The Quarterly Bulletin of the CEAS

COUNCIL OF EUROPEAN AEROSPACE SOCIETIES

3AF – AIAE – AIDAA – DGLR – FTF – HAES – NVvL – PSAA – RAAA – RAeS – SVFW – TsAGI

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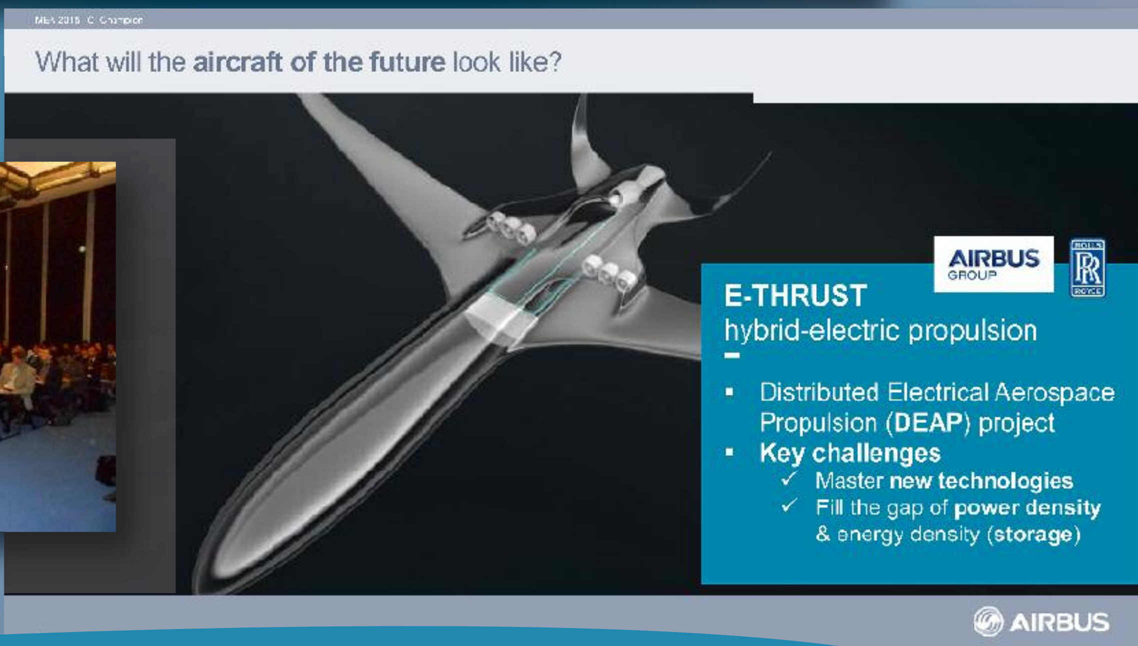

‘TOWARDS MORE ELECTRICAL AIRCRAFT’:

- THE THIRD EUROPEAN CONFERENCE ON THIS THEME HOLD IN TOULOUSE (FRANCE) ON 3-5 FEBRUARY 2015 BROUGHT TOGETHER 300 DELAGATES COMING FROM 17 COUNTRIES.

- IT ALLOWED TO HIGHLIGT RECENT TECHNOLOGY RESEARCH RESULTS, PROJECTS AND HOPES RELATED TO THIS AREA QUITE ESSENTIAL FOR DEVELOPING A GREENER AND GREENER AVIATION.

WHAT IS THE 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 twelve Full Member Societies: 3AF (France), AIAE (Spain), AIDAA (Italy), DGLR (Germany), FTF (Sweden), HAES (Greece), NVvL (Netherlands), PSAA (Poland), AAAR (Romania), RAeS (United Kingdom), SVFW (Switzerland), TsAGI (Russia); one Associate Member: CzAeS (Czech republic); and four Corporate Members: ESA, EUROAVIA, LAETA (Portugal) and VKI (Belgium).
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:
c/o DLR – Rue du Trône 98 – 1050 Brussels.
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
- Aerospace Events Calendar – www.aerospace-events.eu

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

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- Directory of European Professionals

HONOURS AND AWARDS:
- Annual CEAS Gold Medal to recognize outstanding achievement
- Medals in technical areas to recognize achievement

YOUNG PROFESSIONAL AEROSPACE FORUM

SPONSORING

THE CEAS MANAGEMENT BOARD

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- 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

TOWARDS MORE ELECTRICAL AIRCRAFT

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

On 3-5 February 2015, took place in Toulouse (France) the third European 'Towards More Electrical Aircraft' Conference organized by 3AF/Toulouse and SEE/ Bordeaux-Aquitaine. This subject being of highest importance in the present context of the energetic transition process and of the imperious necessity for aviation to be greener and greener, a large part of this bulletin is dedicated to this conference, summarizing the presentations and highlighting the main conclusions.

A number of quite significant technical progresses are being performed but it is evident that the main obstacle rests in the electrical power generation field, more particularly the electrical energy storage.

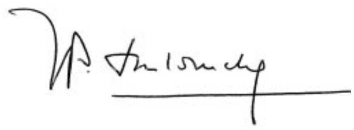
This is the reason why a long time will be necessary before the motto 'Towards More Electrical Aircraft' can become 'Towards All Electrical Aircraft'! However there is no doubt that soon or late the genius of the scientist and technology researchers will triumph in the end.

One of the last recommendations expressed at the Conference was that the subject 'Towards More Electrical Aircraft' will impose more and more international exchanges. Personally paying great attention to the life of the wonderful 'Solar Impulse' exploratory adventure, I would like to express the necessity I feel for a closer cooperation between industry and 'Solar Impulse' team.

Solar Impulse project was initiated in November 2003 by Bertrand Piccard after undertaking a feasibility study in partnership with the *Ecole Polytechnique de Lausanne* (EPFL). Following the successful flights performed from 2009 to 2013 with Solar Impulse 1 prototype, a slightly larger airplane was developed – Solar Impulse 2 – with which Bertrand Piccard and André Borschberg recently undertook a circumnavigation of the globe, departing from Abu Dhabi on 9 March and planning to return to the same location in August 2015. Just a few figures are sufficient to give an idea of the engineering performance high level: wing area: 17,248 photovoltaic cells cover the top of the wings, fuselage and tail plane for a total of 269.5 m^2 – propulsion: 4 electric motors powered from solar cells and 4x41 kWh lithium-ion batteries, providing 13 kW, electric motors each (17.4 HP). Twelve stops are planned to allow the alternation of pilots Piccard and Borschberg (Solar Impulse is one-seat). The aircraft is presently circling the world, cruising at between 50 and 140 km/h at maximum altitudes up to 8230 m, and covering a distance comprised between 440 km (the shortest stage – 13 hours flight time) and 8,500 km (the longest and last leg crossing the Pacific and Atlantic Oceans – 5 days flight).

