Hydrogen lightweight & innovative tank

H2ELIOS

for zero-emission aircraft

NEWSLETTER ISSUE 1

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Jorge Martínez San Martín
H2ELIOS Coordinator
ACITURRI

Dear Reader,

H2ELIOS partners are glad to share with you Issue#1 of the H2ELIOS Newsletter.

The H2ELIOS project (HydrogEn Lightweight & Innovative tank for zerO-emisSion aircraft), integrated within the Clean Aviation program, started on January 2023 and aims to develop an innovative liquid hydrogen (LH2) storage solution for aviation. Hydrogen has been identified as one of the most relevant vectors to de-carbonize air transport. But enabling LH2 use in aircraft implies, among others, addressing the challenge of providing a safe, low-weight, and functional storage solution for it. This challenge involves the concurrent engineering of a whole set of multidisciplinary disciplines & and technologies that will concur in the full-scale testing of an LH2 storage solution.

One year after the project started, several targets have been met highlighting H2ELIOS progress: manufacturing technologies have been matured, the architecture of the hydrogen management sub-system has been set up and a first design gate for the tank demonstrator has been achieved. H2ELIOS partners have also established relevant links with seven other Clean Aviation projects as well as with EASA (European Airworthiness Authority) and other stakeholders of the aviation sector such as MRO, airlines, and airports to gather as many inputs as possible to consolidate this paradigm change.

Enjoy the read & stay connected with H2ELIOS project via our website and social networks!

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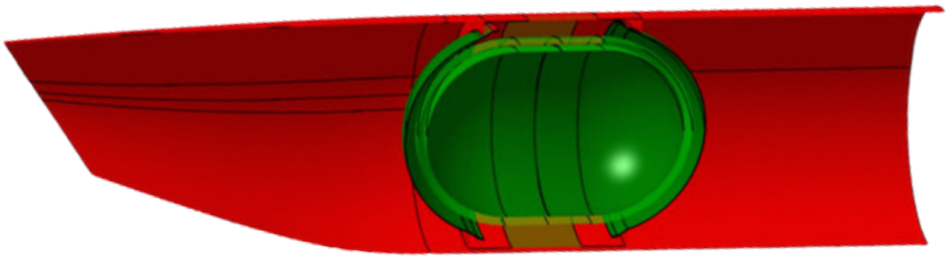
WP2 : Tank Design & Development, by ACIENG

Highlights Summary: The progress done in WP2 in the last months has been summarized in the Feasibility Design Review last October. ACIENG led the task focused on input integration, gap identification, and objective alignment. CTTC-UPC brings thermal and fluid dynamics analysis, addressing functionality-design relations and limitations. UPAT focuses on eco-design for tank structural components, linking design to environmental considerations. Test-Fuchs leads the maturation and development of the LH2/GH2 equipment and piping. The architecture of this subsystem was defined within WP4 and provided inputs to consolidate the general LH2 storage concept in WP2.

The design of the demonstrator is focused on the different technological challenges to validate the liquid hydrogen storage disruptive solution. In this first step has been analyzed the different trade-offs based on the requirements and specifications defined in WP1, which is led by Piaggio (PAI). The primary objective is to determine the load nature, identify materials, assess working temperatures, and define reference specifications, including refueling.

The key elements include the inner tank, outer tank, insulators, inner-to-outer tank connection, and various internal components, such as anti-slosh systems, the designs are based on functionality and efficiency. This document outlines the foundational phase for establishing the thermal and mechanical characteristics of the integral tank within the project.



One of the LH2 storage tank and aircraft integration concepts studied in the initial phase of the project

What's Next: We've reached a pivotal point in our journey with the H2ELIOS project. Having successfully completed the Feasibility Design Review (FDR) stage, we're now transitioning into the crucial Preliminary Design Review phase, set to wrap up in March 2024. In the upcoming months, our dedicated team of partners will be engaged in developing a comprehensive 3D model of our demonstrator. This phase will also include an advanced iteration of thermal sizing - a key step in refining our design. To support this progress, we're finalizing the load cases and material specifications for the demonstrator, ensuring every aspect aligns with our high standards for innovation and efficiency.

