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NEWSLETTER

ISSUE 3

HERWINGT

CLEAN AVIATION

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AIRBUS

Dear Reader,

I am glad to share with you Issue 3 of the HERWINGT Newsletter.

The Hybrid Electric Regional Wing Integration Novel Green Technologies (HERWINGT) project is one of the pioneers in the decarbonization of aviation. It aims to design a novel wing ideal for the future hybrid electric aircraft of the regional segment and to develop architectures, structures, and technologies that enable higher integration of electrical systems. These breakthrough solutions aim to achieve a 50% reduction in fuel consumption, at the aircraft (A/C) level, compared to a 2020 State-of-the-Art (SoA) A/C, in three different ways:

- Pioneering wing configurations and improved aerodynamics leading to drag reduction and enabling a fuel burn reduction of 15% at the wing component level, compared to a 2020 SoA wing.
- Wing structures, more integrated systems, and new material technologies aiming at a weight reduction of 20% at the component level, compared to a 2020 SoA wing.
- The development of technologies enabling the wing for a hybrid-electrical use case (H2/Batteries and fuel systems using Sustainable Aviation Fuels (SAF)).

Enjoy reading and join our community online through the website and social media!

Co-funded by the European Union

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Exploring Advanced Wing Architectures

Three innovative wing configurations have undergone comprehensive analysis and evaluation: the Strut-Braced Wing (SBW) with a high aspect ratio, the Cantilever High Aspect Ratio Wing (CHAW), and a wing integrated with distributed propulsion systems.

Aerodynamic shaping and aeroelastic optimization have been completed for cruise flight conditions. The SBW geometry has been further refined to enhance low-speed stall characteristics in a clean configuration. Additionally, high-lift devices have been aerodynamically optimized to improve performance during take-off and landing phases

Bridging Innovation through Hardware and Simulation

The definition phase for the technology demonstrators, crucial for validating and maturing next-generation aerospace innovations, is close to completion. Foundational design principles have been established, with the majority of Preliminary Design Reviews (PDRs) concluded by mid-2024. Critical Design Reviews (CDRs) were conducted in the final weeks of 2024, covering essential components such as the centre wing box, flap systems, thermoset and thermoplastic leading edges, the induction-based ice protection system, morphing trailing edge, aileron, and droop nose. The centre wing box demonstrator required reinforcement at the interfaces with the load introduction actuators.

Nickel has been chosen as the foil material for the induction ice protection system, which is designed for integration into the thermoset multi-functional leading edge. The test specification for the ice wind tunnel campaign has been formally approved.

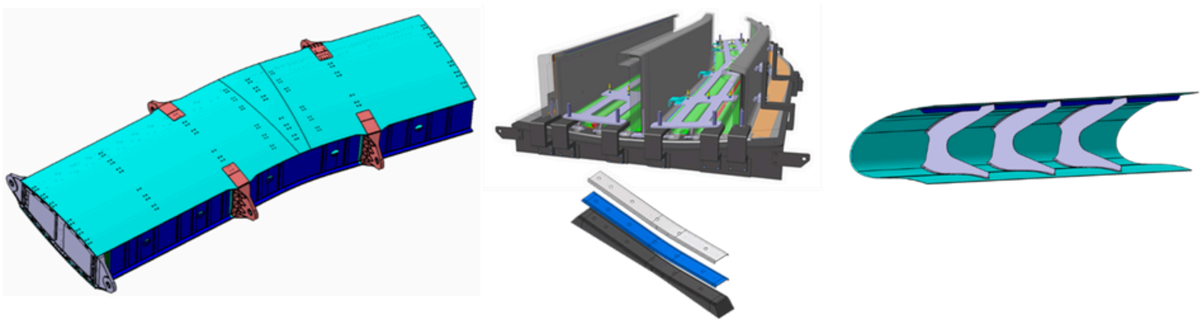


Figure 1. Center wing box and leading edge assemblies.