So, demonstrating the potential of clean technologies and that with a few power it is possible to move over long distances 'Solar Impulse' is bringing quite an important contribution to the advancement of the aeronautics sciences and offering the scientists and engineers involved in 'Towards More Electrical Aircraft' an extremely rich source of innovative technologies.

May I suggest here that Solar Impulse is invited to actively participate in the next European MEA Conference?



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CEAS PRESIDENT'S MESSAGE

Fred Abbink, CEAS President

About Aviation Safety

The year 2015 confronted us with a tragic disaster with a very reliable and safe aircraft, namely the Germanwings Flight 9525 Airbus A320-200, which on March 24 crashed into the French Alps 100 km northwest of Nice. All 144 passengers and 6 crew members were killed.

The crash was intentionally caused by the co-pilot. During the flight, he locked the captain out of the cockpit before initiating a descent that caused the plane to crash into a mountain.

The crash showed that a measure intended to keep terrorists out of the cockpit, had now prevented the captain to enter the cockpit. No doubt that the accident investigation will lead to recommendations of new methods and procedures to prevent this in the future.

As a first reaction, three days after the incident, the European Aviation Safety Agency (EASA) issued a temporary recommendation for airlines to ensure that at least two crew members, including at least one pilot, should be in the cockpit at all times of the flight.

It is clear that although air transport is a very safe means of transport it will require continuous attention and vigilance to learn from accidents and incidents and holistically improve the overall system safety. There may be a role for the CEAS community to further increase its knowledge and expertise in this area to support the aerospace sector.

About Space Exploration

Space telescope

The year 2015 is a special year for space exploration. On April 24 it will be 25 years of successful operation of the Hubble Space Telescope. For the launch of the Hubble telescope the Space Shuttle was used. The Hubble Telescope with its length of 13.2 meter, its telescope diameter of 2.4 meter and its mass of 11,000 kg just fitted in the Space Shuttle cargo bay. During its now 25 years of operation the Hubble telescope was serviced by 5 Space Shuttle missions for repair and refurbishing.

With its four main instruments it can has observe the universe in the near ultraviolet, visible and near infrared spectra. The Hubble observations have led to breakthroughs in astrophysics, such as accurately determining the rate of expansion of the universe, the detection of black holes, black energy and black matter. The last refurbishment in 2009 will allow the Hubble telescope to remain operational till until 2020. The contributions of the Hubble Space Telescope, in combination with the contributions of ESA Herschel and Planck spacecraft, provided enormous steps forward in our knowledge of the universe.

The successor of the Hubble Telescope will be the James Webb Space Telescope (JWST), scheduled for launch in 2018.The Hubble Telescope was in a Low Earth Orbit. The JWST will be at the L2 Lagrange point, 1.5 million km away from Earth. Its telescope will have a diameter of 6.5 meter. A large sunshield will keep the telescope mirror and the four scientific instruments below 50 K, allowing it to observe the Universe in visible to mid-infrared light. It will be a great challenge to develop and operate the JWST. This time possibilities of repair and refurbishment are minimal to non-existent.

The New Horizons Spacecraft

While 2015 is the year of celebrating 25 years of the Hubble Telescope, it is also the year when the New Horizons spacecraft will closely fly by Pluto and its 4 moons, and then further into the Kuiper belt. The New Horizons spacecraft was launched on January 19, 2006. After one year it made its Jupiter fly-by and got a gravity assist speed increase of 4 km/s. The Jupiter fly-by was used to test all instruments and systems. Since then, most of the time the New Horizons spacecraft was in the hibernating mode.

And on December 2014 it was brought back on-line for the encounter with Pluto and the instrument check-out. On July 14, 9.5 year after its launch, New Horizons is planned to reach its closest distance to Pluto. After passing Pluto, New Horizons will continue farther into the Kuiper belt. To study one or two other Kuiper belt objects.

New Horizons will be a worthy successor of the Pioneer 10/11 and the Voyager 1 and 2 missions. It will provide a great insight in the shape, magnetic fields and composition of Pluto, its moons and some other Kuiper Belt objects, and with that complement the knowledge of our solar system.

About CEAS

With respect to the developments of CEAS a number of points can be mentioned:

- At the **Clean Sky Forum**, on March 17 in Brussels, I was asked as CEAS President to give a keynote presentation "European Aerospace Competitiveness; Successes and Challenges". It was an opportunity to present our role serving the European aerospace community.

- In December 2014 the kickoff of the EU Project "European Collaborative Dissemination of Aeronautical research and applications 2" (**E-CAero 2**) took place. The E-CAero2 project is the natural follow-up of the E-CAero project developed within FP7 from 2009 to 2013.

The objectives of E-CAero 2 are:

- Enhanced communication between the involved associations[(1)]: CEAS, EUCASS, ECCOMASS, CIMNE, EUROMECH, EUROTURBO and ERCOFACT in the field of aeronautics;
- Progress in the synchronisation of events of these organisations;
- Take initiatives towards a joint publication policy in Europe;
- Provide a more visible European label and common policy to aeronautical events and publications;
- Establish a unified logistics network and a specific secretariat for events of these organisations;
- Properly quantify the size of the scientific/industrial community and the desirable number of events;
- Offer a better harmonised information stream to scientists and technologists.

CEAS will plays its role in the E-CAero 2 project as the only European organisation representing the 12 Aerospace Member Societies with about 35,000 individuals as members with focus on the establishment of a European aerospace label with better visibility.

• The preparation of the **CEAS 2015 Conference** is in full swing. The Conference Programme Committee has made the set-up of the sessions. It will be a great honour for the NVvL to welcome the 17 Keynote speakers, 200 authors from 26 nations and hopefully over 200 additional participants in Delft in September 2015. At the CEAS Presidents Lunch on Monday September 7 all the CEAS Presidents are invited to meet and to discuss the CEAS Strategy for 2015-2020.