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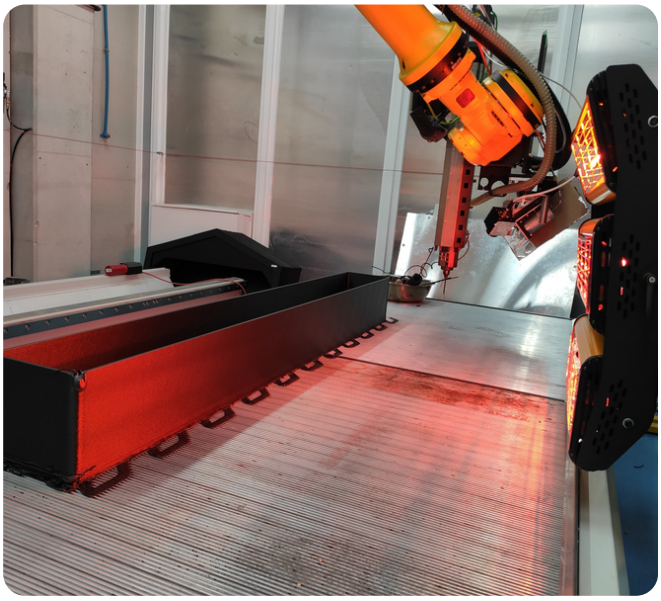
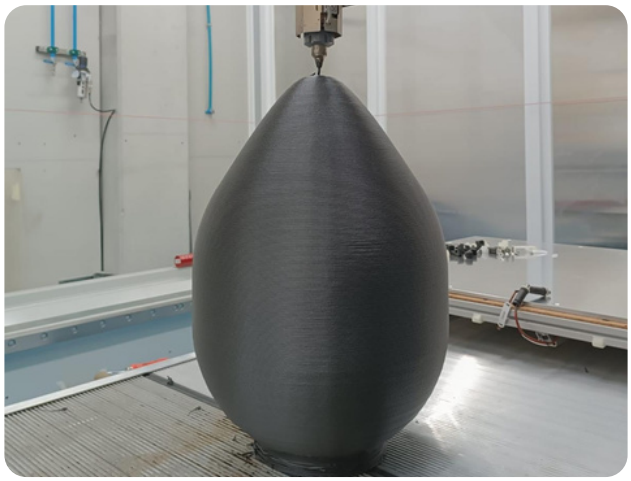
WP3 : Manufacturing and Engineering Development, by AIMEN

Highlights Summary: WP3 plays a crucial role in H2ELIOS's vision, leading the charge in creating functional and full-size prototypes. These prototypes are key in demonstrating the functionality and performance of the liquid hydrogen storage system under simulated operational conditions. This progress brings us closer to our goal of revolutionizing hydrogen storage in aviation.

We're thrilled to report significant advancements in WP3, focusing on the development of the inner tank. AIMEN has been at the forefront, pioneering in additive manufacturing, subcomponent fabrication, and the development of cutting-edge resistance welding and laser preheating systems. ALESTIS has made notable progress in testing coupons for the outer tank, refining the AFP manufacturing process, and developing manufacturing tooling. ACITURRI has contributed significantly to the selection and configuration of insulation materials.



The scale up manufacturing



A vessel shape printed using AM

Our achievements so far include successful preliminary testing and design of the laser preheating system by AIMEN, essential for inner tank manufacturing. Optimized coupons have been produced, demonstrating the scalability of our processes. ALESTIS and AIMEN have also contributed to acoustic studies essential for sensor development, while ACITURRI's market study has identified optimal commercial options for tank design

What's Next: AIMEN is gearing up to develop a welding strategy for joining semi-spherical inner tanks and will also focus on manufacturing subcomponents. ALESTIS will advance the AFP technology tooling development.

