CEAS
Council of European Aerospace Societies

BULLETIN AEROSPACE EUROPE

EASN
european aeronautics science network

Networking Academia to enable a sustainable and circular aerospace sector

INTERVIEW WITH ANDREAS STROHMAYER, CHAIR OF EASN

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:

- 11 Full Member Societies: Czech Republic (CzAeS) – France (3AF) – Germany (DGLR) – Italy (AIDAA) – The Netherlands (NVvL) – Poland (PSAA) – Romania (AAAR) – Spain (AIAE) – Sweden (FTF) – Switzerland (SVFW) – United Kingdom (RAeS);
- 5 Corporate Members: ESA, EASA, EUROCONTROL, EUROAVIA, von Karman Institute;
- 9 Societies having signed a Memorandum of Understanding (MoU) with CEAS: AAE (Air and Space Academy), AIAA (American Institute of Aeronautics and Astronautics), CSA (Chinese Society of Astronautics), EASN (European Aeronautics Science Network), EREA (European association of Research Establishments in Aeronautics), ICAS (International Council of Aeronautical Sciences), KSAS (Korean Society for Aeronautical and Space Sciences), PEGASUS (Partnership of a European Group of Aeronautics and Space Universities) and Society of Flight Test Engineers (SFTE-EC).

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.

WHAT DOES CEAS OFFER YOU ?

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- A structure for Technical Committees

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- Technical pan-European events dealing with specific disciplines
- The biennial AEROSPACE EUROPE Conference

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- CEAS Aeronautical Journal
- CEAS Space Journal
- AEROSPACE EUROPE Bulletin

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- European Commission
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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.

EDITOR: CEAS
Director of the Publication: Franco Bernelli

EDITORIAL COMMITTEE
Editor-in Chief: Jean-Pierre Sanfourche
sanfourche.jean-pierre@orange.fr

Deputy Editor-in-Chief: Lukasz Kiszkowiak
lukasz.kiszkowiak@wat.edu.pl

Committee's Members: Andrea Alaimo, Jonathan Cooper, Cornelia Hillenherms, Britta Schade, Thomas Vermin.

Art Direction & Design: Sophie Bougnon
sophie.bougnon1@sfr.fr / www.sbgraphisme.com

THE OFFICERS OF THE BOARD IN 2024:

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franco.bernelli@polimi.it
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Britta.Schade@esa.int

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www.csvts.cz
President: Daniel Hanus /
hanus@csvts.cz
CEAS Trustees:
Daniel Hanus,
Jan Rohac / xrohac@fel.cvut.cz
Point of contact:
Daniel Hanus : + 420 221 082 295

France – 3AF
6,rue Galilée – F-75016 Paris
www.3af.fr
President: Louis Le Portz /
louisleportz@orange.fr
CEAS Trustees: Louis Le Portz
Bruno Berthet /
bruno.berthet@rafaut.fr
Point of contact: Clara Lasserre /
clara.lasserre@3af.fr
T : +33 1 56 64 12 31

Germany – DGLR
Godesberger Allee 70 –
D- 53175 Bonn – www.dglr.de
President: Roland Gerhards /
roland.gerhards@dglr.de
CEAS Trustees: Cornelia Hillenherms
/ cornelia.hillenherms@dlr.de
Philip Nickenig /
philip.nickenig@dglr.de
Point of contact:
Birgit Neuland / birgit.neuland@dglr.de
T: +49 228 30 80 50

Italy – AIDAA
Casella Postale 227 –
I-00187 Roma V.R. – www.aidaa.it
President: Erasmo Carrera /
erasmo.carrera@polito.it
CEAS Trustees: Carlo Bettanini /
carlo.bettanini@unipd.it
Sergio De Rosa /
sergio.derosa@unina.it
Point of contact: Daniela Vinazza /
daniela@aidaa.it
T: +39 366 144 21 31

Netherlands (The) – NVvL
c/o Netherlands Aerospace Centre
Anthony Fokkerweg 2
NL- 1059 CM Amsterdam
www. nvvl.eu
President: Mark van Venrooij /
mark.van.venrooij@nlr.nl
CEAS Trustees: Mark Van Venrooij,
Fred Abbink / f.j.abbink@planet.nl
Point of contact: Regina Sluitjer /
nvvl@nlr.nl – T: +31 88 511 3113

Poland – PSAA
Nowowiejska 24 – 00-665 Warsaw
www.psaa.meil.pw.edu.pl
President: Tomasz Goetzendorf-Grabowski – tomasz.grabowski@pw.edu.pl
CEAS Trustees: Tomasz Goetzendorf-Grabowski
Lukasz Kiszkowiak /
lukasz.kiszkowiak@wat.edu.pl
Point of contact:
Beata Wierzbinska-Prus /
beata.prus@pw.edu.pl
T: +48 22 234 54 28

Romania – AAAR
c/o COMOTI
Bd Luliu Maniu 220D
061126 Bucharest, Sector 6 –
Romania C.P. 174, O.P. 76
www.aaar.ro – www.comoti.ro
President: Virgil Stanciu /
vvirgilstanciu@yahoo.com
CEAS Trustees: Valentin Silivestru /
valentin.silivestru@comoti.ro
Ion Fuiorea / ifuiorea@yahoo.com
Point of contact: Valentin Silvestru
T : + 4 021 434 02 40

Spain – AIAE
Francisco Silvela 71,
Entreplanta - 28028 Madrid
www.coiae.es
President: José Manuel Hesse Martin /
jmhesse@coiae.es
CEAS Trustees: José Manuel Hesse Martin, Arturo de Vicente /
arturodvh@coiae.es
Point of contact: Santiago Carmona /
info@coiae.es – T : + 34 01 745 30 30

Sweden – FTF
c/o SSC, PO Box 4207
SE-17154 SOLNA
www.ftfsweden.se
President: Roland Karlsson /
rkrolandk@gmail.com
CEAS Trustees: Anders Blom /
anders.blom@innovair.org
Petter Krus / petter.krus@liu.se
Point of contact: Björn Jonsson /
bjorn.jonsson@fmv.se
T: + 46 70-782 62 61

Switzerland – SVFW
Laerchenstrasse 1 CH-5737
Menziken– www.svfw.ch
President :Jürg Wildi /
juerg.wildi@bluewin.ch
CEAS Trustees: Jürg Wildi
Georges Bridel /
georges.bridel@alr-aerospace.ch
Point of contact: Mirjam Hauser /
mirjam.hauser@icloud.com
T: + 41 44 632 11 11

United Kingdom – RAeS
No.4 Hamilton Place – London
W1 J 7 BQ – www.aerosociety.com
President: Kerissa Khan MRAeS /
kerissa.khan@aerosociety.com
CEAS Trustees: Emma Bossom MRAeS / emma.bossom@aerosociety.com
Jonathan Cooper CEng FRAeS /
J.E.Cooper@bristol.ac.uk
Points of contact:
Emma Bossom
T: +44 (0) 20 7670 4332

CORPORATE MEMBERS:

■ **ESA**
24, rue du Général Bertrand –
75345 Paris Cedex 7
www.esa.int
CEAS Representative:
Britta Schade / Britta.Schade@esa.int
CEAS Space Branch Members
Anastasia Pesce /
Anastasia.Pesce@esa.int
Johan Steelant /
Johan.Steelant@esa.int

■ **EASA**
Konrad - Adenauer - Ufer 3
D-50542 Cologne (Germany)
Tel.: +49 (221) 8999 0000
www.easa.europa.eu
CEAS Representative:
Jean-Christophe Nicaise – jean-christophe.nicaise@easa.europa.eu

■ **EUROCONTROL**
Rue de la Fusée 96 - Brussels 1130
CEAS Representative: Marc Bourgois
marc.bourgois@eurocontrol.int

■ **EUROAVIA**
Kluyverweg 1 - 2629 HS, Delft, NL
www.euroavia.eu
President: Leo Buchner /
leo.buchner@euroavia.eu
CEAS Representative: Irina Stoican /
irina.stoican@euroavia.eu

■ **VON KARMAN INSTITUTE**
72, chaussée de Waterloo
1640 Rhode-St-Genèse, Belgium
https://www.vki.ac/be/
CEAS Repres.: Christophe Schram
christophe.schram@vki.ace.be

SOCIETIES HAVING SIGNED AN MOU WITH CEAS:

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1, avenue Camille Flammarion –
F-31500 Toulouse
www.academieairespace.com

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12700 Sunrise Valley Drive
Suite 200, Reston
VA 20191 – 5807 USA
catherineh@aiaa.org - www.aiaa.org

■ **Chinese Society of Astronautics (CSA)**
CSA Zhang yao – WANG Yiran,
n° 8, Fucheng Road, Haidian district
P.O. Box 838
100 830 Beijing, China
wangyr@spacechina.com
www.csaspace.org.cn/

■ **European Aeronautics Science Network (EASN)**
EASN - Rue du Trône 98 –
1050 Brussels, Belgium – htpps://www.easn.net
Chairman: Andreas Strohmayer
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Vice Chairman: Konstantinos
Tserpes (University of Patras)
kitserpes@upatras.gr

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EREA Secretary: Anne-Laure Delot –
ONERA, anne-laure.delot@onera.fr
https://www.erea.org

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President: Dimitri Marvis
Executive Secretary: Axel Probst
c/o DGLR – Godesberger Allee 70 –
D- 53175 Bonn
icas@icas.org – www.icas.org

■ **Korean Society for Aeronautical and Space Sciences (KSAS)**
Room 1001, 635-4 – Yeogdam-Dong
– 135-703 Gangnam – Gu Republic of
Korea – ksas@ksass.or.kr
https://www.ksas.or.kr

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Chair: Emmanuel Zenou
emmanuel.zenou@isae-supaero.fr
www.pegasus-europe.org

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www.sfte-ec.org/

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■ **EASN: European Aeronautics Science Network**
Chairman: Andreas Strohmayer
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Strohmayer@ifb.uni-stuttgart.de
Vice Chairman: Konstantinos
Tserpes – University of Patras
kitserpes@upatras.gr

■ **ECCOMAS: European Community on Computational Methods in Applied Sciences**
Campus Nord UPC - Building C3
"Zona Comercial" – Jordi Girona, 1-3
(08034) – Barcelona (Spain)
www.eccomas.org/
eccomas@cimne.upc.edu
President: Ferdinando Auricchio
auricchio@unipv.it

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admin-cado@ercoftac.org

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christophe.bonnal@cnes.fr

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m.g.d.geers@tue.nl

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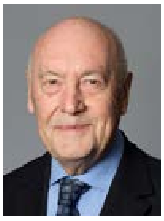
EDITORIAL



Jean-Pierre Sanfourche,
editor-in-chief
sanfourche.jean-pierre@orange.fr

ATTRACTING BEST TALENTS IN AEROSPACE

Aerospace industrial companies and institutions in Europe, despite their undisputable reputation, often find themselves at a disadvantage when attempting to recruit high level talents, obliged to compete with other activity sectors that have created strong value propositions which emphasize the importance of innovation and the creation of leading-edge disruptive technologies. They have to deal with the talent attraction precisely at a time when they have to face the climate change challenge and to prepare for the future of European Defence and Security. In addition, it can be observed that aerospace related studies are not considered as prestigious as other scientific and technical fields. Certain brilliant students graduated from aerospace higher schools even prefer to enter into a finance career rather than into engineering.

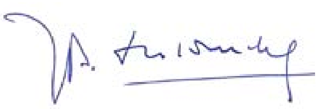
So, under these circumstances, all initiatives aiming at attracting and retaining innovative talent in aerospace is of highest priority. New approaches are henceforth required to recruit and manage the young experts possessing the needed skills and passion for aviation and space. The CEAS member societies have here a fundamental role to play, their primary mission being the promotion of the European aerospace activity.

At the 6th CEAS Air and Space Conference which took place in Bucharest on 16-20 October 2017, the subject had been dealt with. In effect on this occasion a long presentation was given on:

"Proposal for a EU quality label for aerospace education"

It was presented a possible roadmap for the definition of a European quality label for higher education degrees. The goal of the proposed concept was to establish a quality system that can complement the existing national or European accreditation system, providing added value to internal and/or external quality assurance processes in place in the EU countries, the final objective being to improve the quality and skills of the aerospace engineers and researchers.
Now to my knowledge, things did not significantly progress since the Bucharest CEAS Conference. This is the reason why I am strongly recommending that within the programme of the upcoming CEAS biennial conference "AEC2025", appears among the top priority topics:

"Attracting best talents in aerospace"



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CEAS PRESIDENT'S MESSAGE

Franco Bernelli Zazzera
CEAS President 2021-2024

As I go through the table of contents of this issue of the Bulletin, I am pleased to notice that many contributions deal with two fundamental issues: international collaboration and sustainability.
International collaboration is for sure one of the motivations that led to the establishment of CEAS, many years ago. The truly European spirit of CEAS, with no national interests but only the common interest to bring forward, should be the driving force of any other collaborative action within the EU. With this precise spirit, this Bulletin has in the past hosted an interview with the Chair of PEGASUS, a collaborative academic network, and in this issue the reader can listen to the point of view of EASN, another truly European network.

Collaborative actions established with CEAS are not limited to Europe. Two very actual and notable examples are the collaboration with the Korean Society for Aeronautical and Space Sciences and the Korean Society of Propulsion Engineers for the organization of the International Conference on High-Speed Vehicle Science and Technology (HiSST), that is already at its third edition and this year will be held in Busan, Korea from April 14 to 19. The International Technical Committee of the conference includes, in addition to CEAS and European representatives, experts from 7 non-European countries.
A second good example of best practice in international collaboration is the one established with AIAA for the AIAA/CEAS Aeroacoustics conference, that this year will be held on 4-7 June in Rome.

Both conferences have become the reference for their sectors and are breaking all records in terms of submissions and active participation. As this issue of the Bulletin is printed, the HiSST will probably be already ended, but there is still plenty of time to program participation to the AIAA/CEAS Aeroacoustics conference, that I strongly encourage for all the researchers interested in the subject.

Obviously, I need to remind that CEAS is organizing also other thematic conferences in 2024, the CEAS EuroGNC 2024 in Bristol, on 11-13 June, International Forum on Aeroelasticity and Structural Dynamics (IFASD), on 17-21 June in The Hague, and the European Rotorcraft Forum (ERF) in Marseille on 10-12 September.

The aspect of sustainability is now of primary importance for any new aerospace project, being it relevant to atmospheric flight or spaceflight. It appears obvious that aviation should become (almost) carbon neutral rapidly, but this poses severe technical challenges if we want to keep performances at the current level, since this is one of the reasons for the success of commercial flights. This is clearly reflected in the extremely ambitious ZEROe project by Airbus, on the airplane manufacturers' side, and by the SESAR JU AEROPLANE project looking at the aviation operations.

Thinking about sustainability in space operations the first and probably most known issue deals with the space debris problem, but looking at sustainability on a wider scale you can find in this issue a very interesting interview focusing on planetary protection, that has also many fundamental implications on sustainability and on how we should manage space exploration. And looking at the launcher segment, the Ariane 6 promises to be far more "green" than its predecessors, thanks to its liquid hydrogen and liquid oxygen fuel for its main and upper stages and new production techniques to provide hydrogen.

Complementing sustainability and international cooperation, let me however encourage you to read all the contributions to this Bulletin, that promises to be as usual extremely interesting and inspiring for our aerospace community.