Fred Abbink

*(1) **EUCASS** (European Conference Aeronautics and Space Science); **ECCOMAS** (European Community on Computed Methods in Applied Sciences); **CIMNE** (International Centre for Numerical Methods in Engineering); **EUROMECH** (European Mechanical Society); **EUROTURBO** (European Turbo Machinery conference) and **ERCOFACT** (European Research Community on Flow Turbulence Air and Combustion).*

THE TWO LATEST MEETINGS OF THE BOARD OF TRUSTEES

THE TWO LATEST MEETINGS OF THE BOARD OF TRUSTEES

On 9 December 2014, the Board of Trustees met at DLR Office in Brussels (Belgium), Rue du Trône 98, and on 26 February 2015 in the University of Bologna (Italy).

In addition to the routine general management items, five major subjects were deeply dealt with:

- Preparation of **CEAS 2015 Conference** which will take place at the University of Delft (NL) on 7-11 September, which appears as a promising event: see pages 7 and 8
- Memorandum of Understanding between CEAS and the **EREA** (European Research Establishments in Aeronautics).
- Selection of new Corporate Members.
- Continuation of the reflections about the CEAS Strategy and Vision 2015-2025.
- **The E-CAero 2** programme conducted within the framework of the European Commission, with the objective to strongly enhance the cooperation and coordination between CEAS and the different European Associations dealing with aerospace science and technology (above listed). As stated by Fred Abbink in his message, the intention is in priority to coordinate and improve the **research results dissemination** and to optimise the **event programming**. A further ambition is to establish at mid-term time horizon a worldwide well known European Aerospace Community named '**Aerospace Europe**'.

On 26 February 2015 the CEAS Board of Trustees in the famous Palazzina della Viola, which is part of the University of Bologna, in front of the wonderful fresco which shows a piece of history around pope Sylvester and emperor Constantine, probably realised in the 16th century.

ABOUT CEAS 2015

CEAS 2015 will be a joint event combining the 5th CEAS (Council of European Aerospace Societies) Air & Space Conference and the 12th European Workshop on Aircraft Design Education (EWADE).

CEAS 2015 will be hosted by the Netherlands Association of Aeronautical Engineers (NVvL) in close cooperation with the Delft University of Technology (TUDelft) and the Society of Aerospace Students DUT (VSV Leonardo da Vinci) on behalf of the CEAS community.

Programme at a glance

Opening

- Welcome by Fred Abbink (CEAS President), DirkJan van de Berg (President Executive Board Delft University of Technology) and Hester Bijl, (Dean Aerospace Faculty TUDelft)
- Keynote speech

Plenary sessions

- Challenges for the European Aeronautical Industry
  – Jean Botti (CTO Airbus)
  – Hans Buethker (Chairman & CEO Fokker Technologies)
- Challenges for European Access to Space
  – Franco Ongaro (Director TEC & head ESA-ESTEC)
  – Arnaud de Jong (CEO Airbus Defence and Space Netherlands)
- Challenges to the European Airlines
  – Athar Husain Khan (CEO Association of European Airlines AEA)
  – Peter Hartman (Vice-chairman Board of AirFrance/KLM)
- Challenges in realizing a Single European Sky
  – Florian Guillermet (Director SESAR JU)

– Paul Riemens (CEO LVNL)
• Challenges to the European Aerospace Research and Research Infrastructure
– Eric Dautriat (Executive Director CleanSky)
– Rolf Henke (Member DLR Executive Board, chairman ACARE WG 5)
– Michel Peters (CEO NLR)
• Challenges to European Aerospace Education
– Hester Bijl (Dean TU-Delft Aerospace Faculty
• Challenges to the European Air Power in Asymmetric Conflicts
– CDRE Peter Round (Director Capability EDA)
– Lt-Gen Sander Schnitger (Commander Royal Netherlands Air Force).

Technical sessions
Technical papers will be presented by aerospace scientists and engineers from 26 different nations around the world to share and disseminate the latest scientific knowledge and research in areas like Air Transport , Airworthiness, Clean Space, Collaborative engineering in system design, Future education and training needs, Virtual hybrid testing in aeronautics , Aircraft noise, Aerodynamics, Future of the Air Combat Systems in Europe , Aero elasticity and Structural Dynamics, Space Sustainability , Aircraft handling / flight mechanics, Greenhouse gas emissions, Guidance & navigation, Modelling and simulation, Propulsion integration, Structures & Materials and Unmanned aerial vehicles.
Conference panel

Future of Air Combat systems in Europe
Many experts in Europe are concerned that, apart from the British-French Future Combat Air System Demonstration Program FCAS DP, presently no plans are being made to prepare the next generation of air combat systems beyond Eurofighter, Rafale and Grippen. The F35 program, although serving a number of Air Forces in Europe, is US-led and will not secure the future of the European Air Combat industry. A number of studies have been conducted in recent years on this critical issue, such as the "FAST4Europe" study by an industrial consortium led by SAAB and by the Air and Space Academy's as reflected in the white paper "Recommendations to avoid a strategic downgrading of Europe in the field of Combat Aviation" (published at the end of 2013).

The panel will contain presentations from high level actors in the field of Air Combat systems. The talks will address current reflections in Europe, the status of present and future Air Combat Systems across the world.

The session will be moderated by Gerard Brachet, former President of the Académie de l'Air et de l'Espace/Air and Space Academy (2009-2012), current Chairman of its Defense Commission.

Workshop
The 12th European Workshop on Aircraft Design Education EWADE will be held during the CEAS 2015 conference. The workshop aims at enhancing collaboration between European lecturers concerned with aircraft design and discuss Aircraft Design problems from a research and education perspective (http://ewade.aircraftdesign.org/).

On 10 September 2015, the EU-funded project AFLoNext 2nd generation active wing will organize a workshop as a partner in the CEAS 2015 conference. 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 preliminary workshop program can be downloaded here! Feel free to visit our website at www.aflonext.eu for more information about the project.

Project
ESWIRP achievements will be presented at the CEAS Air & Space Conference 2015.

The ESWIRP project (http://www.eswirp.eu/) has been funded by the European Framework Programme 7 to support the integration of and access to research infrastructure of pan-European interest. It has significantly enhanced the interoperability of 3 key world-class aeronautical wind tunnels, and harmonised, improved and optimised the scientific access conditions thereto: DNW-LLF, ETW and ONERA S1MA.