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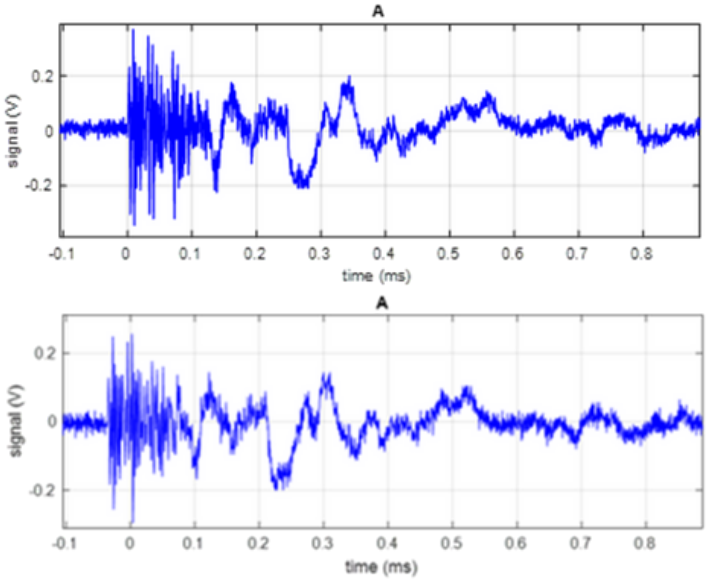
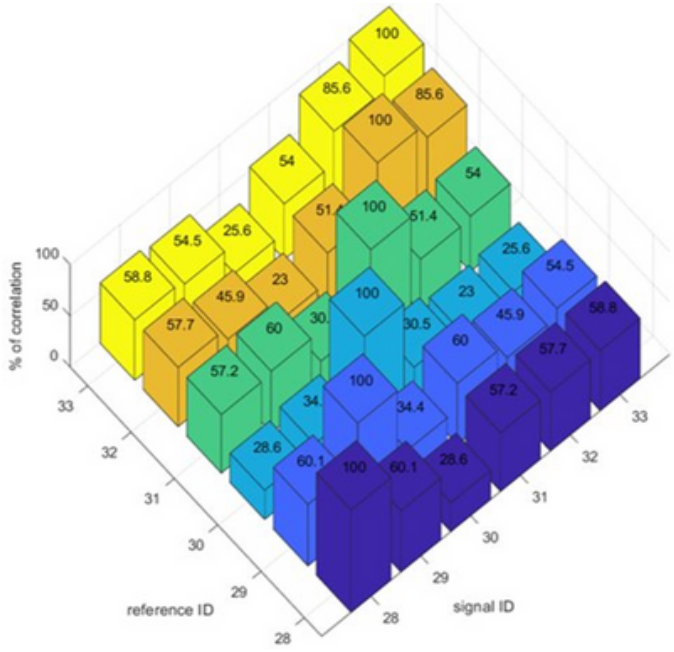
WP4 : Subsystems Development, by CIRA

Highlights Summary: Implementation of SHM systems aims at improving the safety levels of the hydrogen tank, and enhancing its maintenance process. Therefore, the whole technology will be more reliable, cost-controlled, and affordable for installation ion real aircraft. WP4 has been centered on the preliminary assessment of SHM methodologies, based on strain sensing and acoustic emission detection, on simple coupons. The experimental setup and a functionality check of the detection and elaboration chain were also performed.

In our latest advancements in WP4, we have made significant progress in monitoring the integrity of our materials. Through the use of a piezoelectric ceramic-based system for acoustic emission tests, we've been able to accurately identify and analyze the signals emitted by the materials under stress. Our findings are quite revealing – we observed that successive cracks, simulating the progression of existing damage, showed a strong correlation with each other. This insight is crucial as it helps us understand how damage develops and propagates in the materials we are using, ensuring the reliability and safety of our design.



Acoustic emission retrieved by piezo sensors after the accretion of a certain damage at different instants.



