The Quarterly Bulletin of the CEAS

COUNCIL OF EUROPEAN AEROSPACE SOCIETIES

3AF AIAE AIDAA AAAR CzAeS DGLR FTF HAES NVvL PSAA RAeS SVFW TsAGI

Issue 4 - 2017
4th Quarter

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1 **16-20 OCTOBER 2017 IN BUCHAREST:** THE CEAS AEROSPACE EUROPE CONFERENCE 2017 WAS HELD IN THE PRESTIGIOUS PALACE OF THE PARLIAMENT.

2 **12 DECEMBER 2017 AT 18:36 GMT: ARIANE 5 LIFTS OFF FROM GUIANA SPACE CENTRE CARRYING GALILEO SATELLITES 19-22.**
"TODAY'S LAUNCH IS ANOTHER GREAT ACHIEVEMENT, TAKING US WITHIN ONE STEP OF COMPLETING THE CONSTELLATION." JAN WÖRNER ESA'S DIRECTOR GENERAL

WHAT IS CEAS ?

The Council of European Aerospace Societies (CEAS) is an International Non-Profit Association, with the aim to develop a framework within which the major Aerospace Societies in Europe can work together.

It presently comprises thirteen Full Member Societies: 3AF (France), AIAE (Spain), AIDAA (Italy), AAAR (Romania), CzAeS (Czech Republic), DGLR (Germany), FTF (Sweden), HAES (Greece), NVvL (Netherlands), PSAA (Poland), RAeS (United Kingdom), SVFW (Switzerland), TsAGI (Russia); and six Corporate Members: ESA, EASA, EUROCONTROL, LAETA, VKI and EUROAVIA..

Following its establishment as a legal entity conferred under Belgium Law, this association began its operations on January 1st, 2007.

Its basic mission is to add value at a European level to the wide range of services provided by the constituent Member Societies, allowing for greater dialogue between the latter and the European institutions, governments, aerospace and defence industries and academia.

The CEAS is governed by a Board of Trustees, with representatives of each of the Member Societies.

Its Head Office is located in Belgium:
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www.ceas.org

WHAT DOES CEAS OFFER YOU ?

Knowledge transfer:
- A well-found structure for Technical Committees

High-Level European Conferences:
- Technical pan-European events dealing with specific disciplines and the broader technical aspects
- The CEAS European Air and Space Conferences: every two years, a Technical oriented Conference, and alternating every two years also, a Public Policy & Strategy oriented Conference

Publications:
- Position/Discussion papers on key issues
- CEAS Aeronautical Journal
- CEAS Space Journal
- CEAS Quarterly Bulletin

Relationships at a European Level:
- European Commission
- European Parliament
- ASD (AeroSpace and Defence Industries Association of Europe), EASA (European Aviation Safety Agency), EDA (European Defence Agency), ESA (European Space Agency), EUROCONTROL
- Other European organisations

European Professional Recognition:
- Directory of European Professionals

Honours and Awards:
- Annual CEAS Gold Medal to recognize outstanding achievement
- Medals in technical areas to recognize achievement
- Distinguished Service Award

Young Professional Aerospace Forum

Sponsoring

THE CEAS MANAGEMENT BOARD

It is structured as follows:

- General Functions: President, Director General, Finance, External Relations & Publications, Awards and Membership.
- Two Technical Branches:
  - Aeronautics Branch
  - Space Branch

Each of these two Branches, composed of specialized Technical Committees, is placed under the authority of a dedicated Chairman.

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EDITORIAL

Jean-Pierre Sanfourche
Editor-in-Chief,
CEAS Quarterly Bulletin

"Dear readers,

The CEAS Aerospace Europe Conference 2017 took place from 16 to 20 October in the Parliament Palace of Bucharest, Romania, organised by the Romanian Research Institute for Gas Turbines COMOTI, on behalf of the Aeronautical and Astronautical Association of Romania (AAAR). This conference, whose motto was "**European Aerospace: quo vadis?**" benefitted from the participation of 435 registered delegates from five continents and representing 133 institutions and was honoured by the participation of several outstanding keynote speakers. It is related in the article written by Ionut Porumbel, Ph D., Senior Researcher at COMOTI *(pp 7-11)*.

Considering the richness of the numerous and high standing presentations which were given, it is planned to publish in the next CEAS Bulletin an overall picture of them: keynote addresses, technical sessions, special sessions and workshops.

This successful event comes at the nick of time when a number of new initiatives are being taken with the aim to consolidate and increase our notoriety and influence.

Following the Bucharest conference reporting, some papers deal with Aeronautics Technology and Space.

As regards **Aeronautics Technology**, three subjects are covered:

• *A strategic proposal beyond 2020 for European Aeronautics*

On the occasion of the third EU Aeronautics Conference, 18 October 2017, Commissioner for Transport Violeta Bulc received a strategic proposal from the European Parliament Sky & Space Intergroup (SSI) to boost aeronautics beyond 2020.

• *Successful start of Open Rotor Demonstrator*

Safran celebrated on 3 October 2017 in Istres (France) the successful start of Open Rotor engine demonstrator ground tests, in the presence of Clara de la Torre, Transport Director in European Commission Directorate-General for Research and Innovation.

• *Digital transformation of aviation*

The next ten years will be a central period to pave the way for the digital transformation of aviation. During the European Digital Transport Days in Tallin (Estonia) on 7-9 November 2017, the European aviation stakeholders committed officially to SESAR and the digital agenda.

In the domain of **Space Activities**, three topics also are dealt with:

• *Parabolic flights*

Among the platforms ESA is using to conduct scientific research in weightless conditions, are the parabolic flights, very useful because they allow scientists direct, hands-on access to their experiments.

• *Electric Power*

ESA is supporting and pushing the application of Electric Power (EP) technologies on current and future European satellites including telecommunications, navigation, deep space end exploration, Earth observation, space transport and nanosatellites.

• *Galileo*

The successful launch of the four Galileo satellites 19-22 on Monday 12 December is quite an important event. This successful mission brings the Galileo system to 22 satellites, i.e. within one step of completing the constellation since next launch of another quartet planned to take place in mid-2018 will bring the 24-satellite Galileo constellation to the point of completion, including two orbital spares.

I seize the opportunity of this editorial to wish you, Dear Readers, a Happy New Year! "

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CEAS PRESIDENT'S MESSAGE

Christophe Hermans
CEAS President 2017

CEAS @work

On 17 October 2017 the CEAS General Assembly and 39th Trustee Board meetings were held during the CEAS Aerospace Europe conference in Bucharest, hosted by AAAR. We welcomed Franco Bernelli as new Trustee representing AIDAA, Torben Henriksen (ESA) as Space Branch Chairman and Marc Bourgois (representing the corporate member Eurocontrol) as new faces at the table. Unfortunately we had to say goodbye to Amalia Finzi (representing AIDAA), who decided as one of our most experienced board member to leave us. We will miss her enthusiasm, friendly behaviour and her recollection of discussions that took place in the rich history of CEAS.

I'm happy to announce that for the year to come we will continue operating CEAS with the same officers team of president, vice-presidents and director as for 2017.

An important point on the agenda was the discussion about the CEAS strategy 2018 - 2021. It is our mission to be Europe's foremost aeronautics & space community (i.e. Aerospace Europe) bringing together member societies and corporate partners with the aim to further the advancement of aerospace sciences and engineering. The primary objectives of our strategy for the next 4 years are as follows:

- Obvious European focal point fostering knowledge dissemination in aerospace;
- Active partner in European Aerospace Education, Research and Innovation;
- Strengthen unique European label for aeronautical events and publications;
  - Coordination of biennial large scale European aerospace event with MoU partners and member society's support, attracting policy makers (European level), captains of aerospace industry and University scientists,
  - Support member societies and technical committees organizing thematic events with focus on mono-disciplinary engineering.

We defined the strategy to achieve those objectives. How can we further raise the impact of our CEAS scientific / technical journals in Europe? Several ideas as potential answer to this question were raised and will be further assessed. Other agenda items were budget plan for 2018, terms and conditions for organizing the biennial Aerospace Europe conference, its program committee and secretarial support.

CEAS Aerospace Europe Conference in 2017: European Aerospace: Quo Vadis?

Where are we going? The theme of our flagship event, the CEAS Aerospace Europe Conference, inspired well over 300 speakers and 435 registered attendees to address challenges aerospace is experiencing in the exceptional environment of the world second largest building: the prestigious Palace of the Parliament. A visual impression of the conference and its social events can be found on the World Wide Web (http://ceas2017.org/galerie/).

25 Years of CEAS

We furthermore took this opportunity to celebrate our 25 year anniversary. In 1986, the Deutsche Gesellschaft für Luft- und Raumfahrt (DGLR), the Royal Aeronautical Society (RAeS) and the Association Aéronautique et Astronautique de France (3AF) began a series of regular meetings to review and discuss European co-operation issues. This led to a more formal organization when, 25 years ago at the 1992 Farnborough Air Show, the three organizations, along with Associazione Italiana di Aeronautica e Astronautica (AIDAA), launched CEAS. CEAS was formally instituted one year later at the Paris Air Show. In 1995, AIAE (Spain) and NVvL (The Netherlands) came on board, followed by FTF (Sweden) and SVFW (Switzerland) in 1996. These eight bodies formed the core of the original Confederation of European Aerospace Societies (CEAS). Since then CEAS has changed its legal status into a council, now with 13 national aeronautical societies representing roughly 35,000 individual aeronautical professionals all over Europe.

To celebrate our 25th anniversary, we decided last year to publish a booklet about our history and asked Prof. Keith Hayward to author the publication. First copies of the book were handed out to those past presidents present at the conference, being Georges Bridel (SWFW), Joachim Szodruch (DGLR), Pierre Bescond (3AF) and Fred Abbink (NVvL) as token of our appreciation for their efforts towards CEAS. Also all delegates at the conference received the book as a small present of CEAS.

From left to right: Valentin Silivestru, Pierre Bescond, Fred Abbink, Christophe Hermans, Georges Bridel, Joachim Szodruch.

AEROSPACE EUROPE CEAS 2017: WELCOME ADDRESS

By Christophe Hermans, CEAS president

"**Good morning Your Excellency, distinguished guests, ladies and gentlemen,**

On behalf of the Council of European Aerospace Societies CEAS, I welcome you to this 6th CEAS Aerospace Europe conference, for the first time organized in Romania.

Romania has a rich tradition in aviation. At the beginning of the 20th century, pioneers made important contributions to early aviation history. Henri Coand□ being one of them worked in the UK to design aircraft during World War I, and who most of us know from his discovery of the Coanda effect in aerodynamics.

Quo vadis / where are we going?

The themes of this conference are:

- what are the challenges aerospace is experiencing?
- what is the type of experience passengers expect from air and maybe even space transport?
- How can we benefit from the results of space exploration?
- How can we minimize the impact on the environment but on the other hand increase our competitiveness?

I hope, when looking back in time, let's say in 10 years from now, the outcome of the research and development activities presented in the days to come has shown to have been contributing to at least some of the answers of these questions.

Europe has a strong aeronautical sector with:

- an excellent aerospace education system attracting the best students (represented at European level by PEGASUS);
- a strong research community pooling knowledge and infrastructure (university research represented at a European level by EASN and research establishments by EREA & ESRE);
- Agencies like ESA, EASA, EDA, EUROCONTROL
- and a competitive industry base, with Airbus as the no. 1 global airframe manufacturer, major engine OEMs (like RR and SAFRAN), Ariane Group and their supply chains.