A central element of the project, besides networking and joint research activities, has been the transnational access (TNA), which has been provided to 4 consortia with a total of more than 100 scientists from 17 different nations.

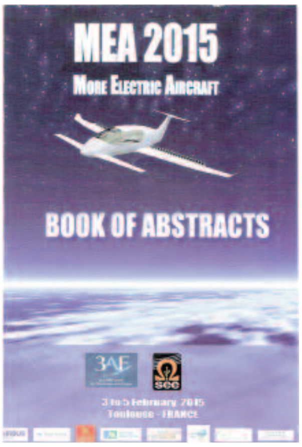
Registration now open on :

http://www.ceas2015.org/

THE EUROPEAN MEA (MORE ELECTRICAL AIRCARFT) 2015 CONFERENCE WAS HELD

IN TOULOUSE, FRANCE, ON 3-5 FEBRUARY

By Jean-Pierre Sanfourche, in cooperation with Catherine Goetz



Abstracts Booklet cover page

The third European Conference on More Electric Aircraft (MEA), co-organised by the Toulouse section of the French Association for Aeronautics and Astronautics (3AF) and the Bordeaux-Aquitaine section of the SEE (French Society of Electricity and Electronics engineers), took place in Toulouse (France) from 3 to 5 February 2015. It was supported by a number of local organisations, most notably the Pole of Aeronautics Competitiveness 'Aerospace Valley', the French Aerospace Lab ONERA, and the Technology Research Institute Saint-Exupéry. About 300 delegates were present including industrials, university teachers-researchers and aerospace students. It is to be noted that the objective of internationalisation was reached since seventeen countries were represented among which USA, China, Russia, Japan, and many EU Member States.

A view of the international MEA Conference held in Pierre Baudis Congress Centre of Toulouse (France), 3-5 February 2015

On this occasion research programmes relating to 'More Electrical Aircraft' were presented and various experts made known their latest advances and challenges in the field.
5 Oral Sessions covering 25 presentations alternated with 3 Poster Sessions summing up 78 tutorial panels.
The present article tries to highlight the main issues of this MEA Conference.

AT AIRCRAFT SYSTEM LEVEL

Presentations have once again shown that the competition between AIRBUS and BOEING is always so alive. Both are highly motivated to go towards more and more use of electricity, and therefore are in favour of major technology innovations insofar as they allow air companies to realise significant fuel savings and to more easily respect the new environmental rules.
For example the European JU CLEAN SKY 2 imposes at 2050 time horizon, relative to 2000: reduce fuel consumption and CO_2 emissions by 75% and reduce NOx emissions by 90%. Such severe constraints make of course understood the high interest for the 'More Electrical Aircraft' trend.
Among various themes, the interest brought to the 'E-Taxiing', that is to say the rolling on ground aircraft engines switched-off, is in this regard very symptomatic. In 2012 Lufthansa Technit had exhibited rolling on track before take-off experimentations based on the use of an electric motor integrated into the landing gear in the place of set of braking discs. More recently system developers have conducted similar experimentations, let's mention among others Safran associated with Honeywell which has exhibited in its turn a main landing gear inside it the electrical motor is integrated and solidly fixed, this time without removing the braking discs from one of the wheels (Figure 1). This experimentation has of course necessitated conduct a new qualification testing of the landing gear because of its mass increase and of the resulting new vibratory behaviour. It appears that such a system is rather adapted to single aisle short or mid-range airplanes which perform several rotations in one day, and seems to offer less interest for long-range airliners.

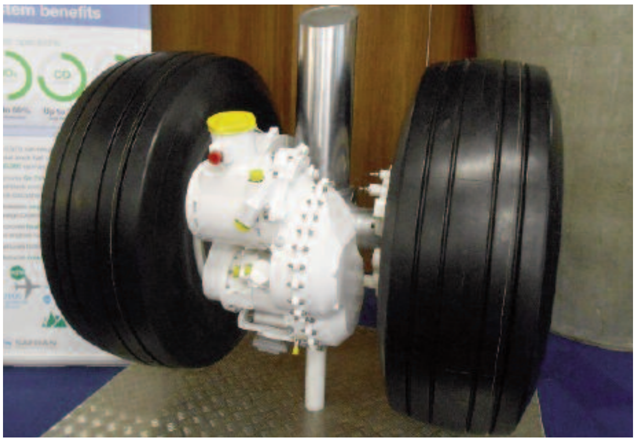


Fig 1. System proposed by Safran/Honeywell: main gear leg inside it an electrical motor is integrated

By what is the necessary electrical power provided in order to action the system? The answer to this question is the Auxiliary Power Unit (APU).

The conference has given the opportunity to SAFRAN MICROTURBO to make known its latest realisation in this domain by exhibiting its new APU which thanks to the 3D manufacturing process, shows a remarkable 40% mass saving relative to previous methods (Figure 2). So the electrical subsystems also contribute to the MEA evolution, and not only the top level systems! It is to be noted that the APUs, although 'subsystems', must satisfy to the same ETOPS (Extended range Twin Engine Operating System) qualification degree which applies to the engines of an airliner.

Fig. 2. The APU of Safran Microturbo

AT ELECTRICAL POWER GENERATION LEVEL

New airliner generations are more and more electrical energy consuming – flying control systems, de-icing, air conditioning based upon electrical compressors, braking devices, in-flight entertainments, etc. – so it is clear that the 'all electric' generalisation is imperatively obliging to increase the power of the generators without increasing their mass and if possible to reduce it.

To increase the ratio electrical power/mass, engineers have to work at several levels, down to equipment level and even component level: semi-conductors, capacities, windings of motor-generators, etc. This appeared on the occasion of the presentations dealing with electronic technologies using silicon carbides which allow operate at higher temperature: this is precisely in this very sharp technology field that partnerships between university and industry are being set up. Just to have in mind an order of magnitude of electrical generators development speed, let us mention the following figures: between 1 and 2 kW/kg in 2002-2006 period, 10 kW/kg in 2009-2012 period, and values of about 15 kW/kg are sighted at 2020 time horizon.

AT SUBSYSTEM AND COMPONENT LEVEL

Presentations also highlighted the fact that if the behaviour in temperature of active components is of prime necessity, it is also essential to confer to the electrical networks structure a high level of reliability as well as to offer possibilities for reconfiguration in accordance with in-flight loads, or in case of failure of one or more constitutive elements of the chain. This reconfiguration possibility requirement also applies to the power converters' interconnections.