■

INTERVIEW WITH ANDREAS STROHMAYER, CHAIRMAN OF THE EUROPEAN AERONAUTICS SCIENCE NETWORK

By Jean-Pierre Sanfourche, Editor in Chief

Andreas STROHMAYER, Chairman of the European Aeronautics Science Network

With a diploma in Aeronautical Engineering, ***Andreas Strohmayer*** *graduated in 2001 at TU Munich to Dr.-Ing. in the field of conceptual aircraft design. From 2002 to 2008 he was director of Grob Aerospace in Mindelheim, Germany, responsible for design, production and support of the Grob fleet of all-composite aircraft, including the development of a 4-seat aerobatic turboprop, a 7-seat turboprop and the SPn business jet. The following four years he was program director for the Skylander Sk-105 commuter aircraft project at Sky Aircraft in Metz, France, then VP Programs at SST Flugtechnik in Memmingen, Germany, setting up an EASA approved design organization. In 2015 he was appointed professor for aircraft design at the Institute of Aircraft Design at University of Stuttgart with a research focus on hybrid-electric flight and scaled flight testing. Since 2016 he is member of the Board of Directors of the European Aeronautics Science Network (EASN), since 2019 Chairman of the Association. In 2022 he has been elected correspondent of the Académie de l'Air et de l'Espace.*

What is the specificity of the EASN organisation? Is it a classical non-profit association, or just a networking organisation?

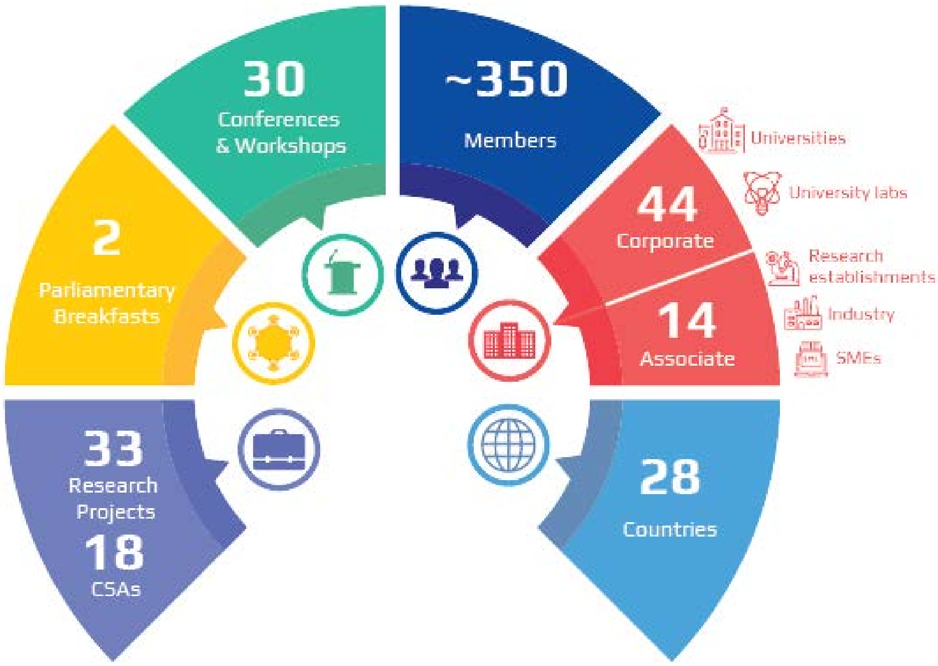
The establishment of the European Aeronautics Science Network (EASN) goes back to 2002 and is based on two subsequent support actions funded by the European Commission. In 2008 the EASN Association was then officially established in the legal form of an international not-for-profit association with the advancement of the aeronautic sciences and technologies as its primary objective. Furthermore, it aims at promoting, encouraging, coordinating and focussing joint efforts between universities, research organisations, industry and SMEs in Europe which are active in the field of aeronautics and aerospace. To this end, EASN pursues a variety of activities in this field:

- The advancement of aviation and space technologies through innovative research and the support of European universities, university departments and institutes as well as university research staff to perform related research.
- The support of scientific and technological cooperation and human mobility within the European research area and the organization of and the participation to relevant activities.
- The support of and the participation to activities aiming to incubate new knowledge, technological innovation and breakthrough technologies.
- The dissemination of knowledge and technological innovation and the execution of dissemination work through its participation either on its own or within the framework of consortia in national or international projects and research programs related to aerospace.
- The support, organization and participation to activities related to scientific knowledge and technology transfer.
- The execution of studies for the development of national and international policies on subjects related to the aims of the Association and the provision of consultancy services for the development of education, research and development policies and activities in aerospace.
- Collaboration with universities, other academic research institutions, research establishments, the industry, governmental and state authorities, the European Commission, and others, to support the aims of the Association.

So being established as an international non-profit organization, EASN offers an open network to academia in the field of aviation and space research.

What are the European countries participating in EASN: among the EU member states? and outside the EU?

Given the European focus of our objectives, our about 350 individual members may be found in all European countries, affiliated to almost all significant universities active in the European aerospace ecosystem. This member base is strengthened by more than 40 corporate



members, i.e. universities, university departments and labs. It is our aim to provide a strong European networking platform to these members and to give a voice to all academic researchers active in the field, in particular also to those that do not have a solid national footprint in aerospace research.

EASN is essentially European aerospace science academia oriented. How can aerospace industry research & innovation centres participate in EASN activities?
European universities have a key role in the chain of the European stakeholders in aerospace by providing education of scientists and engineers as well as generating basic research and incubating technological innovation and breakthrough technologies. But in order to maximise synergies in our research ecosystem, it is of key importance to enable joint efforts between universities, research organizations, industry and SMEs which are active in Europe in the field of aviation and space. Therefore, in addition to individual and corporate members, our statutes also know the status of "associate members", open to research establishments, industry and SMEs. Researchers from these entities can participate in all our activities, which is important to maximise the synergies between the stakeholders in European aerospace research. For example we are in close cooperation with EREA, the association of European Research Establishments in Aeronautics, with respect to research topics and human mobility, and have cooperation agreements in place with a number of European SME clusters to mutually open and support our activities.

Are aerospace defence and security matters included in EASN field?
EASN is open to all researchers and research entities active in the field, this explicitly includes military universities and schools. In doing so, we reflect the current research landscape and cover the complete field of research topics in aeronautics and space, with a particular focus on upstream research, i.e. innovative technologies on low readiness levels, and new knowledge. The question of dual use is inherent to the nature of our domain and our members also participate in calls of the European Defence Fund (EDF). Given the dramatic change we currently see in Europe with respect to the political landscape on our borders, it may well be that defence and security matters in the future will play an even more important role in aerospace. Obviously, this subsequently would also be reflected in our activities.

What are your relationships with EREA?
As stated before, EASN has an excellent relationship with EREA, with regular coordination meetings and intensive exchange on all hierarchical levels. Moreover, EASN has established a Stakeholder Advisory Board, consisting of highly experienced personalities from the aviation sector, with one participant coming from an EREA member organisation. It should be mentioned that scientists from research establishments typically also participate to our International EASN Conferences for dissemination of research results.

A few years ago, TU Delft issued a "Proposal for a EU quality label for aerospace education" (Elsevier 2018 B. Gherman and I. Porumbel editors). Is EASN taking initiatives aiming at bringing forward this dossier?
The primary focus of the EASN Association's activities is clearly on research in aviation and space and not so much in education aspects, while these obviously affect most of our members. EASN therefore also participated in a number of related activities, such as the PERSEUS project, a two-years' Coordination and Support Action funded by the EU's Horizon 2020 Research and Innovation programme, aiming at defining the evolving skill

needs of the European aviation sector and subsequently at formulating strategic recommendations and corrective measures for the improvement and harmonization of the content of the curricula for aviation engineers. Ultimately this was intended to lead to the creation of an integrated European aviation education system, based on sound quality criteria capable of supporting the continuous improvement of the educational system in the sector.

The PERSEUS consortium issued the "Proposal for a EU quality label for aerospace education" to define suitable actions and mechanisms to encourage the next generation of European students to get interested in Aeronautics and thus pursue studies towards a career in the field of Aeronautics and Air Transport. The current declining trend in student enrollments in technical fields, including aerospace, shows that this topic is still of highest relevance today, threatening the sector with a rapidly growing shortage of properly trained personnel. EASN actively promotes the involvement of academia in the Horizon Europe research activities to ensure that universities, playing a crucial role in the education and training of the next generation of engineers, can participate at the forefront of innovative aerospace research.

Is EASN working in liaison with PEGASUS and EUROAVIA?

While the educational aspects, more represented by organizations such as PEGASUS and EUROAVIA, are not in the primary focus of the Association, it is without saying that EASN is open to any activity and cooperation that contributes to strengthening the technological advancement and competitiveness of the European aerospace sector.

How is EASN proceeding for organising its annual international conference with the care to avoid overlapping and on the contrary ensure complementary effect with other aerospace events: ICAS, CEAS, other ECaero- 2 associations?

The EASN International Conferences have involved into a major platform for dissemination and exploitation of European research activities. However, for the conference participants it is obviously important that we have no schedule conflict with other aerospace events. We therefore have established good contacts to the major conferences such as ICAS, CEAS or EUCASS and try to avoid any overlaps. To this end, we have cooperation agreements in place, covering coordination, mutual support and cross-attendance to respective events and workshops. This also holds true for CEAS, where even joint CEAS-EASN congresses as well as seminars on topics of mutual interest are envisaged as part of the agreement.

Dissemination of research results is a one of the most important missions of EASN? Would it be possible for EASN to make use of the CEAS Aeronautical Journal and of the CEAS Space Journal for some selected papers?

As you rightly say, the dissemination of research results is one of our key missions, if not a major motivation for the European Commission to encourage the foundation of EASN with its initial support actions. Part of the cooperation agreement between CEAS and EASN is also to encourage scientists to publish the outcome of their research in the CEAS Aeronautical and Space Journals. In this context, an important prerequisite of our members for a journal publication is to ensure that the journal is listed in an indexed data basis, as this aspect in many cases is a key performance indicator for high quality of their scientific work.

Following the EASN International Conference 2023, what are the main topics you wish to particularly concentrate during the 2024 edition?

For our 14th EASN International Conference, which will be hosted together with the Aristotle University of Thessaloniki, we have set the focus on "Innovation in Aviation & Space towards sustainability today & tomorrow" and it is our intention to keep this new theme for the next editions. The event will take place from 8 to 11 October 2024, at the Concert Hall of in the lively city of Thessaloniki. Personalities from the key stakeholders in Europe's Aviation and Space sectors, representing academia, industry, research, and policymaking, will share their valuable insights during the Plenary Talks.

Moreover, the conference will offer a platform for scientists and researchers worldwide to present their latest research results across a wide variety of thematic sessions. In line with our mission, these sessions, thoughtfully arranged by experts in the field, aim to facilitate knowledge exchange and foster collaboration. Participants will have the opportunity to showcase ongoing projects, exchange on current trends, and explore future requirements within the aviation and space domains, with a focus on forging connections and synergies. Notably, esteemed policy development projects will also be featured, shedding light on the strategic priorities guiding the European aviation sector toward sustainability. And last but not least, connected to our increased engagement in European space research, this year our EASN International Conference for the first time will also be endorsed by the Association of European Space Research Establishments (ESRE) and we look forward to an increased participation from this sector.

Concluding our discussion, may I ask you what the most notable priorities to be undertaken with the aim to ensure quality improvement of EASN performance?

It is our explicit long-term goal to build up an open, unique European platform in order to structure, support and upgrade the research activities of the European universities active in aviation and space research as well as to facilitate them to respond to their key role in realizing the European Research Area. Since its first steps in 2002, EASN has achieved a good level of performance in representing university research, giving a voice to academia among the stakeholders in the sector. To give some examples: the EASN conferences have been established as a major dissemination forum of the sector, EASN has substantially contributed to prepare the Strategic Research and Innovation Agenda of the Clean Aviation Joint Undertaking, and EASN Technology Innovation Services (EASN-TIS), our permanent secretariat established for the representation of the Association in research projects, has a strong participation in disseminating the results of Clean Aviation projects. Naturally, there is always room for improvement and to this end we will further strengthen our links to the research establishments, represented by EREA and ESRE, to the European Commission and the Joint Undertakings, most notably Clean Aviation, SESAR and Clean Hydrogen, to European organizations such as EASA and EUROCONTROL and of course also to SMEs and industry. EASN also will continue to actively support the Advisory Council for Aeronautics Research and Innovation in Europe (ACARE), which assembles all stakeholders in the air transport system, providing an open forum for discussion and coordinating the development of a common vision towards climate neutrality in the sector. An important task today is to jointly shape a new European research agenda for Aeronautics and Space with a commitment of all stakeholders to address the most urgent challenges, and in particular the climate crisis. But at the same time, we have to ensure that innovative research is not limited to firefighting emergencies with an exclusive focus on the threat perceived as today's curse, but prepare for the upcoming challenges not yet picked up by the mainstream public opinion today. This will require a long-term vision as a basis for a roadmap for fundamental and upstream research and we will have to ask ourselves already today what challenges we will find beyond our today's research agenda, to fill the pipeline of fresh ideas and prepare grounds for the upcoming next Framework Programme.

CAN INNOVATION ALONE MEET THE CHALLENGES OF AERONAUTICS AND SPACE?

By Bruno Stoufflet, Vice president of the Air and Space Academy

This paper has been published in the AAE's Newsletter N° 132. By courtesy of Air and Space Academy's management, it is reproduced here after.

Bruno Stoufflet, Vice president of the Air and Space Academy

INNOVATION FORUM

To mark the 40th anniversary of the Air and Space Academy (AAE), a forum was held in Toulouse on 23 November on the theme "Can innovation alone meet the challenges of aeronautics and space?". A high level of European participation characterised each of the round tables.

The day was opened by Jean-Marc Broto (president of Paul Sabatier University, Toulouse) and Michel Wachenheim (AAE president) and covered AAE's three main areas of activity: civil aviation, defence and space.
The inaugural speech by Miguel Bello Mora (Spanish Ministry of Science and Innovation) focused on the creation of the Spanish Space Agency and the priorities of Spain's presidency of the European Union until the end of 2023, in particular the consolidation of activities in which Europe is a leader.

Laurent Castaignède (transport historian and essayist) then took the floor, challenging the central place given to technology in the future of air transport. He pointed out that the history of technology (little taught regrettably) shows that technological innovation, although improving performance on a unitary basis, does not herald the expected overall improvement in most cases because of the "rebound" effect (increase in the number of units thanks to reduced expenditure brought about by performance gain). To break free from this spiral, he would go so far as to propose a quota on the current air fleet! He advanced the concept of a "Rubicon" (an internationally agreed prohibition not to be crossed) and ventured the following list of limitations:
– autonomous vehicles;
– civil supersonic flight;
– drone deliveries;
– human presence in space.

This did not fail to elicit reactions from the audience!

CIVIL AVIATION

Antoine Bouvier (Airbus) and Philippe Couteaux (Safran) emphasised the two existential objectives of air transport:
– maintaining and strengthening European leadership;
– decarbonisation.

Innovation (but not only) is the main response to these challenges and the best bulwark against the emergence of an authoritarian, intrusive and bureaucratic world, which is unavoidable without progress.

The concept of a carbon budget, which defines a sector's rights to consume and rights to emit, has now been widely adopted by aviation, but is only one of the four main challenges facing the various modes of transport:

– climate, naturally;
– energy, limited more by investment than by resources;
– materials: here aviation is the most efficient mode of transport (in terms of passenger-kilometres transported per kg of material);
– environment (land use, biodiversity, noise), where aviation also performs very well.

During the round table, the European Commission representative reaffirmed the need for Europe to take the lead in aviation decarbonisation, thus enabling us to use our regulatory influence in a virtuous way, and ensuring that Europe reaps the social and economic benefits when the technology becomes available.