The characterization of Sustainable Aviation Fuel (SAF) has been successfully completed, and its compatibility with existing aircraft fuel systems has been thoroughly evaluated. The test architecture for fuel quantity indicators has been finalized, and SAF procurement has concluded with the delivery of certified fuel samples to the designated test facilities.

Finite Element Model (FEM) analysis of the Omega-stringer geometry for the Integrated Fuel Vent System demonstrator has been successfully completed, yielding excellent results in terms of structural tightness—further enhanced through advanced surface treatment techniques. In parallel, custom connectors have been produced using 3D printing, supporting rapid prototyping and integration.

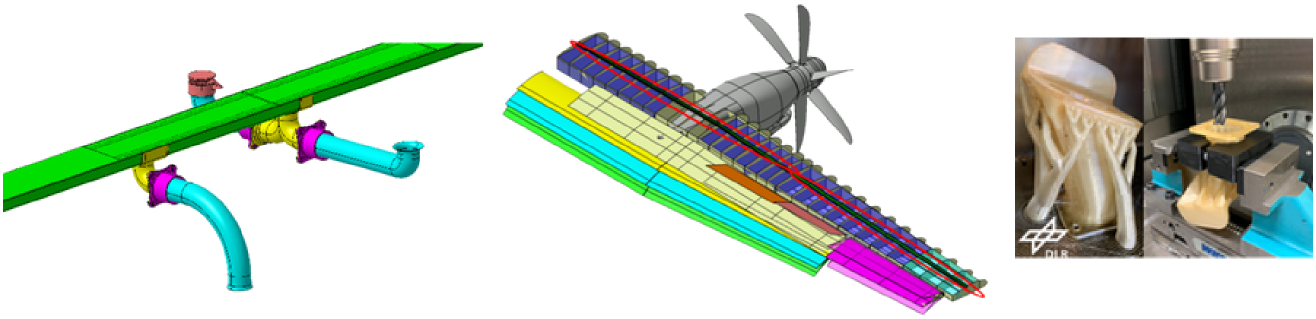


Figure 2. Integrated fuel vent system.

Industrial resources have been defined, and detailed manufacturing and assembly processes have been established for each of the demonstrators, paving the way for streamlined production and integration.

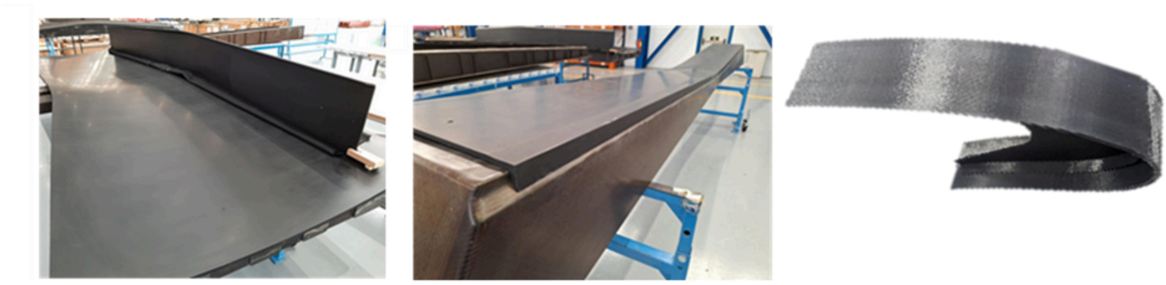


Figure 3. Manufacturing trials.

A total of twenty-three enabling technologies are developed within the project, with the majority successfully reaching Technology Readiness Level 3 (TRL3) by 2024. Progress continued into 2025, with TRL4 evaluations conducted during the first quarter, marking a significant step forward in technology maturation. The following table below summarizes the HERWINGT enabling technologies.