The structure of the magnetic circuits of the electrical machines (gene-starters) is also a fundamental research works performed by simulation with a view to reducing harmonics and twisting oscillations produced by loads' impacts. The stators' windings must allow a better filling-in of notches by minimising the local constraints of electrical fields themselves, and therefore allow an improved semi conductors' behaviour. This necessitates here also simulations to be conducted.

In a little bit more futurist area, there is a trend in the direction towards even higher direct voltages – typically 800-900 Volts – because this would allow reduce further the mass of power supply's cables. But this high voltage would of course increase the risk of arc tracking with a specific danger if it occurs close to a composite structure, an arc which maintains itself and progresses with a flame whose temperature is sufficient to nourish itself with the insulation material and at last lead to a fire. This point will have to be deeply studied.

ENERGY STORAGE AND RESTITUTION

In the basic domain of electrical energy storage and restitution, the technology of super-capacitors coupled with an auxiliary electrical motor is in course of experimentation on helicopter, with different structures of coupling with a battery in order to minimise transitory phenomena as well as parasite emissions.

Studies on new battery technologies allow hope massic ratios in the order of 500 Wh/kg, observing that this is still very far from the content of 1 kg kerosene!

As regards fuel cells capable of replacing batteries later on, the subject has been dealt with during a session common to MEA and the FCFC (Fundamentals and Developments of Fuel Cells) Conference which took place at the same time in the same congress centre. It has been reported on A320 in-flight tests of fuel cells (nearly 700 flights), the objective being to study their behaviour in aeronautical environment: estimation of temperature and atmospheric pressure in altitude for different values of delivered power in flight, either alone, or as auxiliary of a battery, in cabin or in unpressurized zone, with specific limitation constraints as regards power increase rate.

ABOUT THE E-FAN SMALL AIRPLANE

In the propulsion area the small airplane E-FAN (see cover page) is entirely electric, its autonomy being sufficient to perform ab initio in-formation flights at low costs and with a real rapidity of on-ground resupply or exchange.

However it is evident that the 100% electric propulsion for a single-aisle mid-range airliner is not expectable at mid-term horizon, knowing that the power necessary for an A320 is in the order of 10 MW. The largest research laboratories are presently conducting works which converge towards a structure equipped with several electric motors integrated to the wings and supplied by batteries or other fuel cells, the energy being brought through supra conductors cables. The positioning of these motors using also cryogenic technologies allows envisage aerodynamic behaviour's improvement by reducing the aerodynamic drag, leading so to original features, maybe in 2050 timeframe...

ELECTROMAGNETIC RADIATIONS TO BE CONTROLLED

The current inexorable trend towards electrical power increase puts in game performing components chopping at high frequency and with sharp rising fronts, generate radiations led or radiated which must be controlled. Specific software simulation programmes implemented in research laboratories including thermal simulation can lead to optimized solutions.

All those researches and technology developments will enter into operation on aircraft when and only when the TRL – Technology Readiness Level – is considered as high enough. At that time, at more or less long term, the evolution will lead the aircraft manufacturer to reconsider its 'Supply Chain' vis-à-vis its different providers: perhaps will it be obliged to entrust them with more design and integration works for a given aircraft?

MEA WILL NECESSITATE MORE AND MORE INTERNATIONAL EXCHANGES

Today in civil aviation, many hydraulic or pneumatic systems have switched to electric (example Boeing 787): the benefits being weight and cost savings, notably in maintenance. This trend is expected to accelerate further in the coming decades, allowing commercial aircraft to become greener and greener. It will become more and more electrically powered, even though they will never be entirely.

The More Electrical Aircraft evolution will generate more and more international knowledge exchanges and in Europe, will be a strong inciter to better and better integrated programmes. Five words have been regularly heard all over the conference: Innovation, Effectiveness, Simplicity, Economy and Ecology. In effect they perfectly characterize the philosophy to be followed by all the managers, researchers and engineers who are and will be involved in this marvellous adventure of More Electric Aircraft which is going to revolutionise the aviation world.

Annex 1. – The oral Sessions:

Oral session 1 - Architecture Trends for More Electric Aircraft: (1) More Electric Aircraft: a Status on Clean Sky breakthroughs, byJacques Faucher , Etienne Foch, Airbus – (2) The Bombardier More Electric Aircraft, by Antonio Ricciardi, Bombardier Aerospace – (3) Towards a More Electric Falco Business Jet, by Bernard Baldini, Dassault Aviation – (4) More Electric Aircraft, an operator/MRO perspective, by Sven Bruel, Lufthansa Technik – (5) Certification of Electrical System, by Jérome Brue, EASA.

Oral session 2 - The More/All Electrical Engine : (1) Integration of Electrical machines into the Engine Roadmap of Technology Options & Opportunities, by Philip McGoldrick, Safran LPS – (2) Aircraft Starter-Generator system based on Permanent-Magnet Machine fed by Active Front-End Rectifier, by Serhiy bozhko et al., University of Nottingham – (3) State of the art of Helicopter Hybrid Propulsion, by Christian Mercier et al., Airbus Helicopters – (4) Full electrical E-Fan aircraft for general aviation: project overview and main perspectives, innovations and challenges, by Emanuel Jouber et al., Airbus Group – (5) Distributed Electrical Aerospace Propulsion, by Mark Husband et al., Rolls-Royce.

Oral Session 3 - Inserting new technologies into programmes: (1) Transferring the Experience and Technology of Electric Mobility into Aircraft, by Peter Glöcker et al., FAG Aerospace – (2) Electrical Power Generation & Start Solutions for the Falcon 5X Programme, by François Biais et al., Thales AES – (3) APU on More Electrical Aircraft: a vision for the future, by François Rideau et al., Microturbo – (4) Integrated Design by Optimization of Power Systems for MEA, by Bo Wen et al., Virginia Tech – (5) Strategy for COMAC More Electric Aircraft Development, by Yuan Li Kang, COMAC.