Correlation matrix between a subset of acoustic emission signals

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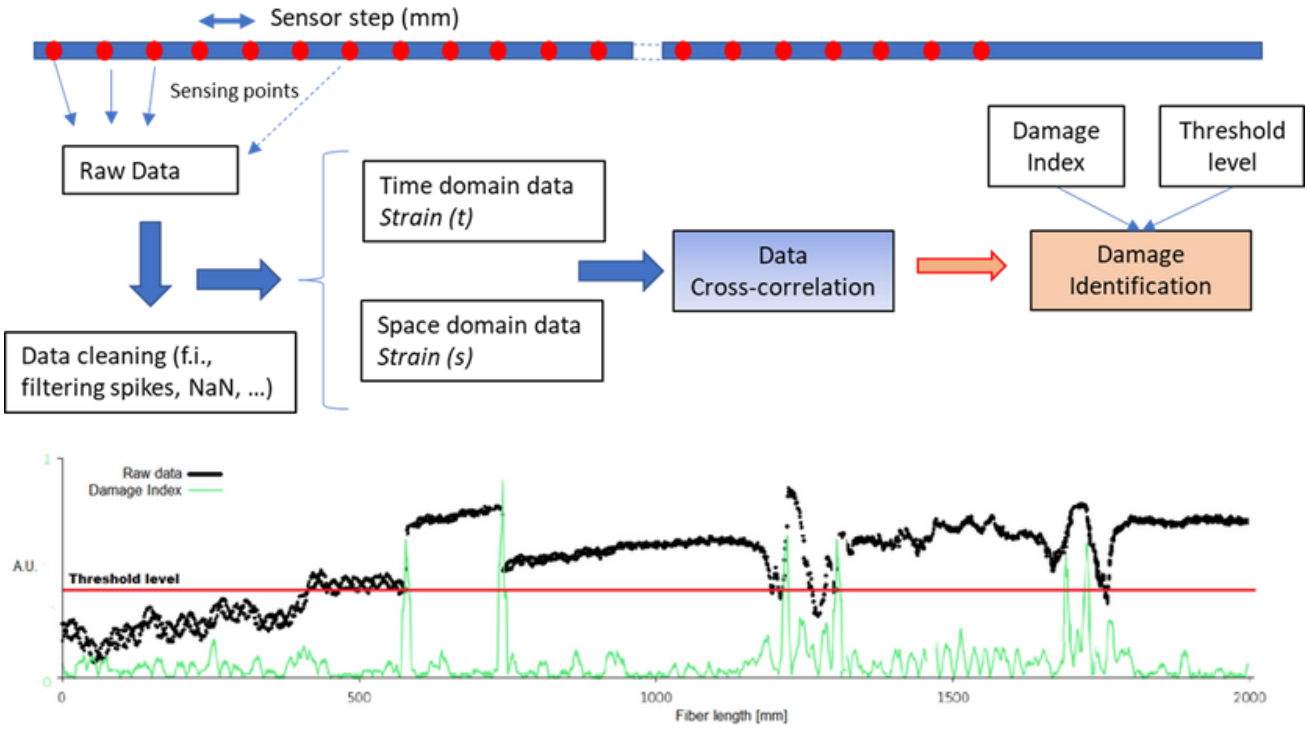
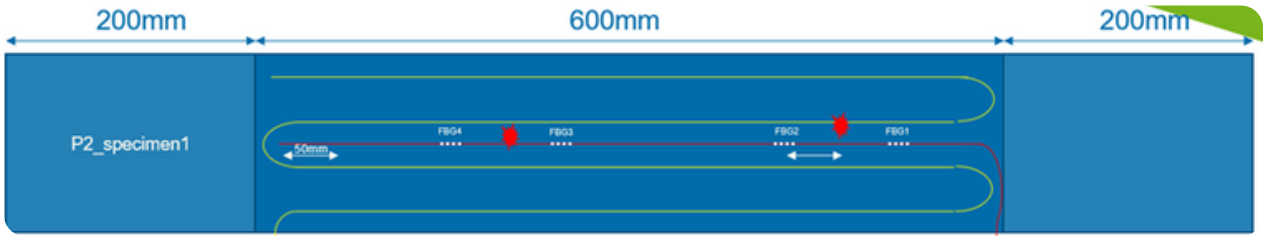
WP4 : Subsystems Development, by CIRA

In recent tests, we've made exciting progress with our strain-based Structural Health Monitoring (SHM) system. By testing simplified coupons, we evaluated their effectiveness in detecting structural damage. We employed both optical distributed and Fiber Bragg Grating (FBG) sensors, which are crucial for developing a real-time SHM system suitable for flight conditions. The results, depicted in diagrams, showcase how the SHM system signals potential issues with red alert bars. Notably, we simulated a streamlined FBG sensor array by selectively using sensors, demonstrating the system's efficiency in real-world applications.



