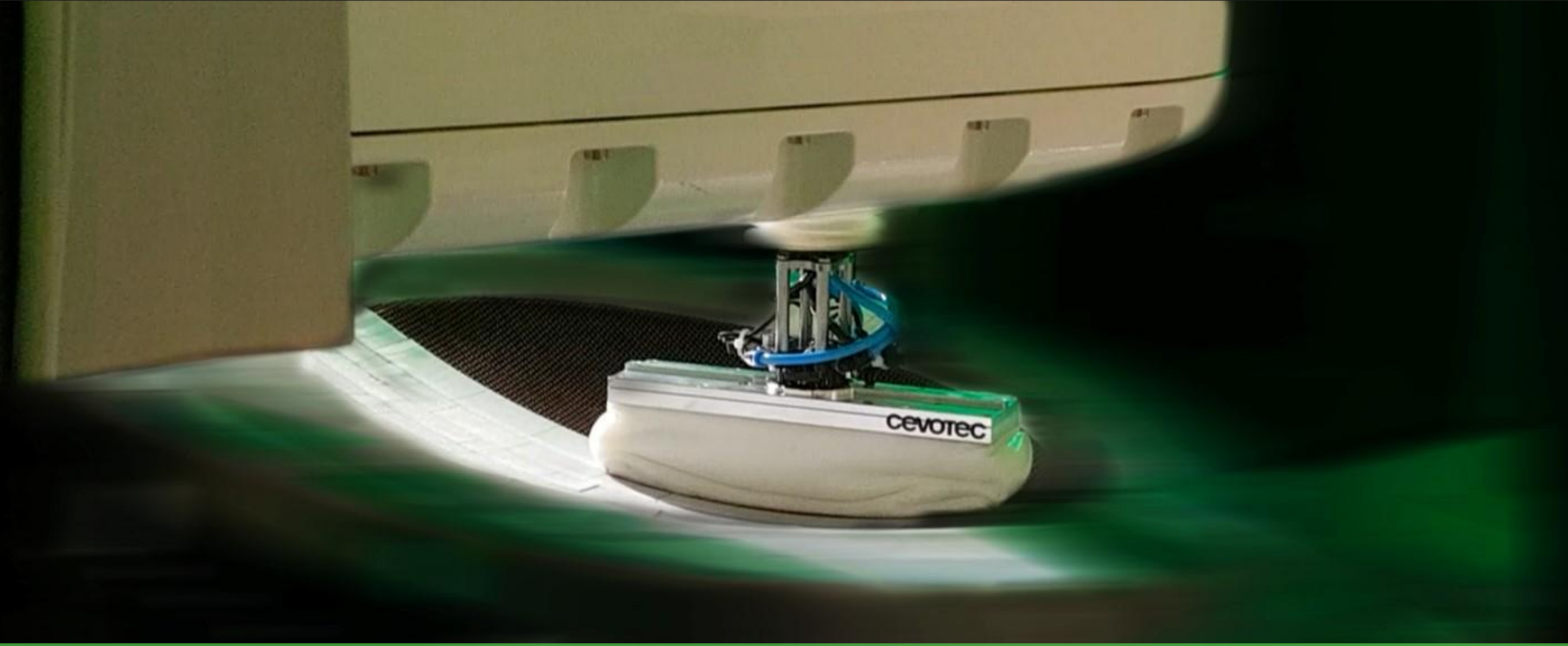


Bridge the gap between AFP & hand lay-up

New automation options for the
lay-up of complex aerostructures

March 2025

cevotec
milestones in composites

Cevotec – Fiber Patch Placement equipment & software

Founded in 2015, Cevotec has become the globally leading technology partner for automated lay-up processes based on Fiber Patch Placement (FPP) technology.

- Located in Unterhaching near Munich, Germany
- High-tech development lab & facilities
- Founded 2015 by current CEO Thorsten Groene together with composite experts Felix Michl, Dr. Neven Majic and Prof. Klaus Drechsler
- Since 2021, partnered with customized machine builder GFM (Austria)
- As of 2025, 25 employees & growing
- Local sales partners in France, North America, Japan, China
- Key products: SAMBA Series production systems
  Artist Studio CAD-CAM software
  Application development and additional services

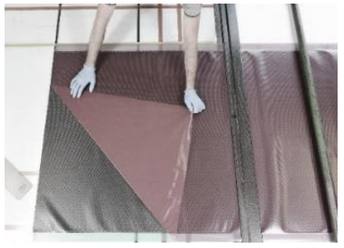
Our mission:

Enabling manufacturers to produce complex composites in high volume and superior quality!

Challenge: Complex composites still greatly manufactured by hand

Need for automation solutions to meet future production demand.

- Long production cycles
- No effective quality control
- High scrap rates (>30%)
- High cost

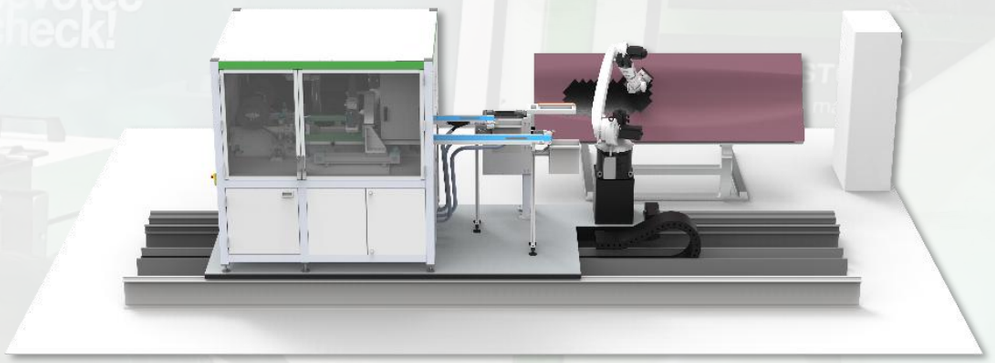


Fiber Patch Placement

Additive 3D fiber lay-up technology for complex composites.

SAMBA *Series*

3D fiber lay-up automation platform

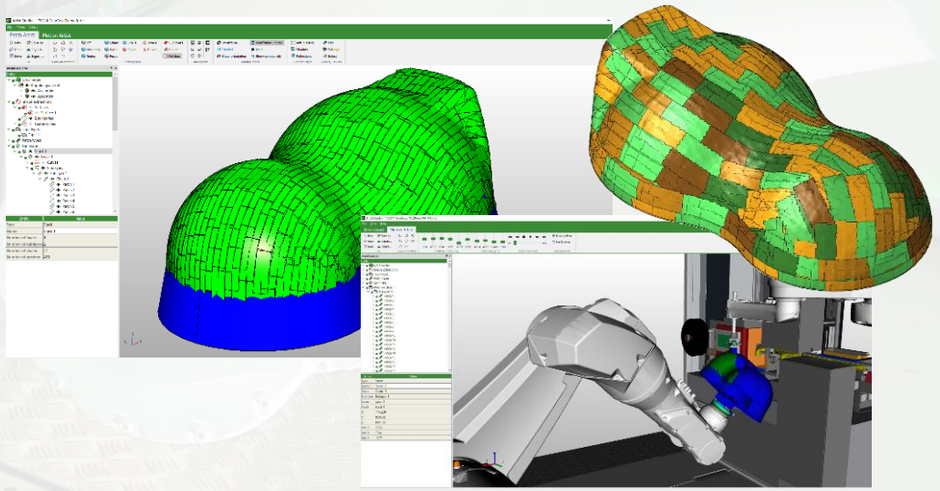


Benefits

- Digitized, automated process chain
- 100% in-process raw material control
- Multi-material lay-up capability
- 20% - 60% cost & time savings

ARTIST STUDIO

CAE software for design & production



Watch on YouTube how FPP works!

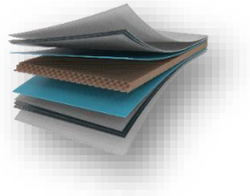
Focus industries

Automated lay-up for complex composites with Fiber Patch Placement.