Oral Session 4 – Fuel Cells for more Electric Aircraft (joint session with FCFC2015): (1) Overview of MEA architecture and key technologies, by Etienne Foch, Airbus – (2) General State of the art of the fuel cells' aeronautical applications – (3) Optomised hydrogen fuel cell systems for MOA and all electric propulsion drivetrains – (4) Fuel Cell System integration for aeronautic applications, by T. Horde et al., Snecma DMS – (5) Key Drivers for Aeronautic Batteries; today and future aircrafts electrically powered, by Florence Fusalba et al.,CEA

Oral Session 5 – Products and Technologies Advances: (1) Advances Magnetic Technologies for MEA, by V.A. Kargopoltsev et al., JSC United Aircraft Corporation – (2) Methodologies for the optimal design of the Integrated Modular Power electronics Cabinet, by X. Giraud et al., airbus/University of Toulouse – (3) Latest advances in Electric Primary Flight Control Actuation, by Yvan Carlier et al., UTC Aerospace Systems – (4) Power Electronics and Control key competencies for aircraft electrical systems competitiveness, by Sébastien Vieillard, Safran LPS – (5) Advanced power electronics for Aerospace Applications, by jan Uhlig et al;, Liebherr aerospace.

Annex 2. – The Poster Sessions:

Poster Session 1 - Architecture and Technologies: Trends for Architectures & Technologies – Integration of MEA equipment, EMC and thermal issues.

Poster Session 2 – Energy Management: Power management – Power generation – Energy storage – Propulsion – MEA cetification;

Poster session 3 – Actuators & Components: Technologies & components – Actuators – MRO, Health Monitoring – Cooling Concepts – High Temperatures Technology.

KEYNOTE ADDRESSEES

Keynotes were addressed on the occasion of the Conference. Due to the importance of the messages expressed, we have taken the initiative to publish here after a summary of each:

- **Eric Dautriat**, Executive Director of Clean Sky Joint Undertaking
- **Charles Champion**, Executive Vice President Engineering Airbus
- **Alain Sauret**, Chief Executive Officer, Safran/Labinal Power Systems (LPS)
- **Colin Smith**, Director of engineering and technology, Rolls-Royce plc.

(see pages 12-17)

A MORE ELECTRIC INNOVATION CHAIN IN EUROPE WITH CLEAN SKY

Eric Dautriat, Executive Director of Clean Sky Joint Undertaking, gave the rationale of the way in which this organisation is coordinating and harmonising the technology research & development works in Europe aiming at progressing towards more and more use of electricity in the future aircraft.

The here below article is a summarized synthesis of his presentation.

First, Eric Dautriat presented CLEAN SKY, the Europe's largest Aeronautics Research Programme ever conducted:

- Clean Sky 1 started in 2008 within the Framework Programme FP 7 of the European Commission and will continue up to 2017;
- Clean Sky 2 was decided and started in 2014 within the frame of 'Horizon 2020', it will cover the period 2014-2020 regarding the contracts and 2024 for the end of the activities.

Regarding More Electrical Aircraft, Clean Sky 1 within the Integrated Technologies & Demonstrators (ITD) systems, mainly focuses on activities linked to the bleedless concept, such as de-icing and anti-icing, or the electronic environmental control system 'E-ECS', with the corresponding 'Power Generation and Distribution System'.

It is to be noted that in parallel, an important study about 'Green Taxiing' is being performed which concerns a possible next generation of the Green Taxiing presently in course of development by Safran and Honeywell: in Clean Sky, an axial electrical motor technology is currently developed by the University of Nottingham in cooperation with Safran.

Clean Sky 2 will go much further, including for example 'electrical wing' and 'smart networks' (Figure 1).

Today in civil aviation, as seen on the Boeing 787, many hydraulic or pneumatic systems have switched to electrical, the main expected benefits being weight saving and cost savings, notably in maintenance. Although these benefits are not huge through the current first steps, there is little doubt that more electrical integration is key, and that this trend is expected to accelerate further in the coming decades, allowing commercial aircraft to become more and more electrically powered.

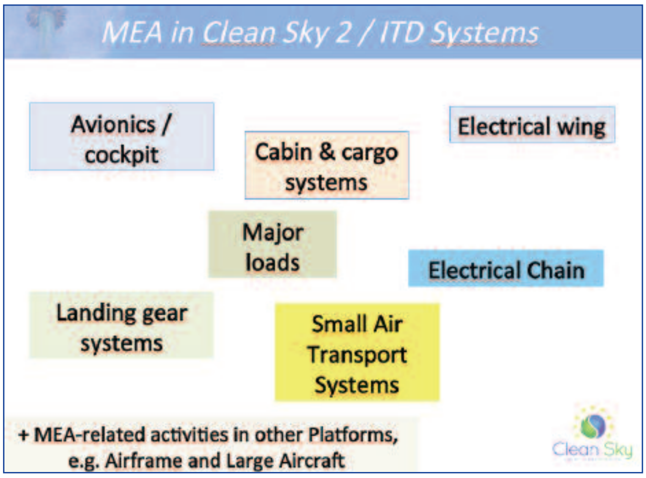


Fig 1. MEA in Clean Sky 2/ITD Systems

Eric Dautriat also mentioned that the use of fuel cells for onboard energy is part of more electrical aircraft perspectives. He said in addition that there is another European Joint Technical Initiative, named Fuel Cells and Hydrogen (FCH). Clean Sky and FCH are together preparing a common workshop on this theme in the second half of 2015. This addresses several levels of on-board powering by Fuel Cells, from emergency power to the replacement of the APU for smaller aircraft at least.

Clearly, a pure electric propulsion is not part of Clean Sky and should not be considered as a realistic trend for commercial transport, but hybrid propulsion technologies will be tested in Clean Sky 2.

The MEA approach is definitively global, i.e. systemic: electrification will contribute to enabling an overall aircraft system optimisation.

A System, holistic approach imperatively requires a collaborative work as early as the fundamental researches phase is undertaken. This exactly corresponds to Clean Sky purpose and management philosophy. Such a challenge as More Electrical Aircraft necessitates long-term engagement – 10 years typically in Clean Sky – and stability for an 'Innovation Chain' putting together the best talents recruited over Europe, providing so a broad and solid base.

Besides it is to be noticed that MEA is an area where the trans-sector approach is highly wished because in matter of electrical systems, non-aeronautical partners can surely bring important and even decisive contributions. This is the reason why the Clean Sky 2 Calls for Proposals are intended to be widely distributed and relayed.

