CEAS
Council of European Aerospace Societies

BULLETIN

AEROSPACE EUROPE

ARTEMIS I MISSION: A NEW ERA OF DEEP SPACE EXPLORATION BEGINS!

1. 16 NOVEMBER AT 06:47 GMT, ORION SPACECRAFT IS LAUNCHED BY NASA'S SLS FROM KSC

2. EARTH AS SEEN FROM ORION 9 HOURS AFTER LIFTOFF

3. 11 DECEMBER AT 17:40 GMT: ORION SPLASHES DOWN IN THE PACIFIC OCEAN

PERFECT PERFORMANCE OF THE ESA'S EUROPEAN SERVICE MODULE

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CEAS

The Council of European Aerospace Societies (CEAS) is an International Non-Profit Organisation, with the aim to develop a framework within which the major European Aerospace Societies can work together.
It was established as a legal entity conferred under Belgium Law on 1st of January 2007. The creation of this Council was the result of a slow evolution of the 'Confederation' of European Aerospace Societies which was born fifteen years earlier, in 1992, with three nations only at that time: France, Germany and the UK.

It currently comprises:

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CEAS is governed by a Board of Trustees, with representatives of each of the Member Societies. Its Head Office is located in Belgium: c/o DLR – Rue du Trône 98 – 1050 Brussels. www.ceas.org

AEROSPACE EUROPE

Since January 2018, the CEAS has closely been associated with six European Aerospace Science and Technology Research Associations: EASN (European Aeronautics Science Network), ECCOMAS (European Community on Computational Methods in Applied Sciences), EUCASS (European Conference for Aeronautics and Space Sciences), EUROMECH (European Mechanics Society), EUROTURBO (European Turbomachinery Society) and ERCOFTAC (European Research Community on Flow Turbulence Air Combustion).
Together those various entities form the platform 'AEROSPACE EUROPE', the aim of which is to coordinate the calendar of the various conferences and workshops as well as to rationalise the information dissemination.
This new concept is the successful conclusion of a work which was conducted under the aegis of the European Commission and under its initiative.
The activities of 'AEROSPACE EUROPE' will not be limited to the partners listed above but are indeed dedicated to the whole European Aerospace Community: industry, institutions and academia.

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YOUNG PROFESSIONAL AEROSPACE FORUM SPONSORING

AEROSPACE EUROPE Bulletin

AEROSPACE EUROPE Bulletin is a quarterly publication aiming to provide the European aerospace community with high-standard information concerning current activities and preparation for the future.
Elaborated in close cooperation with the European institutions and organisations, it is structured around five headlines: Civil Aviation operations, Aeronautics Technology, Aerospace Defence & Security, Space, Education & Training and Young Professionals. All those topics are dealt with from an overall European perspective.
Readership: decision makers, scientists and engineers of European industry and institutions, education and research actors.

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EDITORIAL

A NEW ERA OF HUMAN SPACE EXPLORATION BEGINS

When expressing my enthusiasm for the Artemis programme and particularly since the wonderful success of its first mission, 11 December, including notably the performance of ESA's European Service Module, I am disappointed when observing in my entourage a kind of scepticism, indifference and even sometimes a critical attitude. Among contesting arguments:
"The Apollo programme decided by John Fitzgerald Kennedy in 1962 was a political response to the domination of USSR in space exploration. And if the feats achieved were extraordinary, it is to be observed that the science return has been quite poor. Would not be enough to use satellites and robots to conduct space science researches? Now we have huge more urgent problems to be dealt with on earth."

It is true that Apollo was engaged for political reasons but it is inexact to say that the scientific results were just negligible. The analysis of the samples returned on Earth allowed notable advances in our knowledge of the lunar soil, in Earth sciences and in our understanding of the Earth – Moon system. In addition Apollo has been a powerful accelerator of technological developments. Indisputably, Apollo remains the Major Event of humanity in the 20th century.

The man in the street thinking that Artemis will be a replay of Apollo does not know the subject. As a matter of fact there is no common measure between Artemis and Apollo! This time the objective is to establish a long-term human presence on Moon. Just after, the already programmed Artemis II and III missions (2024-2025), Artemis will take considerable width with the Gateway, the Human Landing System and the Moon base. Gateway will be a spaceship in lunar orbit, providing a place to astronauts to live and conduct science research. The Human Landing System will be the final mode of transportation that will take astronauts from lunar orbit to the Moon's surface and back to orbit. Then the Moon base will give astronauts a place to live and work on the Moon during long stays.
As regards the statement "This space exploration programme could be entirely realised by robotic means" the response is summed up in this formula "Robots don't explore, Human explore". Robots and humans are in fact synergic, this is the reason why the future Moon Base will be "Human and Robotic".

The benefits expected from the Artemis programme are multiple: generation of scientific knowledge in all disciplines of space research, advances in many technology fields, diffusion of innovations in non-space sectors, creation of new industries, setting up of peaceful international co-operations, and inspiration of new audiences around the world: the "Artemis Generation".
With it will be learnt from the Artemis missions on and around the Moon, it will possible to prepare for the next giant leap, sending the first astronauts to Mars.

Yes indeed with Artemis I a new era for space exploration is born, in which Europe will resolutely participate.

Jean-Pierre Sanfourche,
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CEAS PRESIDENT'S MESSAGE

Franco Bernelli Zazzera
CEAS President 2021-2022

The CEAS Board of Trustees just appointed me as President for the year 2023 and I must thank the CEAS community for their trust. I hope not to disappoint anyone. Indeed, 2023 will be challenging for our community and it could set important milestones.

Marking a clear discontinuity with the past, the 2023 Aerospace Europe Conference will be jointly organized by CEAS and EUCASS, both entities having organized all their previous conferences independently and, in some cases, even competing one against the other to attract participants. The last two years saw a gradual approach of the two societies, which brought to the decision to move forward with one single event that will, in the idea of the organizers, represent the largest ever aerospace conference at European level. As this bulletin is published, the call for papers is open and proposes 20 interesting and highly relevant topics, covering all areas of aerospace sciences. Notable is the fact that two sessions will see also the contribution of EASN and EUROTURBO, in a clear orientation toward a unique global event at European level. The conference Technical Committee is also established and includes 120 experts in all aerospace domains, guaranteeing a high-quality panel for the proper management of the hundreds of papers that will be submitted. Considering the importance of the event and the opportunity, CEAS has decided to provide financial support to students whose paper is accepted for oral presentation. One student for each member society and one student from EUROAVIA will receive the grant to participate in the Aerospace Europe 2023 conference.

The year starts also with very positive news from our CEAS Space Journal. The ranking of the Journal in the Scimago Journal Ranking has increased up to 47 and currently CEAS Space Journal is listed as a Q2 journal, with a steady increase in its visibility and quality. Also, the number of downloads doubled during 2022 to more than 100 000 downloads. Therefore, the editorial board decided to increase the frequency of issues from 4 per year to 6 per year. In the near future, apart from publishing the independently submitted manuscripts, the Journal is planning two very interesting special issues, to which our community should pay attention.

At the end of 2022 we had some changes in the composition of the CEAS Trustees. I warmly welcome the new Trustees from 3AF, Dominique Nouailhas, and AIAE, José Manuel Hesse Martín. I count on their support for the achievement of the several CEAS objectives in the near future. I would like to express gratitude to the former Trustees, Pierre Bescond and Estefania Matesanz, for their continuous support and promotion of the Council. Estefania Matesanz has been the main organizer of the first CEAS Women in Aerospace conference, successfully held in 2021. Pierre Bescond has been one of the past Presidents of CEAS and has also taken care of the international relations of CEAS for several years. It is also thanks to his precious support if the approach with EUCASS has been made possible.

It is clear that for CEAS the year 2023 will open new possibilities and will be challenging, but this is nothing more than the right stimulus to inject motivation in all of us. Despite all the instabilities in the world, CEAS will continue working for the best and friendlier collaboration that our aerospace world has promoted over all these years. Whatever the difficulties, CEAS will continue doing its best to cement this European endeavour..

THE 41ST ICAO ASSEMBLY: TOWARDS TOTAL DECARBONISATION

By Michel Wachenheim, President of the Air and Space Academy

With his kind authorisation, we reproduce here below the editorial Michel Wachenheim published in the Letter 127 of the Air and Space Academy.

Michel Wachenheim

The 41st Assembly of the International Civil Aviation Organization (ICAO) was held in Montreal from 27 September to 8 October 2022. 184 of the 193 member states were represented, and 57 international or regional organisations participated as observers, including for the first time the Air and Space Academy (Académie de l'air et de l'espace, AAE). A total of 2,000 delegates shared out the examination of 677 working papers.
The most eagerly awaited decisions concerned climate change policy. In a still complicated context, states succeeded in adopting a target of total decarbonisation of global air transport by 2050. They also decided to immediately lower the emissions cap for international aviation to 85% of its 2019 level. The CORSIA scheme will require airlines to offset any emissions over that level. This is a significant new step on the road to full decarbonisation. No other economic sector has made such a commitment at the global level.
Accompanying this commitment is an obligation of solidarity between developed and developing countries, under the principle of common but differentiated responsibilities, contained in the Kyoto Protocol and the Paris Agreement. This solidarity is one of the keys to success. The goal is a collective one, and rich countries will have to help poor countries to achieve it. This is a huge step forward and sets an example.

How can these targets be met? ICAO is encouraging states to invest heavily in sustainable fuels. These fuels, which are currently more expensive than conventional kerosene, drive up carriers' costs. They will only be made viable for widespread use by ramping up production, based on known technologies. This is the strategy announced by the United States, which is planning unprecedented investment to meet all the needs of American air transport in 2050 and financial incentives to achieve this objective. The European strategy is also moving in this direction, but at the same time exploring a wider range of solutions, such as liquid hydrogen. Whatever the strategies, the technological innovations that emerge from this research will certainly have spill-over effects in other sectors, which could make aviation a leader in decarbonisation.

Although environmental issues are high on ICAO's policy agenda, the safety of international civil aviation remains the Organization's priority and interoperability of systems one of its raisons d'être. Maintaining the accident rate at less than two per million flights requires continuous action by the Organization, which was keen to highlight the progress made by officially awarding safety certificates to five countries at the opening of this Assembly. The new versions of the global safety and air navigation plans, as well as the evolution of the audit programmes, were endorsed by the Assembly.

The ICAO Assembly also adopted a large number of measures aimed at facilitating the flow of traffic, particularly in times of crisis, such as Covid-19. The Assembly encouraged states to harmonise their procedures by applying ICAO standards and recommendations to ensure, for example, the interoperability of machine-readable passport control systems or health information such as vaccination certificates. The development of contactless procedures is becoming a strategic priority. ICAO will prepare a regulatory framework to manage health crises more effectively. 2023 will be declared the "Year of Facilitation Culture".

The Assembly also focused on improving accessibility to air transport for people with disabilities. Recommendations to improve assistance to victims of aviation accidents and their families were also adopted. The policy on unlawful interference with civil aviation was confirmed and strengthened. The Assembly once again condemned acts of destruction of aircraft in flight by surface-to-air missiles or UAS and asked the Council to ensure the continuous adaptation of the Global Security Plan, as security itself remains a priority for civil aviation.
The virtuous nature of these tricky international negotiations should be emphasised as they highlight clear, realistic and shared strategies. It is important that national or regional policies slot into this global framework, by very nature the only suitable framework for this activity. It is no coincidence that the Paris Agreement retained the provisions of the Kyoto Protocol, which entrusted the definition and implementation of climate policies for the international maritime and aviation sectors to the specialised organisations, the International Maritime Organisation and ICAO.

INTERVIEW WITH DR. JEAN-FRANÇOIS BROUCKAERT, HEAD OF TECHNOLOGY OFFICE CLEAN AVIATION JOINT UNDERTAKING.

By Jean-Pierre Sanfourche, Editor-in-Chief

Dr. Jean-François Brouckaert is currently Head of the Technology Office at the Clean Aviation Joint Undertaking.

He is in charge of technical coordination, knowledge management, technology strategy and impact monitoring since January 2022. He joined the Clean Sky 2 Joint Undertaking in November 2014 as a Project Officer for Engines, later in charge of Engines, Systems and Technology Evaluator as a Team Leader, before being appointed Chief Scientific Officer in May 2019.

Jean-François is a Mechanical Engineer. He holds a Master-after-Master and a PhD in Fluid Dynamics & Turbomachinery. He has been working for 20 years at the von Karman Institute in the academic and research field, as a Professor in the Turbomachinery Department.

The author indicates that these considerations reflect only his personal views.
Hydrogen-powered air transport is a promising solution to reduce greenhouse gas (GHG) emissions, and thus to limit aviation's climate impact. But considering the challenging fluid properties and impact on the overall aircraft system, currently optimised for conventional fuel, a high research effort is required, and several important challenges still must be overcome to introduce this technology onto the market.

Hydrogen as on-board fuel or energy will allow for the complete elimination of CO_2, but only if it is produced from renewable sources. What about these renewable sources?

The interest in hydrogen as an aviation fuel stems indeed from the fact that it is a true zero carbon fuel, unlike synfuels which are zero 'net' carbon (only). However, both pathways imply that the energy sources to produce them are green. This means using renewable energies such as solar or wind energy and electrolysis for hydrogen. If we consider synfuels, additionally to the production of green hydrogen, it is often assumed that carbon is captured directly from the air or from an industrial process. Green hydrogen production will require very large amounts of electric power and large amounts of water. Additional energy is then needed also for the liquefaction of the gas and its distribution for available use at aircraft level. The efficiency of this 'well-to-tank' (WTT) process is estimated to be around 58%, roughly twice as efficient as synfuels because of the additional Fischer-Tropsch process, and depending on whether carbon is captured from the industrial process (WTT efficiency of 35%) or from direct air capture (WTT efficiency of 22%). The required amounts of energy needed to power aviation in 2050 are estimated to several tens of PWh (1 PetaWatt = 10^{15} Watt = 1000 TeraWatt or 1 million million KiloWatt!). This will have to be achieved by including aeronautical demand within a global approach to primary energy sources.
Our Clean Aviation Joint Undertaking focuses primarily on aircraft technologies whilst issues such as green and efficient production, industrial storage, liquefaction and distribution fall under the scope of our colleagues at the Clean Hydrogen Joint Undertaking.
Nevertheless, Clean Aviation has recently become a member of the European Alliance for Zero Emission Aviation (AZEA) which aims to bring together all relevant stakeholders to collectively prepare the introduction of hydrogen aircraft into the fleet by 2035. AZEA will also address the development of the necessary airport infrastructure (for refuelling) and the large-scale production, storage and distribution of hydrogen.

What is the principle of H_2 usage in fuel cells?

In simple terms, a fuel cell works as a reverse electrolyser. An electrolyser needs electric power to dissociate water molecules into hydrogen and oxygen. Here, the fuel cell uses hydrogen gas combined with oxygen (taken from atmospheric air), which by electrochemical reaction through a specifically designed membrane (permeable to protons but electrically insulating) produces water (it recombines hydrogen and oxygen into water) and heat as the only by-products of this reaction. This electrochemical reaction produces electricity as electrons travel from anode to cathode (direct current), which is the desired output we are looking to attain. This process has an efficiency usually between 40% to 60%. This means that every kilowatt of electricity produced by the fuel cell will also produce a kilowatt of heat. What to do with this amount of heat is commonly addressed by thermal management.
In terms of climate impact, fuel cells are arguably the cleanest source of on-board energy as they produce no CO2, NOx, or particulates. The only by-products are water at low temperatures (80-90°C) and heat.

PEM (polymer electrolyte membrane or also called proton-exchange membrane) fuel cells are considered the most mature technology for transport applications and have a fairly good efficiency higher than gas turbine engines, however with a lower, power density ratio (a few kW/kg). Attention must be given to what is called the 'balance of plant' (BoP) in terms of all 'accessories' needed around the fuel cell stack itself such as the compressor, humidifier, pumps, heat management, etc.

When using hydrogen for combustion, more water vapour is produced. So, the use of hydrogen in a combustion engine will lead to different emissions compared to 'drop-in' fuel alternatives. How do you plan to assess the full climate impact?

The direct combustion of hydrogen is expected to generate roughly 2.6 times more water emissions than a kerosene-fuelled engine at equivalent energy content. Per se, water vapour is not considered to have a large impact as a GHG, although this is dependent on the altitude at which it is emitted. At the usual cruising altitude of today's aircraft, the combination of water vapour emissions, together with particulates (already present in the atmosphere or produced by the combustion process of the engine) are a trigger for water condensation to create contrails and potentially contrail-induced-cirrus (CiC) clouds. There is currently a wide debate amongst climate scientists about the severity of the impact of contrails and CiC. This is however a matter of understanding complex atmospheric physics and chemistry, where latitude, longitude and altitude of flight are important factors together with existing background concentrations of GHGs along the routes flown by aircraft.

The mandate of the Clean Aviation Joint Undertaking is to develop disruptive technologies primarily at aircraft level and evaluated over a typical mission. This means that in order to achieve our objective of reducing net GHG emissions by at least 30% versus the 2020 state-of-the-art technologies, we will focus on reducing engine exhaust (often called tailpipe) emissions.

The full climate impact assessment is of course the ultimate goal. This is a challenging but common endeavour of the whole aviation community. It implies primarily research progress from the climate scientists, implementation of more efficient air traffic operations and a substantial contribution of advanced technologies. The Clean Aviation Joint Undertaking aims to demonstrate the latter by flight tests within the next 10 years, in order to provide useful measurement data of emissions during flight.

To develop hydrogen-powered commercial aircraft, several technological challenges have to be overcome before its full potential can be exploited. And among these topics, what are the elements which are still at very low maturity level and which therefore necessitate important development, maturation and demonstration?

In a nutshell, when talking about hydrogen for aviation, virtually everything is at very low maturity level and today, proving the feasibility, remains the primary objective Although space launchers are often quoted as an existing application, the specifications are fundamentally different with cryogenic fillings at the last moment and a flight of about half an hour. This is nowhere near what is envisaged for the day-to-day use of hydrogen at airports around the world, and the lifetime and maintenance requirements expected for commercial aircraft. The Tupolev-155 is often quoted as well as an early demonstration of a hydrogen-powered aircraft but remained at the stage of a prototype.

In terms of technologies, the Clean Aviation roadmap focuses on two main streams.

The first one is to convert current engines to run on hydrogen, as was the case for the Tu-155 demonstrator. This entails a complete redesign of the combustion chamber due to the very different burning behaviour of hydrogen (much higher flammability and flame speed, and high risk of flashback). An additional challenge here will be to maintain NOx emission levels at a reasonable level in the short term, before revolutionary concepts (such as micromix combustors for example) make it to the engine. However, a potential reduction of 50% to 80% NOx emissions is envisaged in the longer term by using dedicated advanced combustion technologies. In this field, after improving kerosene combustion simulations for decades, and still working on it, the need to compute hydrogen combustion simulations brings us back quasi to square 1. Today, a substantial amount of work is required in order to validate CFD methods when using hydrogen as a fuel with experimental data which is very scarce, especially at high pressure. There is a pressing need to perform experiments and to obtain validation data. Currently, many experimental facilities are undergoing conversion to hydrogen for this purpose.