Aerospace

Automation for complex, multi-material composites

Multi-material composites



Complex geometries

Tailored reinforcements

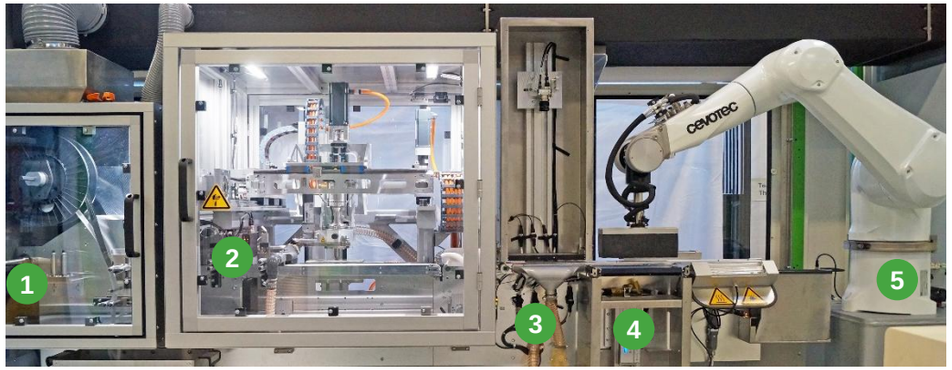
Composite tanks

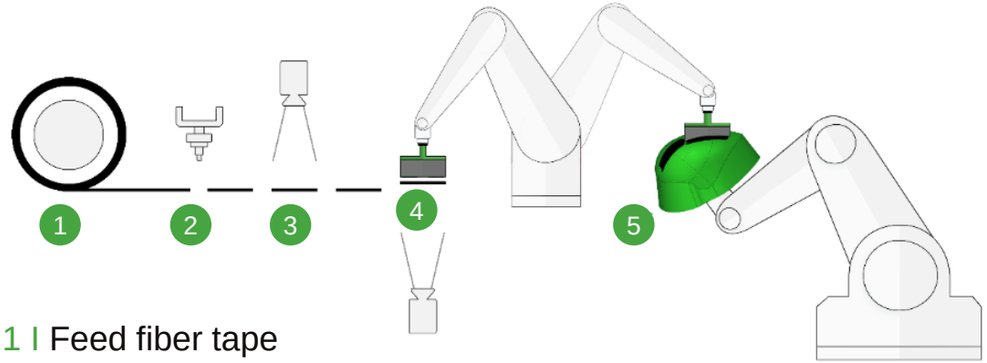
Improving storage efficiency of hydrogen composite tanks with FPP

The Fiber Patch Placement technology

Flexible lay-up technology for complex high-performance composites enabling a fully automated, quality-controlled 3D lay-up.

Process overview





1 I Feed fiber tape

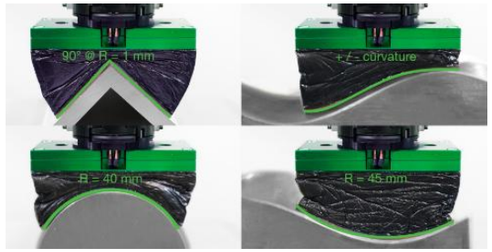
2 I Cut tape into patches

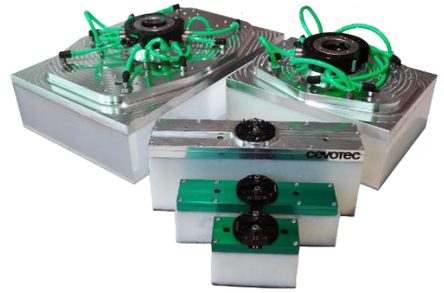
3 I Inspect quality

4 I Pick-up, check position

5 I Place fiber patch

Gripper technology for lay-up on complex shapes

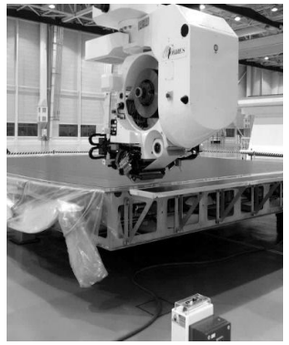




- Controlled fiber deposition on concave & convex surfaces
- Placement directly onto honeycomb cores
- Equipped with compaction-force sensor
- Multiple sizes up to 300 mm x 200 mm
- Suitable for multi-material placement: e.g. adhesives, glass, carbon, etc.

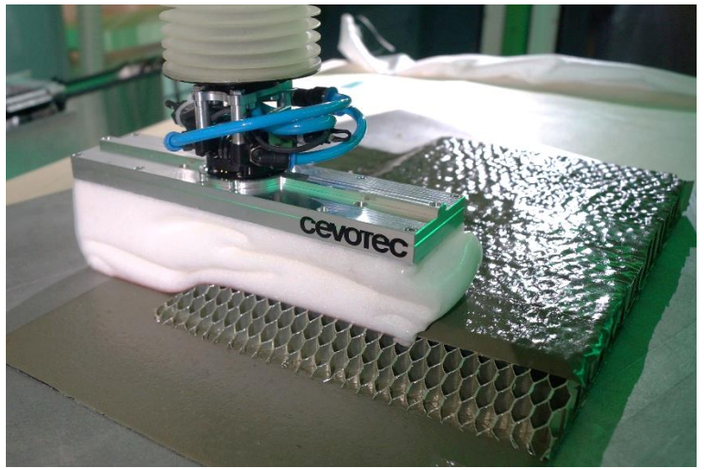
Bridging the gap between AFP & hand lay-up

Fiber Patch Placement technology enables the fully automated lay-up of complex-shaped parts and is compatible with a broad variety of materials.



Automated
Tape Laying

Automated
Fiber Placement



Cevotec's
Automated Fiber Patch Placement

Hand lay-up and other
unoptimized processes

extending capabilities as technology develops

flat / simple-curved parts — *complex to very complex parts* — *highest-complexity parts*

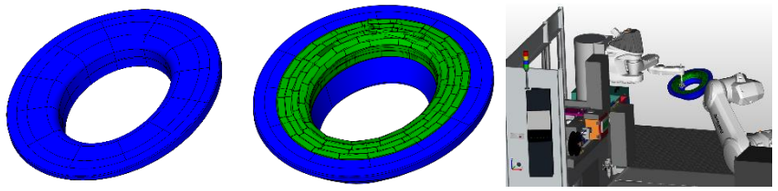
Significantly shortened process for complex composite lay-ups

Working with standardized fiber tape cuts process time & cost by 20-60% – no nesting, cutting and kitting required.

Development phase

Fiber Patch Placement

CAD part design → Laminate design → Robot programming



ARTIST STUDIO

Recurring production

Fully automated 3D lay-up on mold

SAMBA FPP system

Conventional process

CAD part design → Laminate design → Nesting software → Cutting software → Laser projection software → Cutting on CNC table → Kitting / pre-stacking → Hand lay-up on mold