Whilst there is a growing awareness in decision-making circles of energy needs, the relevant national and European roadmaps are not ambitious enough, only partially factoring in this aspect. In France alone, needs can be put at around 150 TWh (the equivalent of 12 EPRs).
The aviation sector alone does not have the means to achieve the promises announced. Indeed success of the net-zero 2050 trajectory depends to a large extent on the energy industry. The main industrial challenge is therefore to develop a low-carbon electricity production sector and provide it at a reasonable cost. In addition, a regulatory framework favourable to sustainable aviation fuels (SAF) needs to be established.

DEFENCE

Jean-Georges Brévot (AAE) highlighted that in the defence world, technological innovation is consubstantial with other forms of innovation: in organisation, command and operations.

In the current context of increased conflict, the defence sector is quite well provided for in prospective funding, the main issue being to find the right balance between responding to a massive need – which would tend to favour low-cost, off-the-shelf purchases – and preparing for the future.

The round table participants agreed that research and development cannot be sacrificed for force size. All the more so as current conflicts are characterised by the element of surprise: both political surprise and surprise in the means employed. We need to maintain a dual vision of innovation: that of a system designed to be sustainable in the long term (the sovereign domain which must withstand all crises, justifying long development times) accompanied by a capacity to generate novel means (redirecting a usage or technology) whose use can be learned very quickly, providing agility.

Innovation must be driven by operational needs, not by technology. In an emergency situation, the Ukrainian forces put in place a very rapid procedure for testing innovations proposed by operational units in the field, from which we could learn.

The future will undoubtedly see sophisticated systems with expendable, low-cost, onboard devices. This presupposes a production chain adapted to cover attrition.

The future will also be one of collaborative combat, which will make full use of digital technology, going and finding value in situ, abolishing time and distance. It would be wise though not to deploy the entire system of systems from the outset, but rather build up the operational chains gradually..

SPACE

By way of introduction, Josef Aschbacher gave a comprehensive overview of all programmes underway in Europe, putting in context the decisions taken at the last European Space Summit.
The round table made it clear that innovation in the space sector in Europe is multifaceted. We are witnessing not only technological innovation as in the past, but also a revolution in usage, with the added emergence of start-ups and disruptive projects in established companies. There is a shared desire for greater risk-taking, with the European institutions willing to play the game.

In the launcher sector, the effect of scale is paramount and innovation choices (e.g. whether or not to reuse stages) cannot follow the same reasoning regardless of launcher size, which could be counter intuitive. In addition, the operator and the market they are addressing have very different timescales, with the risk that the product and associated services will become obsolete; development cycles must therefore be drastically reduced and made evolutive.

In the satellite sector, innovation is largely the result of bringing together the digital and space worlds, not only in terms of technology but also in development methods, infrastructure management and services provided.

SUMMARY

In conclusion, Denis Ranque (president of the Académie des technologies) began by highlighting the two main cross-cutting challenges: leadership and climate change.

He added that technological innovation was indeed necessary but not sufficient for all three sectors. A dose of sobriety (appropriate use, appropriate need) is also essential, with particularly relevance in the civil aviation section.

Aviation has many strengths but suffers from a bad press at the moment. It can boast the following three advantages:
– the sector is highly concentrated and well organised;
– it has built up a relationship of trust with the public authorities which will help put together the private-public partnerships needed to lead the fight against climate change. While most of the players are private, it is the public authorities who are aware of the overall issues

and who manage the externalities not taken into account by the former. The sector is well positioned at the crossroads of these two worlds;
– it is strongly European.

The forum demonstrated that innovation in the defence sector is essential. A lack of innovation increases the risk of a capability gap, and an inability to react quickly enough to innovation on the part of the enemy. This sector is still characterised by slow processes, particularly operational, and insufficient linkage with the user.
Politicians have pushed strongly for the creation of European champions in this area, but have not themselves made the same transformation. We deplore the fact that the European bloc today is neither a sovereign power nor territory.

The great caution once characterising the space sector is no longer the norm; risk-taking, spurred in particular by the multiplicity of players involved in the space sector, is now a reality. One can only welcome the current convergence between established players and instigators of disruptive innovation.

In conclusion, if the 18th century was the century of the Enlightenment, the 19th century that of the Industrial Revolution, the 20th century that of speed (thanks largely to aviation and space) and the 21st century, according to Laurent Castaignède, that of the fight against pollution (CO_2 in the atmosphere and the multiplicity of space debris are examples of this), let us ensure that the remaining 80 years of this century, in the wishes of Denis Ranque, are dedicated to humankind.

FIRST ZEROe ENGINE FUEL CELL SUCCESSFULLY POWERS ON

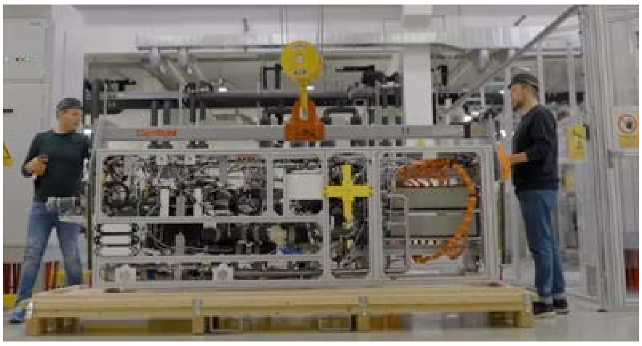
Checking off a key milestone on the path to achieving hydrogen-powered flight

In late 2023, the ZEROe teams powered on the iron pod, the future hydrogen-propulsion system designed for Airbus' electric concept aircraft. As well as the hydrogen fuel cell system, the iron pod contains the electric motors needed to spin a propeller and the units that control and keep them cool. Its successful power on at 1.2 megawatts is a pivotal step on Airbus' ZEROe roadmap to put a hydrogen-propulsion aircraft into service by 2035.

THE POWER OF THE WORLD'S MOST ABUNDANT ELEMENT

In 2020, Airbus shared four hydrogen-powered aircraft concepts with the public. Three used hydrogen combustion and hybrid engines for power, and the fourth was fully electric, using hydrogen fuel cells and a propeller propulsion system. These fuel cells work by transforming the hydrogen into electricity through a chemical reaction. The by-product of the reaction is simple H_2O, resulting in almost zero emissions.

The huge potential of hydrogen fuel cells to decarbonise aviation made it one of the key technologies chosen to be further explored for the ZEROe demonstrator – but there was a challenge. Although hydrogen fuel cells already existed on the market when the project began, none provided the energy needed to power an aircraft while remaining at an acceptable weight level. So in October 2020, Airbus created Aerostack, a joint venture with ElringKlinger, to develop hydrogen fuel cell stacks that would be at the heart of the electric propulsion system on a ZEROe aircraft.
Extensive testing on the fuel cell system took place in Ottobrunn, Germany, just 13 kilometres from Munich, at the E-Aircraft System House (EAS). The Airbus facility is the largest test house for alternative propulsion systems and fuels in Europe, and it is where the main components of the propulsion system that will power the demonstrator's propellers are tested.



In June 2023, Airbus announced the successful test campaign of the hydrogen fuel cell system, which reached its full-power level of 1.2 megawatts. It was the most powerful test ever achieved in aviation of a fuel cell designed for large-scale aircraft, and set the stage for the next big step of the project: integrating the full propulsion system with the electrical motor.

HYDROGEN POWERS ON THE IRON POD

The big day took place at the end of 2023, closing out the year on a high for the ZEROe team. After successfully completing testing of the fuel cell system at 1.2 megawatts in June and the powertrain at 1 megawatt in October, the electric motors of the iron pod were powered on with the hydrogen fuel cells for the first time.

The countdown to ZEROe: Episode 3: Fuel Cell Systems Testing

Airbus' hydrogen-powered aircraft is taking shape. Last time, we talked about one of the most promising propulsion candidates, which is the hydrogen fuel cell. Discover how Airbus is putting them to the test before flight.

"It was a huge moment for us because the architecture and design principles of the system are the same as those that we will see in the final design," says Mathias Andriamisaina, Head of Testing and Demonstration on the ZEROe project. "The complete power channel was run at 1.2 megawatts, the power we aim to test on our A380 demonstrator."

Observing how the many systems interact during this testing is key to enabling the next steps of the project. "This process is how we learn what changes need to be made to make the technology flight-worthy," says Hauke Peer-Luedders, Head of Fuel Cell Propulsion System for ZEROe. "We measure how the propulsion system as a whole works by testing the power needed for several different flight phases, such as takeoff, where we are reaching maximum power levels, and cruising, when we use less power but over a longer period of time."

" It has been three years since we revealed an aircraft concept 100% powered by hydrogen fuel cells. Since then, we have adhered to our initial timeline and made tremendous progress. The recent success of powering on the iron pod system at 1.2 megawatts is a crucial step towards our goal of putting a hydrogen-powered aircraft in the skies by 2035."

Glenn Llewellyn, Vice President of ZEROe Aircraft at Airbus

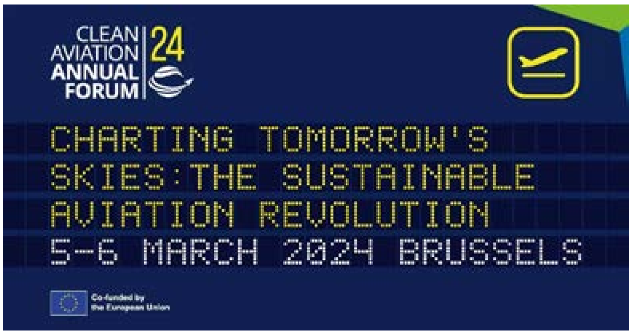
PREPARING FOR THE NEXT STEP

Testing will continue on this first version of the iron pod throughout 2024. Once completed, the next step for the ZEROe team will be to optimise the size, mass and qualifications of the propulsion system to meet flight specifications. Qualifications include the system's reactions to vibration, humidity and altitude, among other factors.

Once these optimisations and tests are complete, the fuel cell propulsion system will be installed on the ZEROe multimodal flight test platform – the very first A380 ever produced by Airbus, MSN001. This will be followed by the ground testing of the systems before the pivotal stage of testing them in flight on the A380, currently scheduled for 2026.

CLEAN AVIATION ANNUAL FORUM 2024: AVIATION AS A MAJOR CONTRIBUTOR TO THE EUROPEAN GREEN DEAL

Press Release 20/03/2024



Clean Aviation's flagship event took its way back in a fully in-person format, welcoming over 400 attendees in Brussels on 5 and 6 March to explore how we can collectively overcome the hurdles to climate-neutral aviation. For the occasion, we gathered under the same roof policy makers and industry leaders, daring the participants to think big, to collaborate strategically, and to innovate like never before.

"THOSE WE ARE TAKING ARE REVOLUTIONARY STEPS TOWARDS SUSTAINABLE AVIATION"

The Executive Director of the Clean Aviation Joint Undertaking, **Axel Krein**, opened Day 1 welcoming a diverse audience composed by EU and Regional decision makers, industry leaders, Original Equipment Manufacturers, researchers and Academia, to the biggest exhibition of technologies ever organised in the occasion of the Annual Forum. The showcase of 16 impressive hardwares and demonstrators from all over Europe represented not only the celebration of the Clean Sky 2 Programme's achievements, but also a bridge to the new projects of the Clean Aviation Programme.

To be able to deliver many more disruptive technologies, however, coordination among the various EU Member States, and regional efforts in the field of aviation innovation needs to be improved. The resources available at EU level need to be better harmonised, and the connection between European and Member State instruments must be significantly improved to allow for a well aligned and complementary approach.

Following the echo of this collective ambition, **Maroš Šefčovič**, European Commission Executive Vice President for the European Green Deal, Interinstitutional Relations and Foresight, took the floor to remind that while climate change is a fact, the aviation sector remains strategic in the transition necessary for a more sustainable future. And Europe established itself as a leader in the global transformation: our collective goal is to ensure that the best world aircraft is made in Europe. This implies to clearly define what aviation needs to do to remain competitive and to concretely move forward in its journey towards sustainability . Aviation deserves a high-quality handover note to next Commission, and a bold strategic agenda for the upcoming Multiannual Financial Framework (MFF).

Jan-Christoph Oetjen, Vice-President of the European Parliament, and Vice Chair of TRAN Committee, complemented the statement coming from the EU institutions, putting emphasis on what will have to be the next Commission's priority: competitiveness. Clean Aviation is already a central player supporting Europe's global competition. The sector is currently employing 13.5 million people (3.6% of all employment in Europe), and represents 1 trillion of economic activity (4.4% of European GDP). While Clean Aviation builds on this momentum to define strategic key priorities for the next legislative term and the future MFF, TRAN Committee will continue to support the Joint Undertaking in its effort to convey more investments in projects for hybrid-electric and hydrogen-powered aircraft.

EU GREEN DEAL AND ROUTE-TO-MARKET TOWARDS CARBON NEUTRAL AVIATION

During the first panel of the day the speakers exchanged their views on the main challenges from 2035 onwards. For **Gabriel Massey**, President & Managing Director of Pipistrel, both technological building blocks and applications are necessary to advance in parallel to bring products into the market. A vision shared also by the CTO of Airbus and Co-Chair of the Clean Aviation Governing Board, **Sabine Klauke**, who is among those cherishing and learning from pioneering spirits like that of Pipistrel. Such approach is a winning one: given the size of the challenge in our hands, we need first and foremost alignment and cooperation among players. Another puzzle piece that cannot be underestimated are co-investments. This global effort requires to be coordinated to ensure that the budget available adds on, and that we can truly proceed at a faster pace and avoid being redundant – underlined **Yannick Assouad**, EVP Avionics of Thales & President of Corac.

IN CONVERSATION WITH ICAO

Jane Hupe, Deputy Director, Environment, at ICAO, shared with the audience ICAO's global approach: the scale

of decarbonisation required by aviation is enormous, and the solutions found for other transports will not apply for this sector. Everybody must be onboard to obtain real global achievements, not only Europe. In this sense, the UN's agency is working, among others, on setting a global CO2 standard introduced into new aircraft designs, long term strategies to act on financial investments reflecting the progress of technologies, and the evolution of the infrastructures.

PIONEERING NEW AIRCRAFT DESIGNS AND LOW-EMISSION TECHNOLOGIES

The second panel discussion saw Safran CTO **Eric Dalbiès**, ZeroAvia CEO **Val Miftakhov**, and MTU Aero Engines CEO **Lars Wagner** agreeing on the advantages of being part of the Clean Aviation's environment, maintaining continuity and stability. European industries are planting the seeds for the technologies of tomorrow, and the benefits of the crops are much awaited. For this, continuity is a key element that needs to be ensured also via multiyear budget plans, granting the room necessary to aviation companies to place Europe in a leadership position.

THE ADDED VALUE OF SYNERGIES AND PARTNERSHIPS

Polona Gregorin, Head of Unit, Air, Rail, Water and Intermodal Policy at the Directorate-General for Climate Action, opened the discussion stating that synergies are necessary also across policy areas; in fact, when these work together, they result in something more than the sum of the individual policies. A theme widely addressed by the speakers was the direction of funds. For Jacqueline Castle, CTO at the Aerospace Technology Institute, non-CO_2 effects and NOx need to receive more and more fundings to be better understood, while **Jo Dardenne**, Aviation Director at Transport & Environment, stressed that not only that fundings need to be adequately regulated in the market where they are invested, but they also need to be allocated to the right technologies – namely those that are the most urgent to bring into the market. The Head of Unit of Programme Development & Communications at Clean Aviation, **Sébastien Dubois,** commented that Clean Aviation is currently aiming to improve coordination between Europe's many regional and industry's initiatives in aviation. By means of detailed technical roadmaps and strategic cooperations for net-zero aviation between the Clean Aviation JU and EU regions, we support European competitiveness, skills, and jobs. As aviation has an inherently long-life cycle, investing in aviation represents a long-term investment.

