Newsletter

Issue 4

We are glad to share with you **Issue 4**, the final issue of the GENEX Newsletter. The "Next end-to-end digital framework for optimized manufacturing and maintenance of next-generation aircraft composite structures" GENEX is a 42-month Horizon Europe project launched on September 1, 2022. GENEX is led by ITA and commits to work towards EU goals by developing three pioneering technological assets which, through integration, will lead to a multi-disciplinary digital twin of the component throughout its lifecycle for the next generation aircraft composite structures.

This issue focuses on the **final event at the premises of ITA** in Zaragoza, Spain, marking the completion of the project in February 2026.

Enjoy the read!

On behalf of **Dr. Andrea Calvo Echenique** Project coordinator

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The GENEX Final Event concluded after two dynamic days that brought together leading experts, industry stakeholders, and researchers for an inspiring deep dive into the digital and sustainable future of aerospace manufacturing. Hosted at the Instituto Tecnológico de Aragón (ITA) in Zaragoza, the first day featured keynote presentations on digital and eco-efficient manufacturing technologies, followed by engaging round-table discussions on recyclable materials, sustainability, certification pathways, composite repair digitalisation, and next-generation health-monitoring systems—all central themes highlighted in the event's official programme. Participants also took part in a dedicated Sister Project Session showcasing DEMOQUAS, TOSCA and DIDEAROT, and visited the ITA laboratories for live demonstrations of GENEX's structural-health-monitoring and composite-repair innovations, offering an exciting behind-the-scenes look at technologies shaping aviation's digital transformation

Keynote speaches

- Digital & eco-efficient manufacturing technologies
- Digitalising composite repair technologies
- Integrated health management systems for aerostructures

Round tables

- Challenges for adopting new recyclable materials
- Impact of digitalization in aviation
- The future of health monitoring systems in aviation

Sister projects

- DEMOQUAS
- TOSCA
- DIDEAROT

Round table

Impact of digitalization in aviation: sustainability, maintenance, repair, certification

TUESDAY, 17 FEBRUARY 2026

Digitalization "passepartout"!

- *What does "Digitalization" really mean in aircraft structures' maintenance?"*

Digitalization: A useful tool or just kind of a fashion?

- *How could Digitalization support sustainability, maintenance and certification in aviations*

Great Ideas need not only wings to fly but also landing gears

- *Which are the financial, legal and practical obstacles for promoting Digitalization?"*

During the roundtable on "*The Impact of Digitalization in Aviation: Sustainability, Maintenance and Certification*," industry experts explored how emerging digital technologies were reshaping aircraft maintenance and broader aviation operations. Speakers discussed the growing use of digital tools in structural maintenance, including digital record-keeping, component passports, training applications, and the early deployment of digital twins. The conversation highlighted how digitalisation had begun to influence maintenance decision-making, support sustainability goals, and introduce new capabilities in verification, validation, and certification processes. Participants also addressed the practical, financial and regulatory barriers that had slowed adoption—such as restrictive IT policies in hangars, uneven acceptance among technicians, and persistent reliance on paper documentation. The session concluded with a shared view that while digitalisation already offered tangible benefits across the MRO ecosystem, accelerating its uptake would require clearer standards, greater interoperability, and a cultural shift within maintenance environments.

Round table

The future of health monitoring systems in aviation

TUESDAY, 17 FEBRUARY 2026

What Does "SHM" Really Mean Today?

- *How do we define modern aircraft health monitoring, and where are we now?*

AI and Automation in Health Monitoring

- *How can it support the personnel currently and in the future?*

Digital Twins and Virtual Aircraft Health

- *Are digital twins the next big leap ?*

During the roundtable on "*The Future of Health Monitoring Systems in Aviation*," experts from AERNNOVA, ITA and Fraunhofer IFAM explored how today's Structural Health Monitoring (SHM) technologies were evolving from simple sensing infrastructures into comprehensive insight-generation tools. Panellists shared their experience with SHM system design, deployment and operational use, assessing which aircraft systems were currently the most mature in monitoring capabilities and where significant gaps remained—such as challenges posed by extreme environmental conditions, new material technologies, and decisions on whether sensors should be embedded. The discussion also examined how artificial intelligence was beginning to support early degradation detection, enable new maintenance-decision workflows, and rely on high-quality datasets enhanced through simulations and data-augmentation methods. Participants reflected on acceptable levels of automation, the risks of over-reliance on algorithms, and the potential for AI to support increasingly autonomous maintenance operations. The group further highlighted the rise of digital twins, outlining their current applications across engines, structures and systems, and their future promise for predictive and adaptive maintenance. Finally, the panel emphasised the need for new skills, advanced training tools, and a forward-looking mindset as aviation moves toward more intelligent, data-driven maintenance ecosystems.