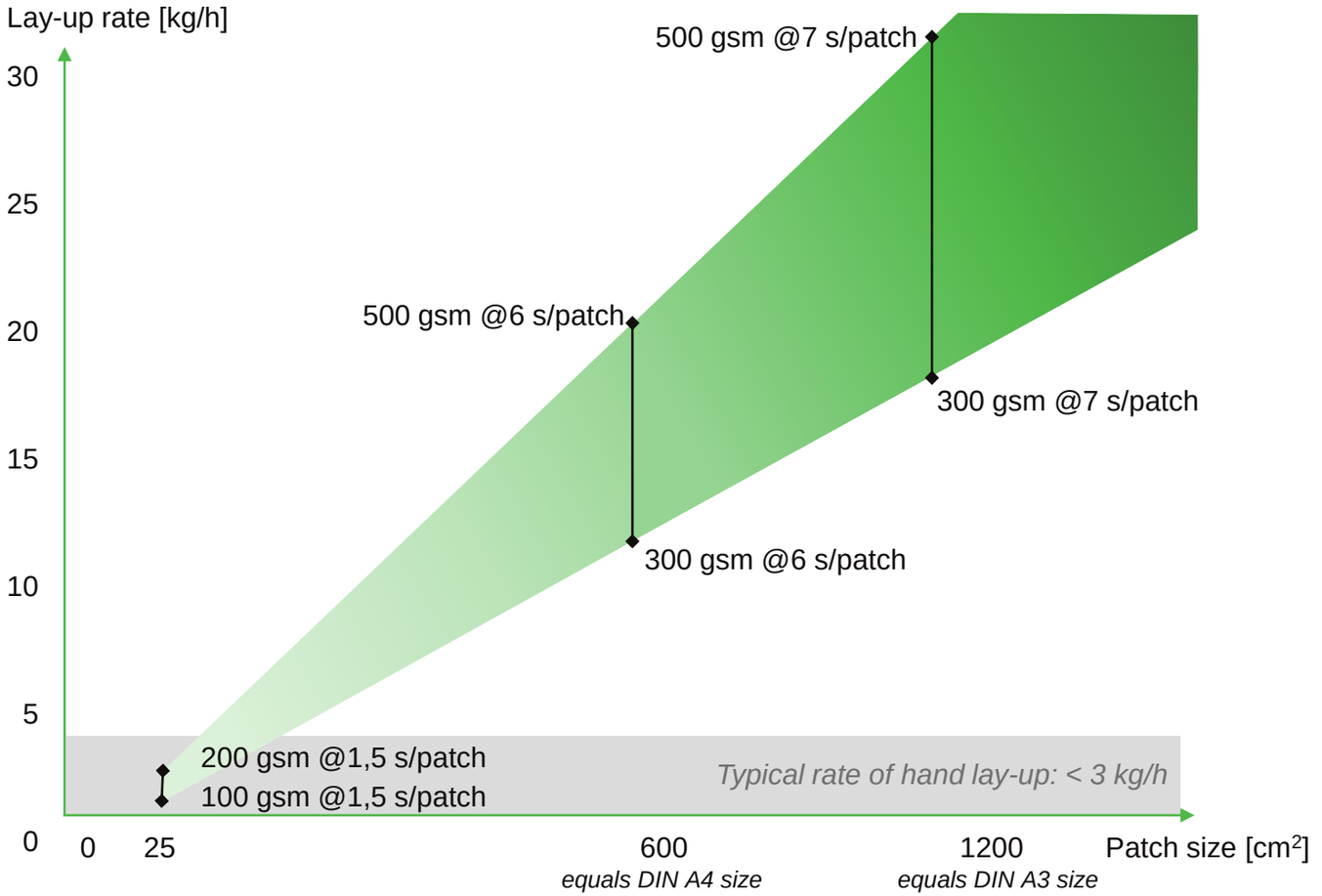
Productivity of FPP lay-up systems

Effective lay-up rates result from process parameters and can be customized to applications.

Lay-up rate:

$$\dot{m} = \frac{patch\ length\ *patch\ width\ *areal\ weight\ *no.robots}{patch\ cycle\ time}$$

- SAMBA *Series* systems are equipped with placement robots and mold manipulators that best fit your application
- For high throughput requirements, two or more placement robots can be fed by one feeding unit.
- The graph illustrates achievable lay-up rates based on different SAMBA *Series* configurations.



SAMBA Series**: Lay-up automation systems based on Fiber Patch Placement**

Scalable and flexible technology for a variety of applications.

SAMBA Pro

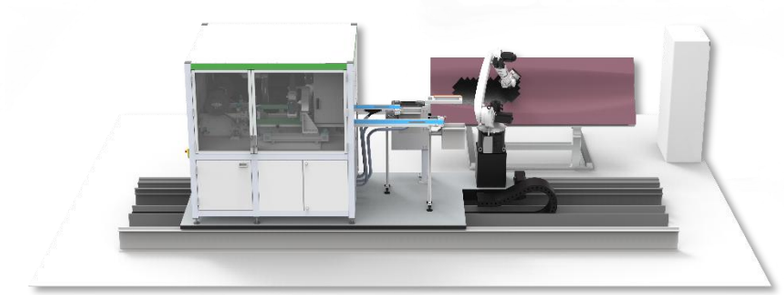
3 modules:

1. Automated material feeding & cutting
2. Placement units
3. Tool holders and manipulators

Watch our video about SAMBA!

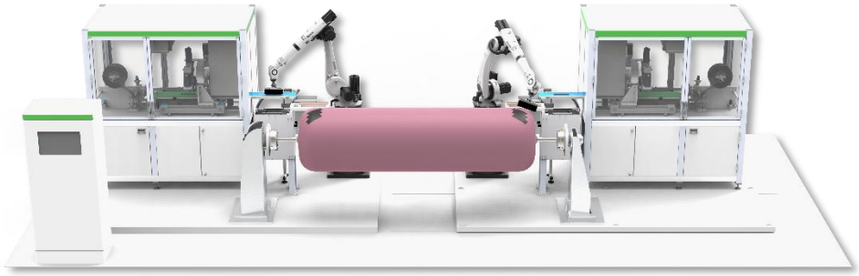
SAMBA Pro Multi

Sample configuration for
aerospace



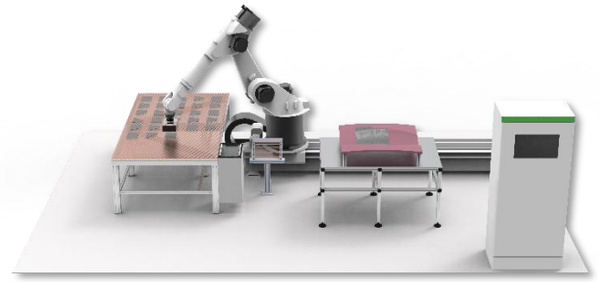
SAMBA Pro PV-1

Sample configuration for
composite tanks



SAMBA Step L

Sample configuration for
research & development



Fiber Patch Placement: SAMBA Systems for aerospace applications

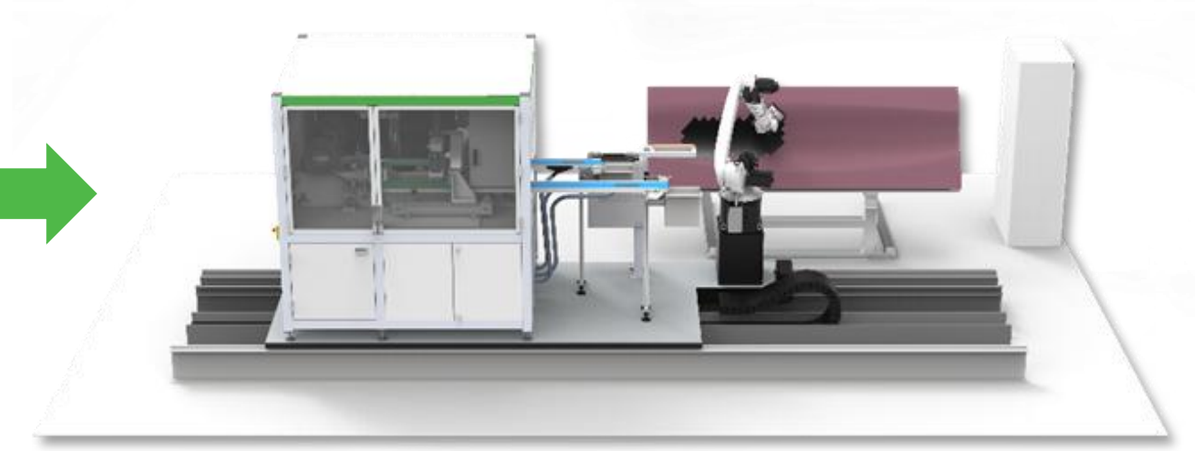
Highly flexible R&D system enables process development; basis for production system specification.