ID	Enabling Technology /System, Sub-System
T1	New materials selection for aeronautical use
T2	Development of new structural concepts and architectures
T3	LRI Thermoset for sandwich-monolithic High Structural Integration
T4	LRI Thermoset for monolithic multifunctional substrate integration
T5	LRI with modified epoxy resin to increase Tg and lightning strike performance
T6	Thermoplastic ISC for low curvature monolithic structural integration
T7	Thermoplastic ISC for high curvature monolithic structural integration
T8	Thermoplastic ISC for multifunctional monolithic high curvature structural integration
T9	Thermoplastic Welding for repairs and structural integration
T10	TP Continuous forming and overmoulding
T11	High rate Automatic fibre placement for TP
T12	Fast curing thermoset
T13	SHMS development for structural integrity prevention
T14	Non-destructive testing for highly integrated structures
T15	Ice Protection System Structural Integration
T16	Erosion protection
T17	New Sensors, Sealants and Materials technologies for SAF
T18	Aerodynamic drag reduction due to high aspect ratio
T19	Aerodynamic drag reduction due to morphing LE & flap
T20	Aerodynamic drag reduction due to morphing control surfaces
T21	Aerodynamic drag improvement and load alleviation due to flight control laws optimization
T22	Control of external surface wing tolerances in benefit of improved laminarity
T23	Virtual Testing

Demonstrators

The HERWINGT project continues to advance its technological roadmap with a comprehensive portfolio of twenty demonstrators, strategically classified into two categories:

- D1 – Hardware Demonstrators
- D2 – Software/Model Demonstrators.

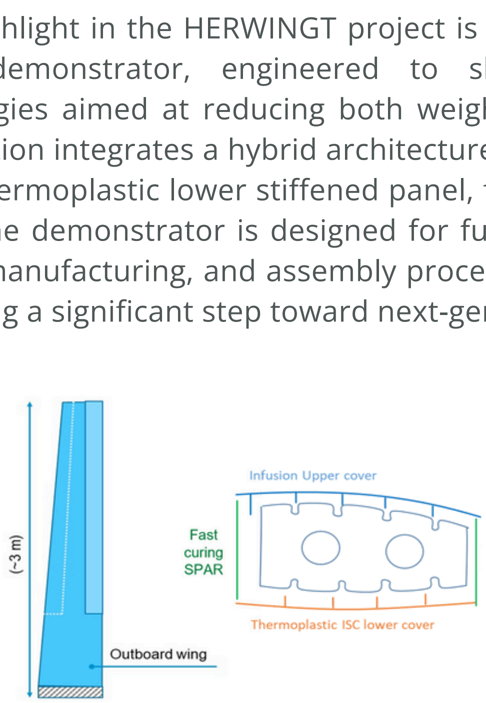
The D1 group comprises sixteen demonstrators involving physical components designed for integration and testing in large-scale systems, such as the flap demonstrator. Meanwhile, the D2 category includes four virtual demonstrators focused on simulations, modelling, and specialized software, highlighted by the bird strike virtual test.

In this Issue, we focus on the hardware demonstrators, with an in-depth look at the eight in the series. The remaining eight hardware demonstrators will be covered in the upcoming Issue 4.

D1-1 Full scale Outer Wing Box

Innovative Outer Wing Box Demonstrator targets lightweight, cost-efficient design:

A key highlight in the HERWINGT project is the development of a 3.2-meter span Outer Wing Box (OWB) demonstrator, engineered to showcase advanced structural and manufacturing technologies aimed at reducing both weight and production costs. This high aspect ratio (HAR) wing section integrates a hybrid architecture, including metallic closure ribs, thermoplastic internal ribs, a thermoplastic lower stiffened panel, fast-curing prepreg spars, and an infusion-molded skin panel. The demonstrator is designed for full-scale structural testing, supporting the validation of design, manufacturing, and assembly processes. The initiative targets a TRL progression from 3 to 5, marking a significant step toward next-generation wing structures.