The second route to hydrogen propulsion is based on the use of fuel cells to power electric motors and propellers. Once again, automotive applications are often taken as a starting point, but, the specifications are equally different as compared to space applications: massflows, lifetime, control system, but first and foremost, reliability and power levels. Today, what we can get "off the shelf" is of the order of hundreds of kW (e.g. for hydrogen cars or trucks), while we need several MW for regional applications and tens of MW for the low end of the SMR market. Still a way to go…

For large air transport applications, only liquid hydrogen systems are viable. But liquefying and storing LH_2 presents unique challenges because the temperature of -252°C must be maintained 'in the tank'. What about the resulting effect on:

- **Tanks;**

- **Fuel distribution systems;**
- **Refuelling:**
- **Overall system design, reliability and safety;**
- **Operational, maintenance and certification.**

In both technology streams mentioned above, an efficient way (low volume and low weight) to store liquid hydrogen on-board an aircraft is needed. The so-called "gravimetric index" (weight of the fuel divided by the total weight of the tank, including the fuel) must be maximised to reduce the weight penalty at aircraft level. Then, there is the added challenge that hydrogen at -252°C, evaporates continuously, no matter how effective the tank insulation. This is often addressed as the boil-off issue. Sloshing under acceleration, deceleration and flight manoeuvres are making this only worse and this mechanism must be understood and limited by installing 'baffles' inside the tank. The fuel level metering in the tank, under any circumstances of the flight is also a critical aspect. The pilot needs to have a reliable indication of the fuel available at all times.
The fuel distribution system as well must also be designed to transport the hydrogen at the right massflow, temperature and pressure conditions either to the gas turbine combustor or to the fuel cell. This includes heating up and vaporisation for which adequate heat exchangers must be designed to maintain safety at all times, considering constraints of material embrittlement, also well known to be a disadvantage of hydrogen. Mechanical design at cryogenic temperatures is a science of its own and many of the system components will be exposed to the risk of icing.
Fuelling (and refuelling for an aircraft) is one of the most critical steps for space launchers, where a long sequence of actions is necessary: cleansing the lines, cool-down, and then the fuelling itself which must be conducted slowly enough to avoid too much boiling.
And last but not least, safety and certification, where no compromise is allowed for aircraft applications, are a top priority. To this end, all projects launched under the Clean Aviation programme will have a direct and substantial involvement of the European Union Aviation Safety Agency (EASA) to monitor the viability of the technical solutions right from the start. Indeed, Clean Aviation recently signed a Memorandum of Cooperation with EASA in an effort to strengthen ties between the two bodies.

At which horizon times do you envisage the successive steps' achievements of the H_2 aircraft propulsion development:

- **Application of a H_2 fuel cell for hybrid electric aircraft?**
- **Direct combustion of H_2 into turboprop engines?**
- **Direct combustion of H_2 in turbofan engines for large long range liners?**

The timeline for the development of a potential hydrogen-powered aircraft is the one agreed by the stakeholders of the aviation community and published in our SRIA (Strategic Research and Innovation Agenda), publicly available on the Clean Aviation website (https://www.clean-aviation.eu/strategic-research-and-innovation-agenda-sria). The programme is divided into two phases: a first technology development phase until 2025/2026 with initial ground tests, and a second phase up to 2030 for further ground tests, targeting flight tests of the most promising configuration(s).

In terms of hydrogen aircraft development, independent of the readiness of airport infrastructure or green hydrogen production at a sufficiently large scale, I would see the commercialisation of a regional aircraft (50 to 70 pax) based on a hydrogen turboprop solution as the most likely scenario from a technical perspective. This is simply due to the challenges concerning certification. For decades the gas turbine has proven to be an extremely reliable propulsion system. The challenge of installing hydrogen equipment on-board would be "limited" to the storage and distribution system, simplifying somewhat the certification of these components and the conversion of the engine to hydrogen direct burn (maybe the least difficult to overcome). Certifying fuel cell solutions, on the contrary, will be more challenging due to the higher complexity of the system.
The tank and the fuel distribution system remain (which in turn raises multiple other issues related to, for example, aircraft structural design and stability & control). However, the reliability and lifetime of the fuel cell itself still needs to be proven, and the electrical distribution system (often operating at kilovolt level), the power management and control system as well as the electric motors, need to achieve certification by demonstrating failure-free operation probably thanks to a certain level of redundancy in the early stages. Therefore, all these components and technology bricks must be first carefully designed for aeronautical applications and de-risked by extensive lab and ground tests before a final architecture may be down-selected as the safest and most reliable one. This is exactly the scope of Phase 1 of the Clean Aviation programme up to 2025/2026.

Let's also note the very active developments and advances currently underway in the field of fuel cell propulsion by smaller start-up companies in Europe and the US, and the strong commitment of the largest airframer in Europe, to explore this solution.

Large long-haul aircraft, today, are simply not in the scope of these developments considering the amount of fuel required onboard (over 120 tons of kerosene, meaning around 40 tons of hydrogen) and the level of power of the propulsion system which can go up to almost a hundred MW for the largest planes currently in service. This, of course, definitely rules out fuel cells but even with very efficient hydrogen turbofans, will be very difficult if the range is to be maintained.

After having reviewed all the above subjects, what are from your point of view the THREE BIGGEST DIFFICULTIES to be overcome?

Before answering this question, I would like to refer the reader to the excellent article by Eric Dautriat (Vice-President of the French Air and Space Academy and former Clean Sky Executive Director), published in an earlier issue of the AEROSPACE EUROPE Bulletin[1] (January 2021) on "The Many Challenges of a Hydrogen Aircraft", sharing some personal considerations based on his experience as a former director of launchers at CNES (the French Space Agency) with Ariane.

Returning then to the three biggest difficulties to overcome: we have addressed in this interview several technical challenges related to the storage of liquid hydrogen on board an aircraft; its distribution, the components of the propulsion system, especially fuel cells, and the complexity and weight penalties of the systems. I nevertheless believe that time and good engineering will deliver adequate solutions to to overcome these hurdles.

However, the main and overarching difficulty will be to maintain a safety level at least equivalent to the one we know today, and we like to remember when we step into an airplane. The hydrogen-powered aircraft will naturally require a multitude of safety measures: sealing levels at cryogenic temperatures for all junctions and numerous detection sensors addressing the risk of leaks in confined spaces, the risk of icing of components, multiple redundancies, frequent verifications procedures, flushing systems for certain enclosures, the risk of material embrittlement and thermal fatigue over time, etc.

The second biggest difficulty also concerns safety but is related to turnaround times at airports: refuelling the aircraft and the appropriate airport infrastructure. Currently, fuelling a tank with liquid hydrogen is a slow procedure (to avoid boiling) which must be handled with care. The proposed solutions to alleviate this problem are based on parallel fuelling of multiple tanks. But behind this additional technical challenge lies the issue of availability of liquid hydrogen at airports. Transport to the airports by tanker trucks is often proposed as a first step. However, talking about large-scale global viability, some solutions consider delegating to airports not only the liquefaction but also the production (electrolysis) and storage of liquid hydrogen. This will require huge infrastructure and investments for which airport authorities would need to be convinced of the long-term commercial advantage and which probably only (massive) state investments would be able to support.

The third and last challenge was also addressed already in the very first question of this interview about renewable energy sources and the huge amount of energy needed to produce liquid hydrogen at large scale. This too will require massive investments in green electricity production means. The projections of the cost of ownership of a hydrogen-powered aircraft and the final cost of liquid hydrogen are of course uncertain. Aviation will be competing with other transport and energy sectors for availability of green hydrogen, and this must be balanced with the other well-known solution from synfuels, which would require even higher needs in terms of energy for production (including direct air carbon capture), but minimal changes in the aeronautical sector and at airports.

To conclude, hydrogen is number 1 in our periodic table of chemical elements, but also number 1 currently in the list of challenges that aviation is facing in order to become green. The smallest and lightest molecule on earth is giving us the largest challenges in aeronautical history. This little molecule though has an extraordinary energy density (almost three times that of kerosene) and — despite all the challenges it is giving us — it is carbon-free !

1. https://ceas.org/wp-content/uploads/2022/08/AE-1-2021-v.-DEF-jps-.pdf, pp20-23.

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The journals were created under the umbrella of the Council of European Aerospace Societies (CEAS) to provide an appropriate platform for excellent scientific publications submitted by scientists and engineers. The German Aerospace Centre (DLR) and the European Space Agency (ESA) support the Journals, which are published by Springer Nature.

The **CEAS Space Journal** is devoted to excellent new developments and results in all areas of space-related science and technology, including important spin-off capabilities and applications as well as ground-based support systems and manufacturing advancements.
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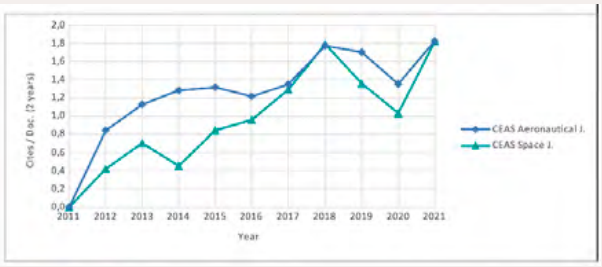

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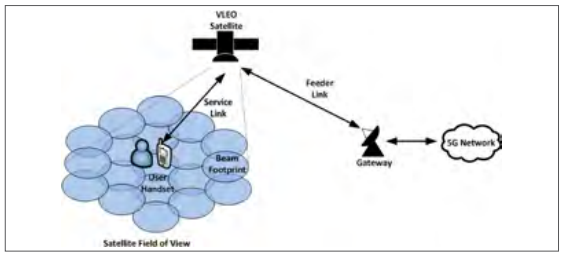
Volume 14, Issue 4, October 2022
Special Issue on "Very Low Earth Orbit Missions and Technologies"



INVESTIGATION OF VERY LOW EARTH ORBITS (VLEOS) FOR GLOBAL SPACEBORNE LIDAR
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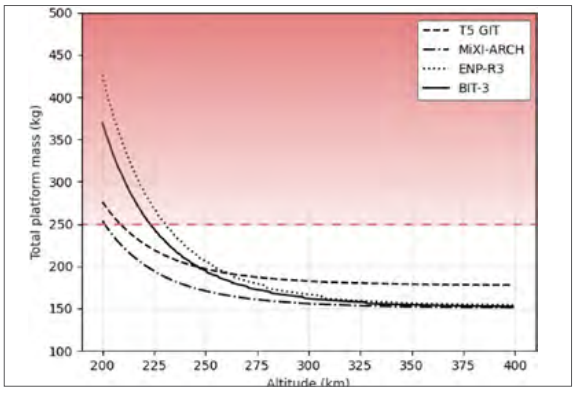

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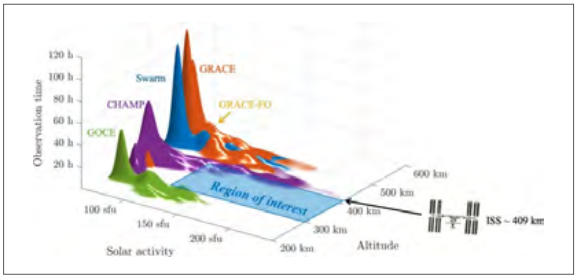

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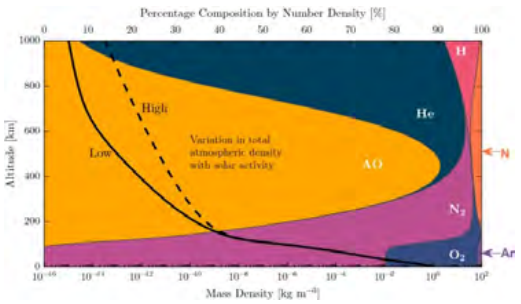
N. H. Crisp,P. C. E. Roberts, V. Hanessian, V. Sulliotti-Linner, G. H. Herdrich, D. García-Almiñana, D. Kataria & S. Seminari/ Published online: 07 April 2022 (open Access)



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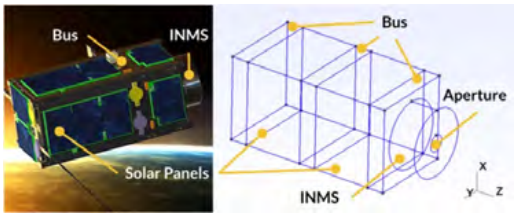

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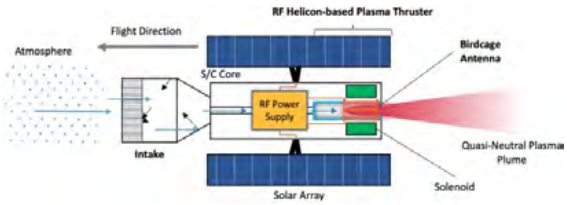

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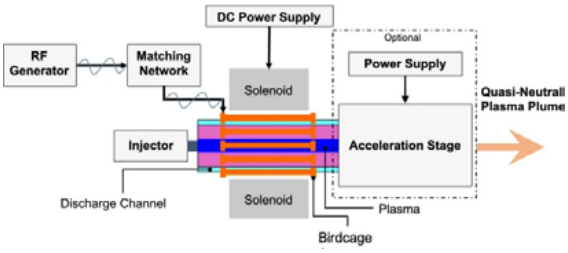

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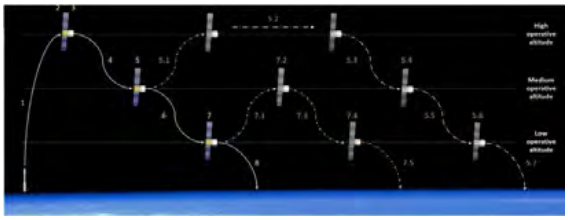

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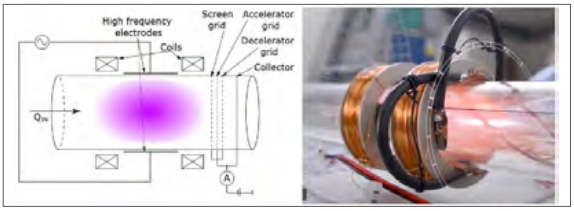

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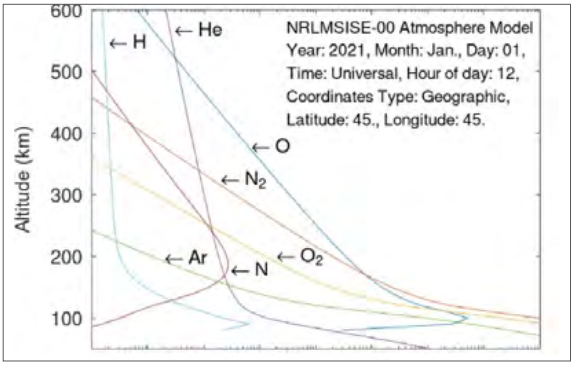

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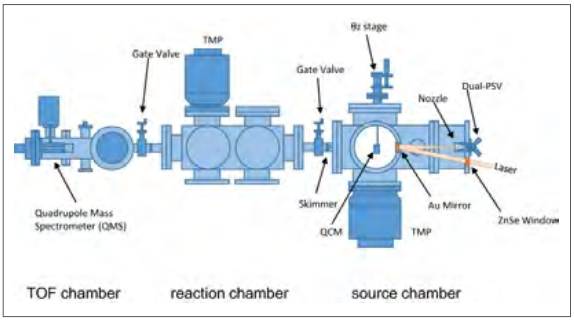

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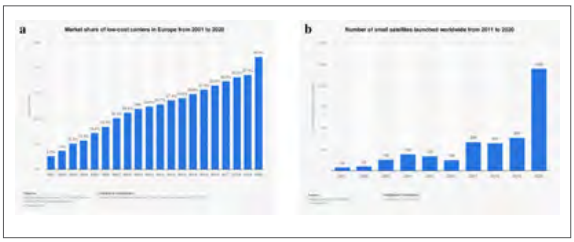

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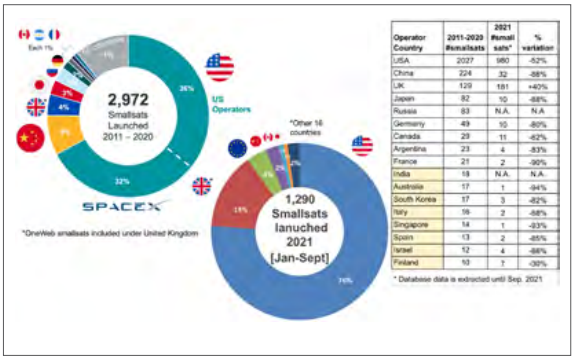

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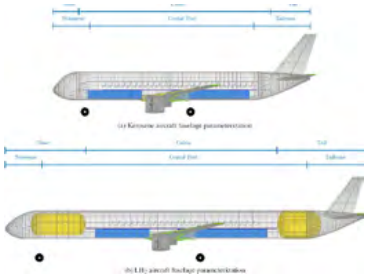

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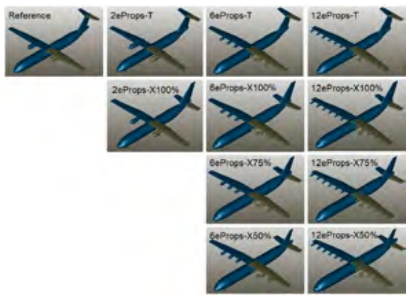

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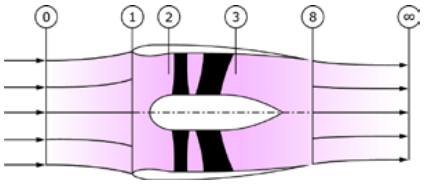

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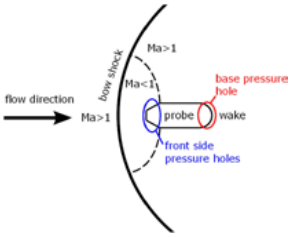

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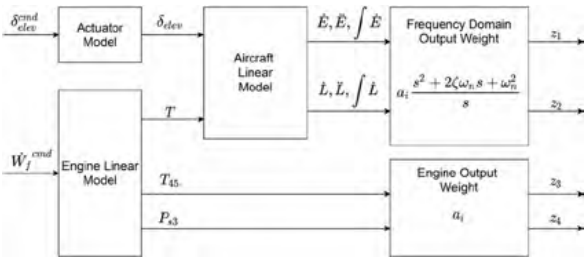
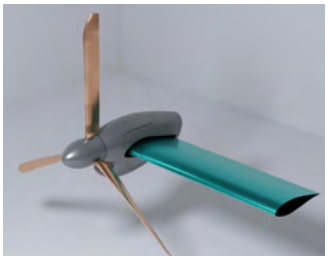


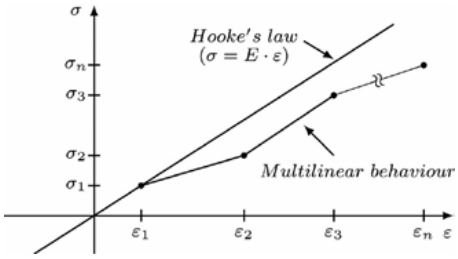
NUMERICAL WHIRL–FLUTTER ANALYSIS OF A TILTROTOR SEMI-SPAN WIND TUNNEL MODEL

Alessandro Cocco, Stefano Mazzetti, Pierangelo Masarati, Stefan van't Hoff & Bart Timmerman/ Published: 1 September 2022 (Open Access)



