

RTM6 for Fixation of Dry Fiber Preforms and Auxiliary Materials

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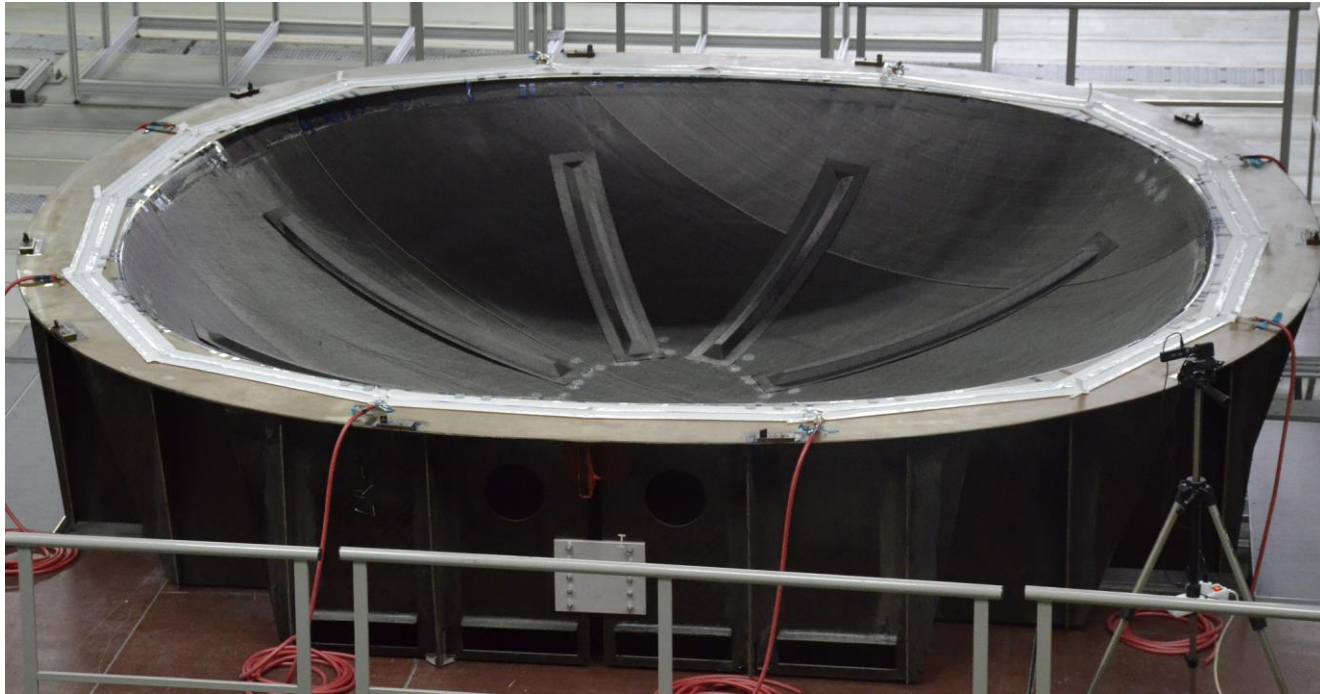
Knowledge for Tomorrow



FIXATION WITH RTM6
MAKES PREFORMING FOR DRY FIBER PLACEMENT
MORE ECONOMICAL
AND AVOIDS INFLUENCE OF ADDITIONAL EXTERNAL MATERIAL,
WHEN RTM6 IS USED FOR INFUSION

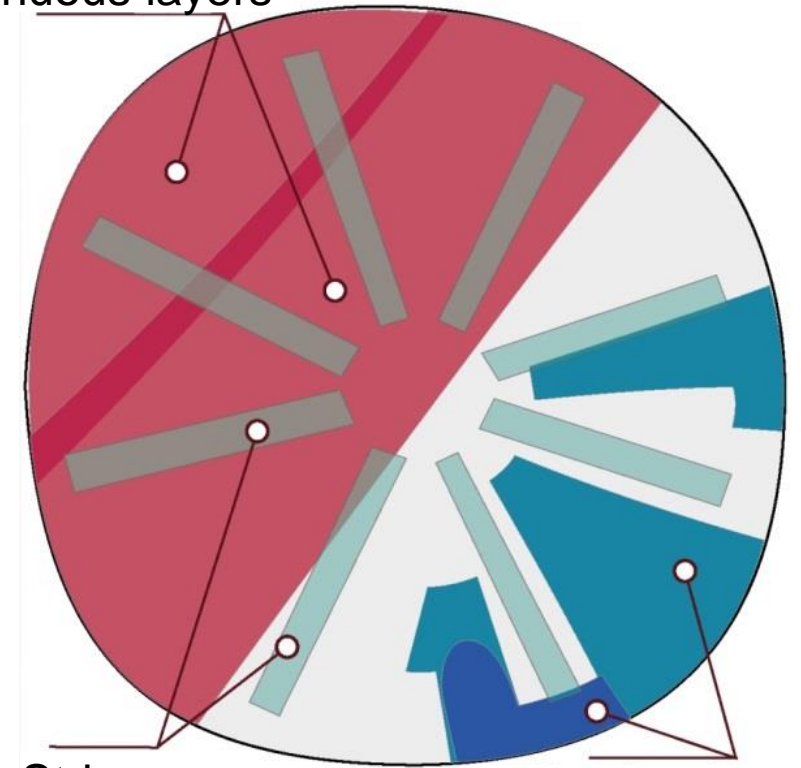


Motivation



Process: Dry fiber preforming + liquid resin infusion (RTM 6)