Keynote Speech

Integrated health management systems for aerostructures

JOSE MANUEL ROYO (ITA)

ITA presented a compelling overview of its advancements in **Structural Health Monitoring (SHM)** and **Health & Usage Monitoring Systems (HUMS)**—key enablers for safer, more efficient, and more sustainable aircraft operations. The session highlighted how these technologies are reshaping aerostructure design, maintenance, and lifecycle management through digital innovation.

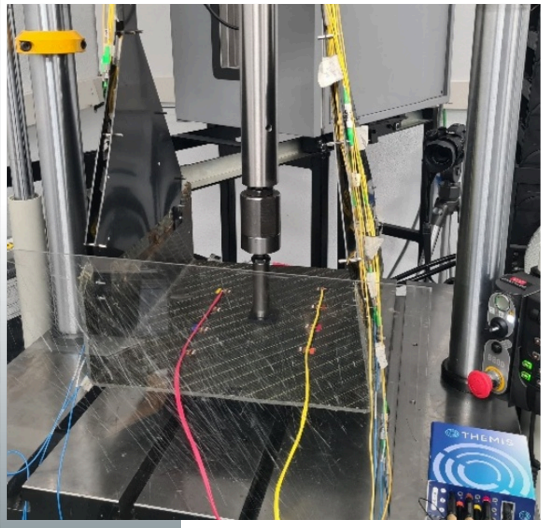
The concept of SHM is grounded in a simple but crucial principle: structures inevitably sustain damage as they age or undergo extreme events. By relying on automated, intelligent sensing and analytics, SHM helps detect, assess, and predict such damage in real time.
This capability supports:

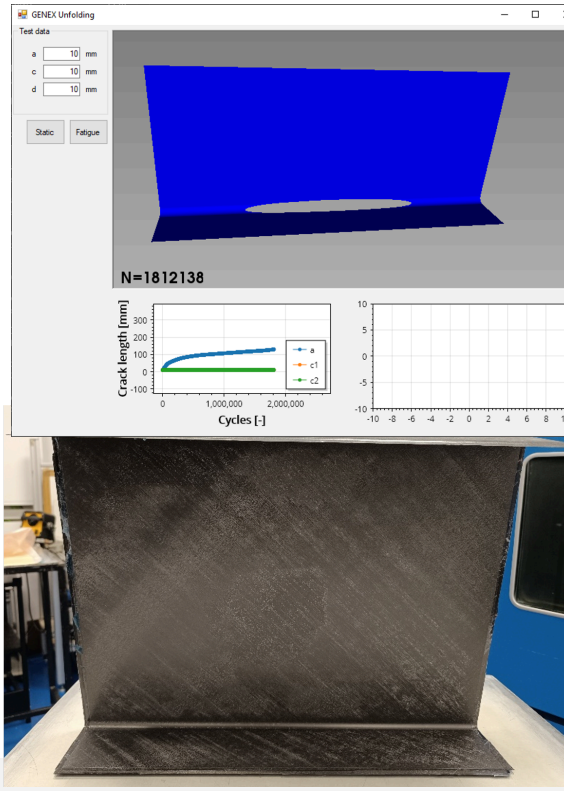
- **Economic benefits**, reducing maintenance burden and maximizing aircraft availability.
- **Life-safety advantages**, ensuring structural integrity even under demanding operational conditions.
- **New business models**, where usage-based frameworks can replace traditional time-based maintenance.

SHM and HUMS sit at the crossroads of manufacturers, lessors, operators, maintenance providers, and aviation authorities—each with distinct priorities. GENEX highlighted how successful SHM integration requires aligning **safety assurance, cost-effectiveness, and reliability and certification readiness.**
Rather than just a sensor technology, SHM emerges as a **system-of-systems**, where data, hardware, certification standards, and operational models converge.

GENEX is developing a comprehensive digital workflow for next-generation composite aerostructures, bringing together HPC simulation, machine learning, advanced sensing networks, and real-time prognostics.

