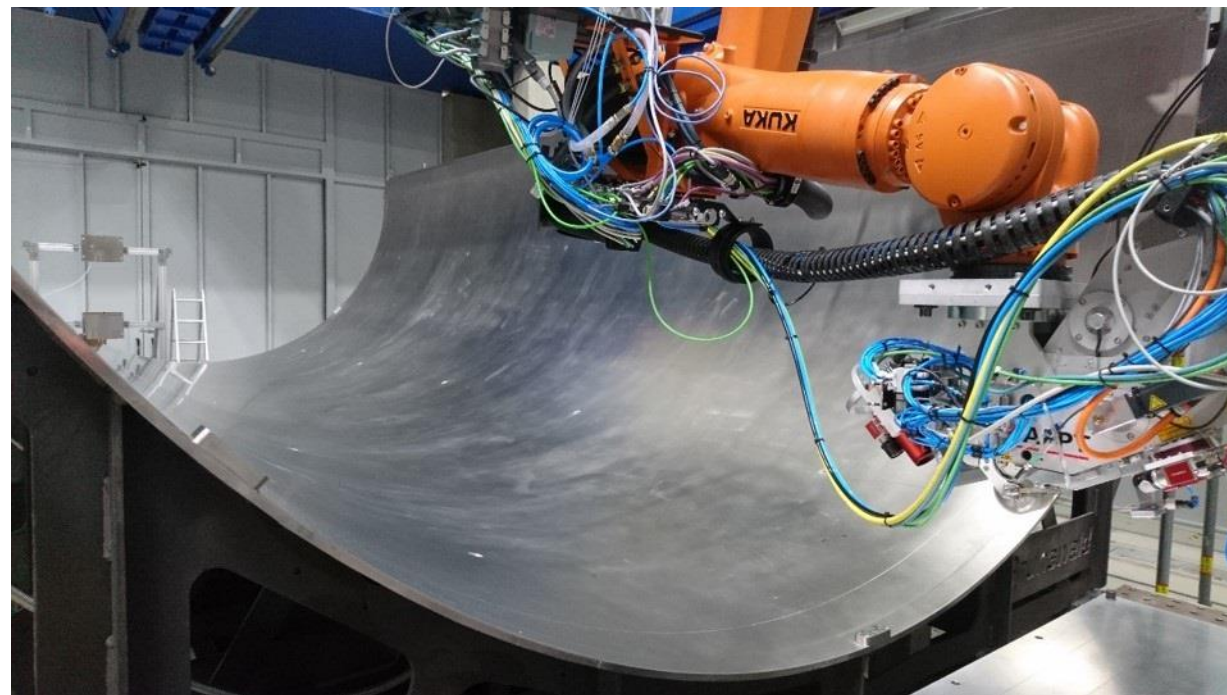
Durability of silicone compaction roller



Conclusion & Outlook

- 9986 m of deployed tape
- Successful application of LSP foil as first ply
- High surface quality of the produced skin with zero gap/overlap strategy
- Still relatively low deployment rate
- Proof of concept for full-scale demonstrator ✓
- Subsequent steps:
 - Integration of stiffeners by welding
 - Build full-scale demonstrator (8 m length)!





Acknowledgement

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 945583. The JU receives support from the European Union's Horizon 2020 research and innovation program and the Clean Sky 2 JU members other than the Union.

Disclaimer

The results, opinions, conclusions, etc. presented in this work are those of the author(s) only and do not necessarily represent the position of the JU; the JU is not responsible for any use made of the information contained herein.