For R&D: high flexibility & adaptation

SAMBA *Step L*

R&D system for process development of large structures

For production: full automation of material feeding

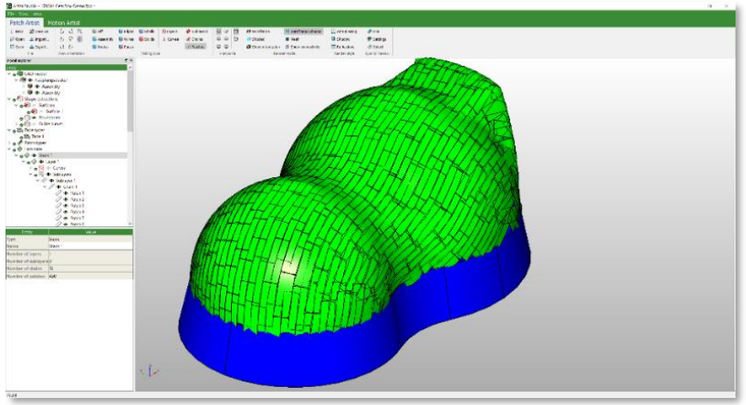


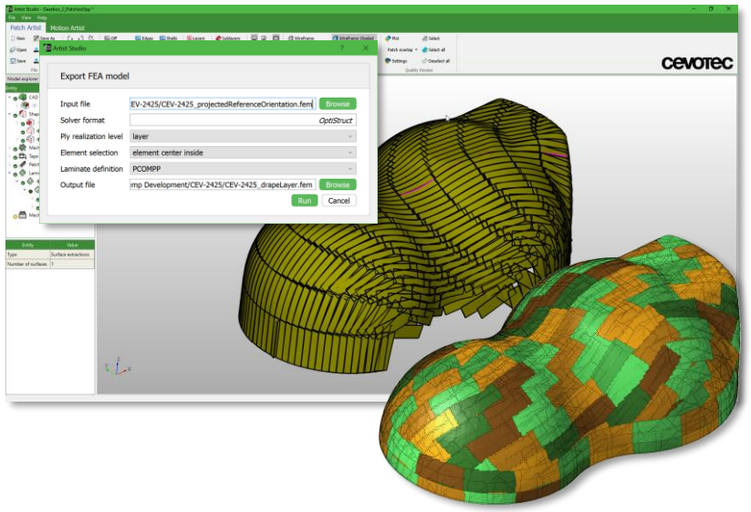
SAMBA *Pro Multi*

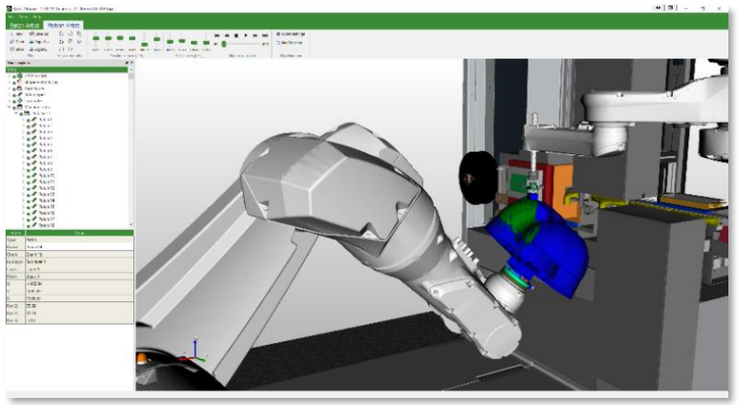
Automated multi-material placement system

ARTIST STUDIO: CAE software platform

Advanced CAD-CAM software with interface module for FEA software to enable comprehensive digital product and process development.







CAD – Patch Artist

- Generating optimized patch laminates
- Automated patch creation on guide curves
- Unique & efficient FPP-specific design features

FE-Module

- Connecting FPP laminates with FE meshes for structural analysis
- Automated modeling of patches, fiber orientation, thickness, patch overlaps

CAM – Motion Artist

- Generating SAMBA machine data through fully automated offline robot programming
- Robot movements with consideration of axis limits, robot range, singularities, collision detection

Watch our video about ARTIST STUDO!

cevo**Lab: The Fiber Patch Placement Competence Center**

Cevotec's high-tech lab optimally supports application and process developments, prototyping and small series production.

Range of services

· Virtual design and studies, e.g. FPP laminate design, FE-based simulation, unit cost analysis

· Prototyping with FPP: material testing, proof of concept, full-scale demonstrators, etc.

· FPP-as-a-service: production of small batches of series products

· Process development and customization of equipment

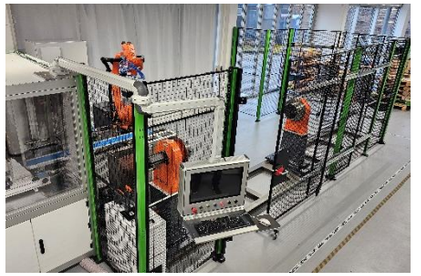
Available equipment

· **SAMBA Pro PV** lab system
  · Kuka KR 22 placement; Kuka KP1-HCS500 rotary tool manipulator
  · Ultrasonic cutting; tape width 20–75 mm; axisymmetric parts, length: <= 350 cm, diameter: <= 100 cm

· **SAMBA Pro** system (Gen 1)
  · Stäubli TP80 scara placement robot and TX 200 6-axis tool manipulator
  · Laser cutting; tape width 12.5 – 50 mm; part size envelope: ~ 1m³, max. tool weight: ~ 100 kg

· **SAMBA Step L** system
  · Large Kuka KR 60-3 placement robot mounted on KUKA linear rail; flexible space for customer tool
  · Material feeding table for patches up to ~200 x 300 m²; part size envelope (LxWxH): ~ 2 x 3 x 2 m³

· **Software** stack:
  · CAD: Autodesk Inventor, ARTIST STUDIO | FEM: Altair Hyperworks | CAM: ARTIST STUDIO



Samba Pro
PV lab

Samba Pro
lab (Gen 1)

Samba
Step L

Watch SAMBA in Rolling Motion!

Partners & references

Premier OEM, manufacturers and institutes worldwide develop innovative automation solutions with us.

Partners & references (selection)

GFM · AIRBUS · LEONARDO

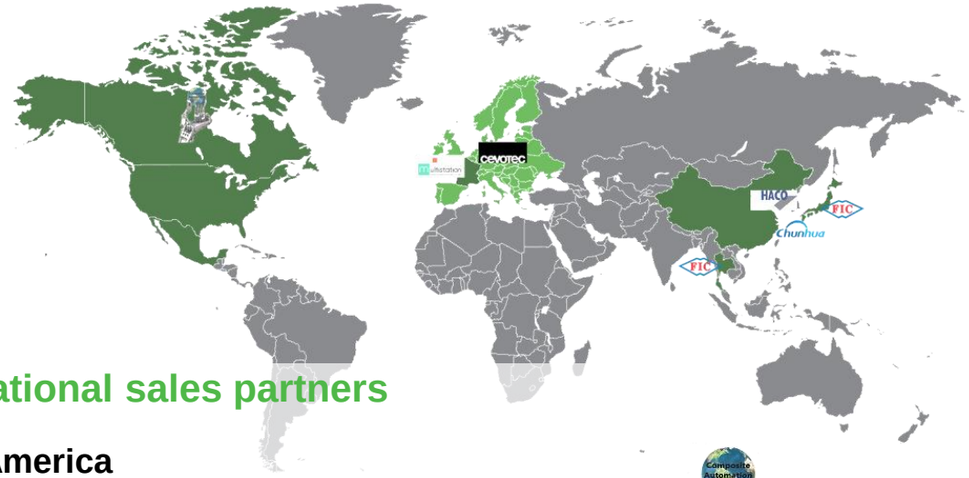
NIAR Wichita State University – National Institute for Aviation Research · Fraunhofer IGCV · THA Technische Hochschule Augsburg

Premium AEROTEC · The Boeing Company · Mercedes Benz AG · TUM · LCC Lehrstuhl für Carbon Composites

manroland web production · CIKONI composites innovation · baumann AUTOMATION

bavAIRia Europe's heart of aerospace and navigation · FPC FIBER PLACEMENT CENTER · HYDROGEN ALLIANCE BAVARIA

COMPOSITES UNITED · M·A·I CARBON · AZL AACHEN EXCELLENCE IN LIGHTWEIGHT PRODUCTION PARTNERSHIP



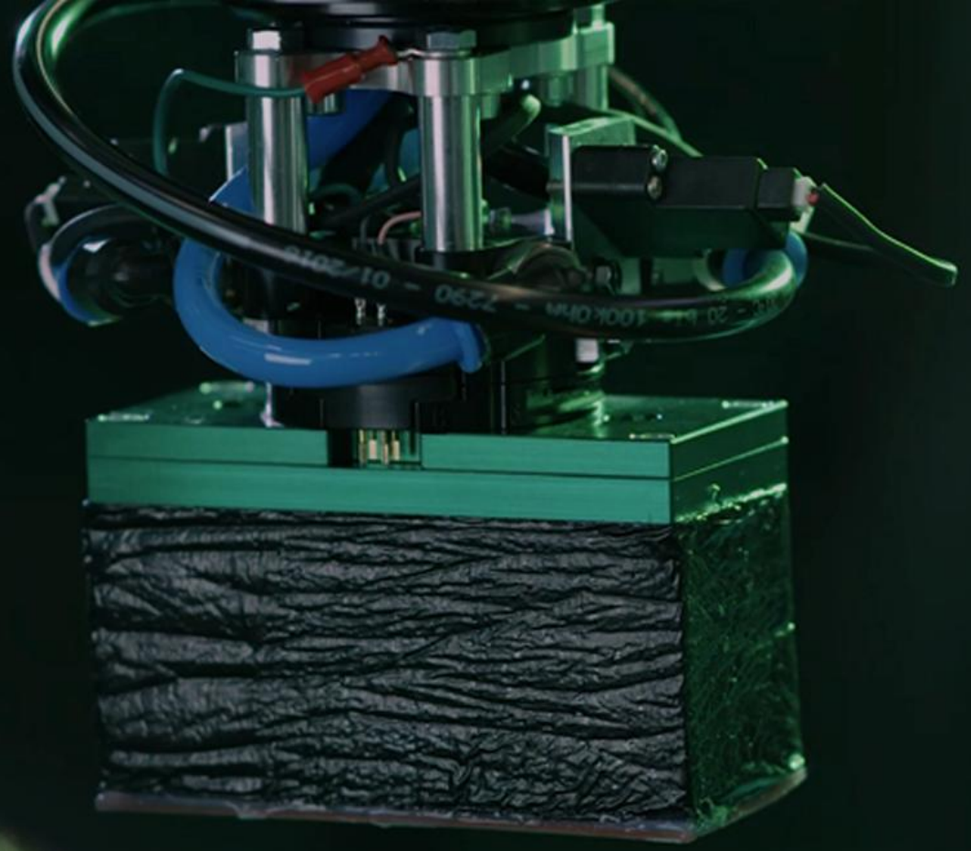
International sales partners

North America
Composite Automation LLC
http://www.compositeautomation.com
john@compositeautomation.com