Key innovations are **characterization of MFC piezoelectric sensors**, **optimized sensor network topologies,** and the **development of wireless sensing nodes enabling**: 8-channel high-speed acquisition, sensor actuation at ±30 V, wireless synchronization, and scalable networked data collectio





A demonstrator case focused on a front spar of a horizontal stabilizer, where static and fatigue tests validated the behaviour of delamination mechanisms and the predictive capabilities of the developed models. Despite the remarkable progress, the consortium also outlined critical challenges that must be addressed for widespread SHM adoption, such as bridging the gap between synthetic and real-world data, managing manufacturing variability and sensor inconsistencies, and establishing probabilistic thresholds to balance false positives and false negatives. Overcoming these challenges will pave the way for reliable, certifiable SHM systems capable of transforming aircraft maintenance into a predictive, data-driven discipline.

Through a combination of high-fidelity simulation, innovative sensing technology, and AI-enabled analytics, **GENEX is laying the groundwork** for more resilient aircraft and more efficient maintenance strategies—pushing the aerospace industry closer to a truly smart, sustainable future.

HPC-Driven Simulation of Ultrasonic Guided Waves

Using open-source, HPC-scalable codes (e.g., dolfin-hpc), GENEX generated large virtual datasets simulating guided wave interactions with different damage scenarios.
These datasets are essential for training robust SHM algorithms.

Machine Learning for Damage Detection

ML models were trained on synthetic waveforms to estimate:

- Damage location
- Damage size
- Severity metrics

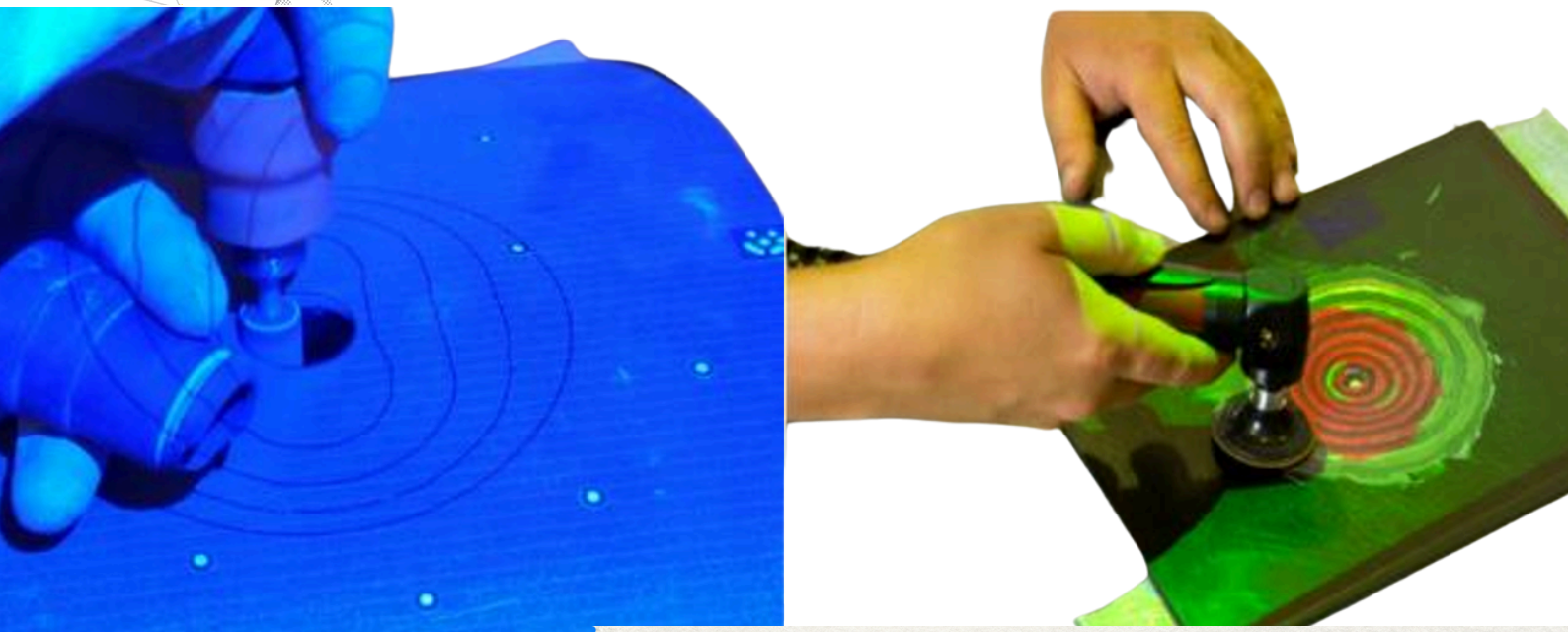
High-performance predictors capable of supporting automated condition assessment.