A SUSTAINABLE LINK BETWEEN AIRPORTS AND AIRLINES

"There is no silver bullet," this is how **Jane Ashton**, Sustainability Director at EasyJet, initiated the last panel of the day. While there is no one single solution that works for all, the initiatives that all the players of the sector can implement are multiple, all interconnected, and mutually beneficial. For instance, despite not having a direct control on Air Traffic Management (ATM), easyJet tries to affect it via smarter aircraft test flights. A stricter collaboration with EUROCONTROL could only be warmly welcomed by **Marylin Bastin**: for the Acting Director at the European Green Sky Directorate, electric and hybrid-electric aviation represent the future of the sky, which is why the sector deserves to get its portion of green energy secured and upscaled. Another fundamental concept emerging was intermodality. To hit its sustainability goals, said its Senior Vice President Flight-/Ground-Operations & Security **Marcus Schnabel**, Lufthansa Group is looking also at boosting inter-modal means to broaden its customer offer. This implies a collaborative effort in understanding how to reinvent modalities already in place, renew infrastructures, and policy frameworks developed together with Governments. Along *intermodality*, sharing knowledge and good practices is another fundamental principle to use as a resource to facilitate the testing and introduction of novelties. **Meiltje De Groot**, CEO of Groningen Airport Eelde – the first hydrogen valley in Europe – is proud of the attention they are dedicating to, among the others, cooperation with energy providers, and readiness of energy supply. Despite being the smallest Dutch airport, that of Groningen is in fact leveraging on its size to open the door to a greater flexibility for testing innovations available – willing, in this way, to be frontrunners and to inspire other airports to follow their example.

AMBITION AND COMMITMENT

The closing remarks of **Axel Krein** were filled with gratification for the collaborative spirit that emerged during the keynotes and panels of Day 1. The speakers called on stage brought not only the diversity of their expertise, challenges, and ambitions within the sector, offering a lively exchange to the audience; they most importantly stood as testimonies that when complementarity overcomes competitiveness, the EU shows the necessary attitude for leading the way forward in aviation. "We have seen the best Forum ever!"

AEROPLANE: THE SESAR 3 JU'S PROJECT OF THE MONTH

Advancing Measures to Reduce Aviation Impact on Climate and Enhance Resilience to Climate Change

Feb. 21, 2024

Carlo Abate from Deep Blue is coordinator of the SESAR JU AEROPLANE project

The relationship between climate and aviation is a tricky one. The aviation industry is making strides to reduce emissions, but it must at the same time adapt its operations to a shifting climate and extreme weather. Carlo Abate from Deep Blue is coordinator of the SESAR JU AEROPLANE project, which is supporting the transition towards a net-zero, resilient aviation sector. In this article, he explains the project's approach to tackling the challenges faced by aviation due to a changing climate.

What is the rationale of the AEROPLANE project and what are its main objectives?

The European aviation sector is highly conscious of the climate impact of its activities. Simultaneously, it is aware of its vulnerability to the increasing frequency of extreme weather conditions. In fact, AEROPLANE tries to answer two questions: how much does aviation contribute to climate change? How much does climate change impact aviation?

In this context, AEROPLANE aims to develop services to support both mitigation (of aviation's impact on climate change) and adaptation (of aviation operations to the effects of climate change). Climate change mitigation focuses on reducing greenhouse gas (GHG) emissions and employing sustainable practices to limit further contributions to global warming. In aviation, this may involve adopting more energy-efficient technologies and improving operations to reduce environmental impact. On the other hand, climate change adaptation refers to the measures and strategies adopted to address and minimise the negative impacts arising from adverse effects of climate change. This includes managing disruptions caused by extreme weather variations, like rain and high temperatures, and effects on air traffic management.

Can you give some examples of proof-of-concept climate services that the project is developing?

AEROPLANE will develop three distinct proof of concept climate services: a methodology to measure aviation's contribution to climate change (considering both CO_2 non-CO2 effects), a methodology to measure the impact of climate change on aviation operations (i.e., impact of high temperatures on take-off performance and noise pollution) and drone operations, and a toolkit that will integrate both measurements. With its expected results, AEROPLANE adopts a user-centred approach in designing solutions tailored to the stakeholder needs.

Is the project targeting conventional aircraft only?

Among its case studies, AEROPLANE focuses also on drone operations, and how these are affected by extreme weather conditions, such as high temperatures, strong wind and rain, etc. During its project lifecycle, AEROPLANE will also involve drone operators to understand how they face the challenges posed by climate change in order to design innovative climate services tailored to their needs.

What are the expected benefits of this project?

When developed and demonstrated, the AEROPLANE solutions will promote a more sustainable aviation, with the twofold objective of increasing the awareness of different stakeholders about the impact of operations on climate and improve the sector's resilience to climate-induced extreme phenomena. For instance, AEROPLANE can greatly contribute to informed decision-making when planning operations, such as avoiding airspace that is particularly sensitive to emissions or provide crucial insights to increase the resilience of airports to extreme weather conditions.

FUTURE COMBAT AIR SYSTEM (FACS)

Enter the Internet of Military Things

The FCAS Air Combat Cloud will bring real-time intelligence to the forefront by harnessing the networked capabilities of different aircraft and platforms. Innovations in AI, big data processing and cyber will help make defence a truly collaborative mission.

Europe's Future Combat Air System (FCAS) will see next-generation manned jets flying alongside unmanned remotely piloted carriers of varying sizes. These assets will be part of a **fully networked 'system of systems**' based on open architectures that will allow the integration of other existing platforms such as the A400M or the A330 MRTT tanker. At the heart of this complex system will be the Air Combat Cloud, which will enable these platforms to work together.

FCAS Next-Generation Weapon System (NGWS) with Eurofighter and Remote Carriers

But what exactly is an Air Combat Cloud? As FCAS Combat Cloud Product Solution Lead at Airbus, Ignacio Rosell is often asked this question.

"How does the Android ecosystem work? We have an operating system that allows applications from different parties to be integrated, and all of this is supported by a communications infrastructure such as 5G, Bluetooth or Wi-Fi. If we apply this analogy to FCAS, **we are developing an important part of the 'Internet of Military Things**'. Our mobile phones could be a fighter aircraft, an unmanned aerial system (UAS), a warship, a satellite, or even a soldier on the ground, each integrating different applications or, in other words, different capabilities. Our air combat cloud has the same components, the communications infrastructure, the operating system and the applications that allow them to operate in a collaborative way," adds Rosell.

A Europe at the forefront of technology

Launched by France, Germany and Spain, and with Airbus, Dassault Aviation and Indra as national industrial coordinators, FCAS is one of the most important European defence programme of the coming decades. In a context of growing global instability, the aim of the project is nothing less than to design an air defence system that will protect Europe while enhancing its strategic autonomy and technological sovereignty.

Speeding up the cycle with learning technologies

Airbus is leading the Combat Cloud pillar, with Thales and Indra as its main partners. This is one of seven areas of the next-generation FCAS technology (*see infographic below the page), headed at Airbus by Marc Paskowski.

It will provide common situational awareness by instantaneously capturing, sharing, fusing and processing massive amounts of data from all connected manned and unmanned platforms in a trusted manner, and transforming this data into actionable information by leveraging the ever-evolving learning technologies. "The concept based on the air cloud is that all elements must constantly interoperate with each other to form a cohesive system that is informed as one and combat as one," says Paskowski.

Development work for FCAS Phase 1B is now underway at the Airbus site in Friedrichshafen. This will be followed by Phase 2, culminating in a flight demonstration of the advanced Combat Cloud by around 2028.

"Our 'operating system' will need to be an open one to accommodate both off-the-shelf and bespoke applications such as manned-unmanned teaming, from Airbus or from any other industrial partner. It will be an evolutionary one, with new applications such as new aerial platforms being integrated along the way," says Rosell. "Our business model around the Combat Cloud won't be unique. An area such as satellite connectivity could be offered as a service, while an 'app' part of an aircraft's mission system could be sold as a product," he adds.

New Generation Fighter and Remote Carriers demonstrators connected to the Combat Cloud are planned for first flight in 2028/2029

The development of intermediate solutions as part of this 'internet of military things' should enable customers to use various levels of cloud capabilities and remote carriers well before FCAS becomes operational in the 2040s. For example, Airbus has already carried out the world's first successful launch and operation of a Remote Carrier flight test demonstrator from a flying A400M.

For those who secure today and tomorrow: responsible AI for FCAS

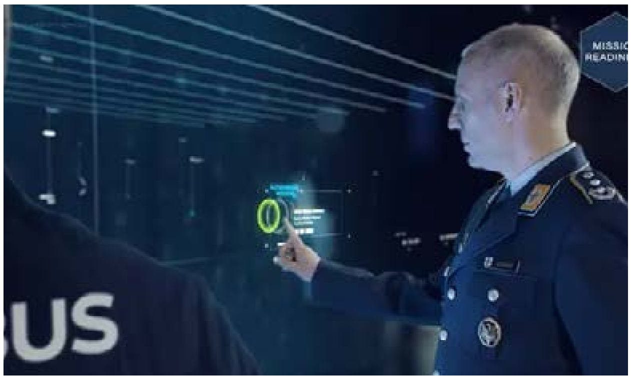
Based on this incremental approach, the air combat cloud will be the digital game-changer for the way military operations are conducted.

"The ability to integrate, operate and communicate from a networked system will shape the air force of the future."

German Air Force Lieutenant General Ingo Gerhartz

Indeed, future scenarios will require a far higher degree of automation for information management and integration of military services and branches throughout the whole mission cycle. For FCAS, innovations in 'deep techs' such as big data processing, artificial intelligence and cyber will provide the advanced intelligence of the cloud, enabling, for example, the distribution of Command and Control (C2) roles, including to the pilot in their fighter, and providing the key players in a mission with all relevant information in real time. "This will give decision makers in the air force an unprecedented level of awareness," highlights Paskowski.

But with a great power comes great responsibility. With the increasing reliance on artificial intelligence in everything we do as 'digital citizens', and the use of platforms such as ChatGPT and its impact in the workplace, the integration of AI at the heart of the FCAS Air Combat Cloud presents new challenges. Questions such as 'how much will the system support the decision-making process?' or 'What are the ethical criteria that can be applied to the use of this technology?'



To control or to be controlled: that is the question

In order to anchor ethical questions and legal principles in the FCAS project, Airbus and the Fraunhofer Institute teamed up in 2019 to launch a joint expert commision on the responsible use of technologies (link). It brings together stakeholders from the German Air Force with universities, research institutes and a broad cross-section of foundations, social science and engineering science design experts.

Building on this guidance, within the FCAS Air Combat Cloud, AI will provide analysis of complex situations during multi-domain operations and recommend the smartest action in the right sequence. The human will then validate the recommendations. If the operational tempo is high, the human will instead simply decide whether or not to veto the recommendations, and the

Both technologically and militarily, the development of FCAS has the potential to set new standards and revolutionise the use of air power.

subsequent processes will again be automated by the AI. "Our European air defence system will be under the full control of a responsible human operator at all times and in all circumstances," concludes Marc Paskowski.

The use of AI at Airbus

Airbus began integrating AI into its products and solutions in the 1990s, with applications for reading and interpreting satellite imagery. The OneAtlas imagery services harnesses the power of Airbus' constellation of optical and radar satellites with trusted AI and cloud technology to provide key insights for example for combating deforestation, optimising agricultural yields and urban planning.

Meanwhile, in the aeronautical sector, Airbus' Skywise big data platform collects data from 24,000 aircraft parameters, enabling airlines subscribing to the service to carry out predictive maintenance and improve the overall operational efficiency of their fleets.

© Airbus 20218 - Photo by P. Masclet / Marter Films

TECHNOLOGICAL PILLARS OF FCAS PROGRAMME

The FCAS programme comprises a total of seven main development areas.

ENHANCED PILOT INTERFACES & INTERACTIONS FOR FIGHTER COCKPITS

22 June 2023, Paris AirShow

THALES TAKES THE LEAD IN THE EUROPEAN EPIIC RESEARCH PROJECT TO DESIGN THE TECHNOLOGIES FOR THE FUTURE MILITARY COCKPIT

- Financed by the European Commission through the European Defence Fund to the tune of 75 million euros, the EPIIC (Enhanced Pilot Interfaces & Interactions for fighter Cockpit) project brings together 27 major players from European industry and research.

- Led by Thales, the project aims to meet the challenges of future air combat by identifying, developing and evaluating breakthrough technologies and new human-machine interfaces to be integrated into the cockpits of future fighter aircraft.

- These technologies will support pilots who have become true collaborative combat strategists by creating an immersive environment to support the mission.

- Thales is coordinating the project and is focusing its work on two key technologies: helmet-mounted sights and the Crew Monitoring System, which monitors the crew's physiological parameters.

At the heart of future air combat, the EPIIC project led by Thales aims to rethink human-machine interaction by using the most advanced technologies to create an immersive environment where the machine supports the pilot. The fighter pilot will be able to supervise and operate a set of platforms, with or without crew, in a highly complex and evolving environment.

The European project Enhanced Pilot Interfaces & Interactions for Fighter Cockpit (EPIIC) aims to identify, develop and evaluate disruptive cockpit technologies that will revolutionize the collaborative air combat of the future. Funded with €75 million from the European Defence Fund, this project, coordinated by Thales, brings together a consortium of 27 manufacturers and research organizations from 12 European countries. [1]

The need to accelerate the OODA loop - Observe, Orient, Decide, Act - and to act with complete discretion, will lead the pilot to become a true strategist, capable of managing the resources at their disposal and of replanning the phases of their mission in flight to ensure its success. The three-year EPIIC project aims to study and develop technological solutions that will improve the strategist pilot's situational awareness and facilitate rapid decision-making in the most complex situations, while monitoring his or her physiological state.

Thales is at the heart of defence issues in all fields and environments, designing technologies to provide armed forces with superior capabilities, both in terms of platforms and collaborative combat between them. **Within the framework of EPIIC, Thales is coordinating the project and focusing its work on two key technologies: helmet sights and the Crew Monitoring System, which monitors the crew's physiological condition.**

- The future **helmet sight** will have to retain the advantages of previous generations - limited weight, brightness, precision, resistance to ejection - while offering a wider field of vision, superior immersion by day and night, and intuitive display of mission and flight information.
- The helmet will also be able to house biological sensors measuring blood oxygenation, heart rate and brain activity, in order to analyze the pilot's condition (hypoxia, fatigue, stress, etc.).

The consortium will also evaluate a virtual assistant solution for the mission commander, taking into account their physiological state, a valuable support in case of cognitive overload, fatigue, stress or tunneling.New displays such as future free-form curved screens, canopy projection of pilot or mission information, and innovative human-system interactions will also be part of EPIIC's research topics.

" We are honoured to lead the EPIIC project, under the aegis of the European Defence Fund, in cooperation with the major European players in industry and research. Together, we have the ambition to combine the best of technologies for the future European fighter aircraft cockpit, the strategic vanguard of collaborative combat."

Yannick Assouad, Executive Vice President, Avionics, Thales

This publication was funded by the European Union. Its contents are the sole responsibility of Thales and do not necessarily reflect the views of the European Union.