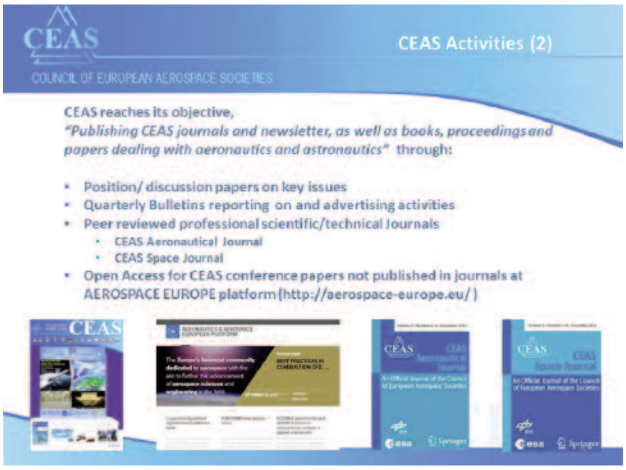
It is therefore equally important to provide at a European level a platform of well recognized global and thematic events, networking opportunities for professionals and high ranked journals to publish peer-reviewed papers.

It is our mission to support knowledge transfer and provide networking opportunities. This why CEAS was founded exactly 25 years ago by 3 of our founding fathers, within 2 years followed by 5 more societies. As the European aerospace industry grew closer together in the mid-eighties of the previous century through a series of collaborative projects and the formation of more permanent cross-border industrial entities, it was evident that a closer cooperation between European aerospace scientists and engineers would be beneficial. The various national European aeronautical societies had served the aerospace community well for decades, even one century. A closer, more permanent relationship would help to increase the research leverage through the creation of a pan European network of researchers. You will find a copy of the book, describing the CEAS history in your conference bag. Tonight we will officially hand it out to some of our past presidents to celebrate our anniversary.

Currently 13 national aeronautical societies (sheet), representing roughly 35.000 individual aeronautical professionals all over Europe, are member of CEAS.

We are also proud (sheet) to closely collaborate with our Corporate Members EASA, ASD, ESA, EUROCONTROL, the students association EUROAVIA (having a permanent seat in our board), LAETA (our friends from Portugal) and of course our MoU partners AIAA, ICAS (ICAS that is celebrating its 60th birthday this year!), EREA and since early this year EASN!

Knowledge dissemination (sheet) is supported by our two scientific CEAS Journals, that we publish with significant editorial support of DLR and ESA (80,000 full articles downloads in 5 years, or 250 per article). Open access paper publications of our thematic and global events can be found on the Aerospace Europe platform, a new initiative recently launched by our partnering societies ECCOMAS, ERCOFTAC, EUROTURBO, EUCASS and EUROMECH in Europe with EU support in the framework of ECAero-2 support action. The platform also contains a calendar of aeronautical events and working environment for use cases in aerodynamics.



So we play a catalytic role, in amplifying communications and co-operation between researchers and engineers in aeronautics. I firmly believe that collaboration at a European scale is crucial. This is why EASN and CEAS have established closer ties that should lead to the organization of a large common aerospace conference in 2019 and a common workshop in Glasgow in 2018 (4 – 7 September).

I wish you all a good conference in this very special conference site; I'm sure you will get to meet interesting people, hopefully some of which will evolve in new partnerships or business.

Thank you!"

AEROSPACE EUROPE CEAS 2017

By Ionut Porumbel, Ph.D, Senior Researcher at COMOTI

The 6th CEAS Air & Space Conference has taken place between October 16th – 20th in the Parliament Palace of Bucharest, Romania, organized by the Romanian Research and Development Institute for Gas Turbines COMOTI, on behalf of the Aeronautical and Astronautical Association of Romania.

The Conference was motivated by the wish to promote new visions and trends in aviation and space related science and technology, according to its basic theme: "European Aerospace: Quo Vadis?". The Conference aimed at gathering together stakeholders in academia, research and industry, as well as policy makres and interested partners operating in aircraft maintenance and operation, with the purpose of facilititing a fruitfull exchange of ideas and state of the art developments in the European aeronautics and space.

THE OBJECTIVES

The objectives of the conference were to:

- Contribute to establish European preeminence in aeronautics and space related science and technology;
- Foster the development of a real collaboration between European scientists and engineers in the field of aviation and space;
- Facilitate the reunion of the main aviation and space institutional stakeholders in Europe;
- Encourage the participation of young professionals and doctoral, master and undergraduate students in participating in a major European scientific event;
- Advance towards transforming the current series of CEAS Conferences towards a European Aerospace Congress.

The Conference benefitted from the participation of 435 registered attendees from five continents (Europe, Asia, North and South America and Africa), representing 133 institutions (universities, research establishments, industrial stakeholders, non-governmental organizations and policy makers, such as the Romanian Government and the European Commission, as well as other Romanian and European authorities in the field of aviation and space).

The conference included 307 oral presentations, of which 33 keynote addresses.

KEYNOTE ADDRESSES

The Aerospace Europe CEAS 2017 Conference was honoured by the participation of several outstanding keynote speakers:

- **Stephen AIREY** - Head of the Cooperating & Associate States Section, European Space Agency (ESA), Paris, France

- **Frank BRENNER** - General Manager, EUROCONTROL – European Organization for the Safety of Air Navigation, Brussels, Belgium
- **Olivier CHAZOT, Ph.D.** - Professor of Thermal Power Engineering. Head of Aeronautics and Aerospace Department. „von Karman" Institute for Fluid Dynamics, Brussels, Belgium
- **Valentin CIMPUIERU** - General Manager, Romanian Air Traffic Services Administration ROMATSA, Romania
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- **Mihnea COSTOIU** - Professor. Rector of the „Politehnica" University, Bucharest, Romania
- **Sir Stephen DALTON** - Air Chief Marshal, President of the Royal Aeronautical Society (RAeS), UK
- **Delia DIMITRIU**, Ph.D - Centre for Aviation, Transport, and the Environment, School of Science & the Environment, Manchester Metropolitan University, Manchester, UK
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- **Dietrich KNOERZER**, Ph.D – Aviation expert. DGLR, Germany.
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- **Laurent LEYLEKIAN**, Ph.D - Program Manager, ONERA, Paris, France
- **Juan Manuel LORA ALONSO** - President of EUROAVIA
- **Catalin NAE**, Ph.D - General Director of the Romanian National Aerospace Research Institute „Elie Carafoli", Bucharest, Romania
- **Guillermo PANIAGUA PEREZ**, Ph.D - Professor of Mechanical Engineering. School of Mechanical Engineering, Purdue University, West Lafayette, Indiana, USA
- **Florin PĂUN**, Ph.D - Group Innovation Director,Akka Technologies, , Paris, France
- **Olivier PENANHOAT**, Ph.D - Technical Coordinator Emissions & Environment. Research and Technology Direction, Safran Aircraft Engines, Villaroche Center, MoissyCramayel, France
- **Marius Ioan PISO**, Ph.D - President of the Romanian Space Agency ROSA.
- **Octavian Thor PLETER**, Ph.D - Assistant Professor. Dean of the Department of Aerospace Engineering. "Politehnica" University of Bucharest, Romania
- **Raoul POPESCU** - General Manager Pratt & Whitney Aeropower Rzeszow, Vice – President of Aftermarket and APU, Pratt & Whitney, Hartford, CT, USA.
- **Bruno SAINJON** - Chairman EREA, Operations Director DGA, President of the Administration Council ONERA, Paris, France
- **Valentin SILIVESTRU**, Ph.D - President General Manager of the Romanian National Research and Development Institute for Gas Turbines COMOTI, Bucharest, Romania.
- **Virgil STANCIU**, Ph.D - President of the Aeronautics and Astronautics Association of Romania. Professor. Department of Aerospace Engineering. „Politehnica" University of Bucharest, Romania
- **Joachim SZODRUCH**, Ph.D - Hamburg Aviation and IFAR, Germany
- **Michael WINTER**, Ph.D - Senior Fellow for Advanced Technology, Pratt & Whitney, Hartford, CT, USA.
- **Sorin ZGURA**, Ph.D - Director, Institute of Space Science, Magurele, Ilfov, Romania.

TECHNICAL PAPERS

The technical papers were peer-reviewed by the Scientific Committee of the Conference and, based on the recommendation of the reviewers, have, or will be published in the Conference Proceedings (ISBN 978-973-0-25597-3) one of the following journals:

- **Transportation Research Procedia, ISSN: 2352-1465**
- **CEAS Space Journal, ISSN 1868–2502**
- **CEAS Aeronautical Journal, ISSN 1869–5582**
- **INCAS Bulletin, ISSN 2066–8201**

SPECIAL SESSIONS AND WORKSHOPS

Several special sessions and workshops have taken place as part of the conference:

ACARE SRIA

Workshop organized by the Advisory Council for Aviation Research (ACARE), where the updated Strategic Research and Innovation Agenda (SRIA), expected in June, will be disseminated and discussed.

Research Infrastructures

Workshop on the current status and future development needs and directions for the worldwide research infrastructure. With the participation of the Italian Aerospace Research Center – CIRA, "von Karman" Institute for Fluid Dynamics, Purdue University, and COMOTI.

• EREA „Future Sky"

Workshop organized by EREA, the association of European Research Establishments in Aeronautics on its Joint Research Initiative in which development and integration of aviation technologies are taken to the European level, and based on the alignment of national institutional research for aviation by setting up joint research programmes. The session will be chaired by Mr Joseph KASPAR, General Manager at VZLU, Czech Republic, EREA Vice Chair and Chair of Future Sky Board.

• Constant volume and distributed combustion

Special session organized by COMOTI and will gather presentation of the latest research results in the field. Some of the latest results obtained in the FP 7 project TIDE will be presented.

• AGILE – Aircraft 3rd Generation MDO for Innovative Collaboration of Heterogeneous Teams of Experts

Special sessions organized by DLR on the latest results from the AGILE Horizon 22020 project aimed at developing the next generation of MDO and aircraft design and on the exploitation activities dedicated to education, including the "AGILE design challenge", dedicated to the Academia and Research organizations.

• Aircraft Flow Control Technologies – AFloNext

AFLoNext is a four-year integrated project (level 2) with the objective of proving and maturing highly promising flow control technologies for novel aircraft configurations. The EC project AFLoNext targets on maturing flow, loads and noise control technologies for transport aircraft. Within the project, two distinct activities focused on active flow control application.CEAS 2017 will include a workshop aimed at the dissemination of the project results in WP 2, targeting local flow separation control at local areas of the wing to improve the low-speed performance, and WP5, addressing flow control in the cruise regime for stabilizing the shock-boundary layer interaction for buffet control.

• Space Technology and Advanced Research

Workshop organized by the European Space Agency ESA and presenting results of the STAR program.

• Innovation in Aero - Engines

Workshop organized jointly by CEAS partner societies EUROTURBO, ECCOMAS, EUCASS, EUROMECH and E-CAero2.

• Wind Turbine Design and Technology

Workshop on the advances in the field of wind turbine design and manufacturing organized by COMOTI.

• Future Through Education

Workshop organized by Euroavia the European Association of Aerospace Students, representing the interests of over 2000 students from 38 universities in 19 European countries.
European Workshop on Aircraft Design Education - EWADE
The 13th European Workshop on Aircraft Design Education EWADE 2017 will be organized as part of CEAS 2017 as a full day event, on the 4th day of the Conference. The workshop will discuss recent advances in aircraft design (research and teaching) and is organized by Prof. Dr.-Ing. Dieter SCHOLZ, MSME from the Hamburg University of Applied Sciences. Details can be foundhere.