Reduced-Order Models for Real-Time RUL Estimation

To complement ML models, GENEX developed physics-based reduced-order models to:

- Simulate fatigue and fracture in composite laminates,
- Accelerate structural reliability assessments,
- Reduce the need for extensive physical testing.

Integrated Health Management Systems for aerostructures



Keynote Speech

Digitalizing composite repair technologies

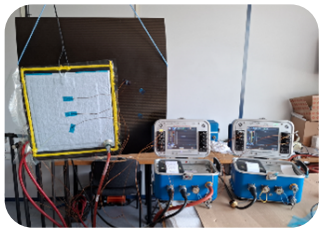
DIRK HOLZHÜTER (DLR)

Composite structures lie at the heart of modern aircraft, yet repairing them remains one of the industry's most demanding challenges: labour-intensive, sensitive to process variability, cost-heavy, and tightly regulated. At the GENEX Final Event in Zaragoza, the **DLR** team, delivering the WP4 objectives, showcased how they are transforming this reality through an integrated suite of digital repair technologies designed to elevate safety, precision, and efficiency across the entire repair chain. WP4 combines four complementary technological pillars: **Visual-assisted scarfing**, **portable LIBS cleaning & surface verification**, **digital heating control & smart blanket design**, and **smart patch repair for crack detection & stopping**.

Key achievements at a glance

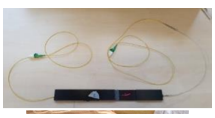
Robust methodology for optimized heating blanket design

- Improved thermal distribution in complex repair settings
- Algorithmic configuration and online process control



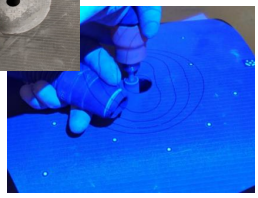
Advancements toward a Smart Patch solution

- TPU selected as a viable crack-stopping material
- Fibre-optic sensors validated under multiple loading modes
- Fatigue performance demonstrated in collaboration with WP5



Visual-assisted scarfing ready for market use

- Mobile, dust-proof scanning and projection system.
- Significant ease-of-use improvements for workers



Digitalising composite repair technologies: Genex - Finale Event, Zaragoza

Teruel Airport

Visit to Tarmac & IAC

JOSE MOLINER (TARMAC) & PEDRO JARAY (IAC)

The second day of the GENEX Final Event took place at Teruel Airport, where attendees were welcomed by the airport's CEO and guided through technical site visits, including the TARMAC facilities and specialised demonstrations that showcased how research outcomes translate into real-world aviation operations. Bringing together expert insights, cross-project collaboration, and hands-on exploration, the event reflected GENEX's mission to advance digital manufacturing, lifecycle monitoring, and sustainable composite technologies for next-generation aircraft structures. Its successful conclusion stands as a testament to the commitment of all partners, speakers, and contributors who propelled this ambitious European initiative forward.

Thank you to IAC TARMAC AEROSAVE

Welcome aboard GENEX flight 105 68 22 2, with destination the future!

This is the final call for passengers ready to dream big, work hard and build the next generation of innovation together. You are now boarding an aircraft designed for a more sustainable tomorrow. A plane made of recyclable and repairable composite materials manufactured within an advanced connected automatic tape laying cell where digitalization, efficiency, and precision work hand in hand. Please sit back and relax. The aircraft's critical structural components are continuously monitored and its structural integrity is permanently assessed throughout its life cycle. Should any issue arise, our crew is fully prepared. A comprehensive portfolio of digital assisted tools combined with highly skilled technical services ensures fast, reliable and efficient repair solutions all before takeoff. From design to manufacturing, from monitoring to maintenance, every step of this journey is seamlessly tracked end to end within our integrated digital platform. At GENEX, innovation is not a destination. It is the way we travel. Thank you for flying with us. We wish you an inspiring journey into the future.

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We wish you an inspiring journey into the future!

Welcome aboard GENEX flight 10101056822, with destination: the future!

GENEX TEAM

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aimen CENTRO TECNOLÓGICO

DLR

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IRES Innovation in Research & Engineering Solutions

AGH

RECENDT RESEARCH CENTER NON DESTRUCTIVE TESTING

Arts et Métiers Sciences et Technologies

KTH VETENSKAP OCH KONST

Capgemini engineering

GMI AERO

AERnnova

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