Funded by the European Union

1 THALES (Coordinator-France), AALBORG UNIVERSITET (Denmark), AIRBUS DEFENCE AND SPACE GmbH (Germany), AIRBUS DEFENCE AND SPACE SA (Spain), ALMADESIGN CONCEITO E DESENVOLVIMENTO DE DESIGN LDA (Portugal), DASSAULT AVIATION (France), DEUTSCHES ZENTRUM FUR LUFT UND RAUMFAHRT EV (Germany), DIEHL AEROSPACE GMBH (Germany), EMPORDEF TECNOLOGIAS DE INFORMACAO SA (Portugal), ESG ELEKTRONIKSYSTEM UND LOGISTIK GmbH (Germany), GMVIS SKYSOFT SA (Portugal), HAT.TEC GMBH (Germany), INDRA SISTEMAS S.A. (Spain), INSTA ILS OY (Finland), INSTITUTUL NATIONAL DE CERCETARE DEZVOLTARE AEROSPATIALA "ELIE CARAFOLI" – INCAS BUCURESTI (Romania), LEONARDO – SOCIETA PER AZIONI (Italy), NEXT2U SRL (Italy), ROCKWELL COLLINS DEUTSCHLAND GmbH (Germany), SAAB AKTIEBOLAG (Sweden), STICHTING KONINKLIJK NEDERLANDS LUCHT – EN RUIMTEVAARTCENTRUM (Netherlands), TECNOBIT SL (Spain), TERMA A/S (Denmark), TOTALFORSVARETS FORSKNINGSINSTITUT (Sweden), UNIVERSITY OF PATRAS (Greece), UNIVERSITY OF ZAGREB FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING (Croatia).

PLANETARY PROTECTION AT ESA

Interview with Silvio Sinibaldi, Planetary Protection Officer at ESA
By Anastasia Pesce, CEAS Space Branch member

Silvio Sinibaldi

Biography
Silvio Sinibaldi is the Planetary Protection Officer for ESA (European Space Agency). His background is Materials Science, Nanotechnology and Astrobiology. He is a professional materials and processes, cleanliness & contamination and Planetary Protection expert having worked at Airbus Defence and Space UK as the Planetary Protection & Cleanliness and Contamination Lead for the ExoMars Rover and Mars Sample Return. Silvio is a member of the COSPAR PP (Committee on Space Research Planetary Protection) panel and other European working groups developing space standards and specifications for industry. He is currently studying a PhD at the Open University investigating innovative methodologies in planetary protection.

What is your role at ESA?
I am the guardian of the ESA planetary protection policy. My main responsibilities include regulatory functions, as I act as planetary protection approval authority for ESA missions. I am also the focal point for the agency Planetary Protection capability. As such, I instigate and manage R&D activities in the field of planetary protection, and I serve the role of leading interactions with COSPAR, UN COPUOS (United Nations Committee on the Peaceful Uses of Outer Space), and multiple international stakeholders.

What is Planetary Protection?
Planetary protection is the discipline of promoting the sustainable and responsible exploration of space by minimising the potential transfer of biological matter to and from Earth and other objects in the Solar System. Despite conditions on other planets might look inhospitable, the necessary ingredients to host life could be present. As such, conscious space projects planning to visit celestial bodies cannot leave their protection to chance.

INTERNATIONAL FRAMEWORK AND OBJECTIVES OF PLANETARY PROTECTION

Article IX of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the "Outer Space Treaty"), requires that State parties to the treaty conduct the exploration of outer space, including the Moon and other celestial bodies, "so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extra-terrestrial matter and, where necessary, [to] adopt appropriate measures for this purpose".
ESA acts on behalf of its Member States, all of which are State parties to the Outer Space Treaty. As such, the execution of ESA's activities shall comply with the Member States' obligations pursuant to Article IX of the Outer Space Treaty.
ESA planetary protection policy, guided by the COSPAR PP policy is based on two fundamental principles:

Principle 1. The Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission (backward planetary protection).

Principle 2. The conduct of scientific investigations of possible extra-terrestrial life forms, precursors, and remnants must not be jeopardized (forward planetary protection). Humans now routinely venture beyond Earth and send spacecraft to explore other planets. Yet with this extraordinary ability comes great responsibility; we must ensure that we do not bring back anything harmful from other worlds. Similarly, we must make sure that we do not introduce terrestrial biological contamination to other planets and moons that have potential for past or present life.
Adopting planetary protection measures is not just an aspiration; it is a legal obligation from the United Nations Outer Space Treaty.

WHAT IS COSPAR?

The primary objective of the COSPAR Planetary Protection Panel (PPP)is to maintain, develop the COSPAR Policy and its associated requirements for the reference of spacefaring nations and to provide guidance upon request with compliance with the Outer Space Treaty. The COSPAR PP policy is a classic example of 'soft law' and rely on stakeholders to adhere to it

The COSPAR PPP ensures that the COSPAR Policy and its associated requirements are up-to-date and represent the actual needs for space exploration. Its structure comprises a total of 25 members: these are formally appointed scientists/experts and representatives from space agencies. As ESA planetary protection officer I am a member of the panel myself.

The Terms of Reference ensure a balance between space agency representatives and scientists.

COSPAR PP policy defines five categories for target body or mission type (orbiter, lander) combinations. For each category there are respective recommended requirements. See table below for details.

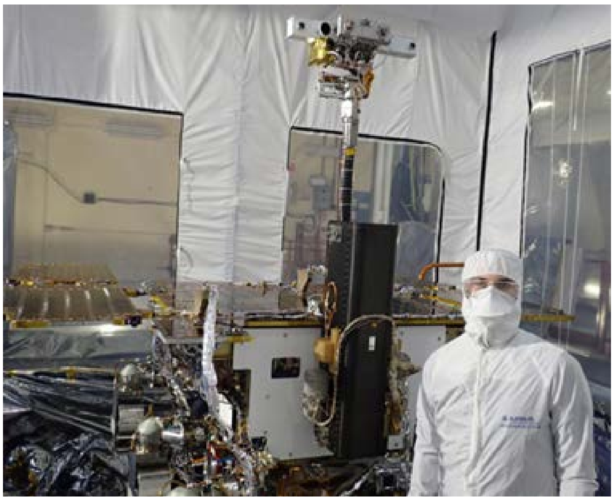
Can you give some examples of what planetary protection entails, specifically for missions to Mars?

In practice, for missions to target bodies, like Mars, of great interest for understanding chemical evolution and/or origin of life in our solar systems; and for which scientific opinion believes that there is significant chance of contamination which could compromise future investigations, planetary protection sets limits for the level of acceptable microbiological contamination and for the probability of impact of spacecraft.

Mars is a primary target in the search for evidence of extraterrestrial life, past or present, and for this reason planetary protection requirements are very much Mars-centric. To satisfy these requirements, for orbiters or for spacecraft performing flybys, mission teams must demonstrate one of two things. Either that there is a very small chance of the spacecraft crashing or impacting on its target world or that, in the event of a crash, the chance of biologically contaminating the planet is below a set limit.

For the ExoMars Trace Gas Orbiter for example, ESA has chosen to satisfy the impact probability constraint. The Agency has demonstrated that there is a less than 1 in 100 chance of an impact on the planet for the first 20 years after launch and less than 5 in 100 chances for the time period from 20 to 50 years after launch.

Schiaparelli clean room . credit: ESA



The ExoMars - Rosalind Franklin - Rover during the environmental testing phase at Airbus Toulouse. Strict planetary protection measures have been applied throughout the project to keep biological contamination under acceptable limits. Credit: Airbus

These assessments are made by scrutinising the design, evaluating the operational reliability of the mission, the flight hardware reliability, the effects of the natural space environment such as micrometeoroids and Mars atmospheric variations. The launcher upper stage is also subject to impact probability requirements, even more restrictive, to ensure that it does not impact Mars after separation from the spacecraft.

For a lander or a rover set to land on the Red Planet, the limits on the level of possible microbiological contamination are very stringent. The ExoMars Rosalind Franklin rover has been built in a biologically controlled cleanroom, with strict operational procedures and personnel trained regularly.

Focus on people and planetary protection implementation strategies

People are the biggest source of contamination for flight hardware. A dedicated training programme for all personnel involved in the construction and testing of the ExoMars Rover, and the development of new cleanroom operating procedures were implemented.

All of the flight hardware, went through numerous cleaning cycles with sterile 70% isopropyl alcohol was and/or exposed to different level of sterilisation, like dry heat microbial reduction, which is achieved by exposing equipments to temperatures above 110°C for a time that can vary from several hours to several days. Tens of thousands of microbiological assays were carried out throughout the assembly, test and launch operations to check that these procedures were working well.

The planetary protection requirements have been verified by internal and independent assessments throughout the project lifecycle during reviews, audits and tests. The final certificate of compliance is issued based on these results and for the launch readiness review.

The ExoMars (Rosalind Franklin) Rover being checked during integration activities inside the Bio CleanFacility at Airbus Stevenage (UK). Credit: Airbus

What are the ESA missions affected by planetary protection ?

Any mission leaving Earth's orbit is affected by planetary protection requirements. Each mission is assigned a category depending on a combination of target body (whether this is of interest to understand chemical evolution and origin of life in our solar system) and the type of mission (i.e. orbiter, fly-bys, landers), according to the COSPAR guidelines. And for each case, control measures prevent harmful contamination to celestial bodies and protect Earth from potential hazards from other worlds.

What are the next big challenges for (PP) ?

The ESA Agenda 2025 and Terrae Novae vision articulate ambitious space exploration plans for the next three years and beyond, aiming to increase European autonomy and leadership in space. These plans include the search for extraterrestrial life, returning samples from Mars, the unprecedented desire for a stable European presence on the Moon's surface and crewed missions to Mars (Terrae Novae 2030+ Strategy Roadmap, June 2022).

The complexity of such missions calls for a rethink of current Planetary Protection approaches, including the expansion of tools and methods used to measure biological contamination. Research and technology developments in the field of molecular biology are considered paramount for planetary protection. These techniques provide key information to assess contamination risks, in the effort to ensure that target bodies are kept as pristine as possible during astrobiological exploration (forward contamination), and to control and safeguard crew health, general public, and Earth's biosphere (backward contamination).

One of the major areas of research is currently going towards the development of probabilistic models and the use of artificial intelligence to circumnavigate some of the current unknown in the field. Real biological test data, gathered from cleanrooms and flight hardware, will then feed any used model to make it robust and credible. There is a big push to investigate innovative and more flexible biological assay methodologies that can be tailored for space planetary missions and that can measure a broader range of microbes, in a timely manner and with reduced costs.

A shift at ESA from a prescriptive to a risk-assessment based approach, would require direct involvement of international partners and stakeholders, multidisciplinary approaches, and larger community consensus. Leadership from COSPAR planetary protection panel is considered key at ESA to succeed and reach international consensus, where European academia, institutions will be active part of the journey.

How do you feel Planetary protection gets implemented?

In Europe, we have made significant strides in planetary protection. Leading European prime contractors such as Airbus, Thales, and OHB have played a pivotal role in this endeavour. They have developed and operated cutting-edge biologically controlled cleanrooms to assemble and test the ExoMars Rosalind Franklin mission, now scheduled for launch in 2028.
Leonardo is developing other facilities to support the development of the Sample Transfer Arm, another ESA-led element of the MSR mission, the robotic arm tasked to pick up the tubes filled with precious Martian samples and prior to an historic launch from the Red Planet and interplanetary delivery to Earth.

ESA is also continuing to develop critical core technologies for the Sample Receiving Facility, which will be built in the coming years and will host the sample from Mars in the frame of MSR.
Europe is ready to avoid harmful contamination on our spacecraft and help maintaining our Solar System as pristine as possible.

How do you interact with your international partners?

The short answer is in an open and collaborative manner. Planetary protection really benefits from international consensus. Requirements are not cast in stones, and new discoveries on target bodies could trigger re-evaluation of needs and implementation measures. In this kind of environment, international cooperation is essential to tackle never faced before problems and analyse planetary protection from different angles. Private and commercial entities for example are playing an always more important role. I do consider communication with them as a key factor for success in planetary protection.

The ESA planetary protection policy is fully guided by COSPAR's.

CATEGORY	MISSION TYPE	TARGET BODY
I	Flyby, Orbiter, Lander	Undifferentiated, metamorphosed asteroids; Io; others to-be-defined (TBD)
II	Flyby, Orbiter, Lander	Venus; Moon (Cat. II, IIa & IIb); Comets; Carbonaceous Chondrite Asteroids; Jupiter; Saturn; Uranus; Neptune; Ganymede*; Callisto; Titan*; Triton*; Pluto/Charon*; Ceres; Kuiper-belt objects > ½ the size of Pluto*; Kuiper-belt objects < ½ the size of Pluto; others TBD
III	Flyby, Orbiters	Mars; Europa; Enceladus; others TBD
IV	Landers	Mars (Cat. IVa, IVb, & IVc); Europa; Enceladus; others TBD
V **"Restricted Earth return"**	—	Mars; Europa; Enceladus; others TBD
VI **"Unrestricted Earth return"**	—	Venus, Moon; others TBD

ARIANE 6 JOINT UPDATE REPORT

22 February 2024

The Ariane 6 Launcher Task Force consists of top management of ESA, as the overall Ariane 6 procuring entity and launch system architect, of the French space agency CNES as the launch base prime contractor, of ArianeGroup as the launcher system prime contractor and of Arianespace as the launch service provider. This group reports regularly on progress being made towards inaugural flight of the new Ariane 6 launcher.

Arrival of the Canopée ship, designed to transport Ariane 6, at the port of Pariacabo in French Guiana on Wednesday 21/02/2024. © CNES/ESA/Arianespace-ArianeGroup/ Optique Vidéo CSG/S Martin, 2024

KEY MILESTONES TOWARDS INAUGURAL FLIGHT:
On the way towards the first flight of Ariane 6, these milestones have been conducted since the last joint update:

9 February 2024: Fairing removal from Ariane 6 test model, Kourou, French Guiana
The fairing and dummy payloads were removed from the Ariane 6 test model and transferred to the Batiment Assemblage Final. With this the test model on the Ariane 6 launch pad has started to be dismantled to make way for the flight model of Ariane 6.
This dismantling also validates the ability to disassemble the launcher in case anomalies would require a change of a stage of the rocket on the launch pad.
In addition, a “Dummy Payload Dismounting Test” will be executed in the Hall d’Encapsulation (HE) that is part of the Batiment Assemblage Final (BAF).

21 February 2024: Arrival of Ariane 6 first flight model main and upper stage, Kourou, French Guiana
The main and upper stage for the inaugural flight for Ariane 6 arrived at Europe’s Spaceport from mainland Europe.
NEXT MILESTONES:

INAUGURAL LAUNCH CAMPAIGN

- **March: Integration of central core, Kourou, French Guiana**

The upper and main stage will be connected in March to form the central core.

- **By mid March 2024: First booster flight model ready and stored, Kourou, French Guiana**

The first booster for the Ariane 6 inaugural flight is being integrated at the booster finishing facility in French Guiana.

- **Early April 2024: second booster for inaugural flight ready and stored, Kourou, French Guiana.**

The second booster for the Ariane 6 inaugural flight is being integrated at the booster finishing facility in French Guiana.

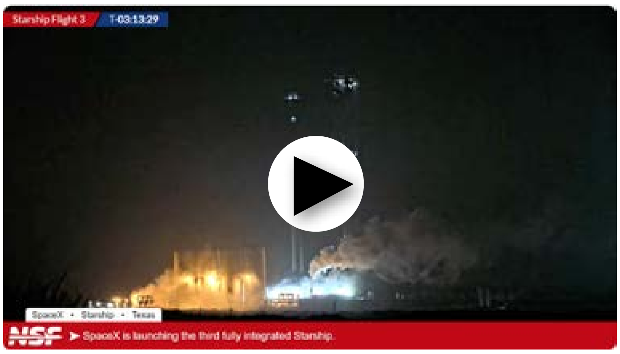
First flight period
ESA, CNES and ArianeGroup are targeting the first launch of Ariane 6 between 15 June and 31 July 2024.