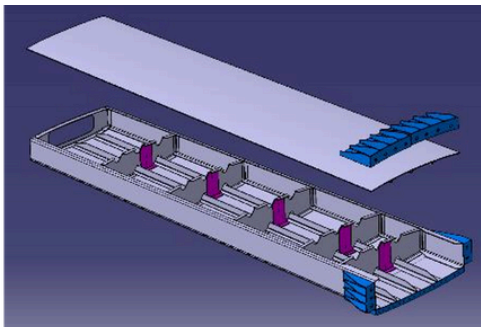


Figure 4. Outer wing box demonstrator.

D1-2 Pylon to pylon Centre Wing Box

Advanced Centre Wing Box Demonstrator tackles integration and manufacturing challenges:

Another key innovation within HERWINGT is the development of a semi-pylon-to-pylon multi-spar centre wing box demonstrator, designed to support hybrid-electric propulsion integration. This highly integrated structure includes lower skins, spars, stringers, and an upper skin interface, all engineered for a HAR configuration. Both the lower and upper sections are manufactured using one-shot Liquid Resin Infusion (LRI) processes, enabling the simultaneous formation of skins, stringers, spars, and stiffeners. The demonstrator aims to validate multi-spar architectures, address complex manufacturing challenges, such as dihedral and sweepback angles, and assess curvature limits during production. Full-scale structural testing will support the transition from concept to application in next-generation aircraft designs.

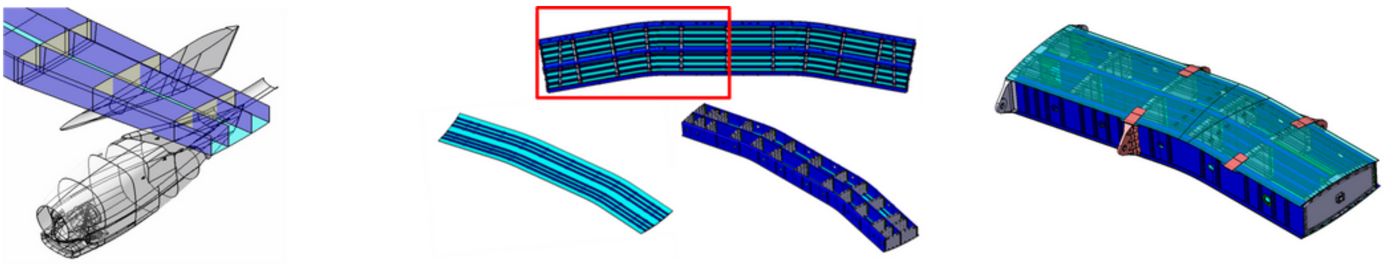


Figure 5. Outer wing box demonstrator.

D1-3 Flap demonstrator

High-Lift Inner Flap Demonstrator showcases advanced integration and manufacturing techniques:

A standout component in the HERWINGT demonstrator lineup is the high-lift inner flap, designed to validate cutting-edge manufacturing methods for highly integrated aerostructures. The upper cover is produced via LRI, incorporating both the leading and trailing edges, while the lower cover employs Thermoplastic In Situ Consolidation (TP-ISC), featuring a welded thermoplastic centre spar. This spar is manufactured using thermoplastic stamp forming, highlighting a multispar concept. The demonstrator aims to address integration challenges, such as combining natural laminar flow surfaces with complex geometries, and to mature one-shot manufacturing processes. "Shop Trials" are also being conducted to assess and enhance internal quality, ensuring readiness for full-scale application.

Figure 6. Flap demonstrator.

D1-4 Thermoset Leading Edge Multifunctional

Multi-Functional Leading Edge (LE) Demonstrator advances structural innovation:

As part of HERWINGT's drive toward integrated, high-performance aerostructures, a multi-functional Leading Edge (LE) demonstrator has been developed, combining advanced structural design with critical operational capabilities. Engineered using Out of Autoclave (OoA) thermoset materials, the LE features a solid laminate construction optimized for bird-strike resistance, ice protection system (IPS) integration, and erosion durability. The design emphasizes minimal assembly through a tooling strategy, maximizing structural integration, while material choices focus on energy absorption and weight reduction. Virtual testing, including bird-strike simulations and dynamic material property evaluations, supports a cost-effective development path.
The final demonstrator, measuring 2.4 meters in length, will be delivered with full IPS integration, marking a significant milestone in multifunctional LE technology.