EXHIBITION

The Conference also included an exhibition, including 108 posters and 51 exhibits. The exibitors were:

- AEROSTAR S.A. BACAU
- Magic Engineering
- Dassault Systems
- INCAS Bucharest - National Institute for Aerospace Research "Elie Carafoli"
- Aeroteh SA
- OPIAR - Association of Romanian Aeronautical Companies
- AEROFINA SA
- INAS SA
- ROSA – Romanian Space Agency
- ROMATSA – Romanian Air Traffic Services Administration
- Romanian Research Institute for Gas Turbines COMOTI

SOCIAL EVENTS

The conference included several social events as well. The first evening, a classical music concert followed by a welcome cocktail took place in the Parliament Palace.
The Engineers` Orchestra performed in the C.A. Rosetti Hall on Monday, October 16th. The orchestral ensemble was formed of 50 musicians, including violins, violas, cellos, contrabass, wood instruments, brass instruments and

percussion, ensuring an extensive and appealing sonority. The concert programme included:

- **Wolfgang Amadeus Mozart** – Overture of "Figaro`s Wedding"
- **Gioachinno Rossini** – Overture of "Barber of Sevilla"
- **Gioachinno Rossini** Aria "Una voccepoco fa" from "Barber of Sevilla" opera, soprano Madalina STAN
- **Edward Elgar** "Salut d'amour"
- **Leo Delibes Aria** "La fille de Cadiz" bolero for soprano and orchestra - soloist Madalina STAN
- **Ludwig van Beethoven** 5th Symphony – part I , Allegro con brio
- **Iosif Ivanovici** "Danube waves" waltz

On Festive dinner

On the third eveneing, a festive dinner for the Conference participants was organized at the Mogosoaia Palace, near Bucharest. Romanian traditional cuisine, selected wines and quality sound back-

grounds came to complement culinary delights in a space filled with history. The Mogosoaia Palace, is about 15 km from Bucharest, and for nearly 120 years belonged to the Brancoveanu family. It was built between 1698-1702 by Constantin Brâncoveanu.

TECHNICAL VISITS

During the last day, four technical visists were available:

• COMOTI & INCAS

The Romanian Research and Development Institute for Gas Turbines COMOTI is the only unit in Romania specialized in development and integration of scientific research, constructive and technological design, manufacturing, experimentation, testing, technological transfer and innovation in the field of aviation turbine engines, gas turbine industrial machines and high speed blade machines. Continuous growth of quality allowed involvement in present days with scientific research, design, testing and small production in main research fields: aviation turbine engines, energy efficiency, including new types of turbo engines fuel, co-generation, unconventional forms of energy, improvement of energetic efficiency for natural gas compression systems, etc. and environment protection, noise reduction in aircraft and industrial turbo engines, wasted waters treatment units, air ventilation systems for the biological stage of wasted water cleaning.

The National Institute for Aerospace Research "Elie Carafoli" INCAS is the leading research establishment in aerospace sciences in Romania, with more than 60 years tradition in aerospace engineering, flow physics and applied aerodynamics, using stateof-the-art technologies and unique infrastructure of national strategic importance. INCAS has been involved in all major national aeronautical projects for civil and military areas, and currently is acting as a major player in EU policy for R&D development under FlightPath 2050 vision and future Horizon 2020 program.

• ROMAERO SA

Formerly Enterprise for the Repair of Aeronautical Material is a Romanian aircraft repair facility with some production capability for outside designs. Headquartered in Bucharest, it was founded by Royal Decree in 1920 as ASAM, and rebranded as IRMA after 1944. In 1978, the company changed its name to IAvB - Întreprinderea de AvioaneBucurești (Bucharest Enterprise Aircraft), rebranded as Romaero S.A., in 1991. Is an aerospace company that integrates two major activities: aerostructure manufacturing and maintenance and repair for civil and military transport aircraft.

• MAGURELE – the research and development town

Măgurele is a town situated in the southwestern part of Ilfov County, Romania. Its population is 9,200. Four villages are administered by the town: Alunișu, Dumitrana, Pruni and Vârteju. Authorities want to transform the rural area with Magurele into a socio-economic centre that will create development and innovation based on the Silicon Valley model. Will become in a few years the Laser Valley – Land of Light, the main Romanian innovation centre and a smart

city that will centralize fundamental research, but also draw together start-ups from cutting edge technology.
The town hosts the “The Institute for Lasers”, where the most powerful laser in the world is to be built – a system with two arms of 10 petawatts, equivalent to 10% of the Sun’s power each. In addition, the platform includes a high-intensity gamma system, the two components allowing experiments that could not be conducted until now.
IAR Brasov and trip to Peles Castle
IAR (Romanian Aeronautic Industry) Brasov is a Romanian aerospace manufacturer founded in 1925. Based in Ghimbav, near Brașov, the company employs around 1,200 specialists including more than 170 engineers. It carries out upgrades, revisions, and overhauls on helicopters and light aircraft.
Finally, the organizers wish to thank their parnters and sponsors of the conference.

PARTNERS

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INCAS

SPONSORS

Several pictures taken during the conference are presented in the following

AEROSTAR S.A. GRUP INDUSTRIAL AERONAUTIC-BACAU-ROMANIA
AEROTEH SA
MAGIC ENGINEERING
DASSAULT SYSTEMES
INAS power to change
AEROFINA
romatsa
rosa
Blue Air

25 YEARS OF CEAS

By Christophe Hermans, CEAS president

“Ladies and Gentlemen, dear past presidents & CEAS Trustee Board members,
I would like to ask the CEAS past presidents, present here today, to join me:

2008	**Georges Bridel (SWFW)**
2009-2010	**Joachim Szodruch (DGLR)**
2011-2012	**Pierre Bescond (3AF)**
2014-2016	**Fred Abbink (NVvL), being specifically instrumental in having the CEAS history described and preserved.**

In 1986, the Deutsche Gesellschaft für Luft- und Raumfahrt (DGLR), the Royal Aeronautical Society (RAeS) and the Association Aéronautique et Astronautique de France (3AF) began a series of regular meetings to review and discuss European co-operation issues. This led to a more formal organization when, 25 years ago at the 1992 Farnborough Air Show, the three organizations, along with Associazione Italiana di Aeronautica e Astronautica (AIDAA), launched CEAS. CEAS was formally instituted one year later at the Paris Air Show.

In 1995, AIAE (Spain) and NVvL (The Netherlands) came on board, followed by FTF (Sweden) and SVFW (Switzerland) in 1996. These eight bodies formed the core of the original Confederation of European Aerospace Societies (CEAS). Since then CEAS has changed its legal status into a council, now with 13 national aeronautical societies representing roughly 35,000 individual aeronautical professionals all over Europe.

To celebrate our 25th anniversary, we decided last year to publish a booklet about our history and asked Prof. Keith Hayward to author the publication.
As current president I’m proud to officially hand over a copy of the book to you as past presidents as token of appreciation for your efforts towards CEAS. As you have noticed, you all have found a copy of this book in your conference bag as a small present of CEAS.
Thank you for your attention! ”

LAUDATIO FOR CEAS AWARD 2017 TO ERIC DAUTRIAT

By Christophe Hermans, CEAS president

"Ladies and Gentlemen, dear Eric,

The CEAS Award has been created in order to recognize persons who have made outstanding contributions of European recognition, to the advancement of aerospace in Europe.

The Award takes the form of a gold medal and a scroll and is presented annually by the President of CEAS.

The Board of Trustees of the Council of the European Aerospace Societies, during its meeting in St. Petersburg on June 9, 2016, has elected Eric Dautriat as the recipient of the CEAS Award 2017.

The Statement of Justification for the nomination for the CEAS Award 2017 reads as follows:
Eric Dautriat has contributed in an exemplary, outstanding way to the French space community and to the of European aeronautics technology development and demonstration, more specifically for the progress in environmental sustainability and competitiveness of the European aeronautical industry.

Since 1998, the Award has been presented 18 times and we are proud we can add Eric Dautriat as this year's laureate to this list of distinguished European personalities in aeronautics.

After a successful career in Space Launchers with Snecma and ESA, Eric Dautriat became in 2009 the Executive Director for the EU Joint Undertaking Clean Sky and Clean Sky 2. In this last function he managed the multi Billion Euro public private partnership programs between the European Commission and the European aeronautics industry, SMEs, research establishments and universities.

Eric just recently retired. He now is still active as an aerospace consultant, writer, traveler and interestingly olive grower!

So please join me in welcoming Eric Dautriat! "

CURRICULUM VITAE OF ERIC DAUTRIAT

Eric Dautriat was born in Bar-Le-Duc, France, 1955
1977 Graduated as Engineer from Ecole Centrale de Lyon.

- **1978-1984** Mechanical Engineer - Advanced Projects - Snecma, Melun Villaroche, France.
- **1985-1988** French Space Agency (CNES) – French Delegate to the Ariane Programme Board and the Scientific Programme Board at ESA.
- **1988-2003** French Space Agency (CNES) – Launchers Directorate – Successively: Deputy Manager Ariane 4 Complementary Programmes, Manager Advanced Programmes, Project Manager Ariane 5 Solid Rocket Boosters, and then Director of Launchers.
  1997-2003 In charge of Ariane 5 Developments by delegation of ESA and in charge of National R&T Activities.
- **2003-2008** Vice President Quality at Snecma (Safran Group)
- **2007-2009** Vice President Quality of Safran Group
- **2009-2016** Executive Director of Clean Sky Joint Undertaking (CSJU), European Commission, Brussels.

After seven years at the helm, Eric Dautriat has been a part of CSJU from his inception and has overseen the completion of several innovative Technology Demonstrators within the strategic research partnership between the European Commission and the aeronautical industry.

Eric Dautriat is Chevalier de la Légion d'Honneur.

A STRATEGIC PROPOSAL BEYOND 2020 FOR EUROPEAN AERONAUTICS

By Sky and Space Intergroup of the European Parliament (SSI)

Aeronautics is a vital sector of our society and economy and must be considered as a wide ecosystem composed of industrial actors (manufacturers for civil and military markets), airport platforms and airlines. It is also of importance for the sovereignty and strategic interests of the European Union and its Member States. It is a sector which meets society's needs by:

- ensuring appropriate and sustainable mobility for passengers and freight;
- generating wealth and economic growth (total turnover equates to more than €160bn) supporting and stimulating the role of SMEs, start-ups and entrepreneurship in the EU;
- contributing significantly to the balance of trade and European competitiveness (€46bn extra-EU exports, accounting for a third of the world market);
- providing highly skilled jobs (half a million highly qualified jobs) and stimulating innovation;
- fostering Europe's knowledge economy through substantial R&D investment (ca. 12% of turnover);
- contributing in many different ways to global safety and security.
- supporting the most sustainable, the most economical and least energy consuming technology.

In addition to the above, as part of the overall aviation sector, the aeronautics sector contributes to 15 out of 17 UN Sustainable Development Goals, to some in small ways and to others with much more significant influence [ATAG 2017 report].

The strength of today's aeronautical industry results from the combination of a highly qualified workforce, robust strategies and continuous efforts on quality, safety, environment standards, and more widely on innovation. As an illustration, each new generation of aircraft is usually 15-20% more efficient than the previous generation of aircraft it replaces. In this respect, EU financial support has been critical to success. Clean Sky 2, SESAR 2020 and transport collaborative programmes have achieved impressive results in terms of cleaner technologies for civil aviation:

– more efficient engines and bio-fuels;
– more efficient aircraft (i.e. airframes, components, wings, etc.);
– improved Air Traffic Management technologies and procedures;
– greener taxiing technologies and improved airport operations;
– more environmentally friendly materials as well as
– longer term research on break-through technologies including electrically powered aircraft.