Japan & Thailand
Fuji Industries Co. Ltd.
http://www.ficjp.com/en/
n.ueno@ficjpn.co.jp

China
Hesse, André & Co. GmbH & Co. KG
info@hesse-andre.com
ChunHua Automotive Technology Co., Ltd.
DavidLi@chunhuarp.com

France, Tunisia, Algeria, Morocco
Multistation SAS
multistation@multistation.com



cevotec
milestones in composites

How to get started with Fiber Patch Placement?

Step 1: ROI & suitability assessment

Includes manufacturability assessment, unit cost & time analysis, benefits & ROI estimation. This service is complimentary for you.

→ **How much does your application benefit from FPP?**

Step 2: Joint application development

Includes virtual studies, application and demonstrator development, equipment customization, and more.

→ **How do you best develop & test your FPP application?**

Step 3: Customized lay-up equipment

Includes SAMBA lay-up systems, ARTIST STUDIO software, customized patch grippers, quality control systems, and more.

→ **Which system configuration is best for your application?**

Get started with

Fiber Patch Placement

☎ **+49 89 2314 1650** ✉ **advantages@cevotec.com** **www.cevotec.com**

We enable manufacturers to produce complex composites in high volume and superior quality.

For a lighter, more sustainable future.

New automation options for aerospace applications

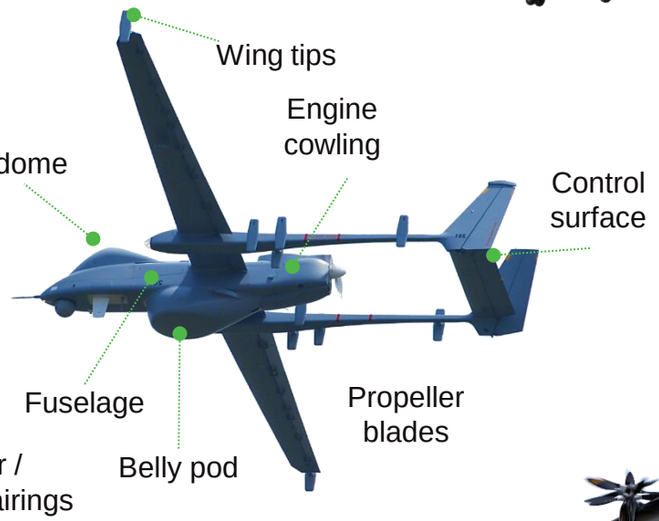
cevotec

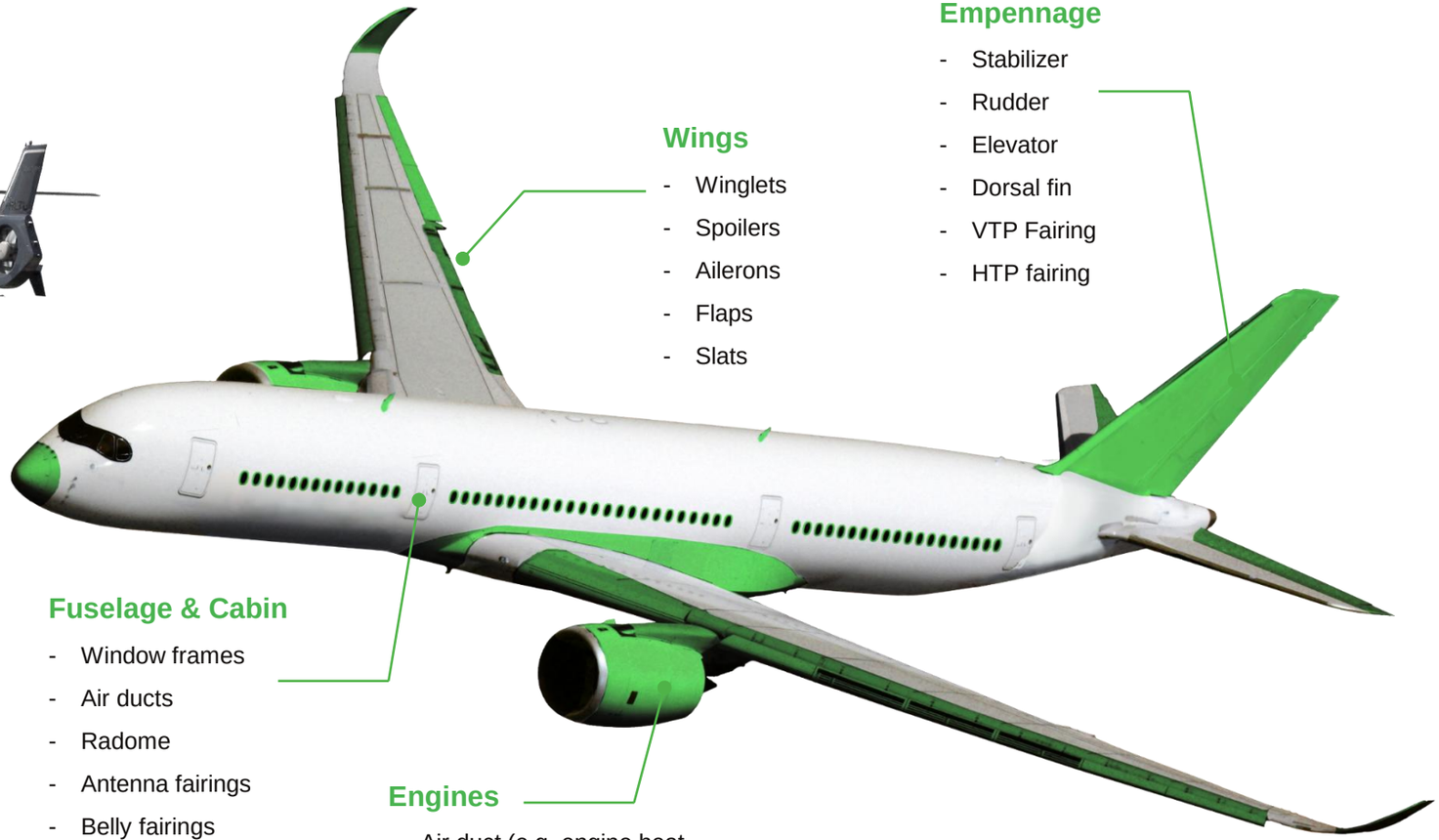
Aerospace applications

Overview of potential target components

Core application areas:

- Sandwich parts (all materials)
- Structural / local reinforcements
- Complex geometry lay-ups





Wings
- Winglets
- Spoilers
- Ailerons
- Flaps
- Slats

Empennage
- Stabilizer
- Rudder
- Elevator
- Dorsal fin
- VTP Fairing
- HTP fairing

Fuselage & Cabin
- Window frames
- Air ducts
- Radome
- Antenna fairings
- Belly fairings
- Landing gear doors
- Cabin liners

Engines
- Air duct (e.g. engine heat exchangers, HVAC)
- Nacelles
- Pylon fairngs

Fiber Patch Placement for aerospace components

Concept and target areas for aerospace applications

1 Automate existing laminate

- Replace manual lay-up for complex parts
- Multi-directional, mostly QI laminates
- Targets: rate expansion, cost reduction, quality enhancement

- **Maintaining general fiber architecture**
- **Laminate adaption to FPP process**