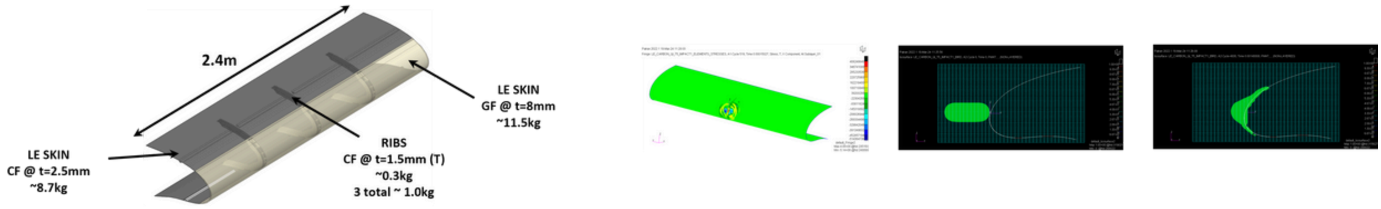


Figure 7. Multifunctional thermoset leading edge demonstrator.

D1-5 Thermoset Leading Edge Baseline

The Hybrid Leading Edge Demonstrator advances lightweight design and virtual validation:

A new LE demonstrator, developed using a hybrid manufacturing approach that combines sandwich construction with LRI, is pushing the boundaries of lightweight, sustainable aerostructures. Designed to support the CWB assembly, this 1-meter-long component has undergone virtual bird-strike simulations without the need for physical structural testing. The demonstrator aims to validate the LRI process for complex geometries, demonstrate realistic weight savings, and assess the sustainability of the manufacturing route. This effort marks a significant step toward integrating advanced composite techniques into next-generation aircraft structures.

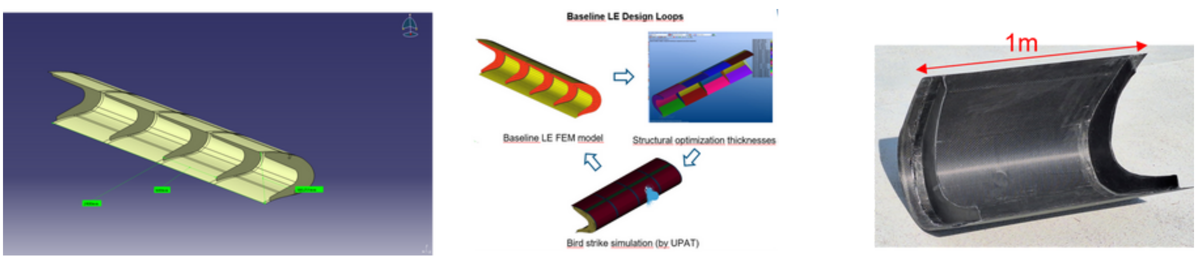


Figure 8. Thermoplastic leading edge demonstrator.

D1-6 Thermoplastic Leading Edge

Thermoplastic Leading Edge Demonstrator targets lightweight integration and advanced welding:

A thermoplastic LE demonstrator is under development to mature advanced manufacturing technologies. Designed with highly curved geometries, the LE integrates most of its components using ISC techniques, enabling a streamlined, lightweight structure. The demonstrator also serves as a testbed for next-generation welding processes, using a consistent geometry to evaluate integration performance. Its architecture is driven by two key objectives: achieving minimum structural weight and maximizing internal space for system installation and routing. The project aims to elevate multiple technologies from TRL3 to TRL5, reinforcing the role of thermoplastics in future-ready aircraft structures.