Logic of the strain-based SHM algorithm (top), and physical effects of an anomaly on the structure (local strain variation, bottom)



Schematic of a single coupon with the locations of imposed, artificial damage, and the track of the optical fiber

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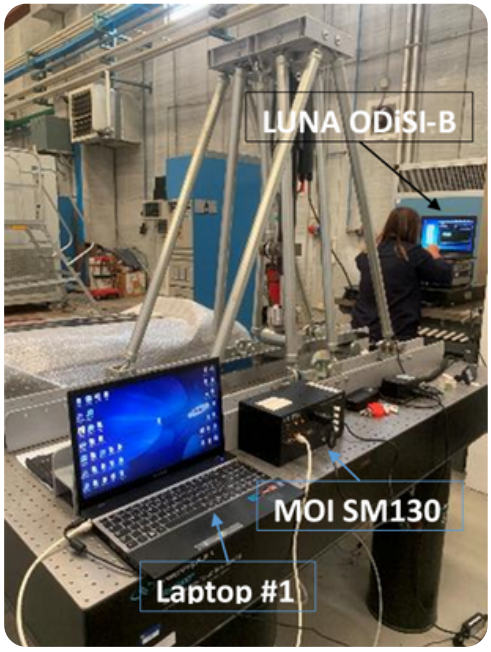

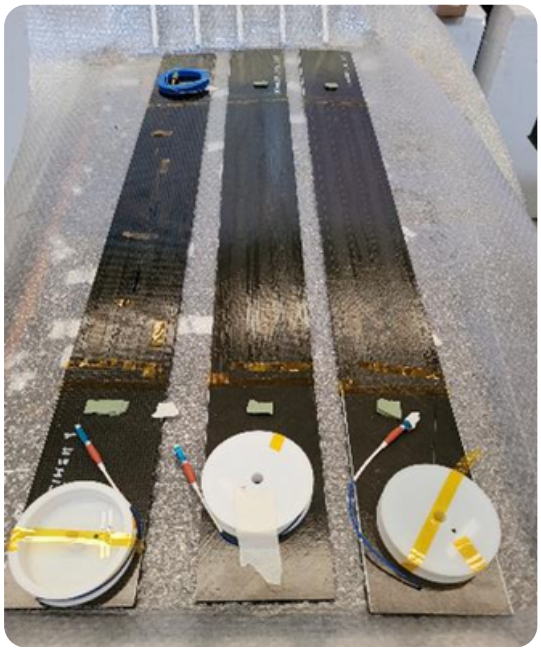

Test set-up (left) and the instrumented coupons used in the experiments (right)

What's Next: In the upcoming period, our focus will shift towards enhancing our testing framework. We plan to conduct extensive preparatory tests, starting from smaller coupon samples and progressively moving towards larger subcomponents, eventually leading to full-scale testing. A significant development will be the integration of optical emission sensors, replacing the current piezoelectric ones. This step is essential for refining our real-time SHM system, which will be incorporated into our existing strain sensing architecture. Our goal is to have both systems fully operational and ready for a comprehensive final test by the end of the year.

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Meetings / Conferences / Exhibitions

The H2ELIOS Kick of Meeting in Madrid, Spain

The H2ELIOS team at the International Paris Airshow 2023

H2ELIOS @ EASN Conference 2023

H2ELIOS 1st Review Meeting in Madrid, Spain

H2ELIOS @ ECATS Conference 2023

H2ELIOS Project showcased at H2CAT Innovation Summit

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CIRA
Italian Aerospace Research Centre

Applus laboratories

aimen
TECHNOLOGY CENTRE

Fraunhofer

UPC

UNIVERSITY OF PATRAS
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ

TESTFUCHS
AEROSPACE SYSTEMS

NTNU
Norwegian University of Science and Technology

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Designed by **EASN-TIS**

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