However, **there is no time for complacency**. The international competition is becoming increasingly fierce from established traditional rivals such as the US and from strong new challengers, notably Brazil, Canada, China, India and Russia. The industry is also exposed to excessive and hidden state subsidies in other parts of the world as well as to technical demands aimed at reducing emissions, despite a considerable increase in passenger numbers and a duplication of passenger planes until 2035. Furthermore, complex new requirements in the field of security (e.g. countering terrorist threats, cybersecurity) and changes resulting from digitalisation and innovation (e.g. drones, autonomous flights) are part of these enormous challenges.

Five High Level lines of action are proposed to enable Europe to succeed:

1. Develop an EU industrial strategy for the European aeronautical industry to ensure its competitiveness and continued leadership in the global civil aviation market. Ensure this competitiveness meets the optimal standards of transparency to support fair competition. Implement in this context also a SME-oriented strategy with economic diplomacy tools in order to foster the internationalization of European companies.

2. Ensure Europe remains a leader in terms of sustainable, safe and more environmental-friendly aviation.

3. Ensure Europe also stays in a leading position in developments relating to energy transition for civil aviation.

4. Ensure that Europe becomes a leader on cybersecurity, digitalization and emerging technologies.

5. Increase EU funding for civil aviation research and innovation and increase EU support against marketdistorting measures of third countries.

These five high-level lines of action can be broken down in 12 concrete action points where the European Institutions can make the difference:

1. **Increase EU civil aviation research/innovation funding** to adequately support the European industry in reaching the ambitious ACARE Flightpath 2050 goals and maintaining the grant-based funding system in FP9.
   As part of that effort, funding for SESAR and CleanSky in the next MFF should be doubled to 5 bln €.

2. Support and increase the funding of SMEs and start-ups to continue creating jobs and adding value to EU internal market.

3. Support Europe's continued leadership in **sustainable and more environmental-friendly aviation**, which is highly dependent on continued funding for civil aviation research programmes through:
   a. launching **Clean Sky 3**, which should encompass the full scope of aeronautic research from upstream to full scale demonstrators involving the whole industrial ecosystem (from large companies to SMEs, Academia and Research Organisations), in order to further develop cleaner technologies and safeguard EU industrial competitiveness.
   b. launching **SESAR 3** which should continue to encompass the full scope of ATM research, as the technological pillar of the Single European Sky Initiative.
   c. **Accelerate the deployment of SESAR solutions** building on the existing work of the SESAR deployment manager. An appropriate budget should be dedicated to SESAR deployment as part of the successor programme to the Connecting Europe Facility (CEF) in the next Mid Financial Framework (MFF). Public funding should mainly be used to give bigger incentives to customers that are deploying new technology early.

4. **Digitalization** (including Digital Aviation Structure to accommodate new automated flying platforms), **automation and electrification** should be key priorities of the next European Research and Innovation policy agenda.
   European technology has always been an important contributor to the very high safety levels achieved by the worldwide civil aviation community (3.8 accidents per million departures for scheduled commercial flights above 5.7 tonnes). Safety should never be taken for granted however and work should therefore continue to develop new technology which can enhance safety even further.

5. Develop **education & training programmes** which should include **civil aviation cybersecurity, automation and digitization skills** as an **EU-wide strategy**.

6. Support ambitious EU research, deployment and regulation for **drones** (from small to large certified drones) and **urban air mobility** into a safe and effective interconnected transport system.

7. Initiate a **high level sectoral** group bringing together the EU institutions and the industry and task a single Commissioner to ensure a coherent and efficient Aeronautics industrial strategy.

8. Build an "**Aerospace Watchtower**" at Commission level, i.e. monitoring non-tariff barriers in key aerospace regions and assessing the relative competitiveness of the EU aeronautics industry.

9. "**Promote European safety regulations, certification standards and policies**" on the international stage as a core official mission of **EASA's** new mandate (mirroring the US FAA) and where beneficial, allow EASA to set up **more offices in third countries**; calls further for **a swift adoption of the EASA mandate**.

10. **Strengthen the voice of the EU in international bodies, such as ICAO** to ensure that international standards and policies take into account the European civil aviation concerns in **trade agreements** by appointing an aerospace representative in the Advisory Group on trade agreements to be created by Trade Commissioner Malmström.

11. **Encourage the insertion of aeronautics as key sector for EU economic diplomacy** as in the trade policy of the EU led by EEAS and concerned directorate generals.

12. **Ensure a high level for the rights of workers** in the aeronautics industry as in the area of social security, a financially secure income base and regular advanced training especially in the area of digitalization; further respect of the rights of passengers.

SAFRAN CELEBRATES SUCCESSFUL START OF OPEN ROTOR DEMONSTRATOR TESTS ON NEW OPEN-AIR TEST RIG IN ISTRES (FRANCE)

Istres, October 3, 2017 - Safran has celebrated today the success of the first ground tests of the Open Rotor demonstrator engine in Istres, southern France. The ceremony marking this milestone was attended by Clara de la Torre, Transport director in the European Commission's Directorate-General for Research and Innovation, Stéphane Bouillon, Prefect of the Provence-Alps-Côte d'Azur region, François Bernardini, Mayor of Istres, Philippe Maurizot, regional councilor, Ross McInnes, Chairman of the Board of Directors of Safran and Philippe Petitcolin, Chief Executive Officer of Safran.

The Open Rotor demonstrator, developed through Europe's vast Clean Sky* research program, is a strategic focus in Safran's Research & Technology efforts, and a key part of Safran's plans to develop a propulsion system meeting aircraft manufacturers' future needs towards 2030. Safran and its partners in the Clean Sky program have received 65 million euros in funding from the European Commission for this project, over a period of eight years.

© Eric Drouin

As its name indicates, the Open Rotor features a breakthrough architecture, with two counter-rotating, unshrouded fans, allowing it to reduce fuel consumption and CO_2 emissions by 30% compared with current CFM56** engines. Launched in 2008 and led by Safran, the demonstration program has already reached several major milestones, including wind-tunnel tests at French aerospace research agency ONERA, leading to the assembly of a demonstrator in 2015, and the start of ground tests on the open-air test rig in Istres in May 2017.

"The Open Rotor is a major focus of Safran's research," said Philippe Petitcolin, CEO of Safran. "With the LEAP** engine we proved our ability to develop and integrate new technologies. Our aim now is to push our innovation strategy even further so we can deliver the best solutions to the market in timely fashion. We are currently studying several paths, both different and complementary, to develop, along with our partners in Clean Sky, the technology building blocks for propulsion systems that will significantly improve performance on tomorrow's airplanes."

"After ten years of development efforts, we are very proud to see the Open Rotor demonstrator perform its first ground tests with success," said Clara de la Torre from the European Commission. "The Open Rotor marks a major step forward in the aviation sector, since it meets two key challenges, namely to reduce fuel consumption and improve environmental performance."

© Eric Drouin/ Safran

Safran is exploring other propulsion solutions as well, in particular the UHBR (Ultra High Bypass Ratio), a shrouded turbofan engine with a very high bypass ratio, which would reduce fuel consumption by 5 to 10%. The UHBR would be a credible solution for aircraft-makers towards 2025, because it could be easily integrated on current aircraft. At the same time, Safran is also studying distributed, electric and hybrid propulsion systems.

At the Istres site in southern France, **Safran now has a new test stand covering some 80,000 square meters (864,000 sq ft), the only one of its kind in Europe**. This new test rig will be used to test the new-generation LEAP turbofan and future upgrades, the Open Rotor and UHBR technology demonstrators, and engines with complex architectures and/or of large size. Completed in 2016, this new test rig reflects the dynamic regional involvement in the Istres test center, with strong support from public authorities, as well as partnerships with local companies and universities. At the same time, this key project has led to the creation of 45 new jobs at Safran.

EUROPEAN AVIATION STAKEHOLDERS COMMIT TO SESAR AND THE DIGITAL AGENDA

8 November 2017, Tallinn – European aviation leaders gathered today to show their support for the digital transformation of their industry, and SESAR as the vehicle through which to achieve this ambitious goal. Initial analysis suggests that with a digitalised infrastructure, the industry could directly unlock around EUR 10 billion per annum from 2035. The meeting follows a declaration by industry underlining the urgent need to act now in order to enable more connected aviation and with that seamless travel and transport for all. An in-depth stakeholder-wide consultation will now begin on the modernisation of Europe's aviation infrastructure and air traffic management (ATM) system. The results of this consultation will be published in the fourth edition of the European ATM Master Plan, due for publication in 2018.

The world of aviation is changing, starting with the aircraft itself. In the not-so-distant future, air vehicles are set to become more autonomous, more connected, more intelligent. The services relating to the transport of passengers or goods are evolving too. Tomorrow's passengers will not make choices primarily on their mobility needs: they expect to get from A to B, door to door seamlessly, safely and efficiently.

The next 10 years will be a critical period to pave the way for the digital transformation of aviation. Aviation's infrastructure and ATM will play an essential role in this process, as it will have to adapt in order to cater for the growth in traffic and diversity of air vehicles in the sky. **Initial analysis suggests that with a digitalised infrastructure, the industry could directly unlock around EUR 10 billion per annum by 2035, which could be tripled by 2050**. A digital infrastructure would make a significant contribution to European citizens' well-being, while strengthening security and fostering positive spill-over effects, such as saving time for travelers or reducing CO_2 emissions.

Recognising the potential opportunities, European industry leaders representing manufacturers, solutions providers, airspace users, airports and air navigation service providers, published a signed declaration, stating : "To help enable this we will co-invest in the future of ATM research and development, through the successor of SESAR 2020, to collectively deliver a single, safe and secure digital European sky, that will allow Europe to maintain global leadership in this digital future".

An important means to ensuring that digitalisation is mapped out, developed and effectively deployed will be through the European ATM Master Plan, the European roadmap for ATM modernisation. The 2015 edition flagged this digital shift, referencing the aspirations of the EU Aviation Strategy and Flightpath 2050. The 2018 edition will bring together aviation stakeholders for a 12-month consultation to further investigate the potential of technological advances and identify the key development and deployment activities needed to bring Europe's aviation infrastructure into the digital age.

"It is clear that a digitalised, modern, harmonised and efficient ATM system, with a global outreach, is instrumental for the success of the EU Aviation Strategy. SESAR has a decisive role to play as the technological pillar of the Single European Sky, it is naturally also its digital pillar. SESAR will therefore play a major part in identifying, developing and deploying the elements of the new digital ATM system," said **Henrik Hololei, Director General of the European Commission Directorate-General for Mobility and Transport (DG MOVE), and Chair of the SESAR Joint Undertaking Administrative Board**.

"We are delighted to have the support of the aviation stakeholder community at this critical point in our modernisation plans," said **Florian Guillermet, Executive Director of the SESAR JU**. "Through the European ATM Master Plan, we plan to further investigate the potential that digital technologies hold for our sector, identifying the priorities where we should focus our innovation efforts for the years to come."