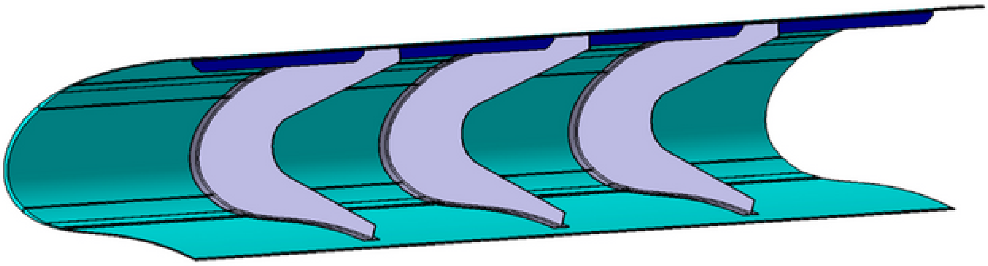


Figure 9. Leading-edge digital mock-up.

D1-7 Multifunctional Strut

Morphing Strut Demonstrator targets adaptive aerodynamic performance:

A novel multifunctional strut demonstrator is being developed to validate a morphing trailing edge concept aimed at optimizing aerodynamic performance across varying flight conditions. Previously tested on rigid wind tunnel models, the concept features a sliding joint mechanism between the trailing edge and the main torsion box. While effective, this design presents a potential jamming risk under significant wing or strut deformation. The current demonstrator seeks to de-risk the technology by proving its operability under representative loads and deformation scenarios in laboratory conditions.

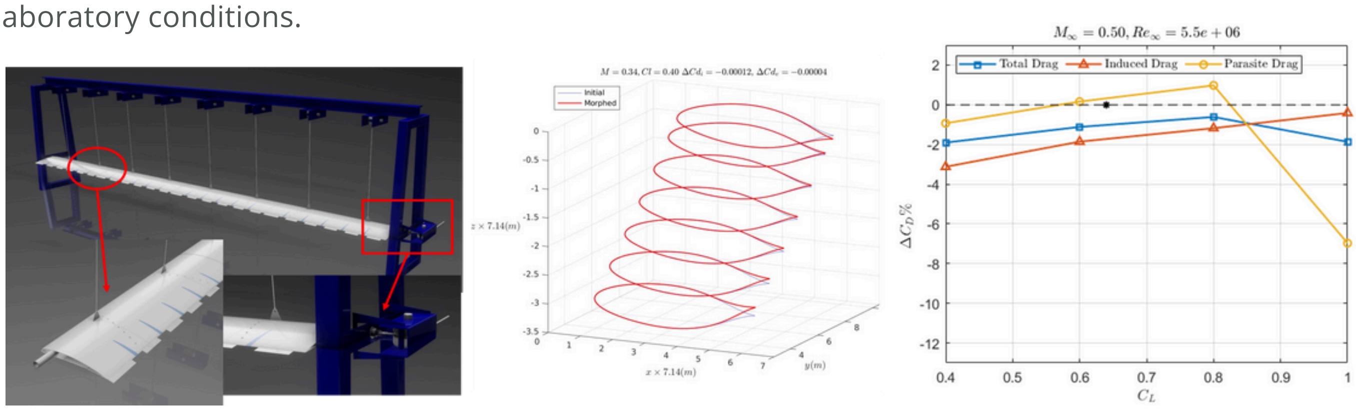


Figure 10. From left to right: Concept of test set-up; Optimized strut deflection; Drag reduction in cruise