Continuous layers



Stringer

Reinforcement layers



Method selection

Cohesive joining

Method	Characteristics
Polyamid binder (Spunfab Ltd.)	<ul style="list-style-type: none">• Additional step for binder activation• Approved method for dry fiber preforming
Adhesive tape, Saerfix EP (Saertex GmbH)	<ul style="list-style-type: none">• High friction coefficient and holding force• Chemical compatibility with resin needed• Not approved for airplane parts
Spray adhesive, Aerofix 2 (R&G GmbH)	<ul style="list-style-type: none">• Not approved for airplane structures• Difficult to implement in robotic production lanes (evaporation)
Epoxy resin, RTM6 , (Hexcel)	<ul style="list-style-type: none">• Standard infusion resin• High viscosity at room temperature• No additional adhesive needed• No visible impact on cured part



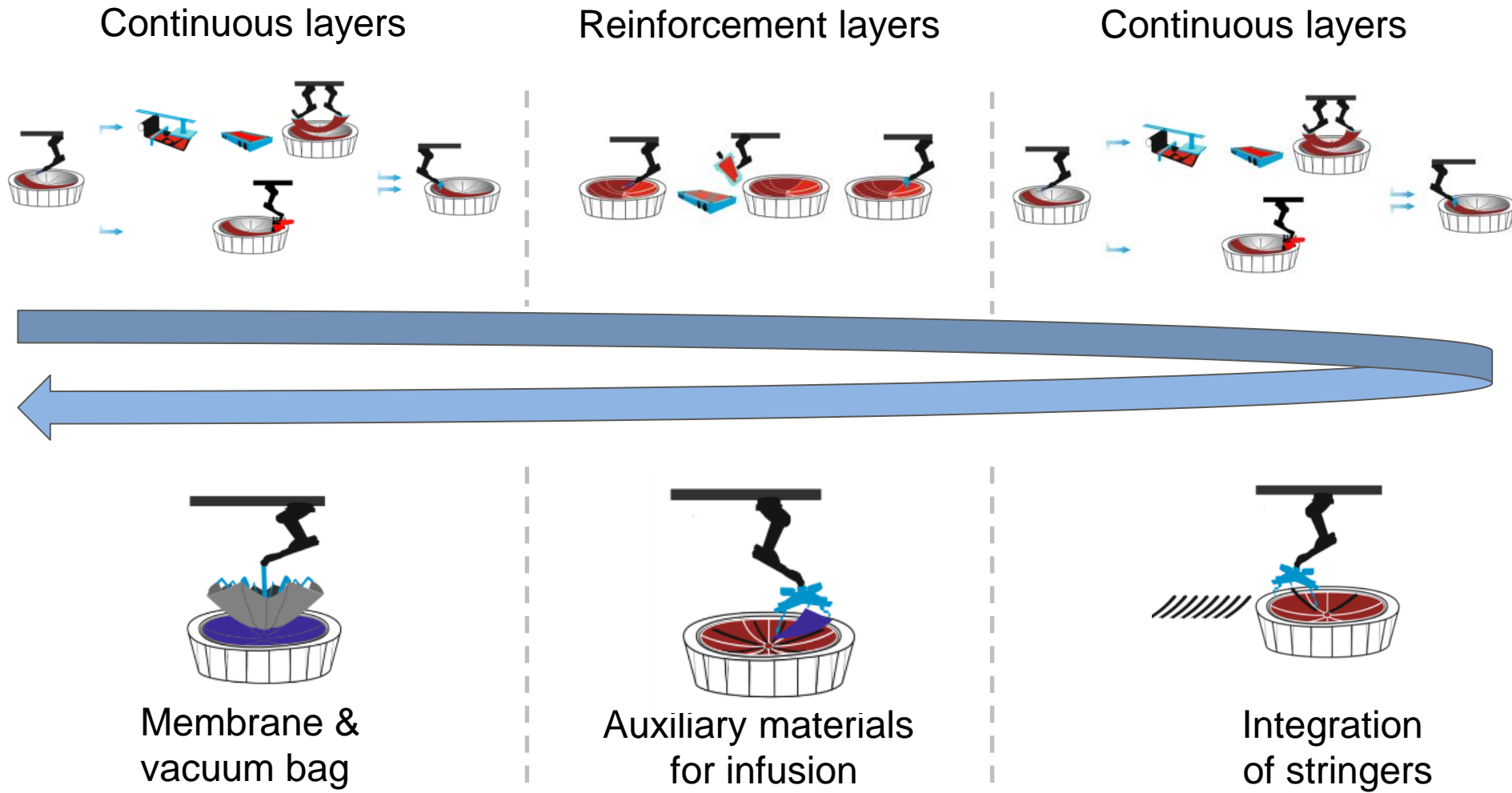
Method selection

Cohesive joining

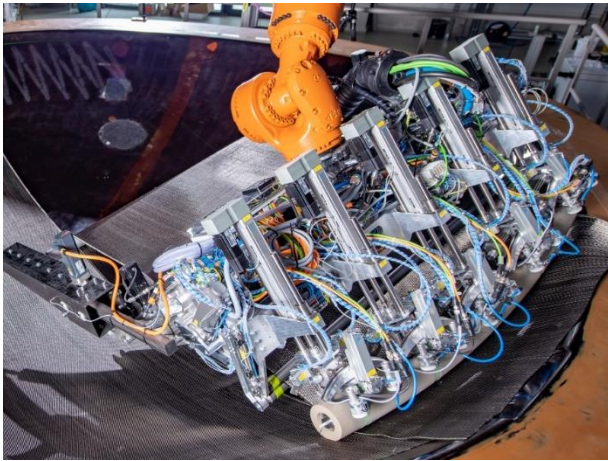
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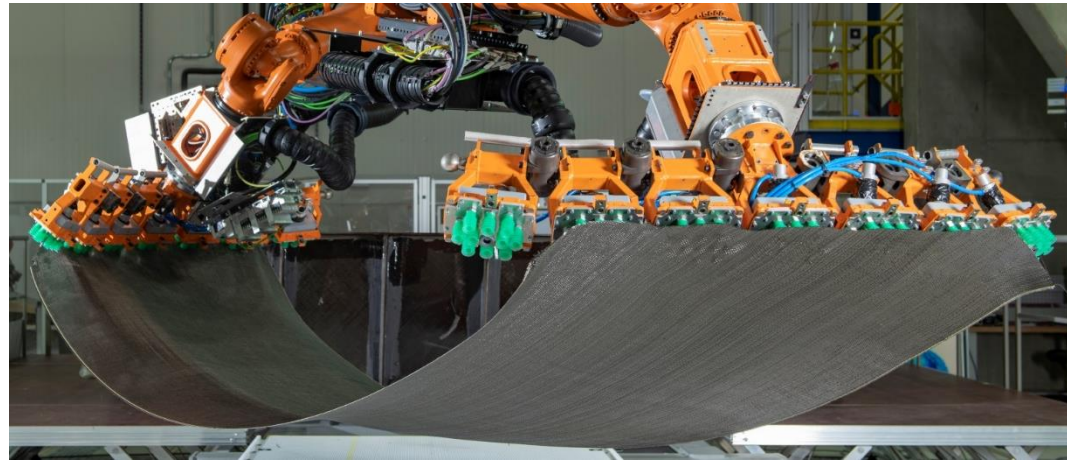
DLR Project PROTEC NSR – Highly automated manufacturing process



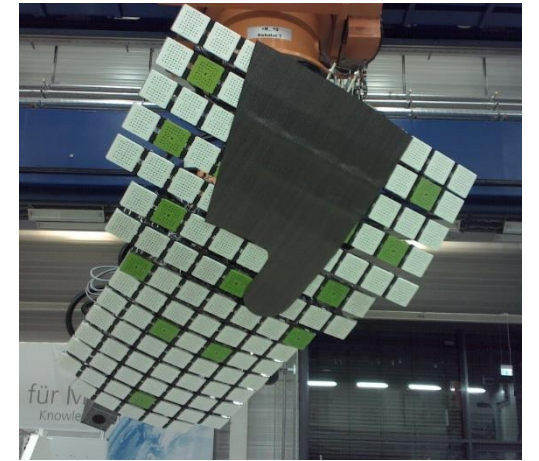
Preforming Process for Rear Pressure Bulkhead (RPB)



(a) Endless lay-up



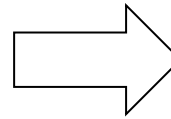
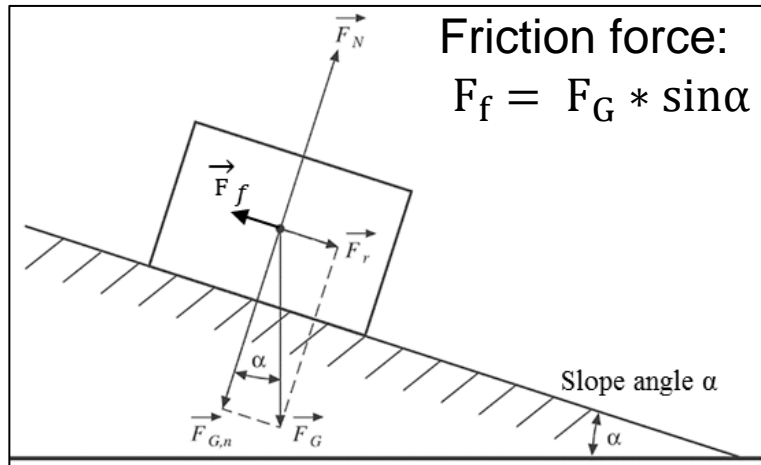
(b) Collaborative lay-up for large plies