AEROELASTIC METHOD TO INVESTIGATE NONLINEAR ELASTIC WING STRUCTURES

Kjell Bramsiepe, Thomas Klimmek, Wolf-Reiner Krüger & Lorenz Tichy / Published: 29 August 2022 (Open Access)

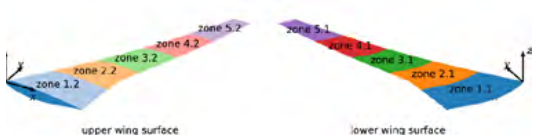


STRUCTURAL OPTIMIZATION OF AN AEROELASTIC WIND TUNNEL MODEL FOR UNSTEADY TRANSONIC TESTING

Johannes Dillinger, Yasser M. Meddaikar, Arnaud Lepage & Nicolo Fabbiane / Published: 1 September 2022 (Open Access)

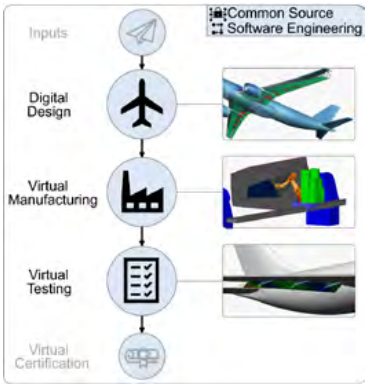
AEROELASTIC-TAILORING OF A WIND-TUNNEL MODEL FOR PASSIVE ALLEVIATION OF STATIC AND DYNAMIC LOADS

Nicolò Fabbiane, François-Xavier Irisarri, Johannes Dillinger & Arnaud Lepage / Published: 24 September 2022Access)



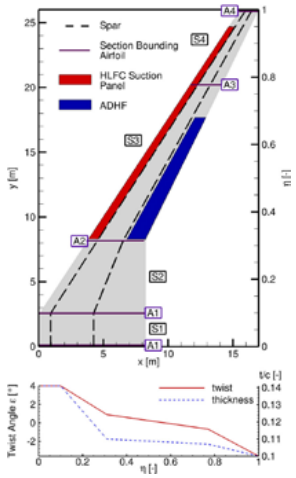
VIRTUAL TESTING OF MULTIFUNCTIONAL MOVEABLE ACTUATION SYSTEMS

R. W. Hollmann, A. Schäfer, O. Bertram & M. Rädel / Published: 1 August 2022 (Open Access)



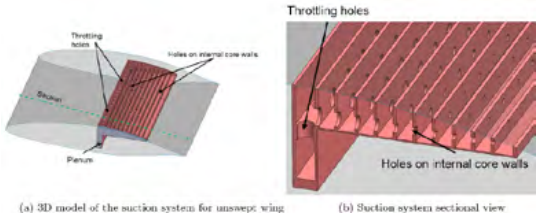
NUMERICAL ANALYSES OF A REFERENCE WING FOR COMBINATION OF HYBRID LAMINAR FLOW CONTROL AND VARIABLE CAMBER

Mauricio M. Jentys, Tim Effing, Christian Breitsamter & Eike Stumpf / Published: 19 July 2022 (Open Access)



DESIGN AND POWER CALCULATION OF HLFC SUCTION SYSTEM FOR A SUBSONIC SHORT-RANGE AIRCRAFT

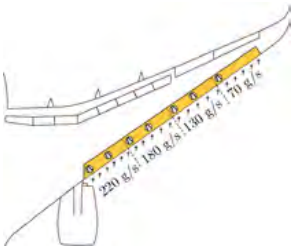
Adarsh Prasannakumar, Johannes Wolff, Rolf Radespiel, Loek Boermans, Christian Hühne & Camli Badrya / Published: 14 September 2022 (Open Access)



(a) 3D model of the suction system for unswept wing (b) Suction system sectional view

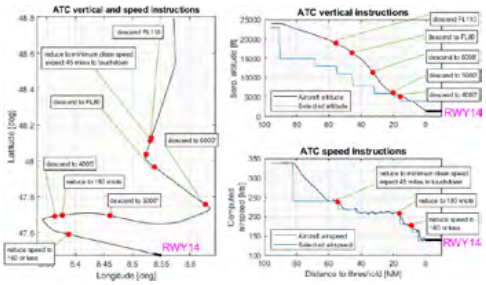
INVERTER PROTOTYPE DEVELOPMENT FOR HLFC COMPRESSOR APPLICATIONS

Alexander Heinz Bismark, Patrick Juchmann & Oliver Bertram / Published: 17 September 2022 (Open Access)



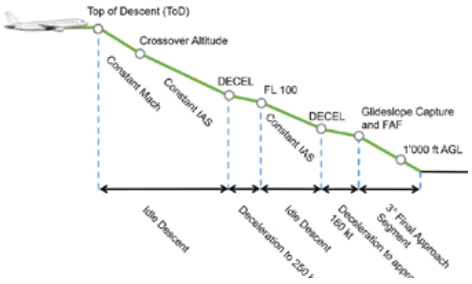
IMPACT OF ATC SPEED INSTRUCTIONS ON FUEL CONSUMPTION AND NOISE EXPOSURE: AN ASSESSMENT OF REAL OPERATIONS IN ZURICH

Fethi Abdelmoula, Mathias S. Roeser, Christoph G. Kühne, Martin Gerber & Jean-Marc Wunderli / Published: 22 August 2022 (Open Access)



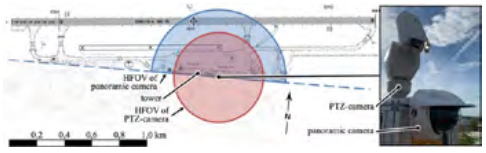
ENERGY-OPTIMIZED APPROACHES: A CHALLENGE FROM THE PERSPECTIVES OF PILOTS AND AIR TRAFFIC CONTROLLERS

Martin Gerber, York Schreiber, Fethi Abdelmoula, Christoph G. Kühne, D. Jäger & J. M. Wunderli / Published: 5 September 2022 (Open Access)



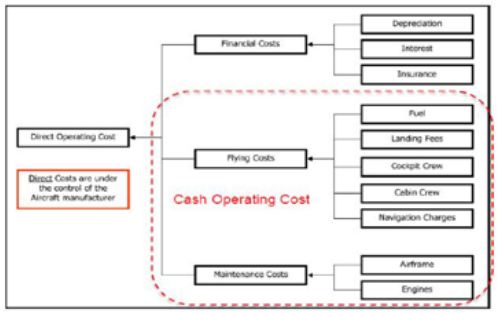
REMOTE AFIS: DEVELOPMENT AND VALIDATION OF LOW-COST REMOTE TOWER CONCEPTS FOR UNCONTROLLED AERODROMES

Fabian Reuschling & Jörn Jakobi/ Published: 3 November 2022 (Open Access)



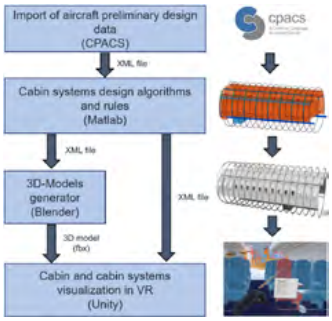
THE IMPORTANCE OF COUPLING AERODYNAMIC AND COST ANALYSIS IN AIRCRAFT DESIGN

Davide Di Pasquale & Mark Savill / Published: 3 August 2022 (Open Access)



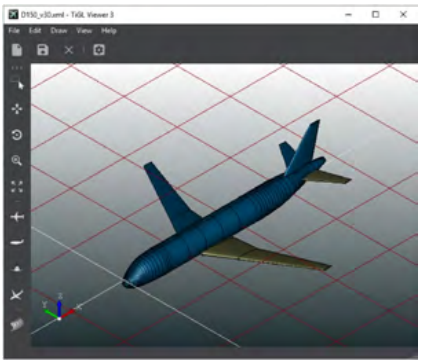
ENHANCEMENT OF THE VIRTUAL DESIGN PLATFORM FOR MODELING A FUNCTIONAL SYSTEM ARCHITECTURE OF COMPLEX CABIN SYSTEMS

Mara Fuchs, Yassine Ghanjaoui, Jutta Abulawi, Jörn Biedermann & Björn Nagel / Published: 22 August 2022 (Open Access)



EXPANSION OF THE CABIN DESCRIPTION WITHIN THE CPACS AIR VEHICLE DATA SCHEMA TO SUPPORT DETAILED ANALYSES

Jan-N. Walther, Christian Hesse, Marko Alder, Jörn Y.-C. Biedermann & Björn Nagel / Published: 23 August 2022 (Open Access)



SESAR 3 ANNUAL CONFERENCE: MAKING EUROPE'S AIRSPACE FIT FOR THE DIGITAL AGE

On 12 October 2022, the SESAR 3 Joint Undertaking's first annual conference was held in Brussels to discuss how aviation and air traffic management are gearing up for the digital age. It brought together representatives from the European Commission, the European Parliament, Member States, as well as industry leaders, research centres, SMEs and universities.
Digitalisation can help Europe's aviation industry become more resilient to crises while delivering smarter and more sustainable air mobility in Europe: this was the key message delivered by speakers to the 350-strong audience attending the one-day high-level conference and exhibition. Besides, climate change was front and centre of the discussions as aviation seeks to ensure that its modernisation efforts meet the European Green Deal's net-zero ambition by 2050.

THE CONFERENCE AT A GLANCE

> To see the video clic on the picture

Industry leaders gathered alongside EU policy makers to discuss the aviation sector's digitalisation efforts at the first annual conference of the SESAR 3 Joint Undertaking. The SESAR 3 JU conference, held in Brussels, featured panel discussions on the digitalisation of Europe's aviation sector – alongside the Digital European Sky Marketplace showcasing some of the latest SESAR innovations. The urgency to address climate change was a running theme throughout the day.

> To see the video clic on the picture

EU policy makers echoed the ongoing challenges facing the industry, while underscoring the supporting role of the SESAR 3 JU. The last few years have been unprecedented, according to Henrik Hololei, Director General at the European Commission's Mobility and Transport Directorate-General, with no signs of the crisis easing yet.
He said that air traffic management (ATM) will face greater pressure to deliver environmental benefits even while demand for air travel continues to grow. "Our airspace should be able to accommodate that without bottlenecks," he said. "The SESAR project has been a success, but the challenges facing our sector require continuous reflection and the lightness of new beginnings," he added.

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The pressure is on to deliver the Digital European Sky and meet EU's green ambitions. For this we need an interoperable, digital, future-proofed ATM system, said MEP Marian-Jean Marinescu. The Single European Sky (SES) reform package can provide an enabling framework, he added, who called for its swift adoption.
'Building back better' was the leitmotif in the first morning session, where panellists discussed the aviation industry's efforts to recover after successive crises, while tackling the sector's carbon footprint. "Industry is really

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making a big effort to recover and 'recover better'," said Mariagrazia La Piscopia, Executive Director at SESAR Deployment Manager. To get there, we have to champion first-mover advantage, encouraging a network perspective of the system and investments plan, she added.
The summer disruptions clearly show the need for modernisation but there are signs of hope with the progressive implementation of technology, noted Philippe Merlo, Director of the European Green Sky Directorate, EUROCONTROL. Partnership and a cohesive value chain will be key, he added.

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A lot has been achieved in terms of innovation in support of smart mobility. We need to accelerate our efforts in preparation for the next generation of mobility and ensure solutions are smart and sustainable by design, Carlos Morais Pires, cabinet member of research commissioner Mariya Gabriel, told conference participants. Coordination is a pre-condition to making a difference; this is rationale of Joint Undertakings which embed co-creation and a critical mass of investments, he added.
Digitalisation of the aviation ecosystem was discussed in a second morning panel, where speakers stressed the opportunity to boost ATM's performance and unlock the potential to reduce the sector's CO_2 emissions.

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We have a vision but we need the building blocks: air-ground connectivity, infrastructure backbone, cyber security - when they are in place we can harvest the benefits, said Ulf Thibblin, Chair of COOPANS Alliance CTO Panel.
Air traffic controllers are enablers for getting solutions deployed quicker into a workable future operational environment. We should ensure their involvement at all stages of innovation and implementation. This was the key message from Marc Baumgartner representing the International Federation of Air Traffic Controllers' Associations (IFATCA).
"We need to accelerate, we still have 10% of wasted CO2 each day in the European airspace [and] there is an extremely strong need to move now [with the Digital European Sky]," said Hugues de Beco, Head of Multi-Programme Projects and Air Traffic Management at Airbus.
Industry players reiterated the added-value of the SESAR 3 JU. If we only manage to achieve the SESAR flagship programmes for a digital sky that would already "be magic", according to Dirk Hoke, Chief Executive Officer at Volocopter – a new member of the SESAR 3 JU, but which has been active in recent years in several large-scale demonstrations. If we can implement and accelerate these projects, he added, "My wish-list is covered!"
A standards and regulatory framework conducive to digital transformation was explored by speakers in the final panel discussion. There was common agreement for the need to embed standards and regulatory work much earlier within the innovation lifecycle, something which the SESAR 3 JU will seek to do.
In parallel, it's about streamlining. When we introduce new technologies into ATM, we must withdraw obsolete, redundant technology in order to avoid unnecessary costs, said Christine Berg, Deputy Aviation Director, Directorate-General for Mobility and Transport, European Commission.

> To see the video clic on the picture

A closing panel reflected the day's discussions, summarising some of the key takeaways,
Constant disruptions and other pressures related to climate change and the energy crisis mean that we need to do more to make sure that the [ATM] framework is more resilient and flexible, more adaptable to all of these uncertainties, said Rachel Smit, a member of Transport Commissioner Adina Vălean's cabinet.

We have the means to be the front runner in green innovation technology, if we put sustainability at the heart of our modernisations efforts, said MEP Karima Delli, chair of the European Parliament's transport committee. However, the global competition is tough, so we need to ensure continuous investments and incentives and avoid brain drain if we want continue to lead the way, she concluded.

SESAR INNOVATION DAYS SHOWCASE AVIATION'S COMMITMENT TO A SMART ANS SUSTAINABLE FUTURE

The 12th SESAR Innovation Days (SIDs) took place from 5 to 8 December in Budapest (Hungary). The conference was hosted by HungaryControl and gathered over 400 participants for keynotes and technical paper sessions.

After a two-year hiatus, 400 of Europe's leading researchers in the air traffic management (ATM) and aviation domains gathered in Budapest for the SESAR Innovation Days to take stock and exchange on a wide variety of topics, from artificial intelligence and energy-efficient flying to meteorology and drone traffic management. Results stemming from the showcased research have the potential to push the boundaries of ATM, making it smarter and more sustainable in the coming years, the participants heard.

Now in its twelfth edition, the SESAR Innovation Days, a flagship event in the aviation research calendar, showcased some of the breakthrough concepts from the SESAR 3 Joint Undertaking's exploratory research portfolio, as well as novel outcomes from the broader ATM research community.
Altogether, the conference brought together 400 participants, and featured some 37 posters and 51 papers, covering data-driven methods for safety and resilience prediction, climate-optimised trajectories, drone traffic management, airport operations, among other research areas. Special plenary sessions looked at the important topics of U-space, the enabling framework for drone integration, the environment and artificial intelligence.

Much of the research presented during the conference stems from the 41 exploratory research projects and the SESAR knowledge transfer network, Engage, which ran from 2020 to 2022, bringing together academic and industry partners, such as universities, SMEs, research centres, airlines, manufacturers, and air navigation service providers from across the European Union and EU Associated Countries.

Speaking at the conference, **Andreas Boschen**, Executive Director of the SESAR 3 Joint Undertaking underlined the importance of collaboration and providing researchers with the right conditions to yield fresh ideas that take us beyond the current horizon of research and innovation. *"This not a pursuit of knowledge for the sake of it; but rather a harnessing of the latest advances in technology to support aviation's sustainable transition, deliver much needed efficiency gains, while enabling the continued growth and diversification of air travel, as new types of vehicles such as drones take to the sky,"* he added.

Echoing that sentiment, **Rosalinde Van Der Vlies**, Director for Clean Planet, at the European Commission's Research and Innovation Director te General, said: "*Aviation has always been at the forefront of innovation - I'm fully convinced that Europe will succeed in delivering an efficient, safe, and green #digital transportation system - your pioneering work is and will be valuable and irreplaceable part of this mission.*"

In his keynote, **László Tóth**, CEO, HungaroControl, emphasised the potential of new technologies to transform ATM. "*Digitalisation and data sciences hold real promise for ATM, offering benefits in terms of greater efficiency and increased flexibility - The SESAR 3 JU offers a pragmatic platform for collaboration and advancing these technologies*," he told participants.

Fittingly, the conference closed with the SESAR Young Scientist Award ceremony, celebrating the next generation of aviation and ATM researchers in two categories, students and PhD. The top prize among the students went to **Marie-Christine Nevir**, Technische Universität Dresden, who developed and initially validated a new workload model for sector-less airspace (i.e. flight centric air traffic control). The jury praised Nevir for the very high level of innovation demonstrated in her work for tackling controller organisation in light of this this relatively new operational concept.

Omar Garcia Crespillo, German Aerospace Center (DLR) & Swiss Federal Institute of Technology Lausanne (EPFL), received first prize in the PhD category for his work on Global Navigation Satellite System (GNSS)/Inertial Navigation System (INS) Kalman filter integrity monitoring with uncertain time-correlated error processes. The jury praised him for a very well structured and written thesis, which demonstrated excellent scientific rigour and innovation in terms of the simulation approaches

It was announced that the next SESAR Innovation Days will take place in Seville, Spain, from 27 to 30 November 2023.

ABOUT HISST 2022 CONFERENCE

Dr Adam Siebenhaar, Chair HiSST Technical Committee

The High-Speed Vehicle Systems science and Technologies Conference, HiSST, promotes discussion between research institutes, academia, and industries from around the globe on research and development of enabling technologies for supersonic and hypersonic vehicles. With the recent addition of India, the HiSST Technical Committee (link: https://ceas.org/hisst/) currently consists of representatives from thirteen countries/agencies:

1	Australia	8	India
2	Brazil	9	Italy
3	China	10	Korea
4	ESA	11	Russia
5	France	12	UK
6	Germany	13	USA
7	Japan		

After a successful 1st HiSST Conference in Moscow, Russia, in November 2018, we had to delay the 2nd HiSST Conference, originally scheduled for May 2020, due to COVID-19 restrictions until September 2022 when we executed it as originally planned in Bruges, Belgium, from September 12 to 16. The host of the 2nd HiSST Conference was Professor Johan Steelant, ESA, who did an admirable job in dealing with one postponement after the other. The Technical Committee mitigated remaining COVID related concerns by structuring all presentations to be optional on-site or on-line. CEAS and ESA managed and financially supported as illustrated below.

A total of 227 persons, from twenty-three countries, attended the conference. The majority was from Europe with Germany and France being in the lead. The Pareto chart to the right below contains both bars and a line graph, where the number of attendees are represented in descending order by bars, and the cumulative total is represented by the line.