NOTES

About SESAR

As the technological pillar of the Single European Sky initiative, SESAR aims to modernise and harmonise air traffic management in Europe. The SESAR Joint Undertaking (SESAR JU) was established in 2007 as a public-private partnership to support this endeavour. It does so by pooling the knowledge and resources of the entire ATM community in order to define, research, develop and validate innovative technological and operational solutions. The SESAR JU is also responsible for the execution of the European ATM Master Plan which defines the EU priorities for R&D and implementation. Founded by the European Union and Eurocontrol, the SESAR JU has 19 members, who together with their partners and affiliate associations represent over 100 companies working in Europe and beyond. The SESAR JU also works closely with staff associations, regulators, airport operators and the scientific community.

About digitalising Europe's aviation infrastructure

The world of aviation is changing. The underlying aviation infrastructure and its future operations capabilities, collectively known as the air traffic management system, will evolve just like the rest of the air transport and aviation value chain. Of course, this will be driven by demand, but as well by technology becoming available e.g. internet of things, big data, artificial intelligence and quantum computing. The transformation to this new era in flying presents many opportunities but also challenges for the European aviation industry.

About the stakeholder declaration

The declaration was signed by Airlines for Europe (A4E), Airports Council International (ACI) Europe, AeroSpace and Defence Industries Association of Europe (ASD), Civil air navigation services providers organisation (CANSO), European Business Aviation Association (EBAA), European Helicopter Association (EHA), European Regions Airline Association (ERA), International Air Transport Association (IATA).

About the European ATM Master Plan

Set within the framework of the Single European Sky (SES), the Master Plan is the main European planning tool for defining ATM modernisation priorities and ensuring the SESAR Solutions become a reality. Both pragmatic and ambitious in its design, the Plan provides a high-level view of what is needed in order to deliver a high-performing aviation system for Europe, and also sets the framework for the related development and deployment activities, ensuring that all phases of the SESAR lifecycle remain connected.

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ELECTRIC PROPULSION

By Tony Schönherr, Electric Propulsion Section, ESA-ESTEC and José Gonzalez del Amo, Head of Electric Propulsion Section, ESA-ESTEC Directorate of Technology, Engineering and Quality

INTRODUCTION

Electric Propulsion (EP) for satellites uses electric power to accelerate the necessary propellant to exhaust velocities higher than could possibly be achieved with chemical systems, which operate with the energy stored in their reagents. As a result, less propellant mass is necessary to perform the required change in velocity, and therefore the overall system is many times more mass efficient. Although the idea for EP was already conceived at the beginning of the 20th century by Konstantin E. Tsiolkovsky and Robert H. Goddard, it would take until the 1960s to see first conceptual systems to be tested in space by the USSR and the USA. Concurrently starting R&D activities in industry and academia in now ESA member states has been creating profound fundamental knowledge and improved technologies to enable Europe to build electric propulsion systems. The technological and political challenges delayed a first European demonstration mission, however, until 1992. On board of ESA's European Retrievable Carrier EURECA, the Radio-Frequency Ion Thruster Assembly (RITA) built by MBB (today: ArianeGroup) was tested successfully for 240 hours of operation (see Figure 1). Since then, ESA has continued to plan and support missions and R&D activities within Europe to prepare industry and academia for the challenges of current and future space needs.

TASK OF ESA

Requirements on space propulsion systems vary drastically with the type of mission application, and as such a universal propulsive solution does not exist. Therefore, a variety of EP system concepts has emerged over the years, and new developments are pursued to meet the needs of future missions. Most notably, electrothermal thrusters like arcjets and resistojets as well as electrostatic thrusters like Hall effect thrusters and ion engines had been developed and applied extensively for commercial and scientific missions alike. Electromagnetic thruster concepts like magnetoplasmadynamic (MPD) thrusters and pulsed plasma thrusters (PPT) were tested on selected technology demonstration missions but show potential for future mission considerations regarding high-power exploration (for MPD) and low-power small satellites and AOCS (for PPT). Consequently, the European Space Agency is supporting and pushing the application of a variety of EP technologies on current and future European satellites for the various applications including telecommunications, navigation, deep space science & exploration, Earth observation, space transportation, and nanosatellites.

TELECOMMUNICATIONS

The commercial telecommunications satellites market is nowadays the most important market for EP. Since the 1980s, EP has been used for station keeping of telecom

Figure 1: Photo of the EURECA Spacecraft during retrieval (image credit: NASA)

satellites (USA, USSR/Russia) and in 2004, Intelsat 10-02 became the first European developed telecom satellite using EP for station keeping. The market has rapidly evolved in recent years, and it is continuing to evolve, based on a range of developments in launch services, platform technologies and operator requirements. In July 2013, AlphaSAT (Inmarsat-4A) became the first European developed telecom satellite using four PPS®1350-G thrusters built by SAFRAN-Snecma for station keeping.

The use of electric propulsion technologies in the telecommunication space market is today a key issue to improve the position of the European space sector. European industry was relatively conservative in their adoption of EP technology compared to the US suppliers, but nowadays a strong push is given by the European Space Agency in this sector with spacecraft such as AlphaSat, Small GEO, Electra and Neosat that will pave the way for the use of this technology, putting European industries in an advanced position to compete for new telecom spacecraft.

Recent developments in platform technologies have been aimed at increasing the available payload fraction and accommodating larger, more powerful payloads. The recent trend in GEO telecom satellites has resulted in a considerable increase of electrical power to satisfy the payload needs, an increase in platform size to accommodate larger payload, and longer mission duration up to 15 years.

Both Airbus DS and TAS are extending the capabilities of their existing Eurostar and SpaceBus platforms to offer orbit raising with EP. Both suppliers are also developing their new all-electric platforms in the frame of the NeoSAT program (Eurostar NEO and SpaceBus NEO, ARTES 14) – a trend that was successfully implemented in space with Boeing's first all-electric 702SP satellites launched in 2015, and that was successfully continued with Airbus-built EUTELSAT 172B in 2017 (see Figure 2)[1]. OHB's SmallGEO platform has been designed to use EP thusters for all orbital manoeuvres, and the company is developing its own all-electric platform (Electra, ARTES 33) which will make use of EP for orbit raising and station keeping.

In view of the increasing power availability of the new GEO platforms and to respond to the needs of higher total impulse and higher thrust, European suppliers of EP thrusters have already initiated development programmes with support by the Agency to qualify high-power versions of existing thrusters. The 5 kW QinetiQ T6 Ion Engine is undergoing qualification for the BepiColombo mission, and the SAFRAN-Snecma PPS®5000 is undergoing qualification for the NeoSAT and Electra platforms. The Sitael HT-5k Hall effect thruster is also under development for potential use on such satellites. Alternatively, high-power clusters of 1.5 kW Thales HEMPT thrusters (in their final step of qualification) and 1.5 kW PPS®1350 thrusters (qualified) could be used.

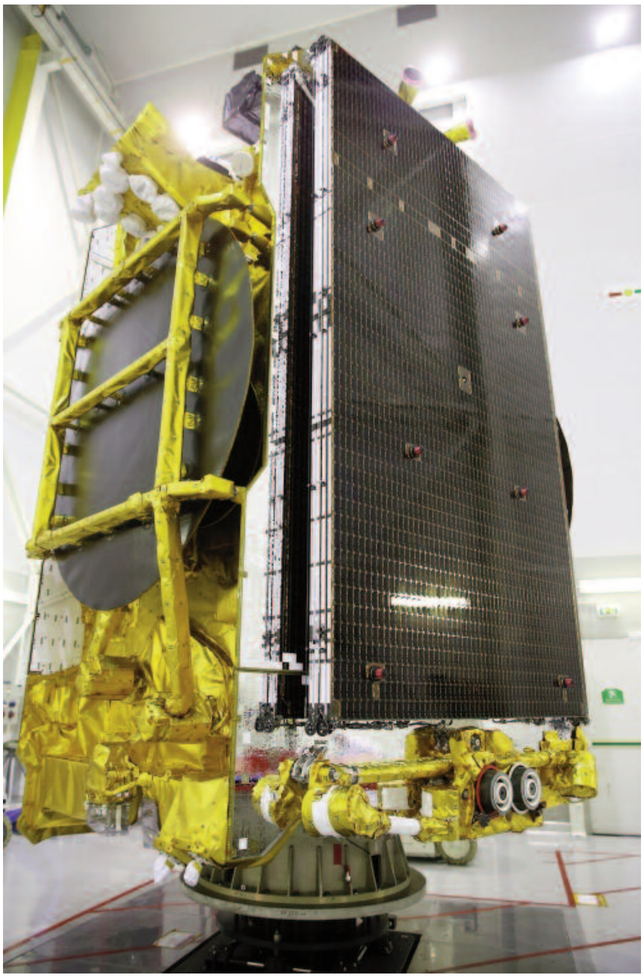


Figure 2: Photo of EUTELSAT 172B telecom satellite before launch. Two of the equipped Hall effect thrusters are visible below the solar panels (image credit: Airbus Defence & Space)

The use of xenon resistojets and xenon arcjets are also considered on telecom platforms for detumbling or safe mode operations; this will simplify the EP-based spacecraft architecture because they will make use of the available xenon from the EP system and therefore avoid the introduction of additional propellant tanks and regulator systems.

New constellations proposed by, e.g., Space X with 4000 spacecraft or Oneweb with 700 spacecraft consider electric propulsion for orbit manoeuvres, station keeping, and disposal. Versatile EP systems will be required and the cost of the system will need to be one order of magnitude lower than current prices. Conduct of testing, material selection, design factors, etc., will be key points to achieve such savings. Small constellations such as ICEYE are going to use the FOTEC field emission thrusters (FEEP) IFM Nano to keep the constellation in orbit and de-orbit all the satellites when the life is finished

NAVIGATION

The Galileo Second Generation (G2G) programme is targeting the possibility to increase the Galileo payload capabi-

1. http://www.airbus.com/newsroom/press-releases/en/2017/10/EUTELSAT-172B-satellite.html

lity without impacting the launch costs. Today, there are no margins in the Galileo platform to allow for such an increase due to mass and power limitations established by the adopted launch strategy.
Several ESA studies concluded that the increase in payload capability could be achieved only by using electric propulsion to transfer the satellite to operational orbit and by changing the launch injection policy. The studies have considered the use of several EP subsystems from different European suppliers. In particular three EP technologies were assessed: Gridded Ion Engines, Hall Effect Thrusters, and High Efficient Multistage Plasma Thruster (HEMPT). ESA is currently funding the European industry to adapt these engines to the Galileo evolution, but the selection of the EP system to be used will be ultimately conducted by the selected satellite manufacturer.

DEEP SPACE SCIENCE & EXPLORATION

Interplanetary missions such as Deep Space 1 (NASA), Hayabusa (JAXA) and SMART-1 (ESA) have paved the road for the common use of EP systems for Science and Exploration missions. Launched in 2003, SMART-1 required only 82 kg of xenon to propel a 350 kg spacecraft to the Moon from GTO using a PPS®1350 Hall effect thruster by SAFRAN-Snecma. Interplanetary missions to Mercury, Mars, asteroids, etc., require high-power EP systems as primary propulsion systems. The ESA Cornerstone mission to the planet Mercury, BepiColombo (see Figure 3), will be propelled by a cluster of high-power (2.5-4.5 kW range) gridded ion engines made by QinetiQ to cover the high change in velocity required to get to the planet. Funded by the European Commission, the HiPER project aimed at conceptual feasibility evaluation of higher-power EP systems including Hall effect thrusters, gridded ion engines, and magnetoplasmadynamic thrusters in the order of 20 kW and beyond. Some of those prototype development activities are continued with ESA support to provide heavy-duty main propulsion systems for future robotic and human exploration missions, e.g., the proposed Deep Space Gateway.
Strict pointing requirements for missions such as Laser Interferometer Space Antennas (LISA) as well as other low-disturbance requirements such as imaging applications require propulsion systems to operate in the micro-newton region. Drag-free and formation-flying missions also require very low but accurate thrust. Only propulsion systems that can deliver both a high specific impulse and ultraprecision controllability are capable to fulfilling the stringent requirements on these types of missions. In many cases EP is enabling for missions such as LISA. These missions may use mini-ion engines, field emission microthrusters, or micro colloids systems.