The Ariane 6 Joint Update Report 22 March 2024 has been recently released.

Consult > https://press.ariane.group/update/

STARSHIP'S THIRD INTEGRATED TEST FLIGHT, 14 MARCH 2024, MOVES STARSHIP CLOSER TO OPERATIONAL STATUS

SpaceX's third test flight accomplished a lot that is was supposed to, lasting 49 minutes, i.e. six times longer than the previous flight (18 November 2023). It reached intended suborbital trajectory, flowing halfway around the world and so accomplishing a key demonstration of its ability to carry heavyweight payloads into Low Earth Orbit. It also demonstrated door opening and closing in space. This flight is an important milestone towards providing NASA with a Starship HLS (Human Landing System) for the Artemis missions.



14 March 2024 at 13:25 UTC, SpaceX launches the third integrated flight test IFT-3 from the company's Starbase launch facility in Boca China, Texas. A complement of 33 Raptor engines, fuelled by super-cooled liquid methane and liquid hydrogen powered the Super Heavy booster with Starship stacked on top.

The 33 Raptor Engines of SpaceX Heavy Booster ignite during IFT-3 of Starship rocket on March 14, 2024. (Image credit: SpaceX via X)

The SpaceX Starship Flight 3 rocket is launched at the Starbase Facility on March 14, 2024 in Brownsville, Texas. (Image credit: Brandon Bell/Getty Images)

"Starship will take humanity to Mars", SpaceX CEO Elon Musk in a post on X accompanying this image of Starship's third test flight on March 14, 2024. –Image credit: SpaceX via X)

FAILURE OF SUPER HEAVY RECOVERY ON THE GROUND

14 About 2 minutes and 42 seconds into the flight, the Super Heavy booster began shutting down most of its engines. It soared out over the Gulf of Mexico. It burnt through most of its fuel and broke away from the Starship spacecraft. It was expected to make an autonomous, controlled landing in the ocean, but it did not light all necessary engines as expected and was lost. While Starship headed into its intended trajectory, The Super

Heavy flipped and conducted a boost-back manoeuvre to set the stage for a soft splashdown in the Gulf of Mexico. The booster nearly completed its intended return flight but was unable to conduct a landing burn shortly before splashdown, resulting in a hard impact. The return was not nominal because the control surfaces had not sufficient authority to put the booster's axis nearly vertical and also because one only of the 13 Raptor engines cardan-mounted had been ignited.

Hot-staging occurred two seconds later, with the nearly simultaneous ignition of six Raptor engines on the upper stage Starship, and the separation of the Super Heavy booster. This hot-staging technique, designed to avoid brief interruption in thrust during stage separation, had been successfully tested during IFT-2 on 18 November 2023.

STARSHIP TESTS AND TECHNICAL DEMONSTRATIONS

The six Raptor engines of the ship burned for about six minutes and accelerated the vehicle to nearly 26,500 km/h. As planned, this speed was close to what would be required to enter a stable orbit around the Earth. While Starship coasted to a maximum altitude of 234 km, the low point (Perigee) of the ship's orbit was inside the atmosphere ensuring aerodynamic drag would bring it back the Earth before completing a full circuit of the planet.

The Starship payload door – a hatch that must open for the spacecraft to deploy satellites into space after reaching orbit – swung open before resealing in a crucial test of that mechanism.

SpaceX also carried out a "propellant transfer demonstration" in the perspective of future missions requiring that Starship is refuelled while it is on orbit.

SpaceX's first three integrated test flights have followed a steady curve of progress:

- The first launch in April 2023 suffered several engine failures and damaged the launch pad;
- On its second flight in November 2023, none of the engines failed and the rocket nearly reached its targeted velocity before a a propellant leak caused it to self-destruct when over the Gulf of Mexico:
- Now the Raptors have a perfect record of two consecutive test flights, proving that the design of complex new engine is maturing:
- Starship completed a full-duration ascent burn and reached intended trajectory and was able to run through a series of engineering demonstrations as it coasted 150 – 235 km above Earth.

STARSHIP'S FIRST REENTRY

Beginning about 46 minutes after launch, Starship beamed down what might have been the most spectacular imagery from the flight. At this point of the mission, the 50-meter long ship was speeding across the Indian Ocean and rapidly failing as Earth's gravity pulled it back into the atmosphere over the Indian Ocean.

Starship's flaps, there to provide aerodynamic control during the final phase of descent, folded up against the ship's main body. The Starship is coaed with 18,000 lightweignt, ceramic hexagon tiles to protect the vehicle from the extremely hot temperatures as it plunges back into the Earth's atmosphere. Thes tiles started glowing orange as a sheath of plasma enveloped the vehicle. Temperatures outside Starship climbed higher than 1370°C and the ship appeared to be under control during the first moments of re-entry.

SpaceX's Flight 3 upper stage glows orange as it heats up during re-entry during test flight 3 on March 14, 2024. (Image credit: SpaceX) Telemetry data continued streaming from Starship back to SpaceX mission control until it reached an altitude of around 65 km. Then, the team lost two key pieces of communication at the same time:

- *Contact with Starlink, the SpaceX's internet service;*
- *The TDRSS (Telecommunication Data Relay Satellite System).*

Likely Starship burned up and disintegrated over the Indian Ocean between Madagascar and Australia.

So, there was no splashdown in the end of IFT-3, Starship having broken apart before.

After the demonstration of launching Starship on 14 March, recovery of Super Heavy on the ground and restart of Raptor engines in flight are a higher priority for preparing upcoming missions.

Five other Starship test flights – IFT 4-5-6-7-8 – will take place between now and the end of 2024.

IFT-3 accomplished several important firsts that will contribute to the development of Starship for Artemis lunar landing missions. One objective closely tied to future Artemis mission operations is the transfer of thousands of kg of cryogenic propellant between internal tanks during the spacecraft's coast phase, and precisely, the propellant transfer demonstration operations were completed. As a key step forward understanding how supercooled propellant sloshes within the tanks when the engines shut down, and how movements affect Starship stability while in orbit, engineers are studying flight test data in order to assess the performance of thrusters that command Starship's orientation in space. They also are learning more about how the fluid's movements within the tanks can be settled to maximize propellant transfer efficiency and ensure Raptor engines receive needed propellant conditions to support restart in orbit.

STARSHIP KEY FACTS AND FIGURES

Starship prototype in launch configuration: Starship spacecraft sits on top of Super Heavy.

Function	sub-orbital spaceflightorbital spaceflightinterplanetary spaceflight
Manufacturer	SpaceX
Country of origin	United States
Project cost	€3.6 billion[1]
Cost per launch	At least US$5 billion[1]

SIZE

Height	121 m (397 ft)
Diameter	9 m (30 ft)
Mass	5,000 t (11,000,000 lb)

CAPACITY

Payload to LEO

Mass	Reusable: 100–150 t (220,000–331,000 lb)
Volume	1,000 m3 (35,000 cu ft)

ASSOCIATED ROCKETS

Derivative work	Starship HLS
Comparable	N1 Saturn V Space Shuttle Falcon Heavy Space Launch System Long March 9

LAUNCH HISTORY

Status	In development
Launch sites	SpaceX Starbase Kennedy Space Center, LC-39A (planned)
Total launches	3
Success(es)	1 (IFT-3)[2][disputed – discuss]
Failure(s)	2 (IFT-1, IFT-2)
First flight	20 April 2023; 11 months ago
Last flight	14 March 2024

FIRST STAGE – SUPER HEAVY

Height	71 m (233 ft)
Diameter	9 m (30 ft)
Empty mass	200 t (441,000 lb)
Gross mass	3,600 t (7,937,000 lb)
Propellant mass	3,400 t (7,496,000 lb)
Powered by	33 Raptor engines)
Maximum Trust	7,590 tf (74,400 kN; 16,700,000 lbf)
Specific impulse	327 s (3.21 km/s) (sea-level)
Propellant	Liquid oxygen / Methane

SECOND STAGE – STARSHIP

Height	50 m (160 ft)
Diameter	9 m (30 ft)
Empty mass	~100 t (220,000 lb)[3]
Gross mass	1,300 t (2,866,000 lb)[a]
Propellant mass	1,200 t (2,646,000 lb)
Powered by	3 Raptor engines 3 Raptor vacuum engines
Maximum Trust	1,500 tf (14,700 kN; 3,310,000 lbf)
Specific Impulse	327 s (3.21 km/s) (sea-level 380 s (3.7 km/s) (vacuum)
Propellant	Liquid oxygen / Methane

STARSHIP SPACECRAFT

The Starship spacecraft is 50 m (160 ft) tall and 9 m (30 ft) in diameter. It uses 6 Raptor engines, three of which are optimized for use in vacuum.[15][31] The engines produce 14,700 kN (3,300,000 lbf) of thrust.[26] The vehicle's payload bay is planned to measure 17 m (56 ft) tall and 8 m (26 ft) in diameter with an internal volume of 1,000 m^3 (35,000 cu ft); slightly larger than the ISS's pressurized volume.[32] Starship has a total propellant capacity of 1,200 t (2,600,000 lb)[14] across its main tanks and header tanks.[33] According to Elon Musk in 2019, the header tanks are better insulated due to their position and are reserved for use to flip and land the spacecraft following reentry.[34] A set of reaction control thrusters, which use the pressure in the fuel tank, control attitude while in space.[35]

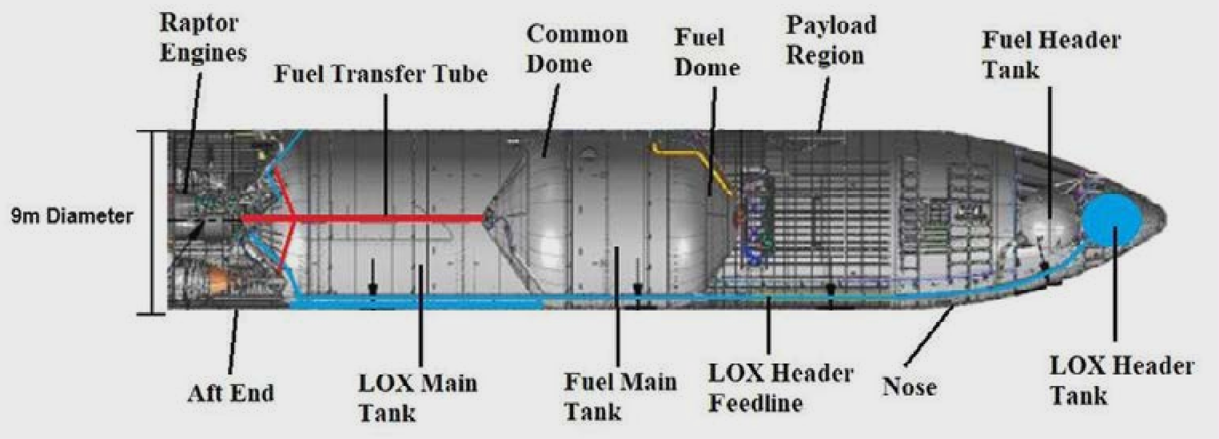


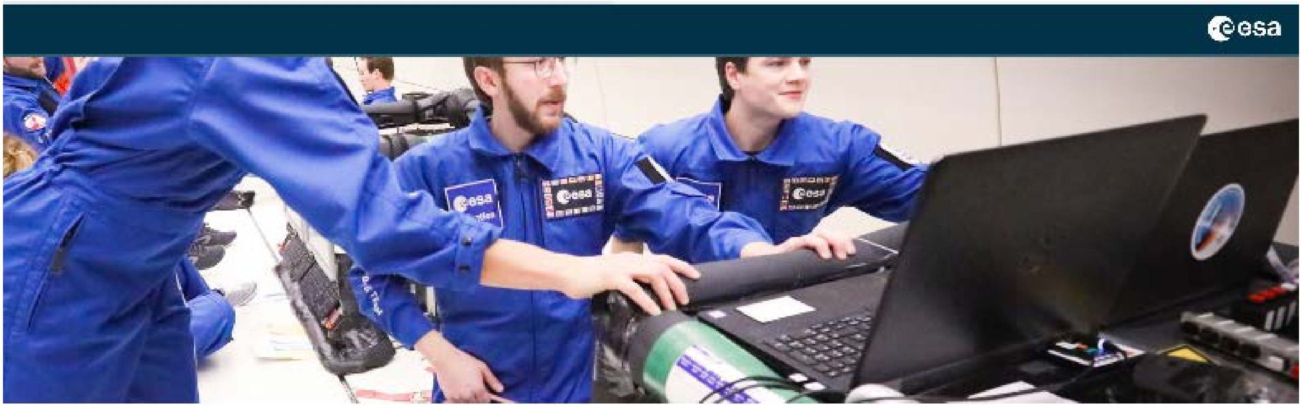
Diagram of Starship's internal structure. Not shown in this diagram are the flaps: the aft flaps are placed at the bottom (or left in this orientation), and the forward flaps are placed at the top (here, right) portion of the spaceship.

Starship's heat shield under inspection

The spacecraft has four body flaps to control the spacecraft's orientation and help dissipate energy during atmospheric entry, composed of two forward flaps and two aft flaps.[36] According to SpaceX, the flaps replace the need for wings or tailplane, and reduce the fuel needed for landing. [37]:1 Under the forward flaps, hardpoints are used for lifting and catching the spacecraft via mechanical arms.[28] The flap's hinges are sealed in aerocovers because otherwise, they would be easily damaged during reentry.[3]

Starship's heat shield is composed of eighteen thousand[38][39] hexagonal black tiles that can withstand temperatures of 1,400 °C (2,600 °F).[40][41] It is designed to protect the vehicle during atmospheric entry and to be used multiple times with minimal maintenance between flights.[17] The silica-based tiles[42] are attached to Starship with pins[41] and have small gaps in between to allow for heat expansion.[3]

ESA ACADEMY



SEVEN NEW TEAMS SELECTED FOR THE ESA ACADEMY EXPERIMENTS PROGRAMME

Regular e-News providing the latest on activities and opportunities provided by the academy.

DATE OF ACTIVITY*	PROGRAMME	DEADLINE TO APPLY	TYPE	STATUS
20-23 May 2024	Space Propulsion 2024	5 April 2024	Conference	Open
10-14 June 2024	Space Standards Training Course	10 April 2024, 23:59 CET	Training Session	Open
17-28 June 2024	ESA/ELGRA Gravity-Related Research Summer School	8 April 2024, 23:59 CEST	Summer School	Open
18-20 June 2024	2nd RAMS Conference	19 April 2024	Conference	Open
24-27 June 2024	International Conference on Space Robotics 2024 (iSpaRo'24)	Date to be announced	Conference	Coming soon
8-12 July 2024	Spacecraft Testing Workshop	26 April 2024, 23:59 CEST	Workshop	Open
15-19 July 2024	Earth Observation Remote Sensing Workshop	29 April 2024, 23:59 CEST	Workshop	Open
5-30 August 2024	CubeSat Summer School	15 April 2024, 23:59 CET	Summer School	Open
October 2024	Fly Your Satellite! Test Opportunities window	3 June 2024, 23:59 CET	Hands-on	On-hold

EUROCONTROL: MOVING FROM TRAINING TO LEARNING

For over 50 years, EUROCONTROL's Luxembourg site has been meeting European aviation's training needs, and with 900,000 course registrations over that time, heading for our millionth enrolment. Our learning journey now continues in 2022 under a new name: the EUROCONTROL Aviation Learning Centre (ALC).