(c) Reinforcement plies

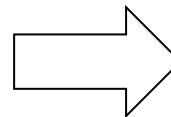
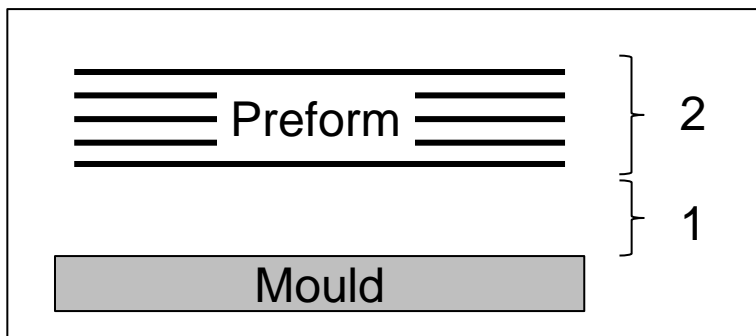


Requirements for Fixation – Theoretical characteristics



Parameters

- Areal weight of ply / preform
- Viscosity of resin
- Amount of resin
- Fixing area
- Pressure during application

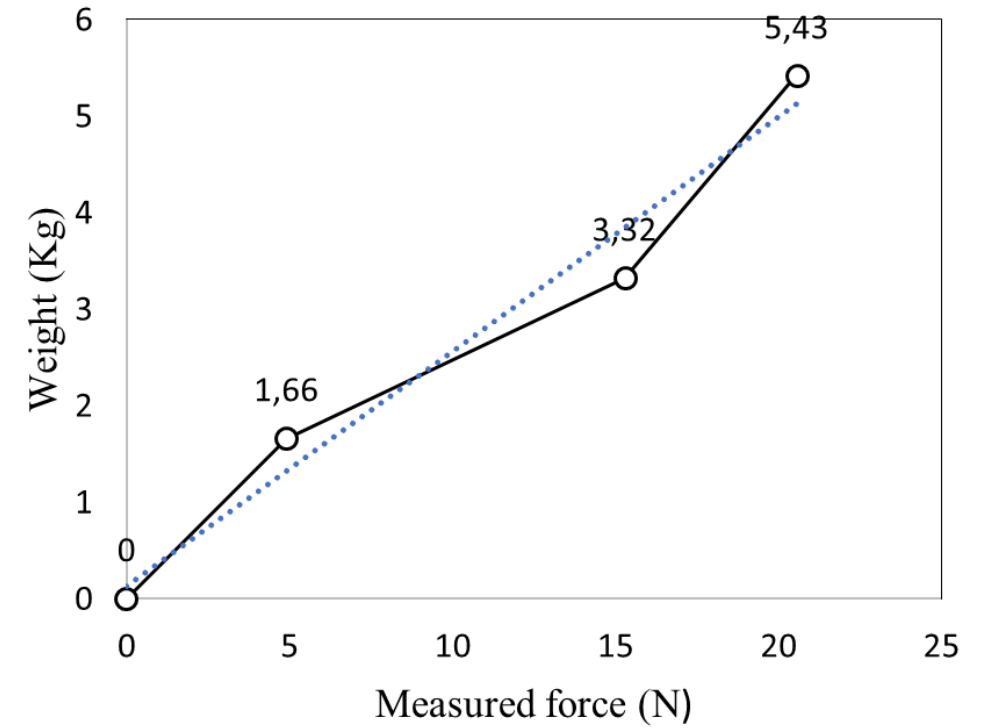
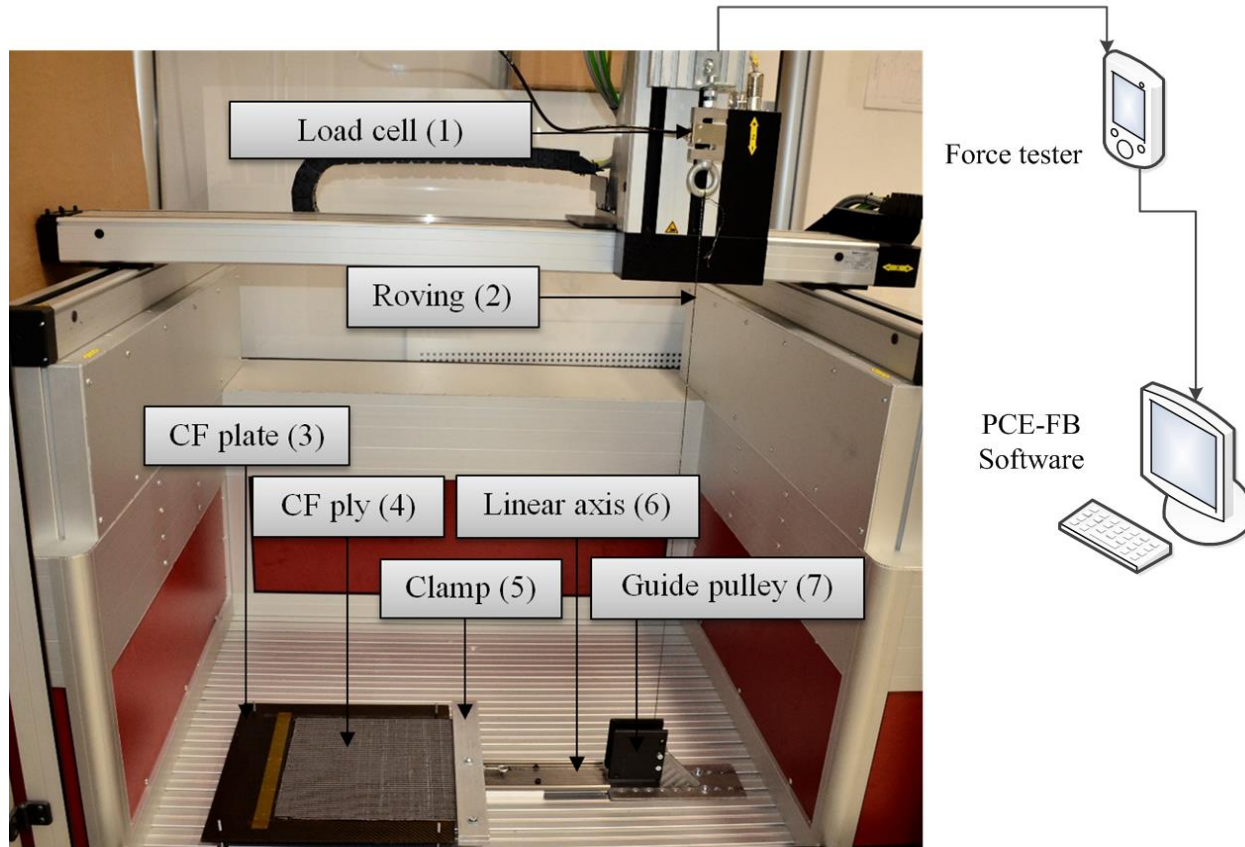