EARTH OBSERVATION

Earth observation also greatly benefits from the use of EP technology as was demonstrated successfully with ESA's Gravity field and steady-state Ocean Circulation Explorer (GOCE) in 2009-2013. The main aim of the GOCE mission was to provide unique models of the Earth's gravity field and its geoid to high spatial resolution and accuracy. The GOCE satellite (see Figure 4) was a low-Earth orbiting spacecraft (at 275 km of altitude) with a small cross section of approximately 1 m^2, and totally symmetrical to minimise the influence of external forces. The actuators for orbit maintenance were a pair of QinetiQ T5 ion engines. Their primary function was to provide variable thrust for compensation of the drag force in flight direction throughout the satellite's measurement phases. In addition, the ion engines supported instrument calibration and satellite maintenance phases by providing sufficient thrust for orbit raising manoeuvres and atmospheric drag compensation.
The Ion Propulsion Assembly (IPA) was operated almost continuously for the mission duration. Consequently, a firing time in excess of 30,000 hours was demonstrated on the primary ion thruster. The success of the ion engine on the GOCE spacecraft has demonstrated the potential of this technology for fine control of satellites flying in LEO. A new post GOCE mission is being designed at ESA – the Next Generation Gravity Mission (NGGM) for monitoring the variations of the Earth gravity. This mission is composed of two small satellites flying in formation in a very low Earth orbit and is considering small-scale EP developments for compensation of the very small cross track drag forces.
One of the major limiting factors to extend mission durations in LEO and to lower the operational altitude is the mass of propellant required to perform drag compensation. The possibility to use the external residual atmosphere as propellant for a conventional electric propulsion system is being explored by ESA since 2007, and several studies had been supported to evaluate performance and system designs for this endeavour. A recent test in early 2017 at SITAEL demonstrated successfully the so-called RAM-EP concept for the first time in Europe including a flow generator to simulate the LEO atmosphere. This is a milestone

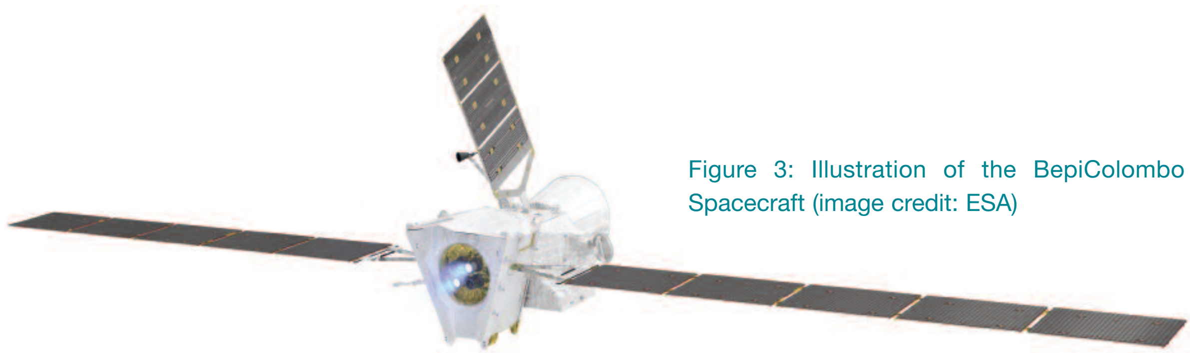


Figure 3: Illustration of the BepiColombo Spacecraft (image credit: ESA)

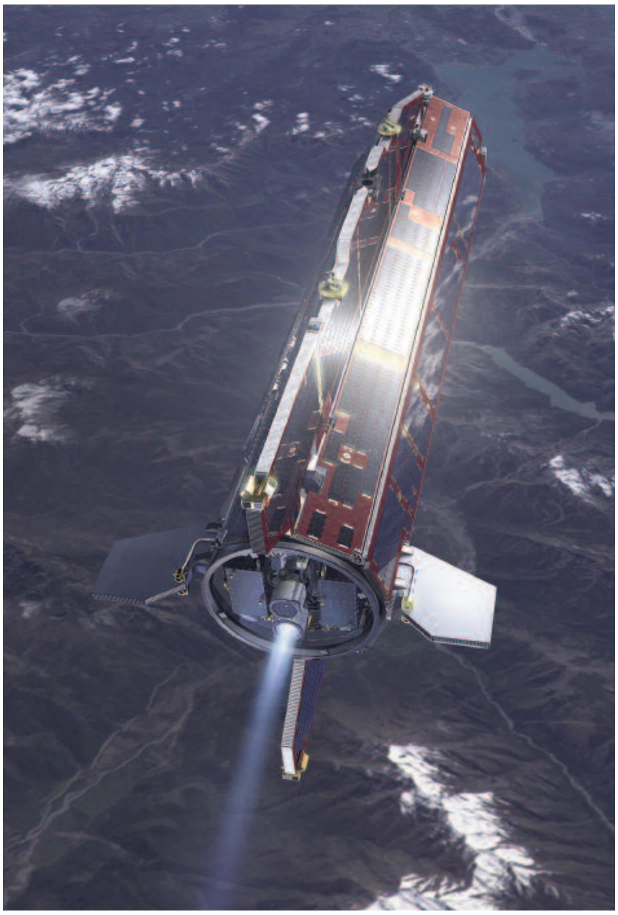


Figure 4: Illustration of the GOCE Spacecraft (image credit: ESA)

that opens the door not only for future low altitude Earth observation spacecraft, but enables new types of exploration and in-orbit servicing missions. In particular, this atmosphere-breathing technology could enable in huge dimensions the realization of the reusability concept and therefore allows for missions with reduced space debris.

SPACE TRANSPORTATION

Based on growing maturation of Electric Propulsion systems and increasing capabilities of such propulsion devices, possible applications to space transportation vehicles have gradually been studied with a more and more detailed level of analysis. Several ESA studies have already been conducted to increase the performance of launchers by adding an electric kick stage to a conventional chemical architecture. For instance, this is the case for the Vega launcher with an electric kick stage composed of a cluster of 5 kW Hall effect thrusters.

Further, Space Tugs are currently under discussion at all three European Large System Integrators. Electric propulsion is considered as one of the key technologies for Space Tugs due to the relatively low propellant consumption compared to chemical propulsion. A clear need has been identified for the development of high-power (15-20 kW), long-lifetime EP thrusters in the framework of future Space Tugs.

MINIATURIZED SATELLITES

Numerous EP micro-propulsion systems are currently in development and qualification in Europe for CubeSats and small satellites. When available and flight qualified, these propulsion systems will enable the smallsats to manoeuvre for the first time and, thus, significantly increase their mission utility and flexibility. Solutions like PPT and FEEP as well as colloidal thrusters have been and are studied with support of ESA and the EU to realize system concepts suitable for the few-watts regime commonly found in microsatellites. First applications on commercial constellation satellites are foreseen in the near future.

ESA PARABOLIC FLIGHTS

By Neil Melville, ESA-ESTEC Parabolic Flights and Drop Tower Coordinator, Directorate of Human Spaceflight & Robotic Exploration

The European Space Agency has a mandate for scientific research in weightless conditions, known as 'microgravity science', via the optional SciSpacE programme, whose predecessors have been running since 1982. In order to cater to the wide variety of scientific endeavours pursued by the European community, ESA provides and coordinates access to a range of different microgravity platforms. Each of these individual platforms presents a specific set of advantages and boundary conditions in terms of purity of microgravity, duration of microgravity, frequency, payload capacity, accessibility and cost.

In the case of parabolic flights, accessibility is the unique factor, being the only platform allowing scientists direct, hands-on access to their experiments during microgravity itself. Although telepresence technology has advanced a great deal, we repeatedly find that there is simply no substitute for direct human control. This principle also underpins the considerable achievements of our research on the International Space Station, however astronauts can only be trained to a certain depth of knowledge and understanding on such a wide suite of experiments. Compare this to the parabolic flights, where the scientists can interact directly with their experiments and bring their own knowledge and experience to bear.

ESA Parabolic Flight Campaigns have been organised since 1984, providing over 800 experiments with over 6000 parabolas in total, equivalent to around 23 orbits of the ISS. ESA Parabolic Flights are provided by

Novespace, a subsidiary of CNES, based in Bordeaux, France. Novespace has by far the largest experience of parabolic flights in Europe, having been operating various parabolic aircraft, since 1989. Since May 2015 Novespace are using a modified Airbus A310 'Zero-G', which has already flown over 2400 parabolas. [See Figure 1]

Figure 1 – Novespace Airbus A310 Zero-G in flight. Credit: Novespace

Typically ESA conducts two campaigns per year in the Novespace facilities at Bordeaux Merignac airport, each consisting of a preparation week and a flight week.
The preparation week includes experiment delivery, incoming inspections, safety verifications, loading onto the Airbus A310 Zero-G, integrated testing, and any calibration or baseline measurements that might be necessary.
The flight week consists of final preparations and a safety briefing, followed by three flight days and one backup day.

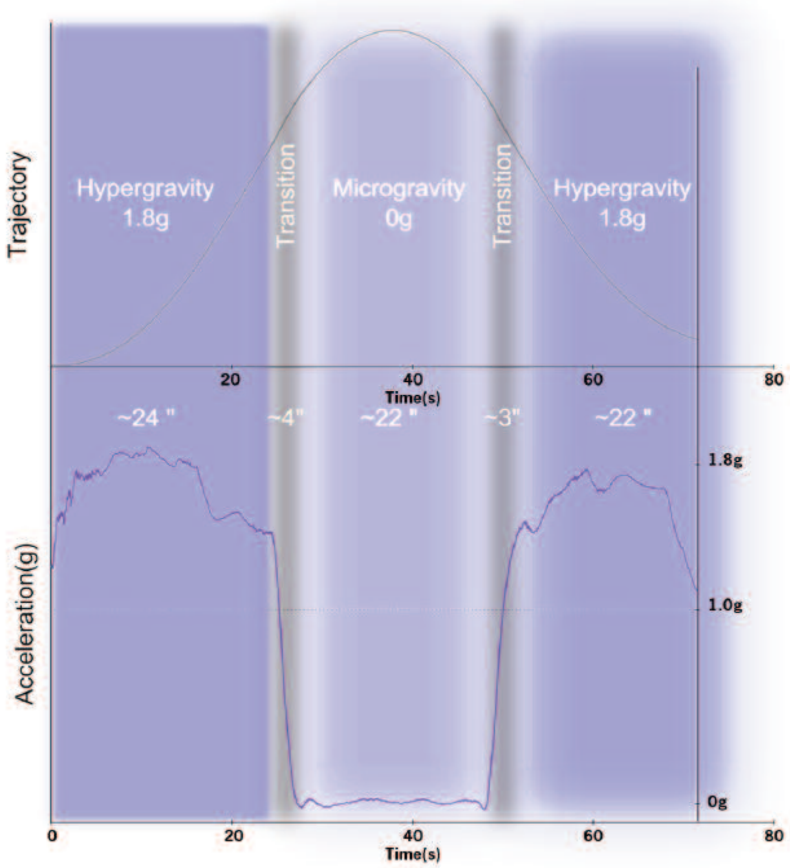


Figure 2 – Gravity profile of a parabola. Credit: Novespace

Novespace performs parabolic flights with the Airbus A310 Zero-G using three pilots simultaneously, one controlling each principle axis. Each parabola is preceded by a "pull up" manoeuvre at maximum airspeed, subjecting the experiments and passengers to approximately 20 seconds of 1.8g, until the plane is 50° nose-up. At this point of 'injection', the pilots coordinate to reduce the sum of aerodynamic forces on the plane to as close to zero as possible: i.e. by flying a zero-lift angle-of-attack, and cancelling air drag with thrust. Each parabola then provides approximately 20 seconds of microgravity, with disturbances typically below 0.02g. Once the plane is 42° nose-down, a "pull out" manoeuvre is executed, again subjecting the contents to 20 seconds of 1.8g, before returning to steady flight. [See Figure 2]

On a typical scientific flight this procedure is repeated 31 times over approximately two hours.
Provided that the timescales of the measurable phenomena under investigation are compatible with these boundary conditions, then a large total microgravity time can be swiftly accumulated: each flight provides 31 parabolas, and each campaign three flights, giving a total of approximately 30 minutes microgravity per campaign.