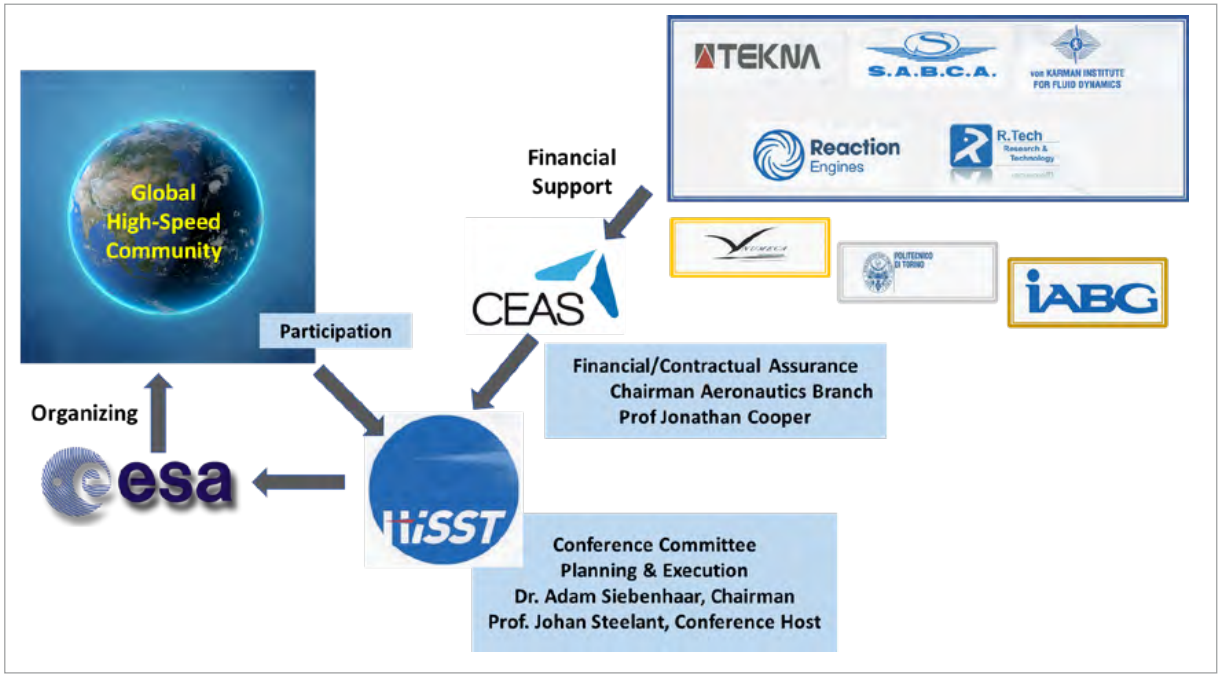
The overall program consisted of four major components:

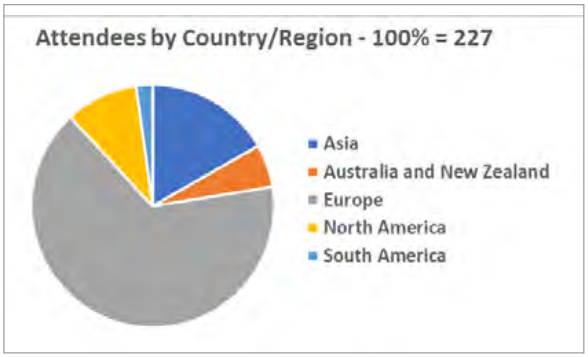
A. Plenary Sessions
B. Paper Sessions
C. Social Program
D. Visit to the Von Karman Institute in Brussels.

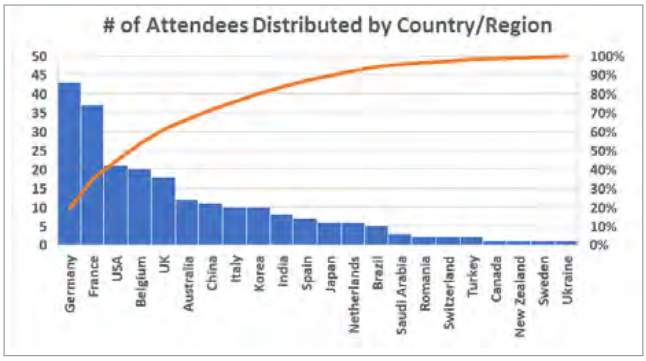
After the conference, the HiSST committee entertained a survey about the quality of the conference. A total of ninety-nine responses were recorded. The survey outcome overall was positive, specific survey results are shown at the end of the above-mentioned sections A. through D.

A. We offered two types of Plenary Sessions.

1. **Global Reviews** have the goal to provide an overview from each Technical Committee Member country of its engagement and plans of relevant high-speed vehicle science and technologies during the recent past, the present, and the near- and long-term future. Ten of the at that time twelve member countries took part in this event.



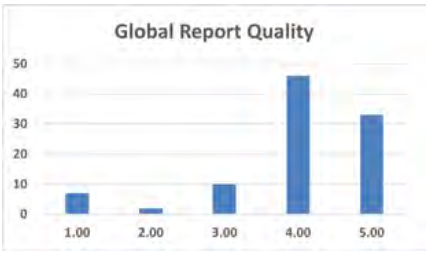


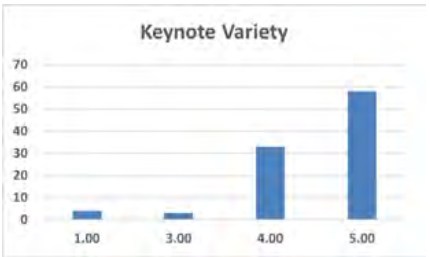


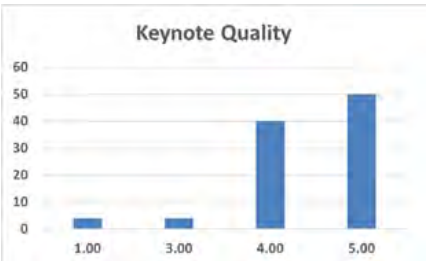
2. Keynote Speeches have the aim to provide insight in a particular field of interest to the high-speed community from the point of view of a renowned expert. The six speeches presented were:

- **Ceramic Matrix Composite (CMC) Thermal Protection Systems (TPS) and Hot Structures for Hypersonic Vehicles,** David E. Glass, NASA Langley Research Center, USA
- **High-Speed Vehicles Research in EU International Programs,** Pablo Perez-Illana, Deputy Head of European Commission's CINEA Agency Horizon Europe Transport, EU
- **Advances in the Simulation of Hypersonic Flows: The Power of HighOrder Numerics,** Graham Candler Aerospace Engineering & Mechanics University of Minnesota, USA
- **Challenges and Recent Progress in Instrumentation of Hypersonic Flight and Ground Experiments,** Ali Gülhan, DLR, Germany
- **Transition in High-Speed Flow with and without Surface Roughness Elements,** Neil Sandham, Aeronautics and Astronautics, University of Southampton, UK
- **Curved Shock Theory and Dual Waverider Concept,** Yancheng You, School of Aerospace Engineering, Xiamen University, China

Section A Survey Results: Global Reports quality, and Keynote variety and quality were high and well received.







B. The Paper Session addressed technical manuscripts covering nine high-speed technology subtopics

1. **Missions & Vehicles**
2. **Propulsion**
3. **Thermal & Energy**
4. **Guidance & Control**
5. **Materials & Structures**
6. **Aerothermodynamics**
7. **Testing & Evaluation**
8. **Operation & Environment**
9. **Fundamentals & History**

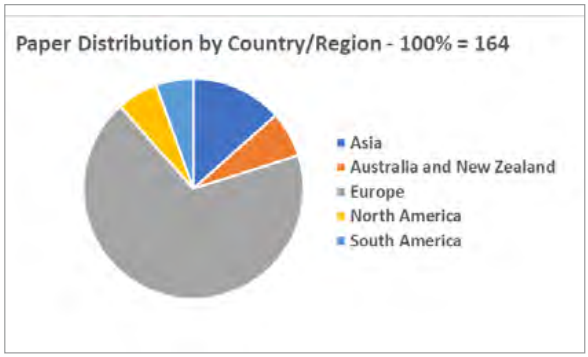
Originally HiSST had received about 360 technical paper abstracts for the conference planned in 2020. After four delays, this number had shrunk to 160 due to still persistent COVID restrictions in China, the Russian East European conflict, authors having graduated and moved on, and other cancellations.

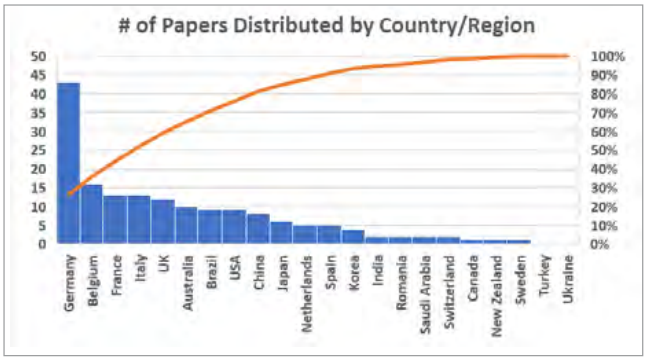
A total number 160 papers from twenty countries were presented. As expected, the majority was from Europe with Germany standing out as the leader. Overall, 70% of the attendees presented a paper which is an attractive number for a conference of this type.

Conference attendants participated in a workshop on the topic of Boundary Layer Transition borne and sustained by the sizeable attendance of experts in this field. The Technical Committee identified two Paper Awards:

Best Student Paper

Quantifying the Surface Heat Transfer on Transpiration Cooled Porous Materials in Laminar and Turbulent Hypersonic Boundary Layers, Imran Naved, Fluid Gravity Engineering ltd, UK; Tobias Hermann and Chris Hambidge, University of Oxford, UK; Hassan Saad Ifti, Uni-

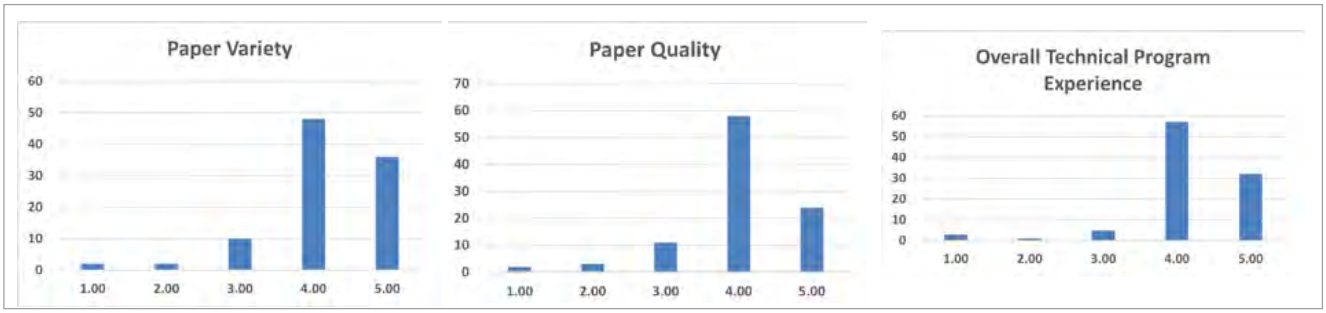




versity of Maryland, USA; Matthew McGilvray, University of Oxford, UK; Iullia S Tirichenko and Luc Vandeperre, Imperial College London, UK

Overall Best Paper
Schlieren Visualization of Dual Injection in Supersonic Cross Flow, Siemen Smink, Sem de Maag, Cor. W. Lerink, Ella Giskes, Harry W.M. Hoeijmakers, Cees H. Venner, Frans B. Segerink, Herman L. Offerhaus, University of Twente, The Netherlands

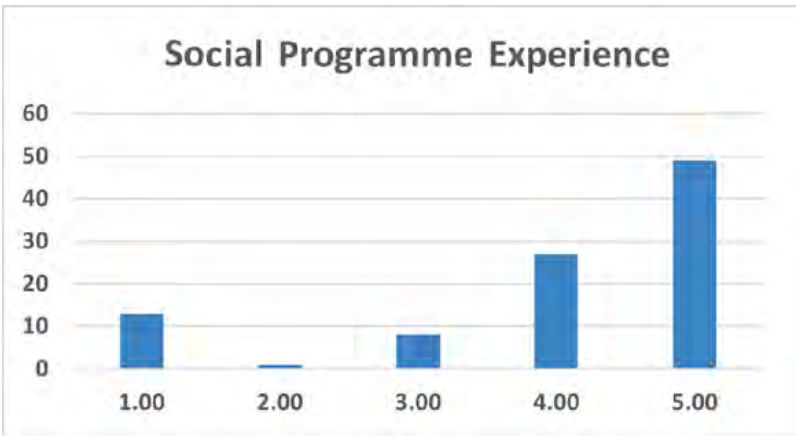
Section B Survey Results:
The attendees' assessment of the paper variety and quality, along with the overall program experience, was very positive.



C. We executed the social program as originally planned, and it consisted of:

- Lunches served at the conference venue from Monday through Thursday
- A Welcome Reception at the old brewery "De Halve Maan" including a guided tour
- A Gala Dinner at the "Belgium Pier Blankenberge" where we presented and celebrated the Best Student Paper and the Overall Best Paper Awards. We base our optimism on very favorable survey results, and are looking forward to welcoming you in Busan,, Korea, in April 2024, 2024 (link: hisst2024.com).

Section C Survey Results:

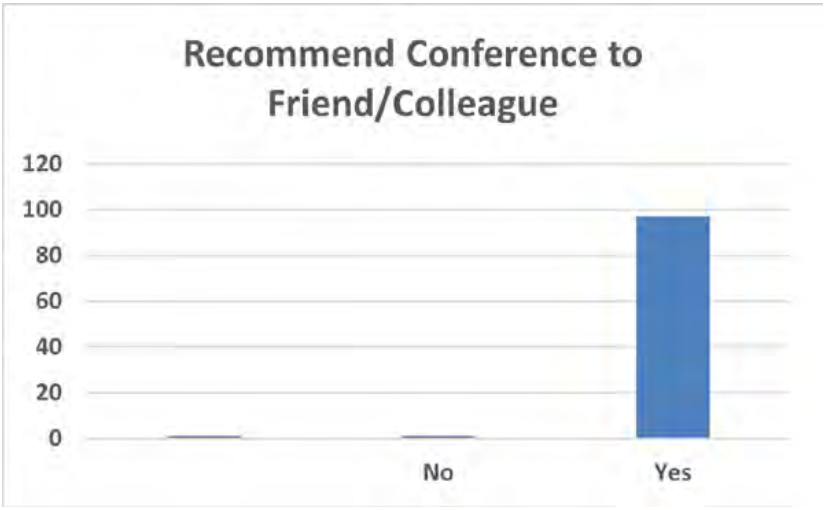


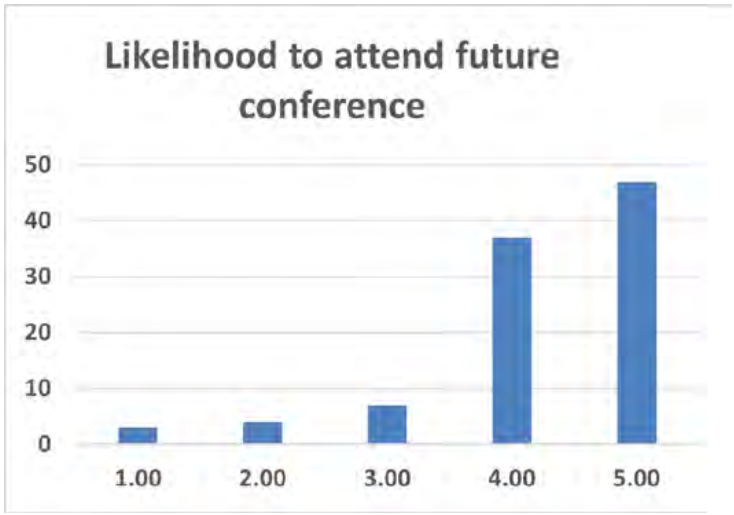
D Participation of the Von Karman Institute, VKI, visit on the fourth conference day was optional. We supplied busses for the roundtrip ride from Bruges to the institute near Brussels and back. VKI scheduled three consecutive institute tours, a tour lasted around one hour.

Next HiSST Conference

Now we are looking forward to the next conference in Busan, Korea. Professor Jeong-Yeol Choi, Pusan National University, assumed the responsibility of hosting the 3rd HiSST Conference which the Korean Society for Aeronautical and Space Sciences, KSAS, and the Korean Society of Propulsion Engineering, KSPE will jointly support.

With COVID behind us and having demonstrated a successful HiSST 2022, we expect to regain our earlier momentum for another great conference. We base our optimism on very favorable survey results.





THE 12TH EASN CONFERENCE ON INNOVATION IN AVIATION AND SPACE

By Prof. Andreas Strohmayer, Chair of EASN

The **12th EASN International Conference on Innovation in Aviation & Space** was successfully held in Barcelona - Spain, from October 18th to October 21st, 2022. It was the first EASN in-person gathering after the COVID-19 pandemic outbreak in March 2020.

The **EASN Association** and the **Universitat Politecnica de Catalunya – Barcelona Tech (UPC**) would like to sincerely thank the Keynote Speakers, Session Chairs, Authors and Presenters, the International Scientific Committee and the local Organizing Committee for making this Conference a big success.
The event included **8 Keynote Speeches**, more than **400 technical presentations and feedback slots** distributed in **75 sessions and workshops**. Moreover, **85 Aviation & Space Projects** disseminated their latest research results as well as the future trends in the respective technological fields. In total, more than **470 participants from 39 countries** joined the 12th EASN International Conference, making this year's gathering the most successful in the EASN Conference series so far.

As its predecessors, the conference has proved to be a major European Dissemination event for research in Aviation & Space, providing a forum for EU funded project's activities, where innovative ideas, breakthrough concepts, and disruptive technologies are presented and discussed with the aim to establish new research partnerships and possible synergies. In addition, a number of European policy development projects also found the floor to present future strategic priorities.

During the three days gathering, highlights of the conference have represented the Keynote Speeches, which were given by distinguished personalities of the European Aviation & Space sector to update the delegates on the future Industrial trends and the European priorities with respect to the medium and long-term goals. More specifically:

- **Mr. Christophe Bonnal,** *Senior expert of the CNES Directorate of Strategy and Chairman of the EUCASS Board*, presented the topic "Space Debris in a nut shell - Long Term Sustainability of Space Operations".

- **Dr.-Ing. Gisela Detrell,** *Research Team Leader in the Institute of Space Systems of the University of Stuttgart* (Germany), gave the speech entitled: "Surviving on Mars".

- **Mr. Pablo Perez – Illana**, *Deputy Head of Horizon Europe Transport unit, CINEA* "Climate, Infrastructure and Environment Executive Agency" of the European Commission, made a presentation about "From inception to implementation of EU Aviation: Research, Innovation and Deployment with CINEA".

- **Mr. Axel Krein**, *Executive Director of the Clean Aviation Joint Undertaking, shared his viewpoint about* "Disruptive technologies: the path to take European aviation to climate neutrality".

- **Dr. Isabelle Lacaze**, *Head of Technological Demonstrator at the Airbus UpNext, gave a keynote speech on* "Anticipating Disruption: Protecting Businesses Through Innovation".

- **Mr. Daniel Marco Pàrraga**, *Director General of Innovation and Digital Economy in the Government of Catalonia, spoke about the* "Catalonia is going into orbit with the NewSpace Strategy".