Constellation of interest:

1. Preform-to-mould fixation
2. Layer-to-layer fixation



Evaluation of friction force



Requirements for Fixation – Parameters

- **Areal weight of ply / preform**
 - 372 g/m²
(Priform, Cytec)

- **Viscosity of resin**
 - High viscosity at room temperature (~ 10 Pas)

- **Amount of resin**
 - As low as possible to avoid capillary effects

Lowest expected pressure for suction cups
(end-effector for continuous plies)

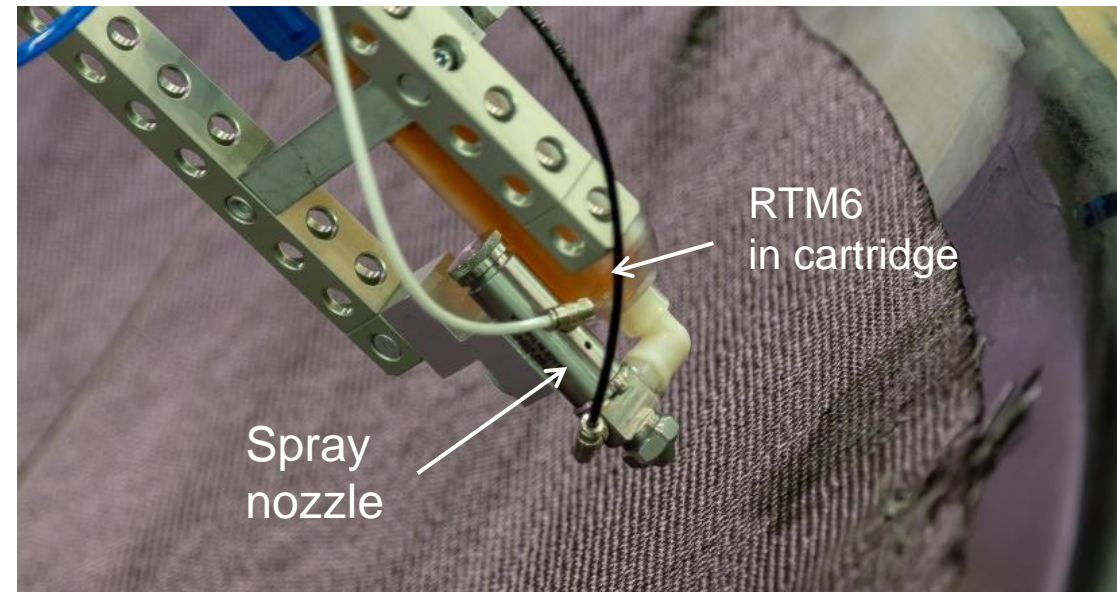
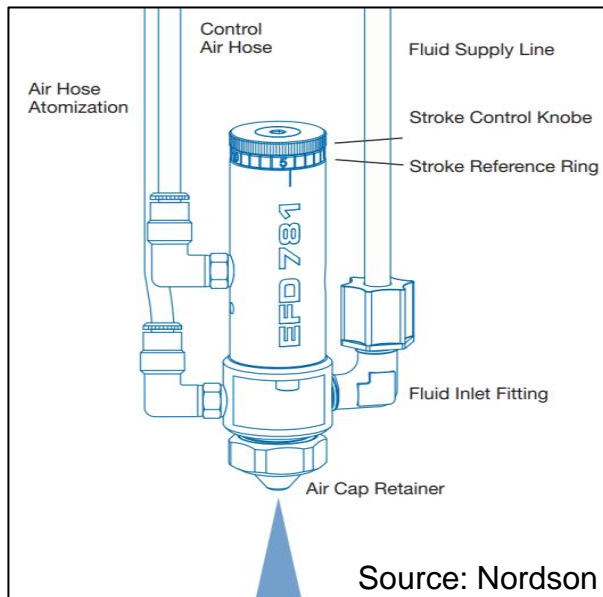
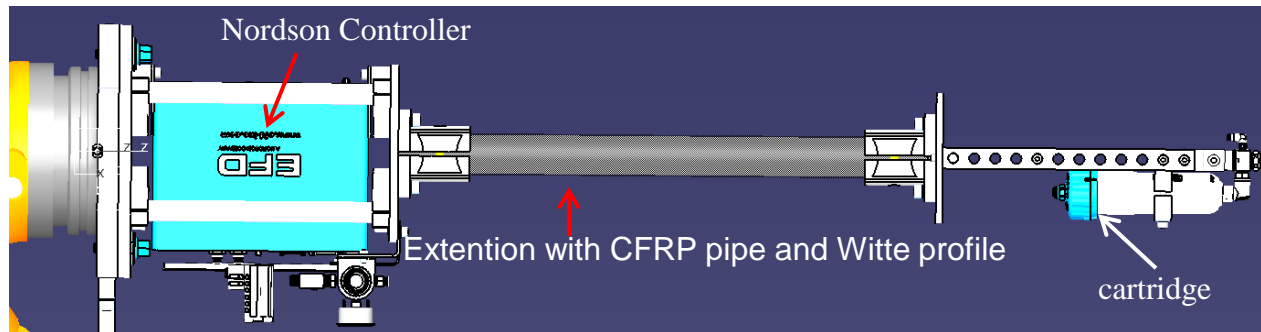