Our new name emphasises our ambition to play a central role in EUROCONTROL's strategy to support European aviation as a state-of-the-art, multi-channel learning centre, providing services to organisations in Member States and across the world.

It also underlines that the focus of our portfolio has become much broader than purely air traffic management/ air navigation services training according to our initial concept as the EUROCONTROL Institute of Air Navigation Services. Nowadays, our aviation learning courses are provided to a broad stakeholder audience, with the 2022 portfolio including a range of programmes such as training for airports; partnership with other bodies like the DAC, Luxembourg's civil aviation directorate, to certify drone pilots; or our world-renowned ELPAC language proficiency test for pilots.

By replacing the word 'training' with 'learning' in our new identity, we underline our ambition to deliver value by going beyond the pure provision of training courses, and giving our attendees a best-in-class learning experience, whether through face-to-face courses or via online events. We aim to provide key aviation learning insights that will help all network actors meet the challenges of the future.

Over the coming years the EUROCONTROL ALC will be building on a multi-channel concept that today comprises classroom courses, online courses, webinars and e-learning, and further enhancing our learning portfolio by expanding the range of courses to support new areas such as sustainability, artificial intelligence and drones.

The EUROCONTROL ALC currently offers more than 230 different courses which you can check out and book on our new digital learning management platform, the EUROCONTROL Learning Zone.

CLASSROOM AND E-LEARNING AVIATION TRAINING COURSES

Sharing our knowledge and experience with our syatkeholders

We provide training for air traffic management staff, regulators, aircraft operators, flow management personnel and aviation experts.

At our EUROCONTROL Aviation Learning Centre in Luxembourg, we support our pan-European activities and the implementation of the Single European Sky's efforts. We also contribute to the SESAR programme by delivering unique high-quality training courses in the areas of

• **Network efficiency**

We are part of the European Network Manager (e.g. ATFM/FMP operations), and have direct access to experts (for example in capacity planning, route networks, etc.) and instructors with long-term and broad experience (for example in OJTI, supervision, etc.),

• **Communications, Navigation and Surveillance (CNS)**

Our instructors are involved in various SESAR research or NM deployment programmes and have access to both the project content and programme managers,

• **Safety**

We have direct access to European Safety Programme staff, and

• **SES regulation**

Our instructors are involved in EASA standardisation visits and in rule drafting.

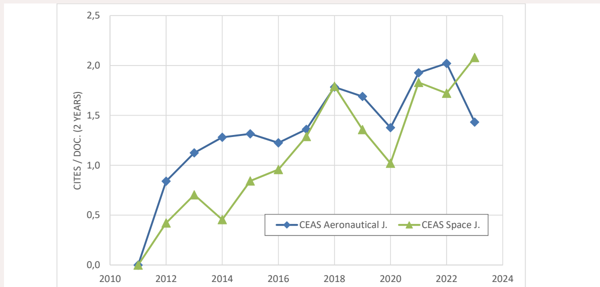
Visit our Learning Zone to learn more

OUTLINE OF THE LATEST ISSUES OF THE CEAS SPACE JOURNAL AND THE CEAS AERONAUTICAL JOURNAL

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.
The **CEAS Aeronautical Journal** is devoted to publishing new developments and outstanding results in all areas of aeronautics-related science and technology, including design and manufacturing of aircraft, rotorcraft, and unmanned aerial vehicles.
Both journals play an increasingly important role in representing European knowledge in aerospace research. Nevertheless, the biggest challenge is still to attract an acceptable number of high caliber scientists and engineers to submit articles for publication. Therefore, we invite you and your colleagues to contribute to the development of these journals by publishing your hard-earned results. Papers which are considered suitable will be subjected to a comprehensive blind peer-review process for potential publication in the CEAS Journals.
A list of articles published in the latest issues of both CEAS Journals is attached.

The Managing Editors:
– Andrea Dieball
– Cornelia Hillenherms
– Wilhelm Kordulla
– Stefan Leuko
– Johan Steelant



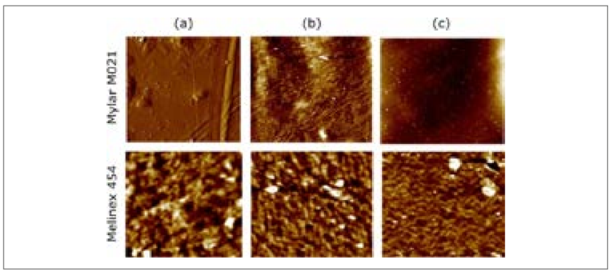
"Cites / Doc (2 years)" counts the number of citations received by documents from a journal and divides them by the total number of documents published in that journal in the past two years – similar to the Impact Factor™.

CEAS SPACE JOURNAL

Volume 16, Issue 3, May 2024

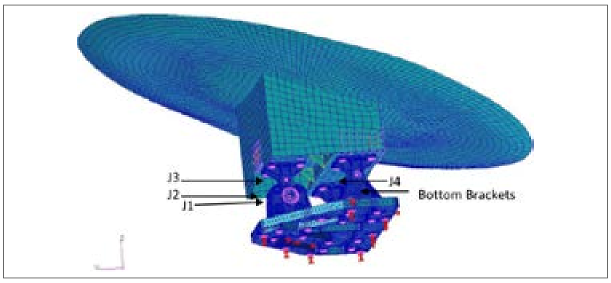
CHARACTERIZATION OF POLYETHYLENE TEREPHTHALATE (PET) MATERIALS UNDER HIGH-ENERGY ELECTRON EXPOSURE

Jainisha R. Shah, Miles T. Bengtson, Sydney Collman, Ryan C. Hoffmann, Dale C. Ferguson, Daniel P. Engelhart & Elena A. Plis / Published online: 12 April 2023



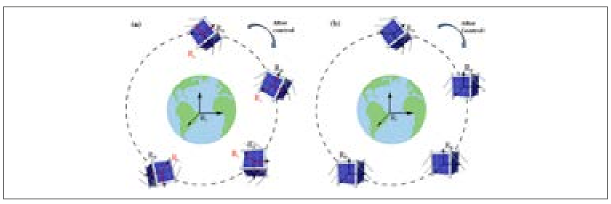
A NOVEL ANTENNA STEERING MECHANISM WITH SELF HOLD-DOWN FEATURE FOR COMMUNICATION SPACECRAFTS

Abhinandan Kapoor, B. P. Nagaraj, Abhishek Kumar, H. N. Suresha Kumar, B. V. S. Dinesh, N. Viswanatha, D. Manoj Reddy, Sidharth Tiwary, A. Shankara, K Prakasha & B. K. Muthu / Published online: 21 April 2023



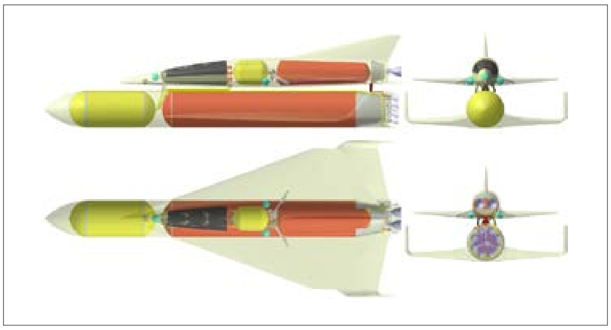
HYBRID ADAPTIVE SLIDING MODE ATTITUDE CONTROL FOR EARTH POINTING NANOSATELLITES

Ilyas El Wafi, Mohamed Haloua, Zouhair Guennoun & Zakaria Moudden / Published online: 29 April 2023



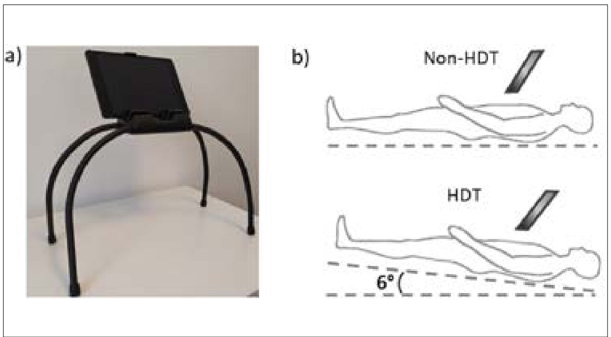
[MISSION DESIGN FOR POINT-TO-POINT PASSENGER TRANSPORT WITH REUSABLE LAUNCH VEHICLES]

Jascha Wilken & Steffen Callsen / Published online: 06 May 2023 (Open Access)



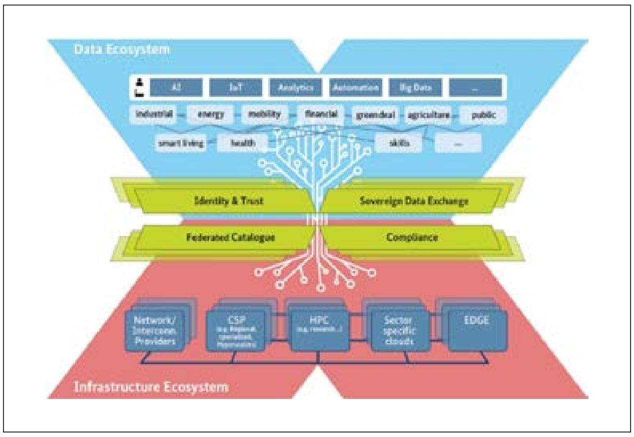
[TASK PERFORMANCE WITH TOUCHSCREEN INTERFACES UNDER CONDITIONS OF HEAD-DOWN TILT BED REST]

T. Bieg, M. Reisinger, P. Fröhlich, B. Hametner & S. Möstl / Published online: 12 May 2023 (Open Access)



[TOWARDS A SEAMLESS DATA CYCLE FOR SPACE COMPONENTS: CONSIDERATIONS FROM THE GROWING EUROPEAN FUTURE DIGITAL ECOSYSTEM GAIA-X]

A. Seidel, K. Wenzel, A. Hänel, U. Teicher, A. Weiß, U. Schäfer, S. Ihlenfeldt, H. Eisenmann & H. Ernst / Published online: 16 May 2023 (Open Access)

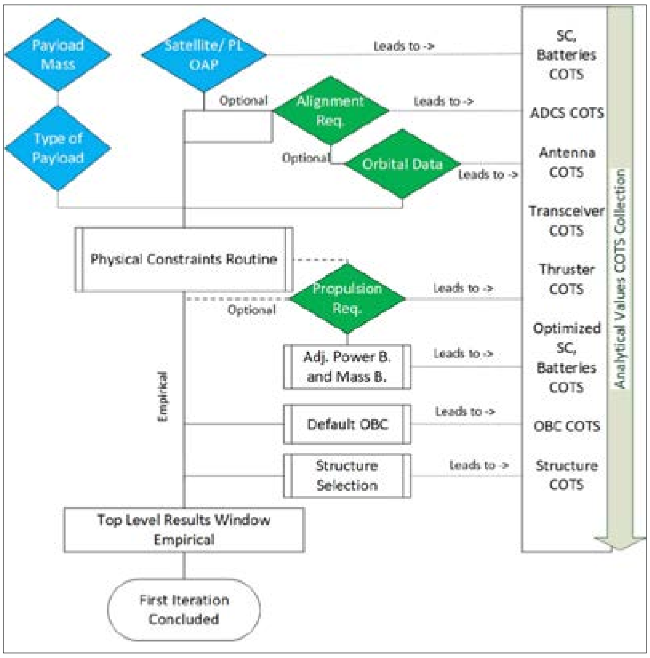


[FAIR FOR DIGITAL TWINS]

Diana Peters & Sirko Schindler / Published online: 29 May 2023 (Open Access)

[GREATCUBE+: CONCEPTUAL DESIGN TOOL FOR CUBESAT'S DESIGN]

Carlo Girardello, Martin Tajmar & Carsten Scharlemann/Published online: 14 June 2023 (Open Access)



CEAS AERONAUTICAL JOURNAL

Volume 15, Issue 1, January 2024

Special Issue: Numerical and experimental studies on high-speed stall phenomena

EDITORIAL I: THANK YOU TO OUR CEAS AERONAUTICAL JOURNAL REVIEWERS

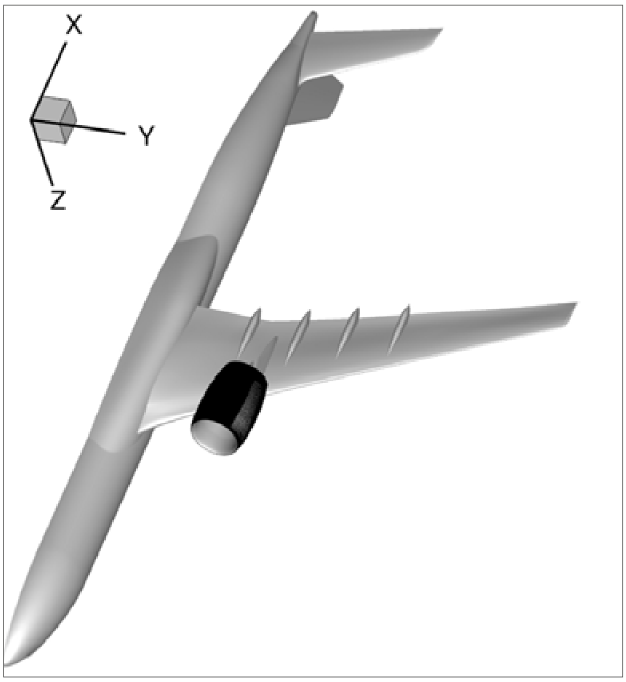
Cornelia Hillenherms & Andrea Dieball / Published: 20 February 2024 (Open Access)

EDITORIAL II: NUMERICAL AND EXPERIMENTAL STUDIES ON HIGH-SPEED STALL PHENOMENA

Thorsten Lutz, Andrea Beck & Lars Koop/ Published: 06 March 2024 (Open Access)

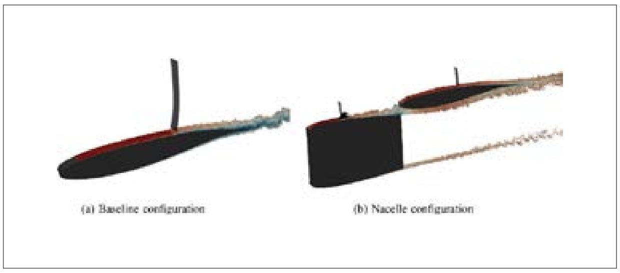
GREY AREA IN EMBEDDED WALL-MODELLED LES ON A TRANSONIC NACELLE-AIRCRAFT CONFIGURATION

Marius Herr, Axel Probst & Rolf Radespiel / Published: 31 May 2023 (Open Access)



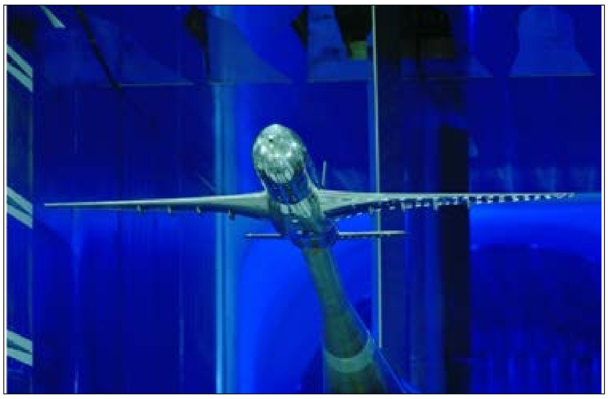
IMPACT OF 2D ENGINE NACELLE FLOW ON BUFFET