- **Mr. Juan Francisco Reyes Sanchez,** *CDTI-E.P.E Spanish Ministry of Science and Innovation and the National Contact Point for Aviation, Horizon Europe*, presented the "European Union transnational R&i aviation funding and the Spanish support".

- **Prof. Dr. Dieter Schmitt,** *Chairman of the EASN Stakeholders Advisory Board and Independent consultant for aeronautics*, gave a fruitful lecture entitled: Quō vādis Aeronautics?

Furthermore, a significant highlight of the conference were the workshops which addressed the edged technological topics of:

- **Clean Sky 2: Thematic topics & Technology Evaluator workshop on Aircraft Concepts**, chaired by Dr. Jean-François Brouckaert, *Clean Aviation Joint Undertaking*

- **ecoDESIGN and Sustainable Productivity**, chaired by Dipl.-Ing. Torsten Moll, *Fraunhofer Gesellschaft, Germany*

- **Urban Air Mobility**

Part I: **Scaled Demonstrators**, chaired by Dr.-Ing. Christian Eschmann, DLR, *Germany*
Part II: **Future Energy Sources for Aviation**, chaired by Mr. Marcello Kivel Mazuy, CIRA, *Italy*
Part III: **Circular Aviation System**, chaired by Mrs. Ligeia Paletti, NLR, *the Netherlands*

Yet, it would be an omission to do not underline the significance and quality and of the presentations made in the frame of the sessions of the conference. They have provided the solid base for the success of the conference.

The fourth day of the Conference was dedicated to technical visits throughout which the participants had the opportunity to explore some innovative and advanced technological destinations of Barcelona's research ecosystem, such as the BSC-CNS Barcelona Supercomputing Center and the Institut de Robòtica i Informàtica Industrial (IRI).

The Proceedings of the 12th EASN International Conference will be published **by IOP Publishing Ltd** in the respective open-access volume of the "12th EASN International Conference on Innovation in Aviation & Space for opening New Horizons" by the **Journal of Physics: Conference Series**. Proceedings are an important part of the scientific record, documenting and preserving work presented at the EASN Conferences throughout the years.

Further to the proceedings, selected full papers will be published in two international journals, following peer review : "Aerospace - Open Access Journal" and "Aircraft Engineering and Aerospace Technology (AEAT)".

Finally, EASN has announced its **13th International Conference on Innovation in Aviation & Space** that will be held in **Salerno**, Italy on **September 5th to 8th, 2023**. The event is co-organized by EASN Association and the University of Salerno and it will be hosted in the Salerno University premises.

Looking forward to welcoming you in Salerno !

LATEST DEVELOPMENTS AT EREA

As every year, EREA and its partners and stakeholders came together to conclude an eventful and dynamic year during the EREA Annual Event in Brussels.
This year the Event was attended by nearly 90 guests representing European aviation sector and the European Commission.
The Annual Event was opened with a keynote speech delivered by EREA Chair, Paweł Stężycki. In his speech,

Pawel Stężycki referred to this year's successes of EREA, i.e. the success of the pilot Networking Event dedicated to Engineers in the topic of hydrogen technologies which concluded with 2 internal EREA project ideas to be further developed by the teams. EREA Chair mentioned the success of EREA in the First Clean Aviation Call and also the success of including the European Flying testbed topic in the draft Work Programme 2023 – 2024 of Horizon Europe. EREA Chair also mentioned the events in Ukraine, the energy crisis and inflation. It was underlined that by acting together – research institutes and universities, we can jointly draw the attention of the European Commission to the problems currently faced by institutions implementing projects under the Horizon Europe Programme.
The next point on the Agenda was a debate between ACARE Co-Chairs: Bart De Vries (KLM), Michel Peters (NLR) and Marco Protti (Leonardo) on the European Aviation Vision "Fly the Green Deal", presented at ILA in June 2022. Main goals of the new Vision are: to put the citizen in the center, to increase momentum on climate neutral aviation and to extend European leadership and improving competitiveness of the European aviation sector. The updated European Aviation Vision "Fly the Green Deal" (FtGD) has come as an answer to the key developments in technology, society and politics experienced over the last 10 years, since the previous European Aviation Vision "Flightpath 2050" was published. The ACARE Chair team encouraged all European aviation stakeholders to use FtGD as basis for the future work and stated that it will welcome in its working groups any stakeholder, willing and committed to achieve the goals of the new vision.

The EREA Annual Event concluded with the handing-over the awards for the EREA Best Paper. Congratulations went to the main authors of the top three papers presenting a short insight of the papers. This year the first prize was awarded to the team from ILOT for the article "Numerical Modelling and Designing Challenges of Boundary Layer Ingesting Fans". Second place for the article "Aeroacoustics Assessment of a Hybrid Aircraft Configuration with Rear-Mounted Boundary Layer Ingested Engine" was awarded to authors from CIRA and DLR. Third place went to the DLR team for the article "Development of a Fully-Coupled Harmonic Balance Method and a Refined Energy Method for the Computation of Flutter-Induced Limit Cycle Oscillations of Bladed Disks with Nonlinear Friction Contacts".

CONTACT INFORMATION

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ABOUT EREA

EREA, the association of European Research Establishments in Aeronautics is a non-profit organisation which gathers Europe's most outstanding research centres active in the field of aeronautics and air transport.

5.982 employees in aviation research

€ 559.000.000 spent on research in aviation

STANDARDS FOR INTEGRATED AIR AND MISSILE DEFENCE (IAMD) MULTIFUNCTION SENSORS NETWORKING INTO FIRE CONTROL CLUSTERS

Collective writing from the NIAG SG260 management team (Chair : Luc Dini-Thales/ Vice-chair : Egido Cañas - Indra/ Secretary : Gustavo Scotti di Uccio- AOS/ System group lead: A. Merbaum- Booz Allen/ Technical group lead:U. Doyurian- Aselsan)

February 24, 2022, marks the change of modern conflict in Ukrain reflecting the use of missiles and air weapons as on other recent crisis theaters, but this time with a wider diversity of weapons and a higher intensity. Without question, it underlines the interest and importance of this subject for a Study Group (SG260) from the NATO Industry Advisory Group (NIAG), gathering 14 nations/ 33 companies/ 65 experts *(see Figure 1)* . This study shows that the integrated air and missile defense can be furthermore improved to enhance the robustness, the resilience and adaptivity of IAMD architecture across NATO allies and partners.

Over ten years ago, NATO endorsed 'Smart Defense', "ensuring greater security, for less money, by working together with more flexibility"[1] in a context of lower intensity scenario. Today, due the diversity, the intensity and the combination of the threat we have to adapt to new challenges.

Assessing the challenges and efficacy of developing standards for Integrated Air and Missile Defense (IAMD) multifunction sensors and enabling them to network across fire control clusters among systems provided by the member nations of the NATO Alliance is the near-term opportunity to realize this approach to Smart Defense as we face the threats upon Europe and the Alliance today: hypervelocity cruise missiles, maneuvering ballistic missiles, artillery, mortars, Unmanned Aerial Systems (UAS / Drones), electronic warfare (EW) and decoys, and conventional fixed and rotary wing aircraft.

The benefits of networking the Multifunction Fire Control Radar (MFR) systems of national air and missile defense assets can be addressed through data and services sharing to achieve greater efficiency and performance. This networking uses new modes of operation leveraging multifunction sensors operating **not only as stand-alone sensors connected by legacy links** (such as Link-16), **but as networked clusters of sensors and Command and Control (C2)**, breaking stove-pipe effects that limits interoperability *(see Figure 2)*. They can operate either in cooperative modes (data exchange, plots/tracks) or in integrated modes (services/resources exchanges), with faster communication links with a higher continuity of active tracking and reactivity (subsecond) and reach three objectives: (a) higher quality fire control data, (b) increased system resiliency, and (c) optimized interoperability.

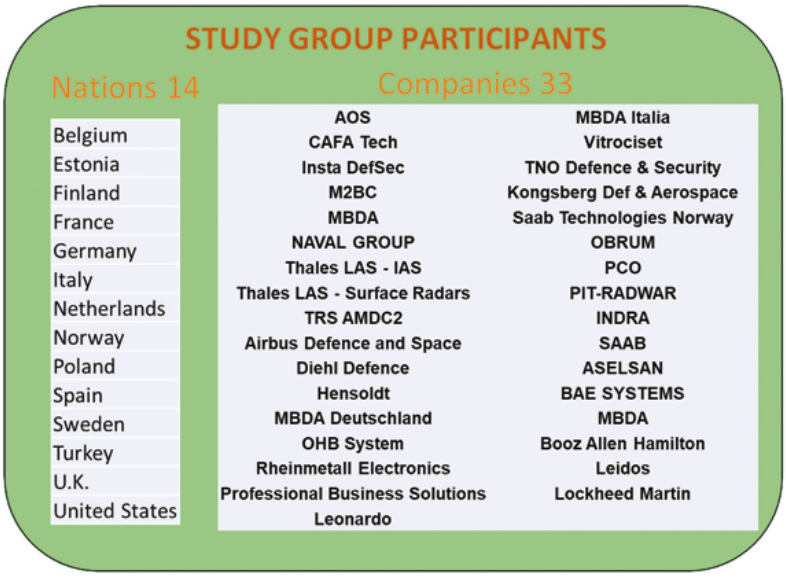

Figure 1: NIAG SG260 Team

1. NATO – News NATO Secretary General calls for 'Smart Defence' at Munich Conference, 4 February 2011.

The fire control cluster netcentric architecture keeps systems clusters interoperable under the current NATO AIR-C4I and L16 while increasing their horizontal scalability.

The dynamic management (latency less than one second) of services shared between sensors and Fire Control Systems creates a surprise effect enhancing defense capabilities by adapting what we have defined as the **'chameleon concept'** applied to fire control cluster modes of action *(see Figure 3)*. This enables the warfighter with greater flexibility to manage the concentration and distribution of resources in real time, optimizing automatically with AI processing, the balance of services, functions and data between the systems and sensors elements of

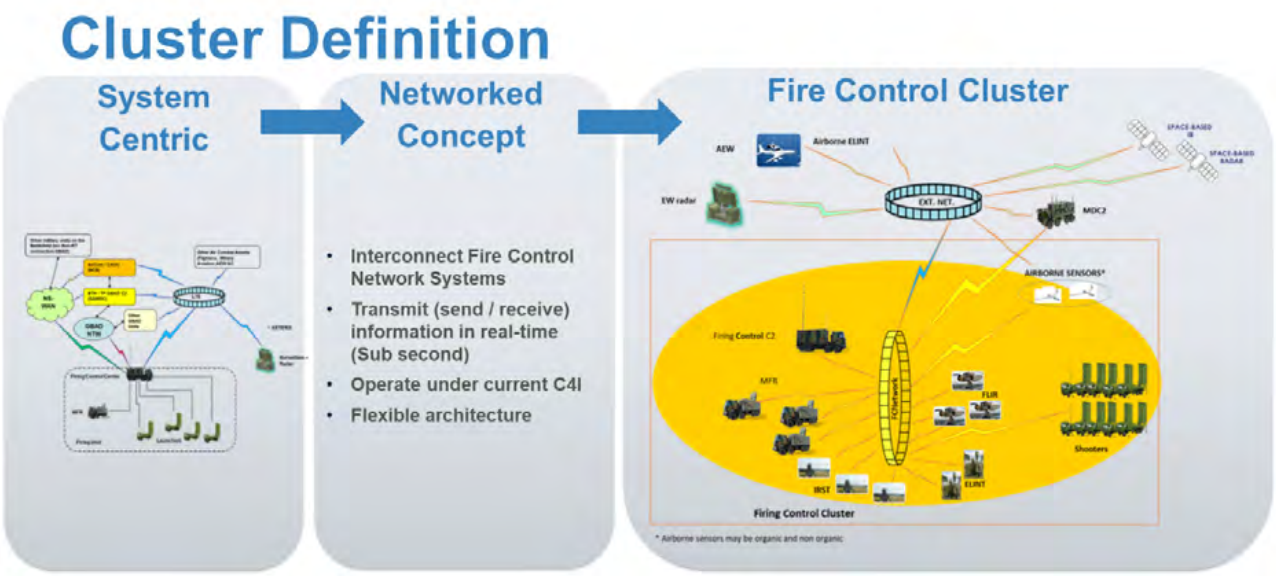

Figure 2: Evolution from system centric architecture wirh legacy datalinks to netcentric interactive clusters

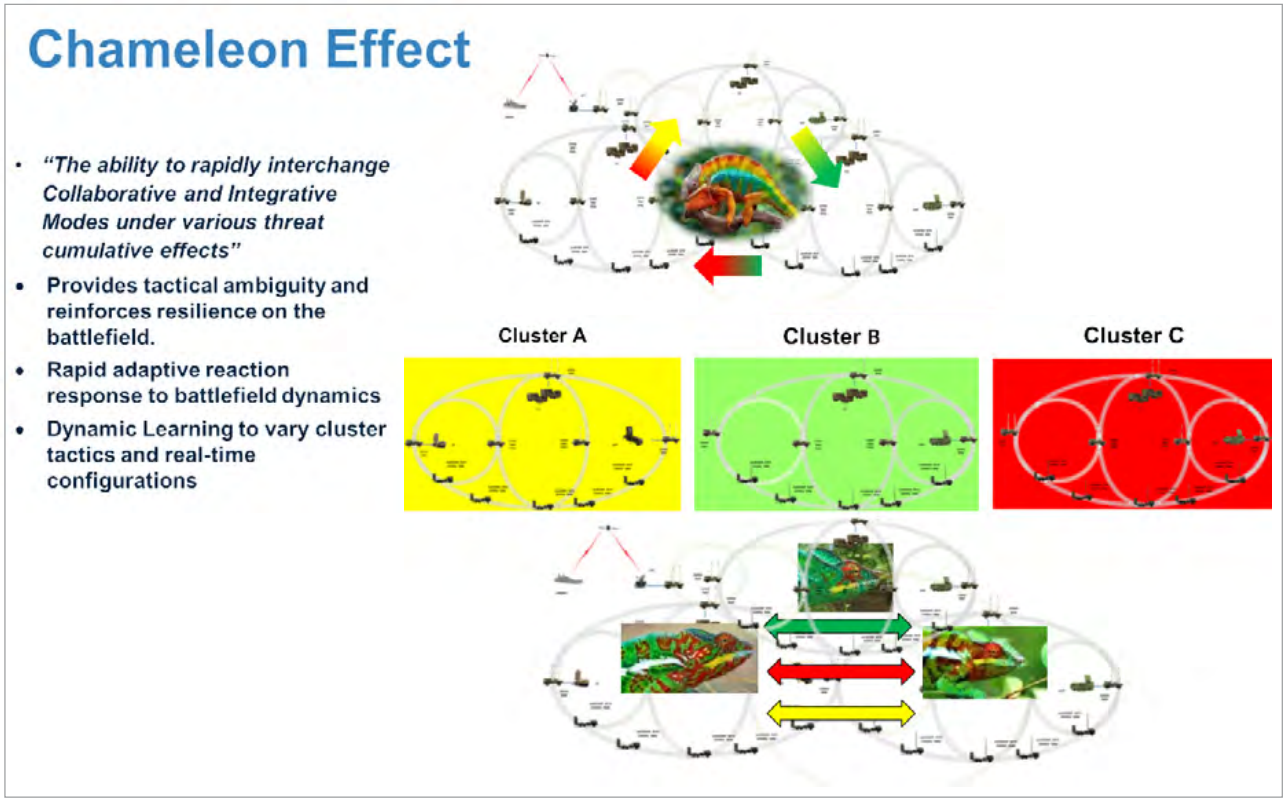

Figure 3: Clusters tactics interaction through mix of data and services (chameleon concept)

a fire control cluster. This optimization is under the warfighter control adapting the modes of exchanges under various and fast changing tactical situations, based on situation analysis with AI and modes of action options.

The transformation of Fire Control Systems must be conducted progressively *(see Figure 4)* to legacy systems or new ones under development by implementing modular functions like data fusion trackers or real time resources optimizers and LOS communications (existing technologies). These modules shall meet the common standards recommended.

In conclusion, the combined effects of interoperable dynamic fire control clusters is an imperative to enhance effectiveness, redundancy, and resilience under harsh combat conditions while increasing the scalability of systems.

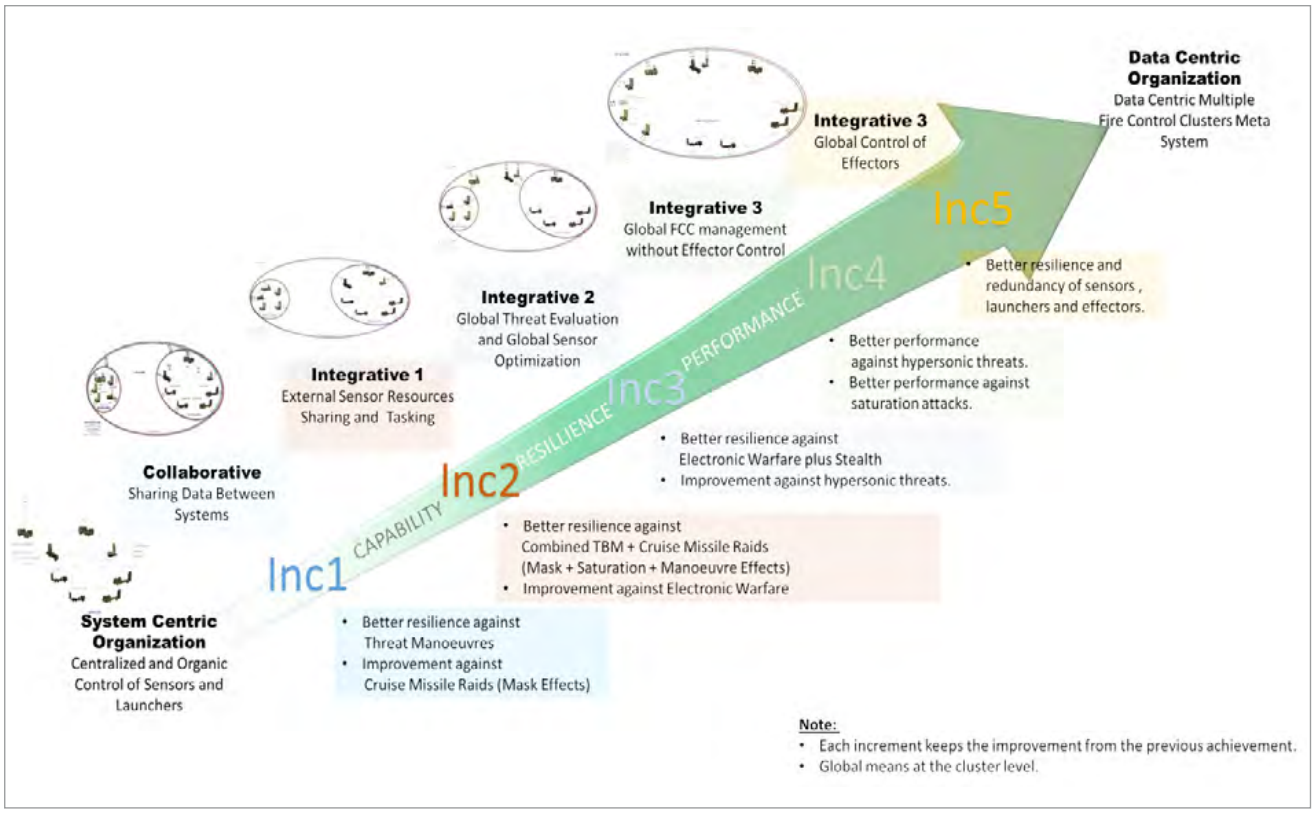

Figure 4: Roadmap

TEMPEST PROGRAMME

ROYAL AERONAUTICAL SOCIETY

At 2022 Farnborough airshow, Tom Robinson FRAeS presented the status of the TEMPEST programme. By his courtesy, we publish it here after.