A more electric Clean Sky innovation chain is being set up with the objective to bring:

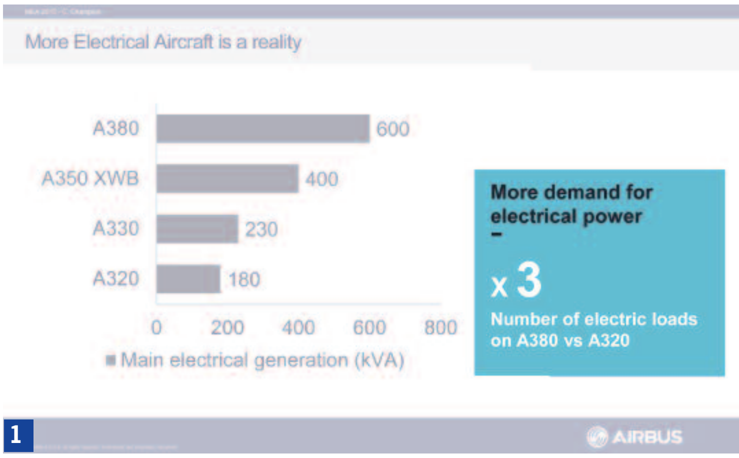
- An optimized, balanced funding for airframers and equipment manufacturers;
- A close collaboration between systems suppliers and airframers;
- The involvement of bottom-up innovation processes from SMEs and Universities to integrators;
- A novel, integrated system design environment with appropriate tools.

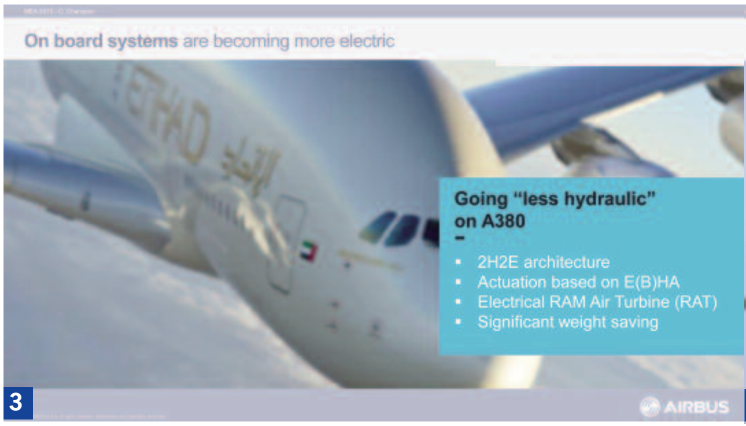
Eric Dautriat concluded his presentation as follows:

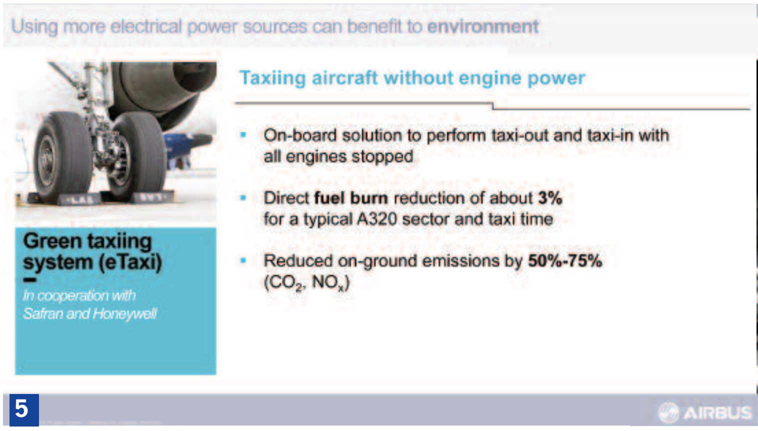
"By hosting a unique blend of high-tech companies throughout Europe and a set of advanced test-benches, Clean Sky wishes like to be the ideal house for highly contributing to the development of 'More Electric' widespread innovation."

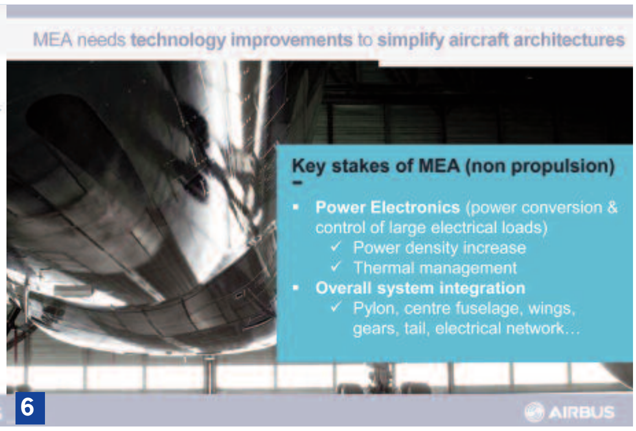
TOWARDS MORE ELECTRICAL AIRCRAFT

Charles Champion, Executive Vice President Engineering Airbus









POWER AND DATA SYSTEMS HUNTING FOR SIMPLIFICATION

Excerpts of the presentation given by Alain Sauret, Persident and CEO of Labinal Power System

Safran is nearly positioned across the whole chain with Labinal Power System acting as the strong arm of electrical power systems.

The proportion of electricity in aircraft is regularly increasing as shown hereafter:

The following chart illustrates how aircraft include more functions and become more electric, impacting cost, weight and complexity in design.

The trend towards more complexity and power optimisation includes two major aspects:

1. There are new functions and power optimised aircraft. As a matter of fact, more electrical power is to be distributed, the volume of data to be transmitted is increasing more and more, electrical architecture is evolving from centralized to distributed power distribution systems and the growing electrification and complexity of systems lead to more integrated power and data.

Towards MEA

	A320ceo, F7X	A380 & A350	Boeing 787	A30X
Wing & nacelle deicing; ECS, Start	Pneumatic	Pneumatic	Electricity	Electricity?
Avionics, Lighting, etc.; Commercial loads	Electricity	Electricity	Electricity	Electricity?
Control braking; Control (FCS, steering); Configure (landing gear, TRAS)	Hydraulic	Partial electrification	Hydraulic	Partial electrification?