- **Pressure during application**
 - 7,86 N/mm² / suction cup

- **Fixing area**
 - Limited by the size of the gripper system



RTM6 End-Effector



Spray pattern - Generation

Use case 1



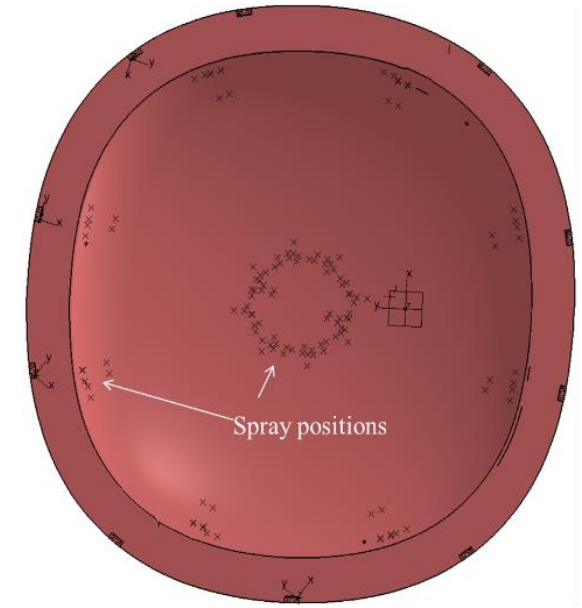
Continuous layers

Use case 2



Reinforcement layers

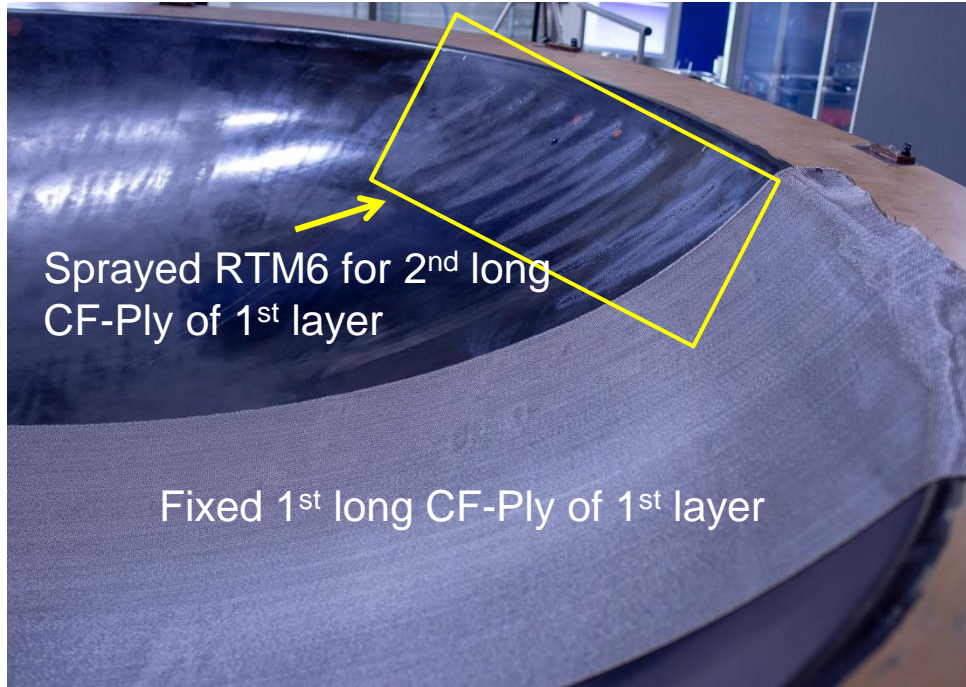
Use case 3



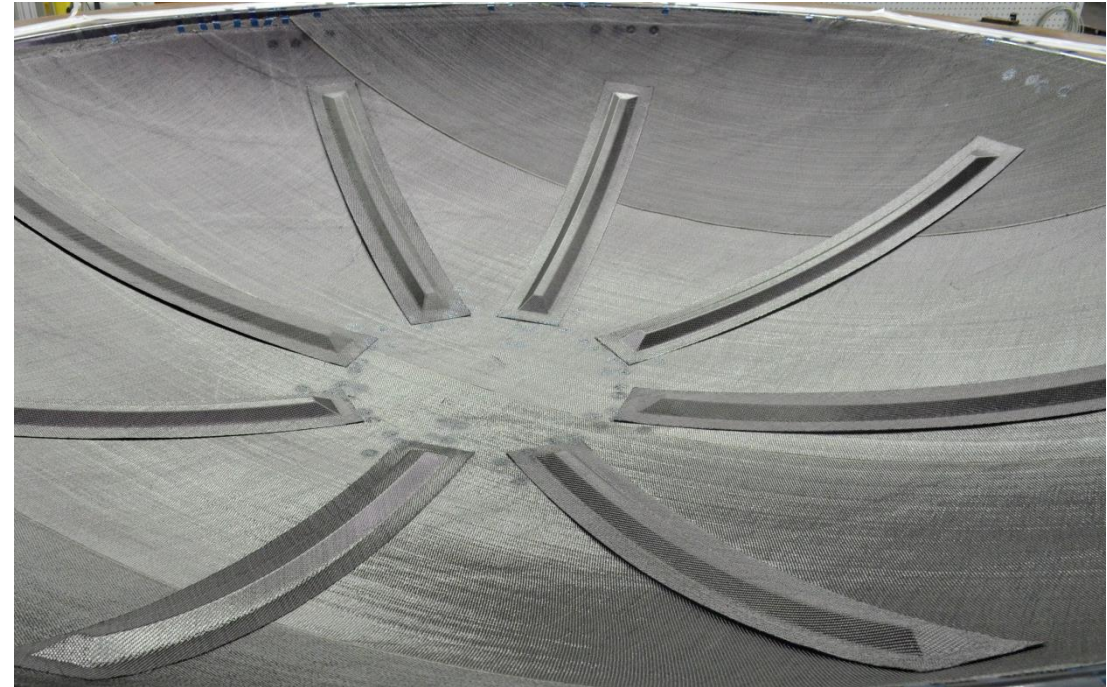
Auxiliary materials



Validation of use case 1 (Continuous layers)