Unveiled by then Defence Secretary Gavin Williamson at Farnborough in 2018, the Tempest future fighter grabbed headlines as the UK unveiled its vision for a follow-on combat aircraft that would replace the Eurofighter Typhoon in the 2040s. More accurately designated as FCAS (Future Combat Air System Technology Initiative), this UK-led project comprises BAE Systems, Rolls-Royce, Leonardo and MBDA as the main partners in the industry consortium, as well as the UK MoD and international participation from Italy and Sweden. Some 2,000 workers across the industry partners are now involved in the project, with the concept and assessment (C&A) phase of the Acquisition programme launched in July last year, and an initial operational capability (IOC) is aimed for 2035. With BAE receiving £250m on behalf of the other partners for this C&A phase, the UK plans to invest a further £2bn over the next four years.

THE DIGITAL THREAD

Digital design and the factory of the future will help accelerate Tempest (BAE Systems)

Tempest's game-changing advances are not so much in its impressive technology but in the shift to digital design, modelling and engineering, as well as a cultural shift of agile development between partners. The reasoning is simple: after extended development times pushed the cost of fighters to unaffordable levels, Tempest aims to reverse this trend and slash the development time in half compared to previous combat aircraft. To achieve this, it is harnessing the full power of model-based systems engineering (MSBE) and model-based design (MBD). Far more than just design blueprints transferred to computer, MSBE and digital design allows the entire aircraft, its systems and even the factory itself to be created and simulated with 3D components that have physical properties – and which can run though multiple configurations and testing. The final result should be a faster, cheaper development path where components fit together perfectly first time and no rework is needed. Says John Stocker, BAE Systems Business Development Director responsible for FCAS: "That digital piece is absolutely key and again at the heart of what makes this a next-generation programme."

Stocker stresses that although the 'core platform' of the Tempest fighter revealed in mock-up format is the most recognisable part, the FCAS TI work currently under way is far larger, with four other key areas:

- adjuncts – which include 'loyal wingmen' UCAVs and which make this a 'system'
- C2 – or the information aspect "it's that digital capability, exploitation of data and that digital thread that runs through this that is such a critical enabler to the joined-up network capability," says Stocker
- Effect – which includes kinetic weapons from MBDA and non-kinetic effectors
- Through life services, including training, support and upgrades – again says Stocker, the 'digital thread' "absolutely runs through all of that as well. For future sustainment, it's massively transformed through digitalisation".

This development though, is not just 'big data' and faster computers, but a cultural revolution going on inside BAE systems and its partners with "scrum teams pushing down responsibility, decision-making as far down the system as we can and allowing those who are closest to the work to make the decisions," says Stocker. This agile development is removing the barriers and traditional time constraints.

INTERNATIONAL BY DESIGN

Will Japan partner on Team Tempest in some way? (BAE Systems)

Unlike many previous British combat aircraft programmes, which were aimed at fulfilling UK and European requirements first, with export orders added on as an afterthought, Tempest has been created to be 'international by design' from the beginning. It has also learnt from experience on the US-led international F-35 programme, and if that locked-down programme model was a 'set menu', Tempest is set to be a '6th generation fighter buffet' – with partners able to pick and choose which bits suit them best. For example, although Italy has joined Tempest itself, Sweden is a partner on the wider FCAS, looking to feed any technology back into its Gripen E. This partnership approach and 'non-linear' development mean that Tempest is thus highly attractive to international partners who will be able to 'mix and match' their budgets, participation and requirements to get the absolute most out of the programme.

Significant news later this year is likely to be a deepening and broadening of the partnership with Japan, who is already collaborating with Rolls-Royce for engines on its F-X and sensor technology with Leonardo. Japan, an island nation, with similar air defence requirements to the UK, and an extremely advanced high-technology industrial base, would, therefore, be an extremely valuable partner.

Indeed, should Japan end up joining Tempest/FCAS as a partner, it is difficult to underestimate the geostrategic shift of this co-operation – marking a break from 70+ years of Tokyo's dependence on US military aircraft from the F-86 to the F-15J and vindicating 'Global Britain' and its ability to strike new deals in an agile and speedy manner.

Stocker stresses that the international aspect and the investment it provides is key to Tempest, refuting claims that the programme is underfunded by the UK: "From my perspective, it's always been absolutely clear that an international programme is critical to this".

GENERATION TEMPEST

Tempest is now shifting the balance towards a new generation of engineers. (BAE Systems)

However, Team Tempest is not just about developing a futuristic fighter and combat air system. It is also about retaining key knowledge, passing this on to the younger generation and inspiring future generations of aerospace professionals. Prior to the launch of Tempest, there was a concern that with fewer and fewer large military aviation programmes, the UK's combat aerospace sector could wither and die, as the older generation retire. The Eurofighter Typhoon dates from the 1980s – some four decades ago. There was then, serious worries that this skill gap would widen and that UK plc would eventually lose this critical in-house experience, skills and knowledge.
However, the unveiling of Tempest and the 'buzz' generated by the biggest new fighter project in decades now seems to be paying off – attracting a younger 'generation Tempest' into the industry to work on this advanced project. It is already changing the demographic among Team Tempest partners with over 1,000 young apprentices recruited between 2018 and 2020. This has noticeably shifted the age profile in Team Tempest from around 14% under 30 back in 2018 to around one fifth today – and 40% of workers are under 40. Indeed, there is now a TECN, (Tempest Early Careers Network), for these young apprentices and graduates who have recently joined and who will be followed by others in the future. As Stocker notes: "Frankly a lot of the people here are just entering their early careers now but as well there will be lots of people who are still at school or not yet born, who are essentially going to be the people who will be delivering this programme".

UNSHEATHING EXCALIBUR

Meanwhile, at an airfield at Lasham in the south of the UK, a Boeing 757 is currently awaiting conversion to a unique flying test bed to support Team Tempest. Called Excalibur and to be converted by 2Excel Aviation and

Forging Excalibur - this 757 testbed will be only stealth fighter flying lab outside the China and the US. (2Excel

with Leonardo as prime contractor, this 757 will be packed with sensors, test equipment and a virtual cockpit as a sixth-generation combat aircraft test bed. A sovereign UK capability (with additional capacity for non-FCAS test work) it will be the only such advanced flying laboratory outside the US or China. AEROSPACE understands that 2Excel is already gearing up for a major recruitment push for engineers and technicians to work on converting this airliner into a unique technology demonstrator that will test the radars, sensors, avionics and 'virtual cockpit' set to go into Tempest.

A PACIFIC OCEAN WORTH OF DATA

Tempest will be able to hoover up and process incredible amounts of data from its sensors. (Leonardo)

Although much of the R&D development going into FCAS and Tempest is classified, there have already been intriguing hints of some of the advanced capabilities being designed in around 60 different workstreams by BAE and its partners. For example, the planned integrated radar/sensor system from Leonardo is expected to possess the computer processing capacity of a large city every second. Meanwhile, Rolls-Royce's embedded electric starter, will allow for a reduced fuselage profile for the jet engines that will power Tempest. Tempest's projected data capabilities are already eye-watering: "this system will generate an exponentially greater amount of data than anything that's been done previously from a combat air point of view," says Stocker, who says that if 1 kilobyte = grain of rice, a Tempest mission will generate a 'Pacific Ocean' full of rice, compared to the 'Isle of Wight' that a pair of Typhoons can collect today. This is yet another example of how the 'digital thread' runs through the core of Tempest from its design to its front-line capabilities all based on the processing of vast amounts of information.

MERGING HUMAN AND MACHINE

Haptic vests are now being flight tested as part of the R&D effort. (BAE Systems)

Another R&D programme under way is a BAE flight test campaign at Warton investigating the use of wearable haptic devices that could potentially make its way into Tempest. This would take the audio warnings, such as 'SAM launch, SAM launch' common in today's fighter aircraft and enhance them by using haptic body vests (adapted from video gaming technology) to 'tap' the pilot on the shoulder in the direction of a threat, or potentially a 'buzz' could indicate 'bingo' fuel. BAE believes haptics could be a highly effective way of getting a pilot's attention for critical alerts, especially when they become task saturated or the radio is extra busy – as audio warnings are the first to be filtered out in high-stress situations. The flight tests, which commenced in June, use a light aircraft in a series of 45-60min flights with the pilot flying a series of manoeuvres, up to 2G, while an observer wearing a haptic vest uses tablets and attempts to complete tests. The goal is to see how effective the haptics are in gaining a pilot's attention under real flying conditions and are the first time this video game technology has taken to the skies.

As well as these haptics, Stocker hints that the 'core platform' Tempest augmented reality cockpit could very well be the most highly merged aircraft-human interface ever designed – with the fighter monitoring the pilot's health, awareness and mental focus to be able to step in at any point to assist with taking care of some non-core functions, allowing the human to complete the mission.

FULL SUCCESS OF THE FIRST ARTEMIS LUNAR MISSION

OPENING A NEW ERA OF SPACE EXPLORATION

The 11th of December 2022 marked the end of the first Artemis Moon mission when NAS's Orion spacecraft splashdown in the Pacific Ocean at 17:40 GMT after having travelled around the Moon and beyond.

Artemis I mission is the first of a series of increasingly complex missions to build a long-term human presence at the Moon for decades to come. Its primary goals are to demonstrate Orion's systems' performance in a spaceflight environment and ensure a safe re-enrtry, descent, splashdown, and recovery prior to the first flight with crew on Artemis II.

The Artemis I mission, which was uncrewed, provided a first test of NASA's Space Launch System (SLS), NASA's spacecraft and ESA's European Service Module (ESM). It was the first integrated flight test of NASA's space exploration systems. The latter were pushed to their limits, vital for ensuring that crew members in the next Artemis missions are absolutely safe.

It is to be highlighted that for the first time, NASA used a European-built system as a critical element to power an American spacecraft. Provided by ESA and its partner Airbus Defence and Space, ESA extends NASA's international cooperation from the ISS into deep space exploration.

LET'S BRIEFLY RELIVE THE ARTEMIS I MISSION FROM LAUNCH TO SPLASH

THE TRAJECTORY MAP

The here below illustration *(Figure 1)* allows to precisely identify the major Artemis I mission milestones.

Liftoff – 16 November at 06:47 GMT, NASA's Space Launch System (SLS) carrying Orion spacecraft lifts-off from Launch Pad 39B at Kennedy Space Center, Florida *(Figure 2)*

Figure 2. The launch of Artemis 1. © NASA

For the ESA's European Service Module (ESM), the first key moment came just 2 minutes after launch when its main propulsion system was activated.

- At 18 minutes into the flight, when it was time for Orion to switch on its own power, the ESM's four-wing solar array was deployed.
- Around 90 minutes after launch, with the upper-stage engine ignition, Orion was propelled towards lunar orbit. At this point the solar panels were folded backward by 35 degrees in order to reduce the loads generated by the SLS's upper-stage *(Figure 3)*
- Around 2 hours after launch, Orion separated from the ICPS (Interim Cryogenic Propulsion System). The ICPS

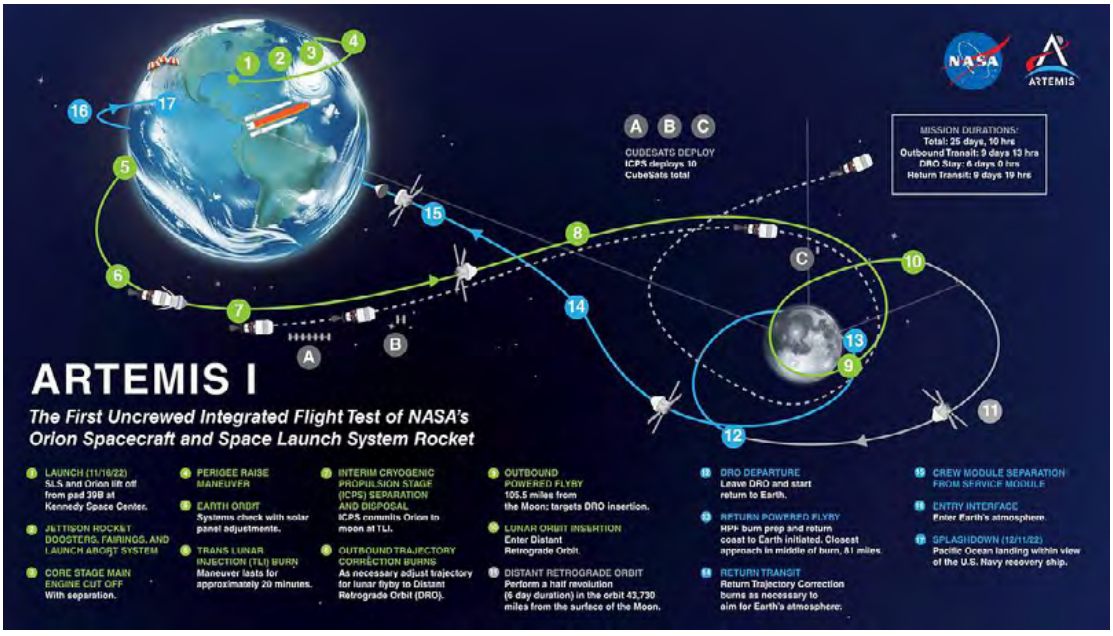

Figure 1. Artemis 1 trajectory map © NASA

https://www.nasa.gov/image-feature/artemis-i-map

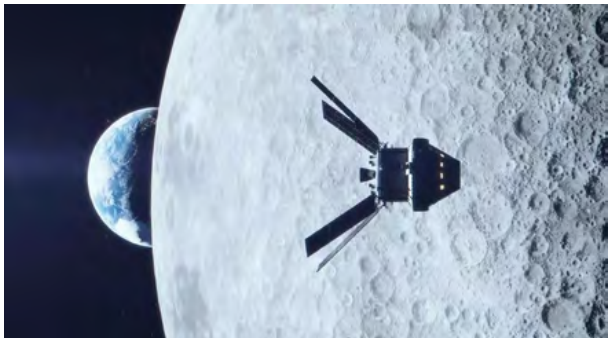

Figure 3 Solar arrays are folded backwards by 35 degrees. © NASA

deployed 10 CubeSats along the way to study the Moon and beyond.

- Around 7 hours after launch, the solar panels were placed in their final position, generating 11 kW of electrical power. *(Figure 4)*

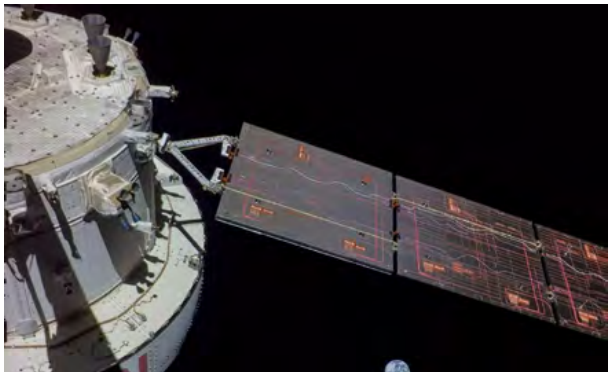

Figure 4 Orion on its way to the Moon – © NASA

- Perigee Raise Manoeuvre - Interim Crygenic Power Systems (ICPS) burn to raise Orion's altitude at the point in the orbit where the spacecraft is nearest the Earth (perigee).
- Trans-lunar injection – ICPS burn to increase Orion's speed from 28,000 to 36,000 km/h in order to escape the pull of Earth's gravity to a precise trajectory to the Moon.
- Outbound Powered Flyby Burn - On 21 November at 12:44 GMT, the first flyby occurred, with the European Service Module firing its 33 engines to send Orion behind and around the Moon, close enough to leverage the Moon's gravitational force and direct the spacecraft towards entry into Moon's retrograde orbit.
- On 25 November at 12:44 GMT, i.e. ten days after liftoff, Orion spacecraft entered Moon's Distant Retrograde Orbit (DRO), stabilized by the ESM.
- From 25 to 30 November: Distant Retrograde Orbit (DRO). Orion spent 6 days around the Moon. It came at 130 km of the lunar surface – closest approach – and achieved a maximum distance from Earth of 432,000 km.
- On 1 December: DRO Exit Burn. European Service Module's engines burn to exit lunar orbit.
- From 1 to 4 December: exiting DRO.
- Return Powered Flyby Burn – European Service Module's engines burn to send Orion close enough to the lunar surface – second close lunar flyby - for a gravity assist from the Moon to engage on a trajectory back to intercept the Earth's atmosphere in preparation for re-entry.
- From 5 to 11 December: return transit.
- 11 December Orion returns to Earth: entry and splashdown.

Just 40 minutes before splashdown, the European Service Module detached from Orion and then burned up in the atmosphere. Re-entry speed: Mach 32 (~40,000 km/h) – temperature reached: ~2,800 °C.

Orion continued its re-entry guided itself with its two thrusters and in the end released its 3 parachutes *(Figure 5)*. On 11 December at 17:40 GMT Orion splashes down in the Pacific Ocean, west of Baja California after a 25.5-day historic mission. *(Figure 6)*

Figure 5 Orion releases its three parachutes before splashing down at 17:40 GMT on 11 December 2022. © NASA

THE SLS

- Three components (Figure 7): One central core stage – Two outboard solid rocket boosters – Upper Stage ICPS (Interim Cryogenic Power System)
- Height: 64.6 m
- Diameter: 6.1 m
- Can produce 4 million kg thrust (15% more than Saturn V)

THE ORION SPACECRAFT

The Orion spacecraft is made of three primary components:

- The Launch Abort System (LAS)
- The crew module, the habitat for up to 4 astronauts (uncrewed for Artemis I)
- The European Service Module (ESM) *[Figure 8]*

THE EUROPEAN SERVICE MODULE

The European service Module is ESA's contribution to NASA's Orion spacecraft. It supports the crew module from launch through separation prior to re-entry. It provides in-space propulsion capability for orbital transfer. It gene-

Figure 6 Perfect splash: Artemis I mission successfully completed. Orion secured inside USS Portland ahead of return to shore.. © NASA

Figure 7 NASA's Space Launch System rocket with the Orion spacecraft for Artemis I arrived at Launch Pad 39B at Kennedy Space Center © NASA/Joel Kowsky

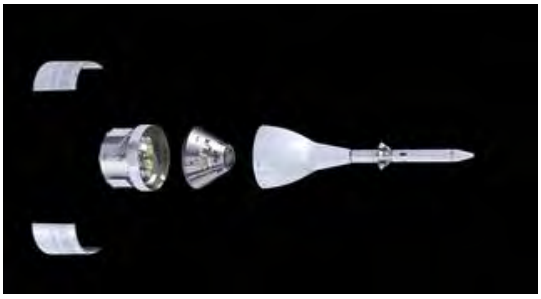

Figure 8 Orion is made of three main sections. From the left: (1) The service module, from the European Space Agency, fuels and propels the spacecraft. (2) The crew module is the habitat for up to four astronauts. (3) The Launch Abort System detaches and flies away after Orion reaches orbit. © NASA

rates electricity power (solar arrays). It provides drinking water, oxygen and nitrogen for breathable atmosphere needed for a habitable environment. It maintains the temperature of the vehicle's systems and components.
General characteristics: height = 4m – diam. = 4.1 m (excluding solar panels 19 m when unfold) – gross mass = 13,500 kg – 33 thrusters – 4 propellant and 2 pressure

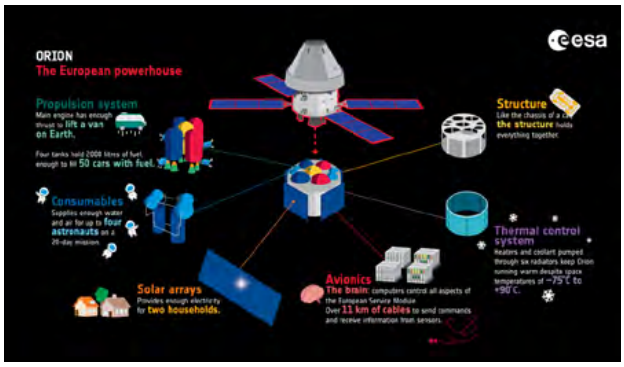

Figure 9 Orion and the European powerhouse © ESA https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Orion/First_Artemis_lunar_mission_ends_so_long_European_Service_Module-1

tanks - maximum thrust = 26.6 kN – 11 km of electrical wiring – Provides everything needed to keep astronauts alive from Earth.