Experiments requiring even larger accumulations of microgravity time, either for statistical significance or to more fully explore the extent of the phenomenon in question, may fly on multiple campaigns. Several experiments are 'frequent flyers', taking advantage of this arrangement to accumulate many hours of microgravity time that would otherwise only be possible upon orbital platforms at far greater cost.
Paralleling the importance of the scientists conducting the experiments in microgravity themselves, it is also a key feature of ESA parabolic flight campaigns that the hardware is designed, provided and maintained by teams from the scientists' institutes. Coupled with the campaign format of three consecutive flight days, this familiarity affords the possibility for educated adjustment of experiment parameters and protocols in between flights, thereby increasing scientific return within a campaign. Such a rate of iteration of flight hardware is several orders of magnitude faster than with experiments on sounding rockets or orbital platforms.

An example of a typical ESA Parabolic Flight life-science experiment is '"Hypocampus – Effects of Parabolic Flight on Spatial Cognition and Hippocampal Plasticity", led by Dr Alexander Stahn as a cooperation between University of Pennsylvania, USA, and Center for Space

Medicine and Extreme Environments, Berlin, Germany. They hypothesise that reduced vestibular input during microgravity affects spatial navigation skills that are associated with the hippocampal formation and precuneus. To investigate this the experiment employs a unique set of virtual 3D tasks for the test subjects to complete before, during and after parabolic flights, and will also incorporate studies of resulting structural and functional adaptations of the brain. [Figure 3] Requiring a large number of human test subjects and flights for statistical significance, this fundamental research into a key relationship between cognition and gravitational environment would not be feasible on any other microgravity platform. This parabolic flight experiment serves as preparation to the ILSRA-2014 experiment which is currently prepared for implementation onboard ISS.

An example of a typical Physical-Sciences experiment is "PROGRA2 – PRopriétés Optiques des Grains Astronomiques et Atmosphériques ", with the principle investigator J.-B. Renard, LPC2E-CNRS. This experiment is used to characterise the unique light-scattering properties of any given sample of fine granular or dusty material. [See Figure 4] By testing a wide variety of possible analogues of interplanetary dust, proto-stellar dust, and dust from comets and asteroids, a database is built up for comparison to real astronomical signals, thereby allowing for positive identification of actual observed dust morphologies, densities, porosities, and granular compositions. [See Figure 5] Parabolic flights are used for this purpose because light scattering measurements can be made within seconds for any kind of particles, randomly oriented, without discrimination by weight or composition. Repeated flights with different samples allows a vast database of reference baseline data to be compiled for future use. The PROGRA2 experiment is partly the continuation of works in the frame of the ICAPS program, funded by ESA, to study dust aggregation processes and the formation of planets in stellar systems. The experiment has been participating in ESA parabolic flight campaigns since 1994, and has collected a wealth of data that could not have been obtained in any other manner.

Other key scientific experiments on ESA Parabolic Flights cover a wide range of disciplines within our top-level scientific road map topics:

- Ultra-precise cold atom sensors, quantum information and high energy particles;
- Soft or complex matter;
- Boiling, evaporation and two-phase heat transfer;
- Advanced material processing;
- Biology under non-Earth gravity conditions;
- Human body under space conditions;
- Psychological and neurosensory adaptations to reduced gravity;
- Cosmic radiations risks for Human exploration of the Solar System;

Figure 3 – Hypocampus experiment on 66th ESA Parabolic Flight Campaign. Credit: Novespace

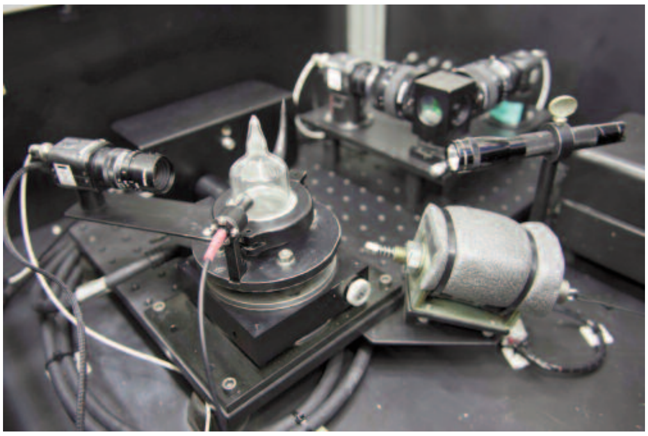


Figure 4 – Close-up view of PROGRA2 experiment hardware for the 58th Parabolic Flight Campaign. Credit: ESA/A. Le Floc'h

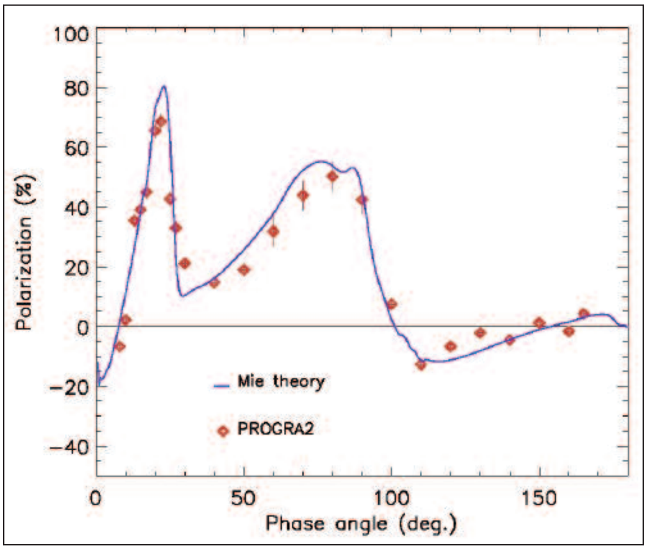


Figure 5 – Comparison between PROGRA2-IR measurements (during the 64th PFC) with the new cameras, and the theoretical calculations using Mie theory for glass beads particles of about 100 micro meter (μm) diameter, in the 950-1100 nm spectral range. Credit, CNRS Orleans, FR

Application to ESA parabolic flights is possible at any time via the Continually Open Research Announcement on the ESA web portal (http://www.esa.int/Our_Activities/Human_Spaceflight/Research/Research_Announcements). Scientific proposals are subjected to peer review, and successful applications are notified accordingly and then added to the pool of experiments awaiting flight. Allocation to specific campaigns is arranged according to scientific priority, and associated science teams are typically invited approximately six months in advance. The intervening time is then spent in technical contact with Novespace to prepare the experiment for flight, including detailed risk assessment and safety review. A record of previously flown experiments (complete up to August 2017) is compiled in the Erasmus Experiment Archive. (http://eea.spaceflight.esa.int/portal/)

Figure 6 – 66th ESA Parabolic Flight Campaign. Credit: Novespace

GALILEO LAUNCH BRINGS NAVIGATION NETWORK CLOSE TO COMPLETION

12 December 2017

Europe has four more Galileo navigation satellites in the sky following their launch on an Ariane 5 rocket. After today's success, only one more launch remains before the Galileo constellation is complete and delivering global coverage.

Ariane 5, operated by Arianespace under contract to ESA, lifted off from Europe's Spaceport in Kourou, French Guiana at 18:36 GMT (19:36 CET, 15:36 local time), carrying Galileo satellites 19–22. The first pair of 715 kg satellites was released almost 3 hours 36 minutes after liftoff, while the second pair separated 20 minutes later.

They were released into their target 22 922 km-altitude orbit by the dispenser atop the Ariane 5 upper stage. In the coming days, this quartet will be steered into their final working orbits. There, they will begin around six months of tests – performed by the European Global Navigation Satellite System Agency (GSA) – to check they are ready to join the working Galileo constellation.

This mission brings the Galileo system to 22 satellites. Initial Services began almost a year ago, on 15 December 2016.

"Today's launch is another great achievement, taking us within one step of completing the constellation," remarked Jan Wörner, ESA's Director General.

"It is a great achievement of our industrial partners OHB (DE) and SSTL (GB) for the satellites, as well as Thales-Alenia-Space (FR, IT) and Airbus Defense and Space (GB, FR) for the ground segment and all their subcontractors throughout

Liftoff of Ariane 5 Flight VA240 from Europe's Spaceport in Kourou, French Guiana took place at 18:36 UTC (19:36 CET, 15:36 local time) on Tuesday 12 December 2017, carrying Galileo satellites 19–22. © ESA-Manuel Pedoussaut

Europe, that Europe now has a formidable global satellite navigation system with remarkable performance."

Paul Verhoef, ESA's Director of Navigation, added: "ESA is the design agent, system engineer and procurement agent

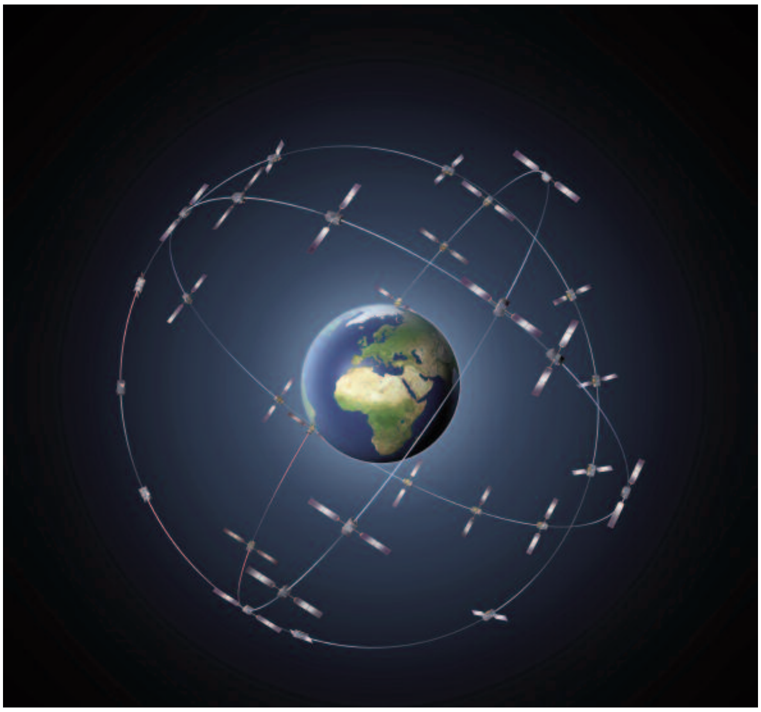
Artist's view of four Galileo satellites mounted on top of a specially adapted Ariane 5 rocket underneath the aerodynamic fairing. © ESA-Pierre Carril, 2017

of Galileo on behalf of the European Commission. Galileo is now an operating reality, so, in July, operational oversight of the system was passed to the GSA.