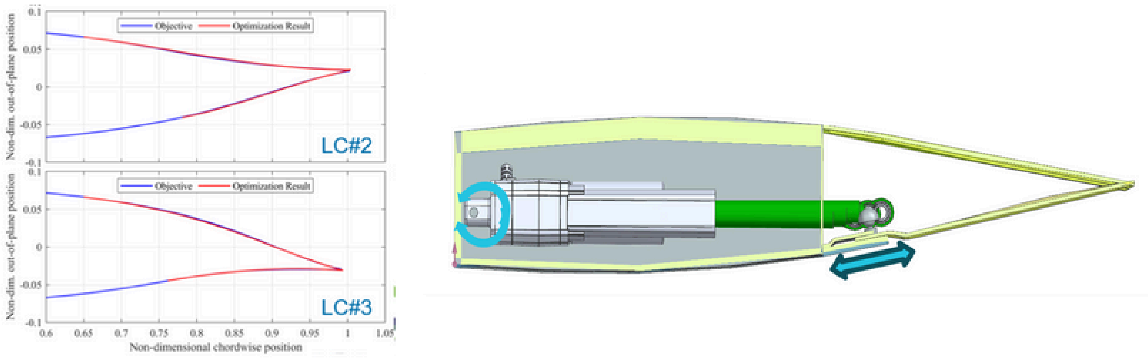


Figure 11. From left to right: Comparison of objective shapes and actual deformed shapes; Illustration of skin sliding due to actuator movement

D1-8 End-to-End Impact Detection SHM System

End-to-End SHM system advances impact detection for next-gen wing structures:

A cutting-edge End-to-End Structural Health Monitoring (SHM) system is under development to enable real-time impact and damage detection in advanced wing architectures. Targeting TRL5, the system integrates piezoceramic transducer arrays with data acquisition hardware and software.
A virtual testing framework tailored for condition-based maintenance (CBM) on the wing has been established and validated. A comprehensive test campaign will evaluate system performance under varied environmental conditions, including both non-damaging and high-energy impact scenarios. The SHM system will be installed and validated on internal and final demonstrators, including shear panel, marking a significant step toward intelligent, self-monitoring aircraft structures.

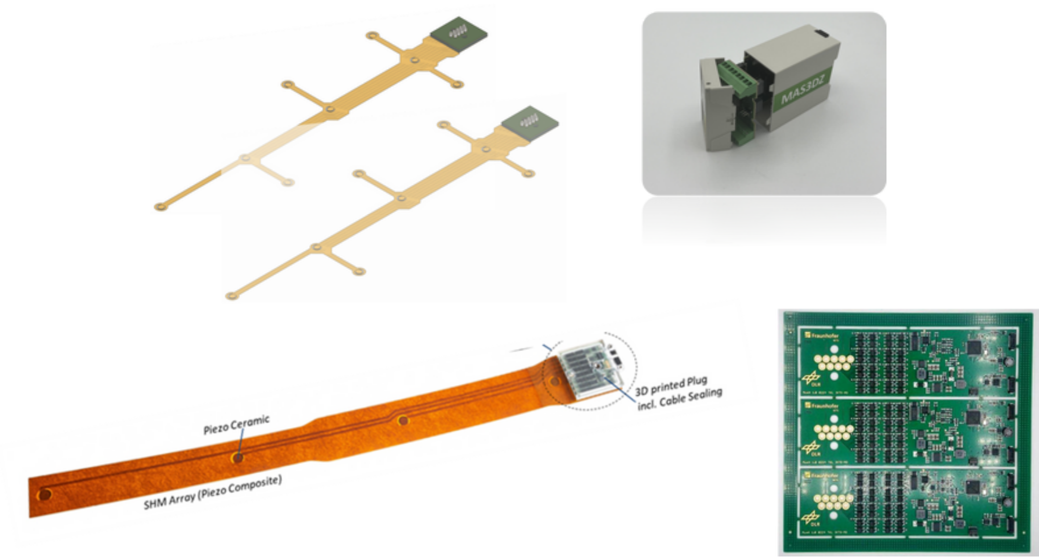


Figure 12. Structural health monitoring components.

A pioneering wing design for a hybrid-electric regional aircraft with a maximum capacity of 100 seats and a range of 500 km to 1000 km

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