2 Enable (local) laminate optimization

- One or two primary fiber orientations
- Local (patch) reinforcements with FPP
- Targets: lighter components, high-rate automation, cost reduction, material savings, continuous safety factors

- **Laminate design considering FPP principles**
- **Entire components or local FPP reinforcements**

3 Enable new (load path optimized) design

- Fibers follow direct (curved) load path
- Optimized fiber alignment
- Targets: significant weight/cost reduction, high-rate automation, next generation aerostructures

- **Optimization by multiple simulations**
- **Laminate design considering FPP principles**

Radomes
Flaps
Winglets
Rudder
Slats
Window frames
Stabilizers
Ailerons
Air Ducts
Fairings
Nacelles
Spoiler

FPP for multi-material structures

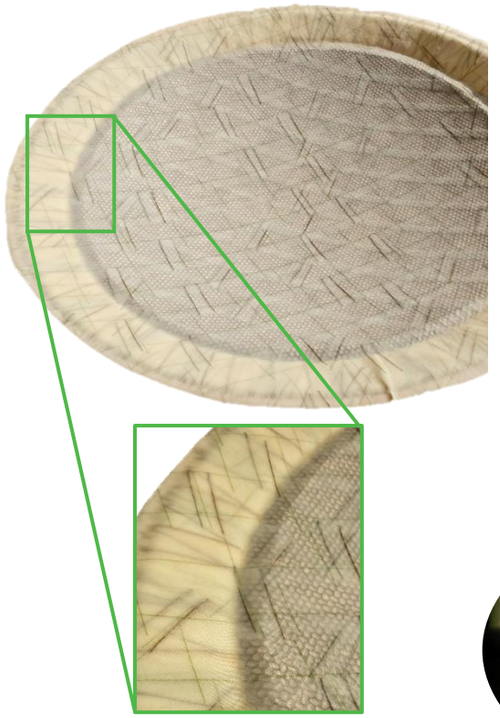
Automated 3D placement of glass fiber prepreg into a concave mold. High compaction pressure avoids debulking.

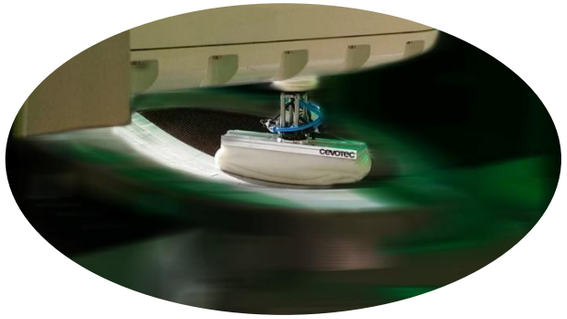
Sandwich structure with integrated monolithic rim

- Plies of glass fiber prepreg precisely placed directly into a concave 3D metal mold
- Manual assembly of honeycomb sandwich core
- Direct placement of second skin onto the sandwich core
- Minimized void content by high compaction pressure
- No bridging effects at chamfered transitions
- Monolithic area placed with the same SAMBA system
- Showcase for debulking capability (tests done on 24 layers of GF prepreg)

→ **Homogeneous sample**

→ **Porosity content < 1%, also in overlap areas**

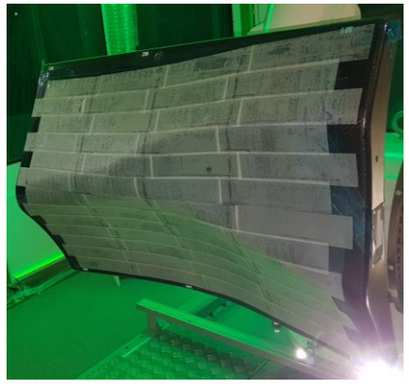




Sandwich panel trials with SAMBA Pro system

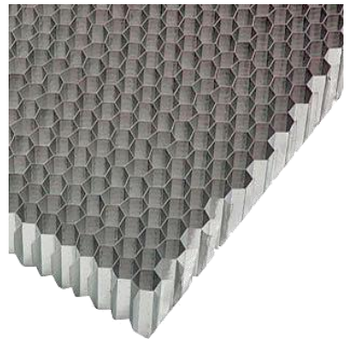
Automated lay-up of all fiber materials of component, directly onto aluminum honeycomb core.

SAMBA *Pro* system loaded with tool



First skin: GF + CF + GF

Autoclave curing

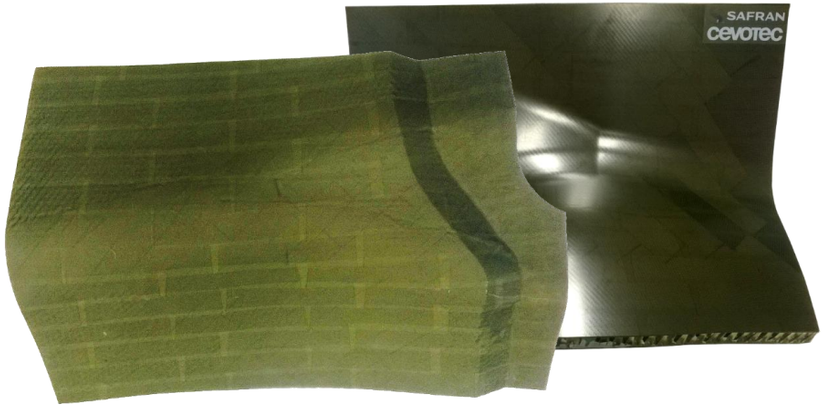


adhesive film + manually applied honeycomb
(image shows illustration only)

Adhesive and GF layers
patched directly on core

Second skin: CF + GF

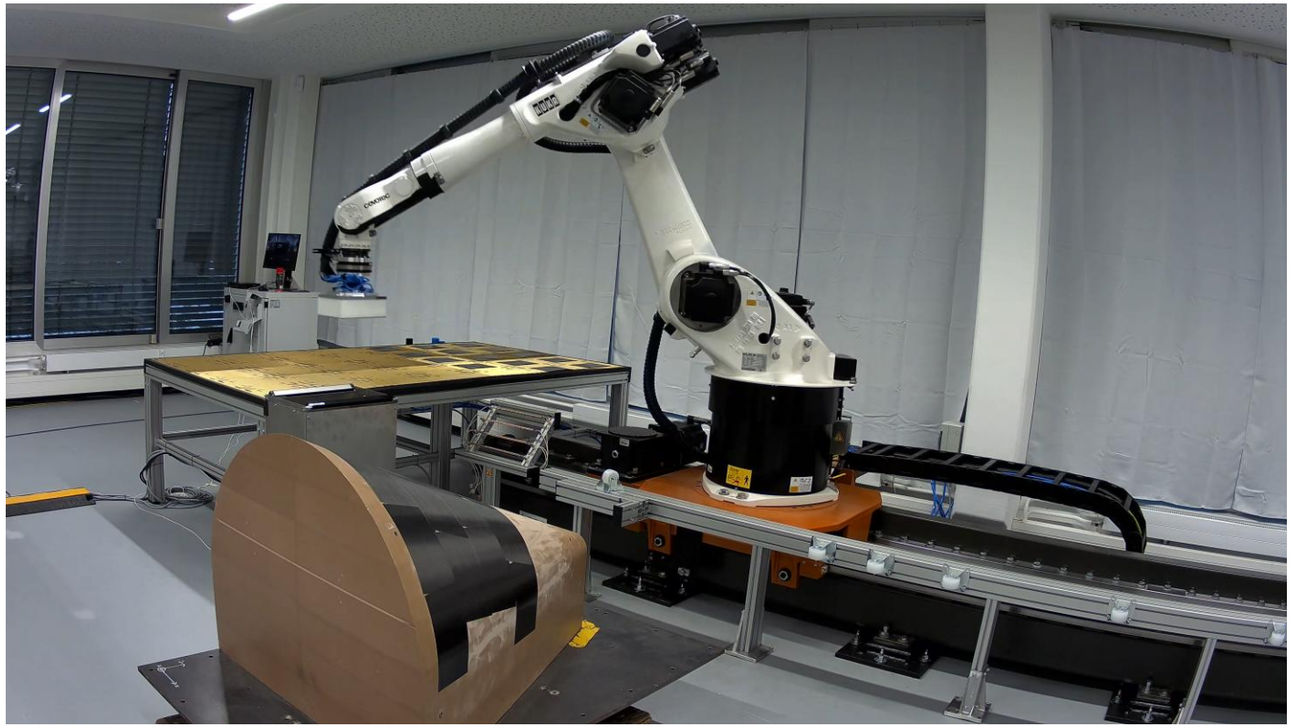
Autoclave curing
Trimming



Final cured & trimmed part

Advanced robotic lay-up operations

Rolling motion to process highly complex convex-shaped parts.