ARTEMIS I MISSION RESULTS

Artemis I mission achieved all its objectives, allowing to validate:

- The NASA's Space Launch System (SLS)
- The Orion spacecraft
- The European Service Module
- The re-entry phase
- The splashdown process.

During the mission, ESA's ESM Mission Evaluation Room team provided in-depth advice and knowledge to flight control at NASA's Johnson Space Center in Houston, linked back to a team at ESA/ESTEC in Noordwijk (NL).
ESA is now placed in the best possible conditions for pursuing its preparation for the next following Artemis missions;

- Artemis II, the first crewed mission with 4 astronauts being sent for a lunar flyby , duration 3 weeks maximum - launch date 2024;
- Artemis III, the second crewed mission and the first crewed Moon landing mission – 4 crew members of which two astronauts will land on Moon's South polar region and stay for about 1 week – Launch date 2025. This will be the first Moon landing mission since Apollo 17 in 1972.

In addition to the successive ESMs, ESA is also managing the European contributions to the Gateway. These include the ESA-led international Habitation Module (I-Hab) and ESA's refuelling module, part of ESPRIT (European System Providing Refueling In frastructure and Telecommunication). They will be ferried to lunar orbit by the Orion spacecraft of the Artemis Iv and V missions respectively.

Synthesis written by Jean –Pierre Sanfourche on the basis of NASA and ESA information.

MINISTERS BACK ESA'S BOLD AMBITIONS FOR SPACE WITH RECORD 17% RISE

Europe will strengthen its autonomy, leadership and sustainability in space, following today's decision to increase ESA's budget by 17% compared to the last Ministerial meeting in 2019.

At the ESA Council at Ministerial level held in Paris on 22 and 23 November, government ministers representing ESA's Member States, Associate States and Cooperating States resolved to together strengthen Europe's space ambitions, ensuring a continuous concerted effort to serve European citizens.

Ministers confirmed that Europe's independent access to space is crucial to secure the benefits that space brings to life on Earth – including climate change monitoring and mitigation, secure communications and navigation under European control, and rapid and resilient responses to crises.
By committing to future space exploration, Europe has also committed to advancing scientific understanding, fulfilling its potential and retaining its talent for generations to come. ESA is working to ensure that essential space-based services are secure, and that Earth's orbital space is responsibly managed.

Josef Aschbacher, ESA Director General, said: "When faced with economic hardship, it is important to invest wisely in industries that create jobs and prosperity in Europe. Through this investment, we are building a Europe whose space agenda mirrors its political and future economic strength. We are boosting space in Europe, kicking off a new era of ambition, determination, strength and pride. Climate and sustainability will remain ESA's highest priority, our science and exploration will inspire the next generation, and we shall build a place where European space entrepreneurs thrive."

Robert Habeck, Federal Minister for Economic Affairs and Climate Action in the German government, chaired the ESA Council at Ministerial level. He said: "Today at the ESA Council at the Ministerial level, together with all the Ministers from ESA Member States, we secured a further step to strengthen Europe's space infrastructure on which every citizen relies every day, ranging from climate monitoring satellites to navigation and telecommunication.
"We also approved an important set of projects that keep our orbits safe, inspire our young people, offer opportunities for small and large companies to succeed in Europe and further strengthen our reputation as a high-tech region that can attract talent. By acting together, especially in challenging times, we can ensure that Europe remains a leader in science, technology and sustainability."

Climate remains a high priority for ESA Member States
Ministers agreed to devote €2.7 billion to ESA's Earth observation programme.
This includes funding for FutureEO, ESA's world-leading Earth science, research and development programme that harnesses innovation and develops pioneering missions, while fostering innovative ways of using Earth observation data.

They committed to further developing the continuity of the space component of the Copernicus programme based on newly identified needs; the operational Aeolus-2 mission to measure global wind speeds and improve weather predictions; strengthening the monitoring of new essential climate variables and supporting climate action; the InCubed-2 initiative to support commercialisation in the Earth observation industry; developing a digital twin Earth model using high-performance and cloud computing or artificial intelligence; continuing the development of the TRUTHS mission, which will ensure the cross-calibration of data from various climate missions that underpin critical models; expanding the network of third-party Earth observation missions; and preserving essential long-term climate data sets.

They gave the green light to two ambitious missions: the next ESA Earth Explorer, Harmony, that promises to provide novel data to answer crucial questions related to ocean, ice and land dynamics, which have a direct bearing on risk monitoring, water and energy resources, food security and climate change; and MAGIC, a gravity mission that will observe the volume of water in oceans, ice sheets and glaciers in order to better understand sea-level change and to improve water management.

Science consolidates its world-leading role

With €3.2 billion dedicated to the scientific programme, ESA is implementing the missions from its Cosmic Vision programme while preparing the new space science programme, Voyage 2050, which defines the broad vision of ESA science for 2035 to 2050. Member States confirmed the world-leading role played by the science programme, while recognising that difficult economic conditions eroded the potential for any large funding increases.

On time for launch in 2023 are Juice and Euclid, two ambitious missions that embody European leadership and collaboration. Juice will explore Jupiter and its ocean-bearing icy moons – studying where life may have formed elsewhere in the Solar System. Euclid will map a large part of the Universe, observing billions of galaxies through ten billion years of cosmic time, to unveil the secrets of the mysterious dark matter and dark energy that together make up 95% of the Universe.

The funding will continue the development of ESA's world-leading fleet of dedicated missions to study extrasolar planets – Plato and Ariel – set to launch in 2026 and 2029, respectively. Launching with Ariel will be Comet Interceptor, ESA's innovative fast-class mission that comprises three spacecraft and will be the first to visit a truly pristine comet – an interstellar object that is only just starting its journey into the inner Solar System.

Boost to the ESA exploration programme and confirmation for the Rosalind Franklin rover

Space exploration offers a unique combination of cutting-edge science, technological innovation and inspiration for the next generation. Ministers approved €2.7 billion for the next phase of Terrae Novae, ESA's new worlds space exploration programme focussed on three destinations – low Earth orbit, the Moon and Mars. Terrae Novae leads Europe's human journey into the Solar System using robots as precursors and scouts.

Ministers decided to extend European participation in the International Space Station up to 2030, enabling ESA astronauts to continue working in orbit around Earth on board Europe's Columbus research laboratory.

The next destination is the Moon and the major new element approved is Europe's large logistic lander, Argonaut, which will be capable of routinely dispatching science payloads and cargo to the Moon throughout the 2030s. Ministers also agreed to start work on the next batch of European Service Modules. These elements reinforce Europe's essential role in the Artemis programme, including the flights of three ESA astronauts to the lunar Gateway, and support Moon surface exploration, heralding the possibility for an ESA astronaut to set foot on the lunar surface. ESA will continue to work on building its elements of the Gateway, and to support the development of international lunar services with the Lunar Pathfinder satellite.

Looking towards Mars exploration, and with strong backing from the science community, the decision was made to build a European lander to take the Rosalind Franklin rover to the surface of Mars to explore whether life existed in the ancient lakes of the red planet.

The next steps were also confirmed for ESA's cooperation with NASA on Mars Sample Return, a daring plan to return physical samples from another planet for the first time. Following the recent completion of the design work, full development of both the giant Earth return orbiter and the sophisticated sample transfer arm for the sample retrieval lander will begin. The first Mars samples have recently been acquired by the Perseverance rover.

Bolstering connectivity, security and sustainability from space

Some €1.9 billion was dedicated to improving life on Earth through always-on-everywhere connectivity. Most of this will be channelled through ESA's programme of Advanced Research in Telecommunications Systems, which seeks to foster innovation in the European space industry to enable companies to succeed in the highly competitive global market for telecommunications satellites and their applications.

The first step towards creating an EU-led secure connectivity system was taken with the funding of a new ESA programme. With €35 million firmly subscribed in the first phase, ESA will initiate the preparatory activities that will lead to the development and validation of a European constellation of satellites for secure connectivity. The second phase, for €685 million, is due to be confirmed in 2023.

Other funded plans include ESA's Moonlight programme to encourage private European space companies to offer a lunar telecommunication and navigation service by putting a constellation of satellites around the Moon, and a new programme called civil security from space, which comprises a space-based rapid and resilient response for real-time crisis management to serve European citizens.

Future navigation technologies get the green light

Based on ESA's achieved expertise in developing Galileo and the European Geostationary Navigation Overlay Service for the European Commission, ESA's FutureNAV programme will enable the Agency to respond to future trends and to the needs of satellite navigation in the field

of positioning, navigation and timing, allowing Europe to stay at the cutting edge of satellite navigation technology. The next steps include an in-orbit demonstration of navigation satellites in low Earth orbit and a single satellite mission called GENESIS to reach unprecedented measurements of Earth and improved positioning performance.
The budget for navigation has therefore risen to €351 million. Additionally, ESA's Navigation Innovation and Support Programme will continue to support the development of innovative positioning, navigation and timing technologies and foster commercialisation in Europe, the largest and ever-growing downstream space market.

Space safety to advance missions and technologies
With a rise to €731 million, the space safety programme will step up its efforts to protect Earth from hazards originating in space through missions including: Vigil to monitor the Sun's activity; the Hera probe that will perform a detailed post-impact survey of the Dimorphos asteroid; and the first removal of an item of space debris from orbit, scheduled for 2026.
The programme will also kick-start a valuable new market for in-orbit servicing, while developing new technologies to help ensure a sustainable, circular economy in space.

Space transportation becomes stronger and more environmentally sustainable
The ESA budget for space transportation has risen to €2.8 billion. ESA will further strengthen its Ariane 6 and Vega-C launchers, complete the development of the reusable Space Rider that can stay in low Earth orbit for more than two months before returning to Earth for refurbishment, and develop a green hydrogen system to fuel Ariane launchers at Europe's Spaceport in French Guiana, with the goal of eliminating carbon in hydrogen production by 2030. It will continue to mature critical technologies that underpin European capabilities while responding to environmental sustainability and cost-efficiency requirements, along with preparatory activities for the advent of human space transportation capabilities. ESA will also increase the efforts of its Boost! programme to help space entrepreneurs turn their space transportation projects into commercial reality.

Scaling up European technology and fostering commercialisation
Finally, the ESA budget for technology has increased to €542 million. Ministers have decided to start a new ESA programme called ScaleUp for supporting space commercialisation and the development of a new space ecosystem in Europe. ESA will work with European space firms to bring new technologies to the stage where they are ready for space and the open market through the "develop, make and fly" elements of its General Support Technology Programme. ESA will strengthen its independent and secure capacity to fly all types of missions by investing in new multi-mission infrastructure and next-generation ground segment capabilities developed by European industry.

Through its ScaleUp programme, the Agency will also aim to make Europe a hub for space commercialisation by providing business incubation, business acceleration, intellectual property and technology transfer services to new companies, while ensuring that business ideas scale up in new marketplaces and attract private and institutional investment.

PEGASUS: 25 YEARS OF SUCCESS

By Gustavo Alonso, Chair of PEGASUS

Next month of April, PEGASUS partners will hold their 50th Council meeting and celebrate the 25th anniversary of the network. Created in 1998, PEGASUS (Partnership of a European Group of Aeronautics and Space UniversitieS) is the partnership of the best European aerospace universities and currently has 28 members in 11 different European countries, representing extraordinary well the aeronautics and space higher education system in Europe. Today, more than 3000 aerospace engineers graduate at Master level from the member institutions of PEGASUS each year. PEGASUS partners have a reputation for high-quality research and a quality recognition in education and research (https://www.pegasus-europe.org).

The objective of PEGASUS is to offer highly relevant educational and research programs and thereby attract the best students and scientists. Coordinated developments, exchange of staff and students and innovation are the basis on which these objectives are achieved.

The strategic lines are, from an internal perspective, to improve the quality of the partners' educational process and curricula to specifically serve the needs of the aerospace industry, which are changing. This means strengthen furthermore the cooperation, continuing the harmonization of the different educational programmes and the exchange of students and staff. From an external perspective, PEGASUS works to increase the cooperation between the partners and the industry as well as with national and European research and technology organisations.

One of the most important tools to improve cooperation in education and research is to promote and facilitate international students and staff exchange. Exchange enables to share experience different for every partner, meet cultural differences and improve communication, get to know new approaches for scientific problems solving, combine unique know how of the partners and many more benefits. Within PEGASUS, the Working Group in Education has been developing different strategies to increase the cooperation and students and staff mobility, adapting always to the changing environment.

There is a very intense flow of students' mobility among the PEGASUS members, which is facilitated by the mutual recognition among the partners of the quality of their educational programmes.

The experience shows the success of PEGASUS to promote and facilitate the students' mobility, but also that there is still work to be done to increase the exchange of professors. The Working Group in Education is actively working in this line, using the opportunities brought by the intensification of the different modalities of distant learning and other blended or hybrid methods currently being implemented.

One of the most outstanding achievements is the organization every year of the PEGASUS Student Conference. It is intended for Master Students who have graduated from the PEGASUS Universities not more than one year before the date of the conference. It offers them a unique

Country	Institution
	Politecnico di Milano Politecnico di Torino Università degli Studi di Napoli Università degli Studi di Pisa Università degli Studi di Roma Università degli Studi di Bologna
	Ecole-air de Salon de Provence ENAC Toulouse ENSMA Poitiers ISAE Toulouse ESTACA
	TU Delft
	UPM/ETSIAE Madrid US/ESI Sevilla UPV/ETSID Valencia UPC/ESEIAAT Barcelona
	IST Lisboa
	Vilnius Gediminas Technical University

Country	Institution
	RWTH Aachen TU Berlin TU Braunschweig Universität Stuttgart TU Dresden
	Cranfield University University of Bristol University of Glasgow
	KTH Stockholm
	CVUT Prague
	Politechnika Warszawska
	University of Zilina

opportunity to get together, to exchange experiences, traditions and to create opportunities at international level. The conferences has been for many years sponsored by the AIAA, offering the possibility to AIAA student members to participate.
The Conference is organized on the basis of competitive selection. The first selection is operated at local level since each University is allowed to present not more than three papers. The written papers are then evaluated by two professors from different countries to the author(s) of the paper, recognized as experts in the covered topic. The final, combined score is obtained after the oral presentation at the conference by two other professors.
PEGASUS partners also work together to intensify the cooperation in research. These efforts are channeled by the Aerospace Research Working Group. One new initiative proposed is the creation of thematic research working groups. These should be composed by scholars working and teaching in the same disciplines, creating a higher awareness of the possible cooperation in the specific sectors. The first of these thematic groups is in the area of astrodynamics and has already started working on proposing a European PhD-level course on advanced astrodynamics tools and techniques.
The coming decades the aerospace sector is being confronted with enormous challenges imposed by the growth of the air transport industry, sustainability concerns, the emergence of new competitors (in aeronautics and space), geopolitical tensions, and the increased use of space by public and private organizations. A consequence of these challenges is that there will be a large demand in knowledgeable people. Deficiency of well qualified aerospace engineers is already noticeable. The engineers to be graduated from the European universities will have to operate in a multinational and multidisciplinary environment. The days that aircraft and spacecraft were designed by aerospace engineers only are over. An aircraft or a spacecraft nowadays is a highly integrated system were many disciplines have to work together. In this challenging scenario, PEGASUS can contribute to the creation of highly skilled workforce with a multi-cultural and multi-disciplinary background. Exploiting the strength and diversity of the educational offer of each member of the network, students can benefit from mobility programs to create their technical end cultural background by mixing a wide variety of contributions. This is possible because all members of the PEGASUS network have agreed on some basic principles, harmonizing the fundamental pillars of the aerospace education on top of which each student can build its unique profile and expertise.

Since its foundation, PEGASUS aims to offer itself as the European portal for higher education and university-based research in aerospace, being recognised as the most efficient channel to get university inputs at the integrated EU level. PEGASUS is very active supporting the European policies related to innovation in aerospace, which are needed to achieve the EU's self-imposed goal: the so-called "Route to net zero European aviation". PEGASUS is in close relation with industries and research centres, and from the institutional point of view PEGASUS is an active member of ACARE. PEGASUS participated also in the group of stakeholders that designed the new Clean Aviation European partnership.
PEGASUS is active in other initiatives of the European Commission, like the EC Expert Group on policies and programmes relevant to EU Space, Defence and Aeronautics industry, or the Pact for Skills, following closely this initiative to see how Universities can contribute in the best possible way to the up-skilling and re-skilling of the aerospace and defence workforce.

As part of this institutional cooperation, PEGASUS and CEAS have signed a Memorandum of Understanding in 2022, intended to serve for the development of a mutually beneficial scientific, technological, and organizational cooperation between both organizations in aerospace activities, promotion of developments in aerospace and popularizing the achievements and research in all areas of aerospace. The intended scope of the cooperation under this MoU include activities such as:

- Joint organization of conferences and workshops on specific topics of mutual interest
- Joint organization and promotion of students' events to support education and training of students in aerospace
- Joint participation in Specific Coordination and Support Actions in the frame of national and international funding schemes and programs
- Mutual exploitation of newsletters, bulletins, and other means of reaching the respective communities for publishing news of interest to the European Aerospace community
- Coordination of activities and development of streamlined policies with respect to important issues and challenges raised by European Commission, such as the framework programs, and other European bodies such as the Joint Technology Initiatives.
- Coordination, mutual support, and encouragement of cross-attendance to the scientific events of the two Parties as well as cooperation concerning the publication the respective scientific papers.

Universities are an essential element in the European aeronautics (aviation in general) and space ecosystems, together with the industry, research and technology organizations, and of course the European institutions. PEGASUS is the only association of aeronautics and space universities in Europe, and can add much value and contribute to the scientific and technological advancements that are needed to build a world-leading European aerospace sector.