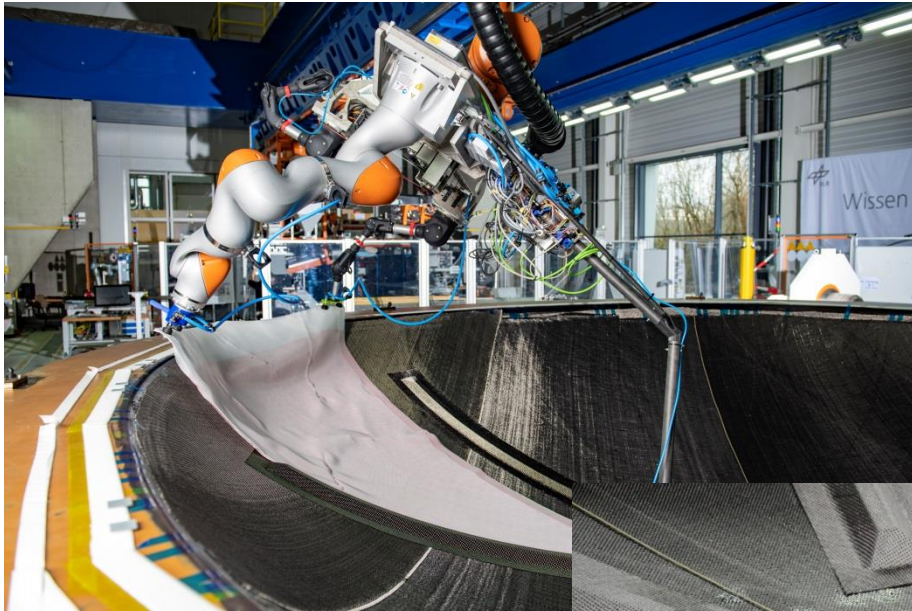
(a) Fixation of 1st CF-layers



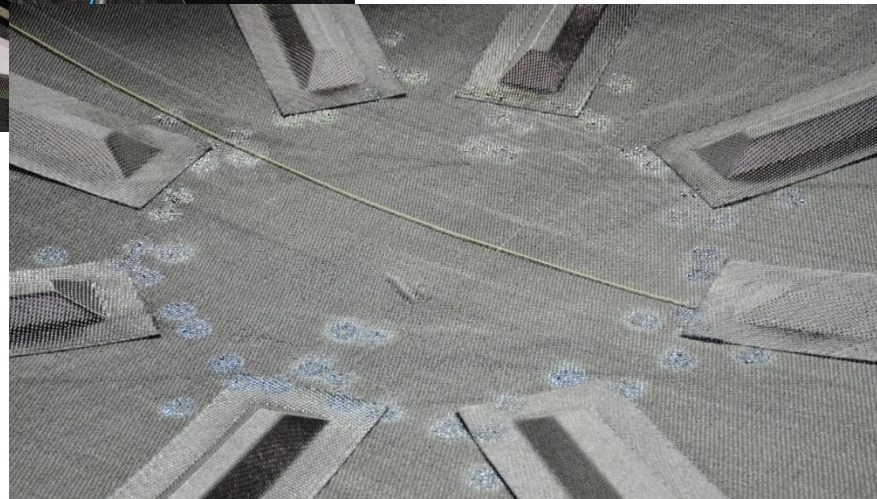
(b) Fixed 59 CF-layers with RTM6



Validation of use case 3 (Auxiliary materials)



Deposition with multi-kinematic gripper