Thomas Lürkens, Matthias Meinke & Wolfgang Schröder/ Published: 14 March 2024 (Open Access)



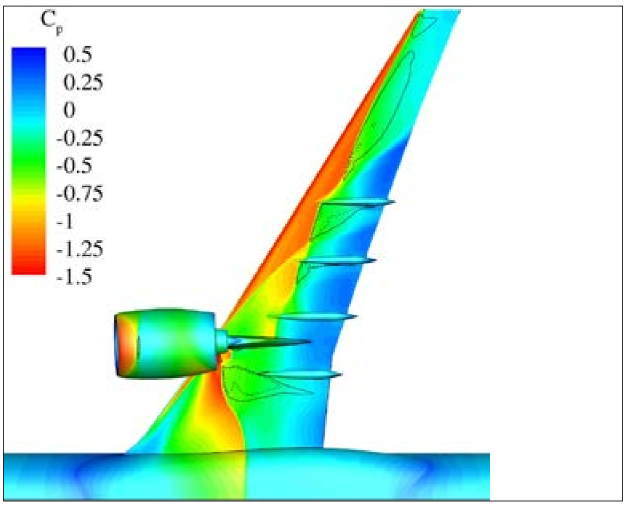
TIME-RESOLVED PRESSURE-SENSITIVE PAINT MEASUREMENTS FOR CRYOGENIC WIND TUNNEL TESTS

Daisuke Yorita, Ulrich Henne & Christian Klein / Published: 10 January 2023 (Open Access)



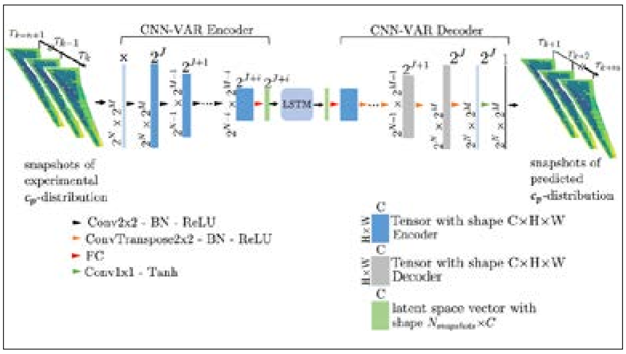
EXPERIMENTAL ASSESSMENT OF WING LOWER SURFACE BUFFET EFFECTS INDUCED BY THE INSTALLATION OF A UHBR NACELLE

Spinner Sebastian & Rudnik Ralf / Published: 22 December 2022 (Open Access)



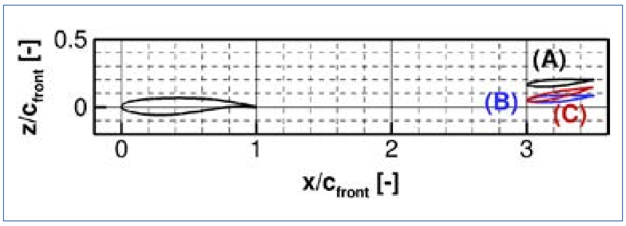
PREDICTION OF WING BUFFET PRESSURE LOADS USING A CONVOLUTIONAL AND RECURRENT NEURAL NETWORK FRAMEWORK

R. Zahn, A. Weiner & C. Breitsamter / Published: 14 March 2023 (Open Access)



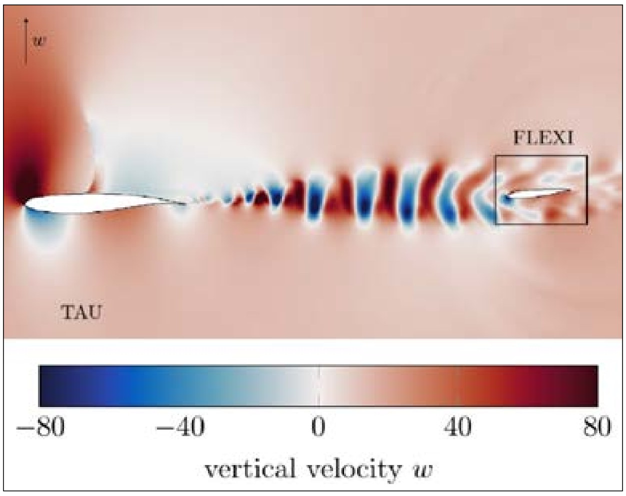
WAKE TAIL PLANE INTERACTIONS FOR A TANDEM WING CONFIGURATION IN HIGH-SPEED STALL CONDITIONS

Johannes Kleinert, Maximilian Ehrle, Andreas Waldmann & Thorsten Lutz /Published: 14 June 2023 (Open Access)



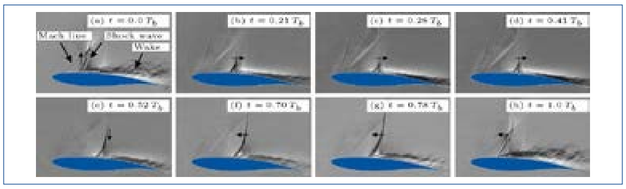
A TIME-ACCURATE INFLOW COUPLING FOR ZONAL LES

Marcel P. Blind, Johannes Kleinert, Thorsten Lutz & Andrea Beck / Published 09 March 2023 (Open Access)



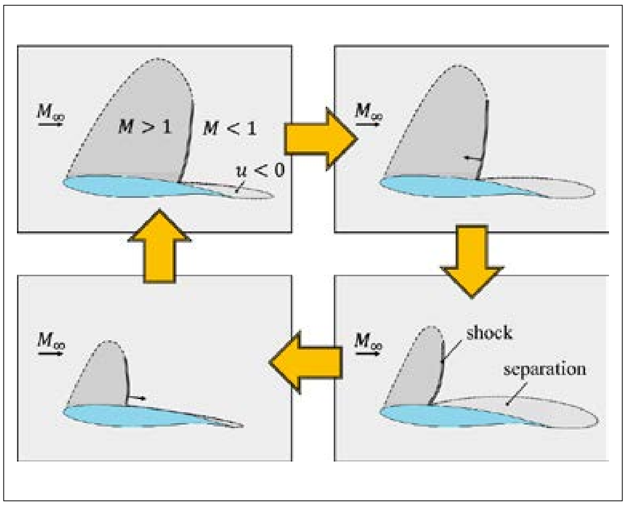
EXPERIMENTAL INVESTIGATION ON THE TURBULENT WAKE FLOW IN FULLY ESTABLISHED TRANSONIC BUFFET CONDITIONS

Christopher Julian Schauerte & Anne-Marie Schreyer / Published: 02 November2023 (Open Access)



COMPARISON OF SHOCK-BUFFET DYNAMICS ON A SUPERCRITICAL AIRFOIL WITH AND WITHOUT A PITCHING DEGREE OF FREEDOM

Sven Scharnowski, Alessandro Accorinti, Tim Korthäuer & Christian J. Kähler / Published: 24 November 2023 (Open Access)



2024

AMONG UPCOMING AEROSPACE EVENTS

APRIL

10-12 April – ERCOFTAC – **DLES14 – Direct Large Eddy Simulation** – Erlangen (Germany) – https://www.ercoftac.org/events/

14-19 April – ESA – **HiSST 2024 – 3rd International Conference on High-Speed Vehicle and Technology** – Busan (South Korea) – https://www.hisst2024.org

15-18 April – ESA – **SESARJU/DLR – TRA2024** – Transport Research Arena – Transport Transitions: Advancing Sustainable and Inclusive Mobility – Dublin (Ireland) – https://www.sesarju.eu/events

17-19 April – RAeS – **International Conference on Energy from Space** – Potential of Space-based Solar Power (SBSP) to be unlocked – London (UK) – RAeS/HQ – https://www.aerosociety/events/

17-20 April – Aero Friedrichhafen – **The leading show for General Aviation** – 30th Anniversary – Friedrichhafen (Germany) – https://www.aeroexpo.de

26-27 April – PEGASUS – **PEGASUS Student Conference** – Terrassa (Spain) – https://www.pegasus-europe.org/pegasus-student-conference

29-30 April – EUROCONTROL – **FLY AI Forum 2024** – 2nd Edition: How is AI shaping aviation? Brussels (Belgium) – EUROCONTROL/HQ – https://www.eurocontrol.int/events

29 April - **01** May – ASME – SSDM 2024 – **ASME's 2nd Annual Aerospace Structures, Structural Dynamic and Materials Conference** – Seatle, WA (USA) – Hyatt Regency Lake Washington Renton, WA – Seatle's South Airport – https://event.asme.org/SSDM

30 April - **01** May – FSF – **BASS 2024** – Business Aviation Safety Summit – Austin, TX (USA) – Austin Marriot Downtown – https://flightsafety.swoogo.com/BASS2024

30 April - **02** May – ICAO – **ICAO Global Implementation Support 2024** – Punta Cana (Dominican Republic) – Bavaro Convention center – https://www.icao.int/meetings

MAY

8-10 May – IAA – **4th IAA Conference on Space Situational Awareness** – ICSSA – Dayton Beach, FL (USA) – https://iaaspace.org/event

19-23 May – ESA/SSO – **26th ESA Rocket & Balloon Symposium** – Lucerne (Switzerland) – Hochschule Luzern HSLU – https://atpi.eventsair.com/

21-23 May – RAeS – **RAeS Future Combat Air and Space Capabilities Summit 2024** – Updated assessment on the strategic direction of air and space capabilities in the UK and beyond – London (UK) – RAeS/HQ – https://www.aerosociety/events/

27-31 May – CNES/ESA – **4S Symposium – Small Satellites Systems and Services Symposium** – Space Transformation – Palma de Mallorca (Spain) – https://atpi.eventsair.com/

28-30 May – NBAA/EBAA – **EBACE 2024 – European Business Aviation Convention & Exhibition** – Europe's premier business aviation event – Geneva (Switzerland) – https://ebace.aero/2024/about

29-31 May – EUROMECH – **EMMC19 – 19th European Mechanics of Materials Conference** – Madrid (Spain) – https://euromech.org/

JUNE

03-07 June – ECCOMAS – **ECCOMAS2024 – 9th European Congress on Computational Methods in Applied Sciences and Engineering** – Lisbon (Portugal) – https://www.eccomas.org/

04-06 June –EC/EASA/EUROCONTROL/SESARJU – - **Global TBO Symposium** – First Global Trajectory Based Operations Symposium – Brussels (Belgium) – EUROCONTROL/HQ – https://www.sesarju.eu/events

04-07 June – AIAA/CEAS – **Aeroacoustics 2024 – The 30th AIAA/CEAS Aeroacoustics Conference** – Rome (Italy) – https://www.aidaa.it/2023/01/18/aiaa-ceas-aeroacoustics-conference/

05-09 June – BDLI – **ILA 2024 Berlin Air Show – Berlin ExpoCenter Airport** – Schönefelt Airport - https://www.ila-berlin.de

11-13 June – CANSO/ATCA – **Global ATM Summit and 28th AGM** – Baku (Azerbaidjan) – https://canso.org/event/

11-13 June – 3AF/EST – **ETTC 2024** – European Test and Telemetry Conference – Next steps in sustainable testing in challenging environments for all transport sectors (air, ground, space and maritime). Nuremberg (Germany). NümbergMesse GmbH – https://www.telemetry-europe.org/ettc-2024/conference/ - (EST European Society of Telemetry)

12-14 June – CEAS/RAeS – **EuroGNC2024** – Bristol (UK) – University of Bristol – https://eurognc.ceas.org/

AMONG UPCOMING AEROSPACE EVENTS

17-21 June – NVvL/CEAS – **IFSAD 2024 – 20th Edition of the Internal Forum on Aeroelasticity & Structural Dynamics** - The Hague (NL) – New Babylon Congress Centre – https://www.ifasd2024.nl

19-20 June – FSF – **SAFETY FORUM 2024** – Aviation Weather Resilience – Brussels (Belgium) – EUROCONTROL/HQ – Benik@FlightSafety.org – https://flightsafety.org/events

24-26 June – ESA/JAXA/NASA – **TRISMAC2024** –Trilateral Mission Assurance Safety Conference – Space Exploration: New challenges and opportunities – Hosted by ESA – Frascati (Italy) – ESA/ESRIN – https://nikal.eventsair.com/trismac-2024/

JULY

02-04 July – ACI EUROPE – **34th ACI Europe Annual Congress & general Assembly 2024** – Istanbul (Turkey) – Swissotel The Bosphorus – https://www.aci-europe/events.html

13-21 July – COSPAR 2024 – **45th Scientific Assembly** – Busan (Korea) – https://www.cospar2024.org

22-26 July – Farnborough – **Farnborough International Air Show** – Pioneer the Future – Farnborough, Hampshire (UK) – https://farnboroughairshow/com

22-26 July – EUROMECH – **ENOC11- 11th European Nonlinear Oscillations Conference** – Delft (NL) – https://euromech.org/

29 July - **02** August – AIAA – **AIAA Aviation Forum** – Las Vegas, NV (USA) – www.aiaa.org/events

30 July - **02** August – ASCEND powered by AIAA – **ASCEND Conference** – Las Vegas, NV (USA) – www.aiaa.org/events

SEPTEMBER

09-13 September – ICAS – Hosted by AIDAA – **34th Congress of the International Council of the Aeronautical Sciences –** Florence (Italy) – www.icas2024.com

10-12 September – 3AF/CEAS – **ERF2024 –** 50th Edition of the European Rotorcraft Forum – Marseille (France) – Palais du Pharo – https://www.3af-erf2024.com

10-13 September – ERCOFTAC – **FMC2024 – XXVI Fluid Mechanics Conference –** Warsaw (Poland) – https://fmc2024.pl.edu.pl

16-20 September – EUROMECH – **EFD1 – 1st European Fluid Dynamics Conference** – Aachen (Germany) – https://euromech.org/

18-19 September – ESA – **ISD 2024** – Industry Space Days - - Space for business opportunities – Noordwijk (NL) – ESA/ESTEC – https://atpi.eventsair.com/

25-27 September – ICAS – **SESECA 2024 – 11th International Systems & Concurrent Engineering for Space Applications Conference –** Noordwijk (NL) – ESA/ESTEC – https://api.eventsair.com/

30 September - **02** October –DGLR – **DLRK2024 –** Deutscher Luft und Raumfahrt Kongress– Hamburg (Germany) – Hamburg Universität – www.dglr.de

OCTOBER

8-11 October – EASN – **14th EASN International Conference –** Innovation: Aviation and Space towards sustainability today and tomorrow. Thessaloniki (Greece) – Concert Hall – https://www.easnconference.eu

14-18 October – IAF/IAC – Hosted by AIDAA – **75th International Astronautical Congress –** Milan (Italy) – www.iac2024.org

15-18 October –ESA – **SPCD 2024 – 5th Space Passive Components Days –** Noordwijk (NL) – ESA/ESTEC – https://atpi.eventsair.com/

NOVEMBER

06-08 November – PSAA – **READ 2024** - Warsaw (Poland)

12-17 November – China – **AirshowChina 2024 –** China International Aviation & Aerospace Exhibition – Zhuhai Guangdong (China) – www.airshow.com.en

13-15 November – Bahrain – **BIAS2024 –** Bahrain International Airshow 2024 – 10-Year Anniversary – Sakhir Air Base (Bahrain) – https://www.bahraininternationalairshow.com

19-21 November – ADAIrexpo – **Aviation & Aerospace Exhibition Expo 2024 –** Join the leaders in the aviation industry - Abu Dhabi (UAE) – https://www.adairexpo.com