AEC2023 LAUSANNE

CALL FOR ABSTRACTS OPENED!

You are invited to submit a 500-word abstract before February 1, 2023.

ATTENDEES

Conference Fees

	Early Bird		Full Price	
	without Gala	with Gala	without Gala	with Gala
Professional	CHF 1'040	CHF 1'180	CHF 1'248	CHF 1'398
Student	CHF 430	CHF 570	CHF 516	CHF 666
CEAS Member	CHF 990	CHF 1'130	CHF 1'188	CHF 1'338

ABOUT THE CONFERENCE

The Aerospace Europe Conference 2023 is a joint event between the **10th European Conference for Aerospace Sciences (EUCASS)** and the 9th conference of the Council of European Aerospace Societies (CEAS). The objectives in 2023 are to strengthen the link between space and aeronautics, facilitate cross-fertilisation and lay the foundations for a major unified international congress of aerospace sciences in Europe. With rich scientific content for the future of space and aeronautics, the Aerospace Europe Conference 2023 will present cutting-edge ideas for the world of tomorrow. Organised at the Swiss Tech Convention Center in Lausanne, Switzerland, the conference will also be an opportunity to discover the city, the Olympic Capital of the world, as well as the Swiss Federal Institute of Technology ranked 16th in the QS World University Ranking.

WHERE?

SwissTech Convention Center
Quartier Nord EPFL
Route Louis-Favre 2
1024 Ecublens
Switzerland.

WHEN?

9-13 July, 2023

TARGET AUDIENCE

This is the tenth EUCASS conference after Moscow (2005), Brussels (2007), Versailles (2009), Saint Petersburg (2011), Munich (2013), Krakow (2015), Milano (2017), Madrid (2019), Lille (2022) and the the nineth CEAS conference after Berlin (2007), Manchester (2009), Venice (2011), Linkoping (2013), Delft (2015), Bucharest (2017), Bordeaux (2020), Warsaw (2021).

COVERAGE AND TOPICS

EUCASS is the largest aerospace conference in Europe. Along with the Council of European Aerospace Societies, the trend for 2023 will be:

- **AERODYNAMICS and FLIGHT PHYSICS** for Aircraft and Launch Vehicles including Re-Entry Bodies
- **CLIMATE-NEUTRAL AVIATION FUELS** and alternative propulsion systems
- **FLIGHT DYNAMICS/GNC and AVIONICS** for Aeronautics and Space Applications
- **SPACE STUDENT PROGRAMS**
- **NEW SYSTEMS FOR FUTURE SPACE OPERATIONS**
- **PROPULSION PHYSICS** for Aeronautic and Space Applications
- **REUSABLE SYSTEMS FOR SPACE ACCESS**
- **SUSTAINABLE SPACE** Logistics and Space Debris
- **SUSTAINABLE AVIATION** Design and Flight Operations
- **SPACE EXPLORATION** In-situ resource utilization
- **TURBOMACHINERY** for Aeronautical and Space Applications

More Informations
https://eucass-ceas-2023.eu/

SPACE CONFERENCE 2022 - DIGITALISATION AND PRIVATE COMPETITION BOOST SPACE TRAVEL

By Michael Geimer

There is a gold-rush atmosphere in space travel. More and more private companies are using space for commercial business ideas. How this new-space trend is changing spaceflight was the focus of the Space Conference 2022 (Raumfahrtkonferenz). 250 representatives from space research and industry as well as politics met in Stuttgart on 24 October 2022. In lectures and discussions, they talked about what drives New Space and how digitalisation and private competition are creating new technologies.

The biennial conference was organised by the German Society for Aeronautics and Astronautics (DGLR), the German Aerospace Center (DLR), the University of Stuttgart and the Baden-Württemberg Ministry of Economics, Labour and Tourism.

NEW SPACE COMBINES IT AND SPACE TRAVEL

Today, digital technologies and services are taken for granted in global communication, trade and mobility. With innovative business ideas, private companies and start-ups in New Space go one step further. They combine digital information technologies with space travel. The goal is to expand the commercial use of space.
Many business models of New Space companies rely on existing and future satellite services. Data transmission via satellite is becoming a service for a global internet, streaming services or an Internet of Things. Swarms of many thousands of small, low-cost satellites will transport huge amounts of data worldwide.

FROM THE UNIQUE TO THE SWARM OF SATELLITES

How New Space is changing the space industry was the focus of the first part of the space conference. Presentations and discussions gave an insight into what Germany must do to continue to play a pioneering role. Disruptive business ideas, faster technology developments and shorter innovation and product cycles, for example, are placing new demands on satellite construction – away from time-consuming and cost-intensive single items and towards the agile development and series production of low-cost small satellites.
"Since 2015, the global space economy has grown by 5.6 per cent per year, more than twice as fast as the global economy as a whole. Both the economic potential of spaceflight and its possibilities for meeting current challenges are gigantic," emphasised Dr Walther Pelzer, DLR Executive Board member and Head of the German Space Agency at DLR, in his opening statement. "It remains important that we position ourselves well for the long term. Our prosperity is based on know-how and technology. That is why we need to invest more in space travel and enable new business models".
Winfried Kretschmann, Minister President of the State of Baden-Württemberg, presented the state's space strategy. In his presentation "The Orbit-LÄND Baden-Württemberg: Aerospace in Transformation", he emphasised Baden-Württemberg's role as the number one space state in Germany with a view to industry, research and education.

QUO VADIS SPACE TRAVEL GERMANY?

In the second part of the conference, Baden-Württemberg start-ups and medium-sized companies presented their projects, motivations and paths. They talked about challenges and made suggestions on how to better promote a new-space culture in Germany. In her presentation "New Space Germany - Quo Vadis?", Dr. Anna Christmann shed light on how to build bridges between research, start-ups and industry.

Dr Anke Pagels-Kerp, DLR Director Space, underlined the role of DLR space research as part of the space ecosystem, using the example of DLR sites in Baden-Württemberg. "Whether in communications and navigation, launch components or orbital propulsion systems, or even quantum technologies – we develop our ideas in close cooperation with partners from industry." She highlighted the already successful and the new spin-offs from DLR institutes that stem from these partnerships.

SATELLITE ARCHITECTURE MADE IN BADEN-WÜRTTEMBERG

At the event in Baden-Württemberg's capital the focus was on space projects in the south-west of Germany. The participants talked about architectures for future swarm satellites, virtual development and standardised construction methods for series production.

"Space travel is undergoing a fundamental transformation. I see the transformation process characterised by the buzzword 'New Space' as a challenge," said Dr Nicole Hoffmeister-Kraut, Minister for Economics, Labour and Tourism of Baden-Württemberg. She described the great opportunities New Space holds for Germany and

Baden-Württemberg in particular. "Many companies and research institutions from the state of Baden-Württemberg are demonstrating in exemplary joint projects how they can continue to occupy a top position in international competition with innovative products and processes."

THE SATELLITE MARKET WILL INCREASE TENFOLD BY 2040

Current market analyses assume that the satellite market will grow to 2,700 billion US dollars by 2040. This corresponds to ten times the volume of the global automotive industry in 2020. Thanks to its systemic technology portfolio, the conference participants see the Baden-Württemberg space industry in a strong position for the New Space.

AIDAA

DATE & PLACE

The third edition of the Aerospace PhD-Days will be held in Bertinoro (FC), Emilia-Romagna, from the 16th to the 19th of April 2023.

THE CONGRESS

The Aerospace PhD-Days, International Congress of PhD students in Aerospace Science and Engineering is organised by AIDAA, the Italian Association of Aeronautics and Astronautics. AIDAA was founded in 1920 after the first world war by scientists and high officers of Italian Army and Air Force with the aim of promoting research, meetings, exchange of information, with the final goal of promoting the civil air transport in peace time. The PhD students will have the possibilities to share their activities to the colleagues all over the world and, thus, to create a net of the International young researchers; moreover, it will be possible to have a complete overview of the whole research activities in Aerospace.

The Aerospace PhD-Days are open to any PhD student in Aerospace Science and Engineering or with a PhD topic in the aerospace field. PhD graduated in 2023 are welcomed too. In order to participate, an extended abstract on the PhD topic or part of it (min. 2 and max. 4 pages) must be submitted (submission deadline 28/02/2023).

The main topics will be related to aeronautics, space, and aviation.

IMPORTANT DATES:

Abstract submission deadline: 28th February 2023
Notification of acceptance: 15th March 2023
Registration deadline: 20th March 2023
Conference: 16-19th April 2023

The congress will be held in Bertinoro (FC) in the Emilia-Romagna region from the 16th to the 19th of April 2023.

More information will be available on this page.

CONTACT US

phd-days@aidaa.it

AIDAA
ASSOCIAZIONE ITALIANA
DI AERONAUTICA E ASTRONAUTICA

The Italian Association of Aeronautics and Astronautics is a national non-profit cultural association, recognized as the second oldest scientific aerospace society in the world.

2023

AMONG UPCOMING AEROSPACE EVENTS

JANUARY

23-27 January – AIAA – **2023 AIAA SciTech Forum** – This Forum will explore advancements in digital technology and the possibilities it creates in aerospace industry – National Harbor, MD (USA) – MD & ONLINE – www.aiaa.org/SciTech/CFP

24-25 January – Business Bridge Europe – **15th European Space Conference** – Brussels (Belgium) – spaceconference@b-bridge.eu

FEBRUARY

02 February – RAeS – **Lecture: Hydrogen Air Vehicle Propulsion** – Cambridge University – www.aerosociety.com

13-16 February – ESA – **HAPS4ESA – State of the Art and Future Perspectives for High Altitude Pseudo Satellites in Europe** – Noordwijk (NL) – ESA/ESTEC – https://atpi.eventair.com/

MARCH

07-09 March– ESA – **ESCCON – European Space Components** – Toulouse (France) – https://atpi.eventair.com/

14-16 March– SAE International – **AeroTech: DIGITAL SUMMIT** – Fort Worth, Texas (USA) – https://www.sae.org/attend/aerotech

14-16 March– ATCA – **World ATM Congress 2023** –28042 Madrid (Spain) – IFEMA Parque Ferial Juan Carlos I – https://www.worldatmcongress.org

22-23 March– CAJU – **Clean-Aviation Forum** –Brussels Belgium) – CAJU/HQ – 56-60 Av. de la Toison d'Or – 4th floor – Brussels & Online – www.clean-aviation.eu

28-30 March– ESA – **SESP 2023** –Workshop on Simulation for European Space Programmes – https://atpi.eventair.com/

29-31 March– 3AF – **AERO2023** – **57th International conference on Applied Aerodynamics** – Bordeaux (France) – https://www.3af-aerodynamics.com

APRIL

03-07 April – IAA – **8th IAA Planetary Defence Conference** – In cooperation with ESA and the Commission of Geophysics of Austrian Academy of Sciences – Vienna (Austria) – https://atpi.eventair.com/

11-13 April – AIAA – **AIAA Defense Forum** – San Diego, CA (USA) – www.aiaa.org/defense

16-19 April – AIAA – **PhD Days 2023** – 3rd Edition of the Internal Congress of PhD students in Aerospace Science and Engineering – Bertinoro – Emilia Romagna (Italy) – Centro Residenziale Universitario (CEUB) – https:// www.aidaa.it/phd_days2023 - contact: phd-days@aidaa.it

17-21 April – COSPAR – **COSPAR 2023 - 5th Edition of COSPAR Symposium and 45th Scientific Assembly –** Among topics: Space Science with Small Satellites – Singapore – Nanyang Technical University – Contact: cospar@cosparhq.cnes.fr – https://www.cospar-assembly.org

19-22 April – AERO – **Aero Friedrichshafen** – The Leading Show for General Aviation – Friedrichshafen (Germany) - Friedrichshafen Airport – https://www.aero-expo.com

24-28 April – ETC – **ETC15 - 15th European Turbomachinery Conference** – Fluid Dynamics and Thermdynamics – Budapest (Hungary) – https://www.euroturbo.eu

MAY

03-05 May – EUROMECH – **Colloquium – Finite fracture mechanics** – Lyon (France) – https://euromech.org/ Dominique.leguillon@upmc.fr

07-12 May – IAA – **14th IAA Symposium on Small Satellites for Earth Observation** – Berlin (Germany) – https://iaaspace.org/events/

08-12 May – ESA – **First Microwave Week at ESTEC** – Noordwijk (NL) – ESA/ESTEC – https://atpi.eventair.com/

09-11 May – ESA/NASA – **EnVision Venus Science Workshop** – Understanding why Earth's closest neighbor is so different - Berlin (Germany) - https://atpi.eventair.com/

10-12 May – AAE – **International Conference on Space Exploration** – With support of AIDAA, Politecnico de Torino and SGAC – Turin (Italy) – Turin University – https://academieairespace.com/space-exploration/

20-22 May – ECOMAS – **CM3 – TRANSPORT 2023 – Computational Multiphysics, Multi Scales and Multi Big Data – CM3** – Jyväskylä (Finland) – University – https://www.eccomas.org/

22-25 May – EUROMECH – **Colloquium – Data-driven fluid dynamics** – Italy – https://euromech.org/

23-24 May – RAeS – **Future Combat Air and Space Capabilities - Conference** – London (UK) – RAeS/HQ – www.aerosociety.com

AMONG UPCOMING AEROSPACE EVENTS

22-24 May – ESA – **Conference: New capabilities and countries in European Space** – London (UK) – RAeS/HQ – www.aerosociety.com

22-24 May – ESA – **Conference: New capabilities and countries in European Space** – London (UK) – RAeS/HQ – www.aerosociety.com

23-25 May – EBAA/NBAA – **EBACE 2023** – European Business Aviation Conference and Exposition – Geneva (Switzerland) – Geneva Palexpo Geneva – https://ebace.aero/2023/about/

JUNE

05-07 June – ECCOMAS – **COUPLED PROBLEMS 2023** – X International Conference on Coupled Problems in Science and Engineering – Chania, Crete Island (Greece) – https://coupled2023.cimne.com

07-08 June – FSF/EUROCONTROL/ERA – **Safety Forum 2023 – 10th Edition** – Brussels (Belgium) – EUROCONTROL/HQ – Rue de la Fusée 96 – https://flightsafety.org/

12-16 June – ESA – **GNC 2023 - 12th International ESA Conference on GNC Systems** – Sopot (Poland) – https://atpi.eventair.com/

12-16 June – AIAA – **AIAA AVIATION Forum** – San Diego, CA (USA) – www.aiaa.org/events - www.aiaa.org/aviation

13-14 June – 3AF– **ETTC2023 - European Test and Telemetry Conference** – Toulouse (France) – http://ettc2023.org/

13-15 June – 3AF – **IAMD2023 – 15th International Conference Integrated Air and Missile Defence** – Porto (Portugal) – https://www.3af-integratedairmissiledefence.com

19-21 June – ECCOMAS – **ADMOS 2023 – X International Conference on Adaptative Modelling and Simulation** – Gotheburg (Sweden) – https://admos2023.cimne.com

19-25 June – GIFAS/SIAE – **SIAE2023 – Paris International Air Show (54th Edition)** – Le Bourget (France) – https://www.siae.fr

21-23 June – ICEAF – **7th International Conference on Engineering Against Failures** – Spetses (Greece) – http://iceaf.eu

26-28 June – ACI EUROPE – **ACI EUROPE/World Annual Global Assembly 2023** – Hosted by Aena – Barcelona (Spain) – https://www.aci-europe.org/events.html

JULY

09-13 July – CEAS/EUCASS – **AEC2023 – Joint 10th EUCASS – 9th CEAS Conference** – Lausanne (Switzerland) https://www.eucass-ceas-2023.eu

19-20 July – ICAS – **17. International Conference on Aeronautical Sciences** – Helsinki (Finland) – https://waset.org/aeronautical-sciences-conference-in-july-2023-in-helsinki

SEPTEMBER

03-06 September – EUROMECH – **ETC18 2023 – 18th European Turbulence Conference** – Valencia (Italy) – https://www.euromech.org/ www.etc18.webs.es

04-07 September – AIDAA – **AIDAA XXVII International Congress** – Padova (Italy) – University of Padova – https://www.aidaa.it/aidaa2023/

05-07 September – DGLR/CEAS – **ERF2023 – 49th European Rotorcraft Forum** – Bückeburg (Germany – Lower Saxory) – https://erf2023.dglr.de - https://ceas.org/european_rotorcraft_forum

05-08 September – EASN – **13th International Conference on Innovation and Space for opening New Horizons** – Salermo (Italy) – https://easnconferenec.eu

14-16 September – ESA – **41st Antenna Workshop** – Noordwijk (NL) – ESA/ESTEC – https://atpi.eventair.com/

19-21 September – DGLR – **General Aerospace Congress – DLRK 2023 - Luft und Raumfahrtkongress 2023** – Stuttgart (Germany) – https://dlrk2023.dglr.de – contact: dlrk@dglr.de

24-25 September – DGLR – **German Aerospace Congress** – https://dlrk2023.dglr.de

OCTOBER

02-06 October – IAF – **74th International Astronautical Congress** – Global challenges and Opportunities – Give Space a Chance - Baku (Azerbaijan) www.iac2023.org

02-06 October – ESA – **ESPC 2023 – European Space Power Conference - 13th Edition** – Elche (Spain) (NL) – https://atpi.eventair.com/

02-06 October – ESA – **EDHPC 2023 – European Data Handling & Data Processing Conference** – Juan-les-Pins (France) – https://atpi.eventair.com/

03-05 October – RAeS – **8th Aircraft Structural Design Conference**

AMONG UPCOMING AEROSPACE EVENTS

11-13 October – WEC - **WEC 2023 – 7th World Engineers Convention** - Prague (Czech Republic) – https://www.wec2023.com

17-19 October – MRO Europe Aviation Week – **MRO Europe Conference** - RAI Amsterdam (NL) – https://mroeurope.aviationweek.com/en/home/html

17-22 October – SEOUL – Seoul ADEX 2023 – **Seoul International Aerospace & Defense Exhibition 2023** - Seoul (South Korea) – Seoul Airport – Seongnam Air Base – www.seouladex.com/intro/intro.php

23-25 October – AIAA – **2023 ASCEND – Accelerating Space Commerce Exploration and New Discoveries** – Las Vegas, Nevada (USA) – Las Vegas and ONLINE – https://aiaa.org/events

23-26 October – ASCEND/AIAA – **ASCEND Conference** – Las Vegas, NV (USA) - www.aiaa.org/events

23-27 October – ESA – **ISSO – International School on Space Optics** – Noordwijk (NL) – ESA/ESTEC – https://atpi.eventair.com/

NOVEMBER

12-16 November – UAE– **Dubai Airshow 2023 – The Center of Aerospace Strategy and Inspiration** – Dubai (UAE) – Dubai World Central Al Maktoum Jebel Ali – https://www.dubaiairshow.aero

14-15 November – 3AF – **CAT 2035 – Combat Aéroterrestre 2035 - 2nd Edition** – Versailles (France) – https://www.3af-cat2035.com

16-18 November – The Scientist – **GSEAMAE 2023 – 3rd Global Summit and Exposition on Aerospace and Mechanical Engineering** – Rome (Italy) – https://www.thescientist.com/2023/aerospace-mechanical-engineering - contact: gseame2023@thescientist.com