Watch Rolling motion

→ **Application development for next generation aerostructures**

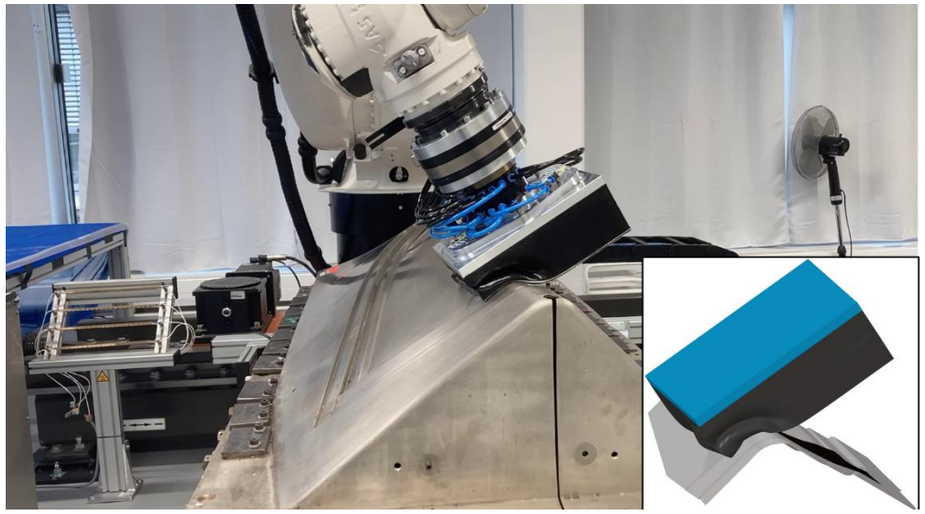
→ **Basis for R&D project ACoSaLUS**

Rolling motion placement feature

- Rolling movement of the 6-axis robot for highly complex and convex shaped parts
- Movement of the placement robot follows a curve with a different normal for each point of the curve
- Calculation of best contact curve by dedicated ARTIST STUDIO software
- Easy offline programming via digital twin

Automated placement of CF skins on complex tool

Skins of carbon fiber have been successfully placed on complex tool for manual lay-up; advanced rolling motion process developed based on gripper simulations

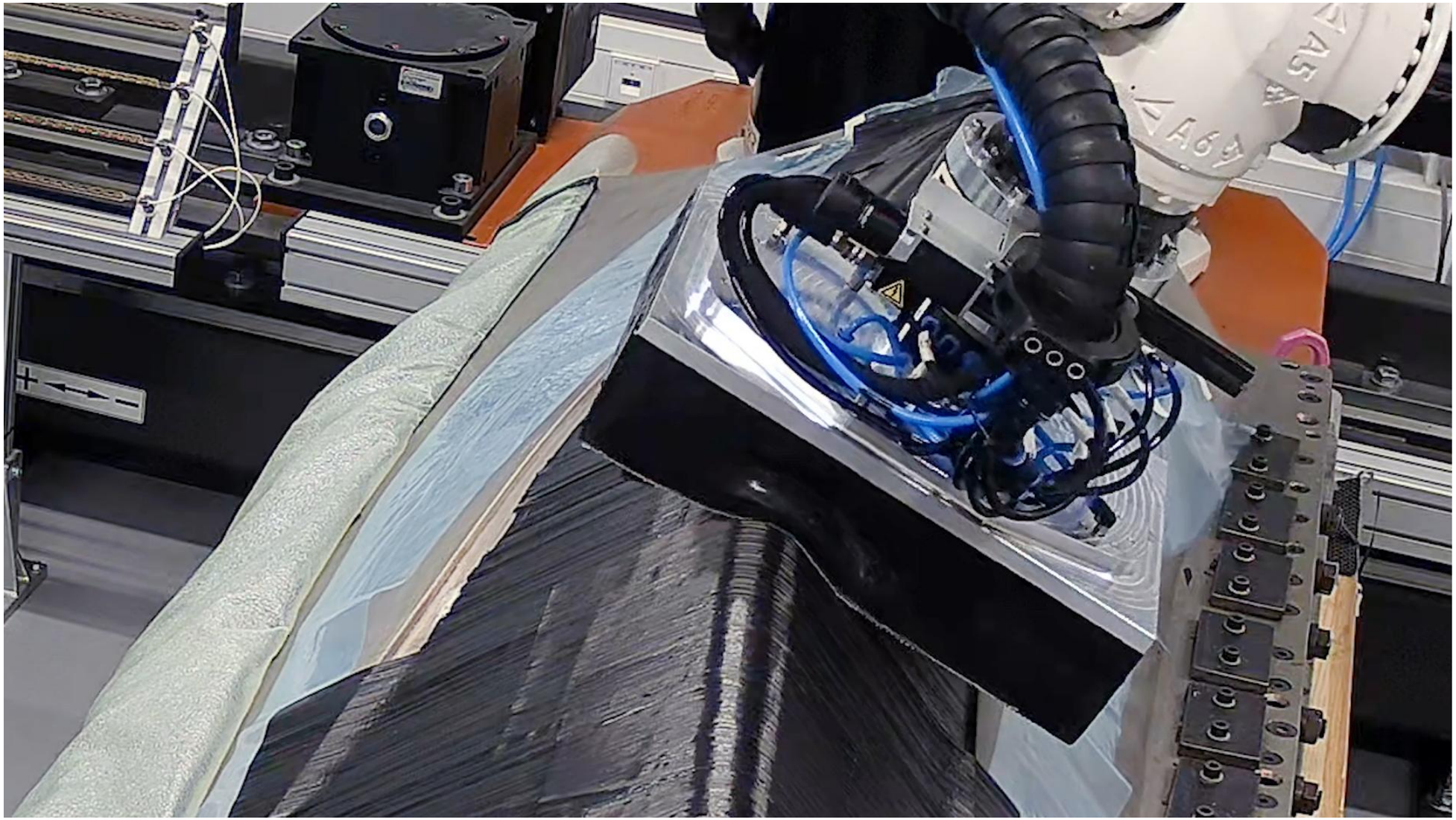


· Material: SGL SIGRAPREG C U264-0 E910 (40% resin)

· Size of patches: to up DIN A5 (approx. 200 x 150 mm)

→ Successful placement of patches on complex tool

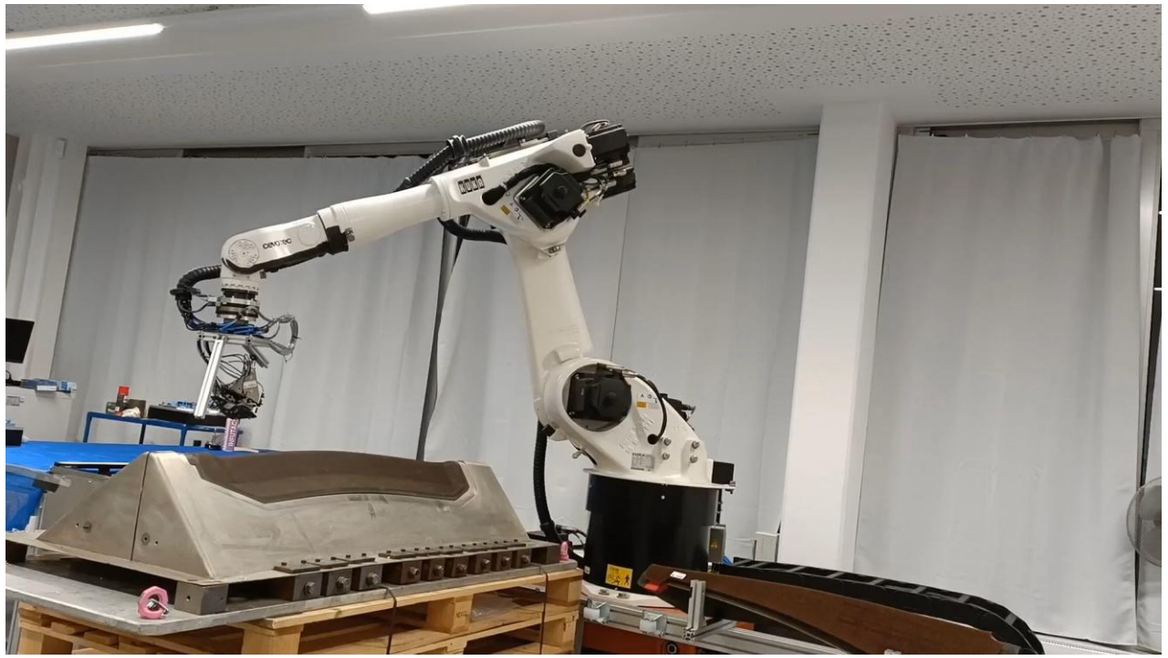
→ Placement tolerance of +/- 1 mm, no placement defects observed, optimization ongoing



Watch “Fiber Patch Placement for sandwich parts in aerospace”

Development of automated honeycomb gripping & placement system

Continued development for automated honeycomb placement in R&D project with GKN, SGL Carbon & academic partners. Additional features for fixation and honeycomb nesting are up next.