“Accordingly, GSA took control of these satellites as soon as they separated from their launcher, with ESA maintaining an advisory role. This productive partnership will continue with the next Galileo launch, by Ariane 5 in mid-2018.
“Meanwhile, ESA is also working with the European Commission and GSA on dedicated research and development efforts and system design to begin the procurement of the Galileo Second Generation, along with other future navigation technologies.”

Four Galileo satellites seen before being encapsulated by the protective payload fairing on 7 December, completing the Ariane 5 for flight VA240, scheduled for 12 December 2017. © ESA-CNES-Arianespace / Optique vidéo du CSG - JM Guillon

Next year’s launch of another quartet will bring the 24-satellite Galileo constellation to the point of completion, plus two orbital spares.
Learn more about Galileo at:
http://www.esa.int/Our_Activities/Navigation



The complete Galileo constellation will consist of 24 satellites along three orbital planes, plus two spare satellites per orbit. The result will be Europe’s largest-ever fleet, providing worldwide navigation coverage. © ESA-P. Carril

AMONG UPCOMING AEROSPACE EVENTS

2018

08-12 January • **AIAA** – AIAA SciTech Forum and Exposition: AIAA/AHS Adaptive Structures Conf. – AIAA Aerospace Sciences Meeting – AIAA Atmospheric Flight Mechanics Conf. – AIAA Information Systems Infotech Conf. – AIAA GNC Conf. – AIAA Modeling and Simulation Technologies Con. – AIAA Non-Deterministic Approaches Conf. – AAS.AIAA Space Flight Mechanics Conf. – AIAA/ASCE/AHS/ASC Ctrustures and Materials Conf. – AIAA Spacecraft Structures Conf. – Wind Energy Conf. - Orlando, FL (USA) – www.aiaa.org/events

16-17 January • **CLEANSKY/INEA** – EU Aviation research policy on Noise - 1210, Brussels (Belgium) Two-day workshop - COV2 25/SDR 1 – Auditorium Nowotny – Covent Garden place Rogier 16 1210 Brussels – www.cleansky.eu

23-24 January • **SESARJU** – CORUSU Workshop – Barcelona (Spain) – Castelldefels – CORUSU: Concept of Operation for EuRopean UTM System; aim: to manage drones in European Very Low Level (VLL) airspace - www.sesarju.eu

24-25 January • **EUROCONTROL** – Networking Manager User Forum – Brussels (Belgium) – EUROCONTROL/HQ – Rue de la Fusée 96 – 1130 Brussels – Annual operational networking event http://www.eurocontrol.int/nm-user-forum-2018

31 January – 02 February • **3AF** – ERTS (Embedded Real Time Software and Systems) Conference – Toulouse (France) – www.erts2018.org

06 February • **RAeS** – Air Weapon Systems Conference – London (UK) – RAeS/HQ – Maximising the value of Air Weapon Systems. Improving through life costs and capability of Weapon Systems across all the Defence Lines of Development (DLODs) – www.aerosociety.com/events

06-08 February • **3AF** – 8th International Symposium on Optronics in Defence and Security – Paris (France) – www.optro2018.org

06-11 February • **Singapore Airshow** – Changi Exhibition Centre – Singapore – www.singaporeairshow.com/

06-08 March • **CANSO/ATCA** – World ATM 2018 – IFEMA, Feria de Madrid – 28042 Madrid (Spain) http://www.worldatmcongress.org/201

26-28 March • **3AF** – 53rd International Conference on Applied Aerodynamics – AERO2018 – Salon de Provence (France) - Ecole de l'Air – www.3AF-aerodynamics2018.com

26-28 March • **EUROMECH** – 16th European mechanics of Materials Conference – Nantes (France) – www.euromech.org/

16-19 April • **Space Foundation** – 34th Space Symposium – Colorado Springs, Colorado (USA) – Conference Hotel The Broadmoor 1, Lake Ave. – Premier global, commercial, civil, military and emergent space conference – https://www.spacesymposium.org

17-19 April • **IATA** – Safety and Flight Operations Conference 2018 – Montréal (Canada) – Fairmont The Queen Elizabeth Hotel – Theme: Technical progress and safe operations embracing technology driven change – www.iata.org/events

18-21 April • **AERO Friedrichshafen** – Global Show for General Aviation – 25th anniversary - Friedrichshafen (Germany) Messe Friedrichshafen – www.aero-expo.com

25-29 April • **BDLI** – ILA Berlin 2018 – ExpoCentre Airport – Schönefeld – Berlin (Germany) – https://www.ila-berlin.de/

08-10 May • **AIAA** – AIAA DEFENSE Forum – Laurel, MD (USA) – www.aiaa.org/events

14-18 May • **3AF** – 6th Space Propulsion International Conference – Seville (Spain) – Barcelo Renacimiento Hotel – https://www.spacepropulsion2018.com

28-30 May • 25th Saint Petersburg International Conference on Integrated Navigation Systems – Saint Petersburg (Russia) www.elektropribor.spb.ru

28 May – 1 June • **CNES/AIAA** – SpaceOps 2018 – 15th International Conference on Space Operations – Inspiring Humankind's Future - Marseille (France) – Palais du Pharo – www.spaceops2018.org

28 May – 1 June • **ESA** – 15th European Conference on Spacecraft Structures, Materials and Environmental Testing – Noordwijk (NL) – ESA/ESTEC – https://www.esaconferencebureau.com

28 May – 1 June • **ESA** – Small Satellites Symposium – Sorrento (Italy) – Hilton Sorrento Palace https://www.esaconferencebureau.com

29-31 May • **EBAA/NBAA** – EBACE 2018 – European Business Aviation and Exhibition – Geneva (Switzerland) – Geneva's Palexpo – http://ebace.aero/2018/

07-09 June • **France Air Expo** – Paris Le Bourget – France Air Expo – General Aviation – https://milavia.net/

11-15 June • **ECCOMAS** – ECCM-ECFD Conferences – Glasgow (UK) – Scottish Exhibition & Conference Centre – 6th European Conference on Computational Methods and 7th European Conference on Computational Fluid Dynamics – 25th Anniversary of ECCOMAS – http://www.eccm-ecfd2018.org/

18-20 June • **ACI Europe** – ACI world Annual Congress & 28th ACI EUROPE General Assembly Congress & Exhibition – Brussels (Belgium) – Square, Brussels – The annual meeting for air transport chief executives and industry leaders – www.aci-europe-events.com

25-29 June • **AIAA** – AIAA Aviation and Aeronautics Forum and Exposition – Atlanta, GA (USA) – Hyatt Regency Atlanta - Aeroacoustics – Aerodynamics – Fight mechanics – Atmospheric and Space Environment s – Aviation Technology, Integration and Operations – Flight Testing – Flow Control – Fluid Dynamics – Thermophysics and Heat Transfer – Modeling and Simulations – Multidiciplinary Analysis and Optimization – Plasmadynamics and Lasers - https://www.aviation.aiaa.org

25-29 June • **AIAA/CEAS** – Aeroacoustics Conference – Atlanta, GA (USA) – Hyatt Regency Atlanta https://www.aviation.aiaa.org - www.aiaa.org/Aeroacoustics/

02-06 July • **EUROMECH** – 10th European Solid Mechanics Conference – Bologna (Italy) – www.euromech.org/

09-11 July • **AIAA** – AIAA Propulsion and Energy Forum and Exposition – Cincinnati, Ohio (USA) – Duke Energy convention Center - Propulsion – Energy Conversion Engineering - www.aiaa.org/events https://www.propulsionenergy.aiaa.org

14-22 July • **COSPAR** – COSPAR 2018 – Pasadena, California (USA) – 42nd COSPAR Scientific Assembly – 60th anniversary of COSPAR's creation – Theme: Expanding the knowledge frontier of space for the benefit of humankind – https://cosparhq.cnes.fr/ http://www.cospar-assembly.org/ http://cospar2018.org

16-22 July • Farnborough International Airshow 2018 – International Exhibition and Conference Centre – Farnborough, Hampshire (UK) – https://www.farnboroughairshow.com/

AMONG UPCOMING AEROSPACE EVENTS

24-26 July • **RAeS –** Biennial RAeS Applied Aerodynamics Research Conference – Bristol (UK) – www.aerosociety.com/events/

19-23 August • **AAS/AIAA** – Astrodynamics Specialist Conference – Snowbird, UT (USA) – http://www.space-flight.org

27-29 August • **AIAA** – AIAA Space and Astronautics Forum and Exposition – New Orleans, LA (USA) – www.aiaa.org/events

04-07 September • **EASN-CEAS** – 8th International Workshop – Glasgow (UK) – University of Glasgow – Theme: Manufacturing for Growth and Innovation – https://easnconference.eu

09-13 September • **EUROMECH** – 12th European Fluid Mechanics Conference – Vienna (Austria) – www.euromech.org/

09-14 September • **ICAS** – 31st ICAS Congress – Belo Horizonte (Brazil) – Av. Augusto de Lima, 785 – Centro – www.icas.org – icas@icas.org

17-19 September • **AIAA** – AIAA SPACE and Astronautics Forum and Exposition 2018 – Orlando, FL (USA) – Hyatt Regency Orlando - Complex Aerospace Systems – https://www.space.aiaa.org

18-21 September • **ERF** – ERF 2018 – Delft (NL) – 44th European Rotorcraft Forum

26-28 September • **ESA** – SECESA 2018 – Glasgow (UK) – Technology & Innovation Centre (TIC) - Systems Engineering and Concurrent Engineering for Space Applications Conference https://www.esaconferencebureau.com

01-05 October • **IAF** – IAC 2018 - 69th International Astronautical Congress – Bremen (Germany) – Exhibition & Conference Centre, Bremen – Theme: IAC2018 involving everyone https://iac2018.org www.iafastro/bremen-germany

03-05 October • **3AF** – IES 2018 – 14th European Forum – Economics Intelligence Symposium - Chartres (France) – www.aaaf.asso.fr www.ies2018.com

09-11 October • **RAeS** – 6th Aircraft Structural Design Conference – Bristol (UK) – Bristol Science Centre www.aerosociety.com/events/

16-18 October • **Aviation week** – MRO Europe 2018 – Amsterdam (NL) – RAI Convention Centre Amsterdam – Theme: Maintenance, Repair and Overhaul - www.mroeurope.aviationweek.com - www.rai.nl

23-25 October • **3AF** – AEGATS'18 – Advanced Aircraft Efficiency in a Global Air Transport System – Toulouse (France) www.aaaf.asso.fr

06-08 November • **SAE International** – SAE Aerospace Systems and Technology Conference – London (UK) www.sae.org/events/

06-08 November • **Dubai** – Helishow Dubai 2018 – Al Maktoum international Airport, Dubai South (United Arab Emirates) – https://www.milavia.net/

06-11 November • **China** – Air Show China 2018 – Zhuhai, Guangdong, China – https://www.milavia.net/

14-16 November • **Bahrain** – BIAS 2018 Bahrain International Air Show – Sakhir Air Base, Bahrain https://www.milavia.net/