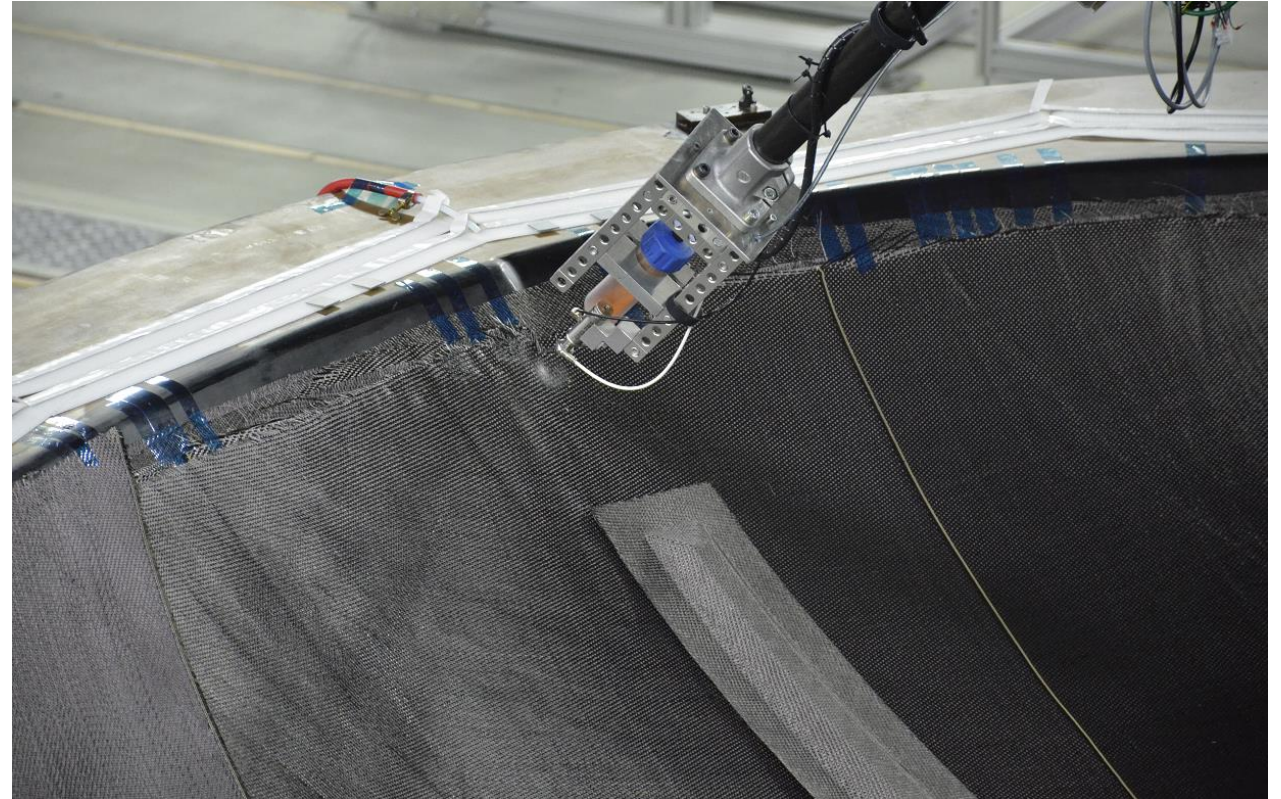


Fixed auxiliary packages



Summary

- Total amount of resin: 1,2 kg
- Spray time CF layers: 11 hrs
→ Multiple nozzles would reduce time
- Spray time for auxiliary materials: 12 min
- No visible impact on cured part



Thank you!