Automated honeycomb placement

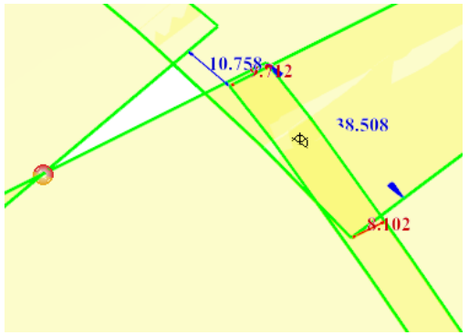
- Proof of automated handling using our patented gripper design
- Within the R&D program, the compaction behavior and 2nd skin lay-up will be further tested
- Additional measures for fixation upon placement will be investigated
- Especially for concave structures, nesting operations are being developed for gap-free HC placement

→ Further development for industrial application

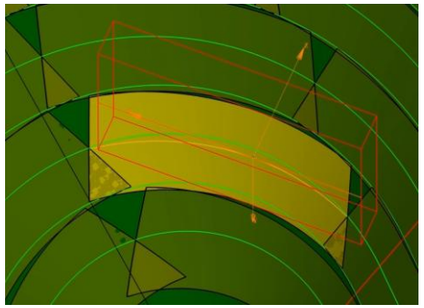
→ Fully automated lay-up of sandwich structures incl. honeycomb cores

Software features for precise multi-material lay-up

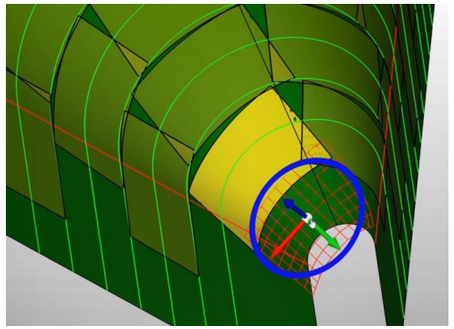
Design features for generating different types of overlaps, working with trapezoidal patch shapes, efficient manual adjustment features.



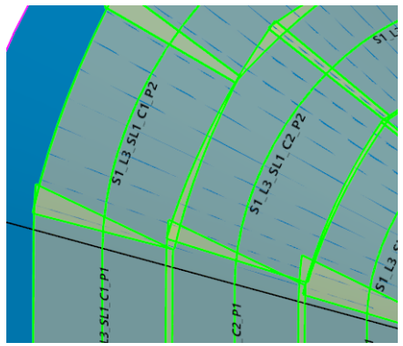
Overlap measurement



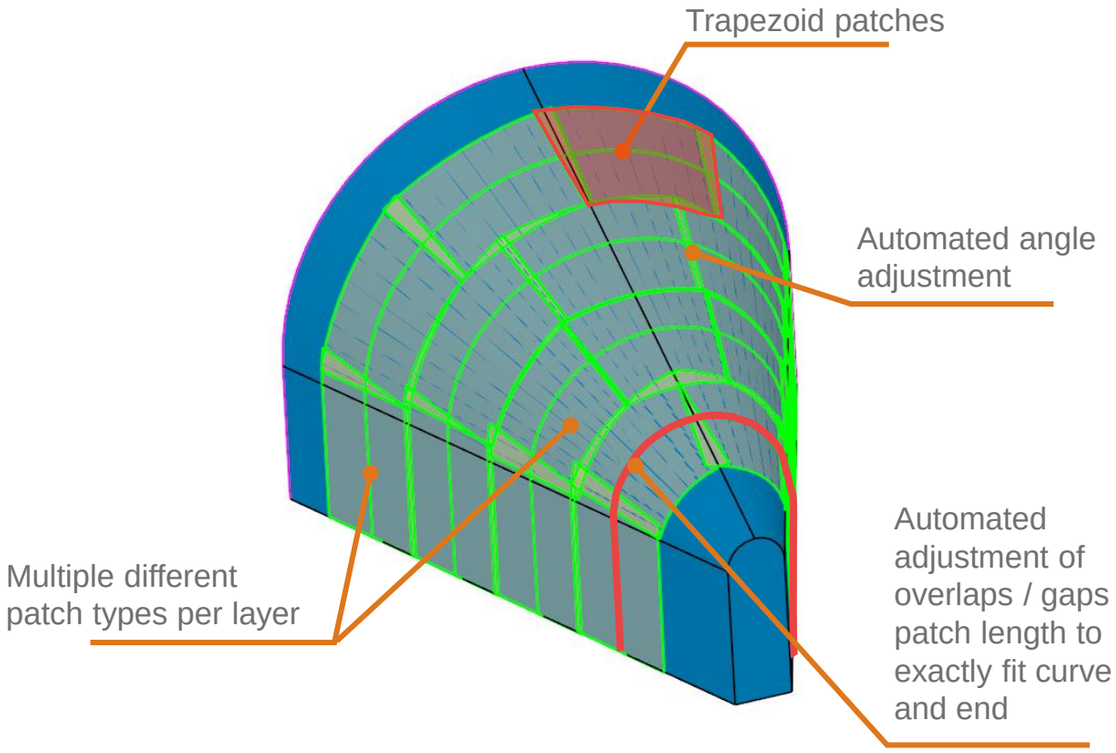
Enhanced Rolling motion



Enhanced manual modification of patch positions



Ply book functionality



Summary: Fiber Patch Placement for multi-material (sandwich) structures

FPP provides new options to automate complex fiber lay-ups with difficult to handle materials, effectively bridging the gap between AFP & hand lay-up.

Lay-up focus

- Multi-material placement (glass, carbon, adhesives, coppermesh, etc. with different tack levels)
- Complex geometries, sandwich structures

Benefits

- Time & cost reduction for production: lay-up + non-productive time (e.g. debulking steps) + material cost reduction (no cutting & kitting)
- Increase of capacity / production rate on same floor footprint
- Remove non-ergonomical manual lay-up operations

Key differentiators to robotic AFP

- Ability to handle broad variety of material (in parallel, in one system)
- Ability to lay-up on more complex and smaller shapes / surfaces
- Ability to design one-layer laminates with defined overlaps → entire core material covered with one-layer lay-up
- Opportunity to significantly reduce debulking steps through defined deposition pressure

Typical properties of parts for high FPP value

- “Difficult-to-automate” materials in the stack (adhesives, glass fiber, honeycomb cores, etc.)
- Geometric complexity
- Complex or non-standard laminate design (e.g. defined overlaps)

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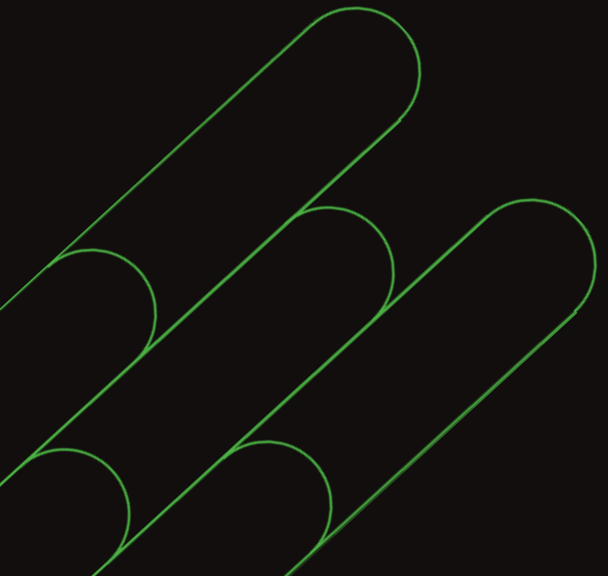
milestones in composites



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