2/ MEA2015 Conference – Alain SAURET — SAFRAN Labinal Power Systems

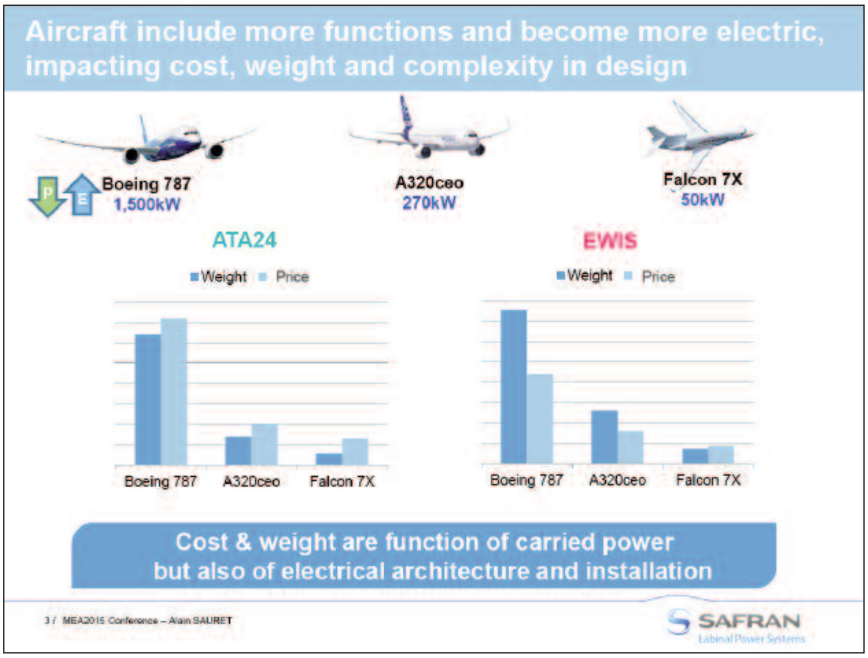
2. Costs need to be reduced, how? By reducing RC through more integration (number of parts reduction), by reducing NRC through more concurrent engineering across the entire chain with the objective of simplifying, by reducing OC through more flexibility of functions and robust products at EIS.

Simplifying the current power and data systems could be the enabler for a MEA with more functionalities.

The challenge of simplifications is high, which will need, on the one hand, a large cooperation effort between air framers, equipment suppliers and certification authorities jointly challenging architectures and products respecting the role of each player in the team, and on the other hand, academia and industry jointly developing new technologies through a lean mid and long-term roadmap.

Building new standards will require a successful technology insert, based on robustness and maturity demonstration methodology, as well as a fit for purpose approach for both incremental and breakthrough evolutions. It will also need to invest in tools and processes for better modelling and simulation, as a 'learning machine' and for more efficient development, certification, production and operation. Last but not least, new cooperation models will be needed, reducing NRC for both air framers and equipment suppliers, and also anticipating and sharing risks and revenues over the Life Cycle.

Concerning 'Green Taxiing', Safran, Honeywell and Airbus are working on this electrical system perfectly fitted to the main undercarriage which allows an aircraft to move on the ground without using its engines and thus fuel. Such an option should reach the single-aisle aircraft market soon.



On this subject Alain Sauret said: "*There is a great demand from Airlines for this system, and as a result we are finalizing the technical definition for introduction onto the market in three or four years' time.*"

HOW THE MORE ELECTRICAL AIRCRAFT IS INFLUENCING A MORE ELECTRIC ENGINE AND MORE!

Excerpts of the presentation given by Colin Smith CBE FRS, Director Engineering and Technology, Rolls-Royce plc

After having briefly recalled the history of Rolls-Royce and listed its products today, Colin Smith introduced the subject of the MEA Conference, saying that over the last 100 years transportation had become increasingly electrified and increased particularly sharply over the last decade with the Boeing 787 'More Electric Aircraft'. But he added: **"It would take a hundred years, in my view, before you replace kerosene as the prime fuel with pure batteries. A simple comparison in energy is that 1 kg of kerosene has about the same energy capability as 50 kg of lithium-ion."**

HOW IS ROLLS-ROYCE MOVING TO A 'MORE ELECTRIC ENGINE'?

THE PRESENT

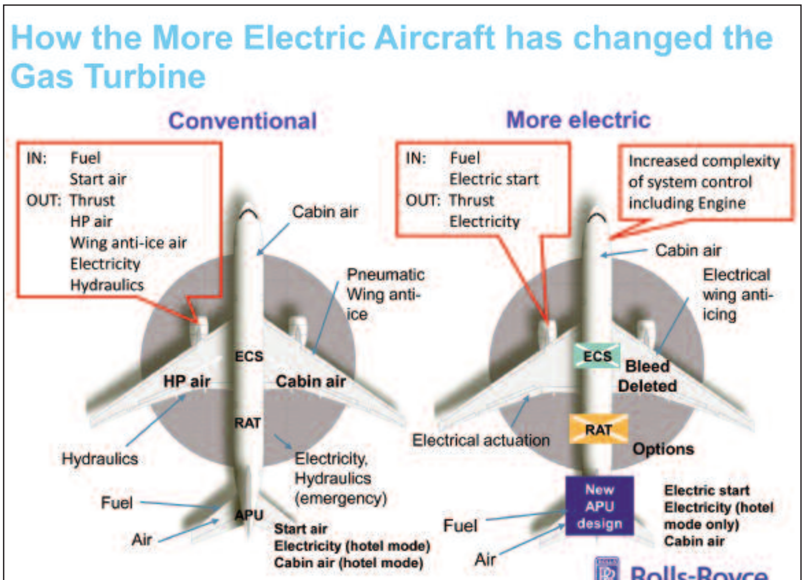
The key driver is the Overall ACARE (Advisory Council for Aerospace Research in Europe) Environmental Targets for 2020, relative to 2000: Reduce perceived external noise by 50% - Reduce fuel consumption and CO_2 emissions by 50% - Reduce NOx emissions by 80%, which represent a doubling of the historical rate of improvement.

How the more electrical aircraft has changed gaz turbine: see figures 1 and 2.

The aircraft electrical power requirements have regularly progressed over the past years and are more and more rapidly increasing.

Examples of previous Rolls-Royce experience were presented, among which the Trent 1000: see figures 3 and 4.

To move to a More Electric Engine, the key technology components are: novel starter generator, electrical accessories, electrical actuators, advanced bearings, potential to remove the accessory gearbox, can be bled or without bleed system engine. This implies a number of challenges as regards technology: x1 magnitude order for thermal integration, x2 order of magnitude for power electronics, ▶



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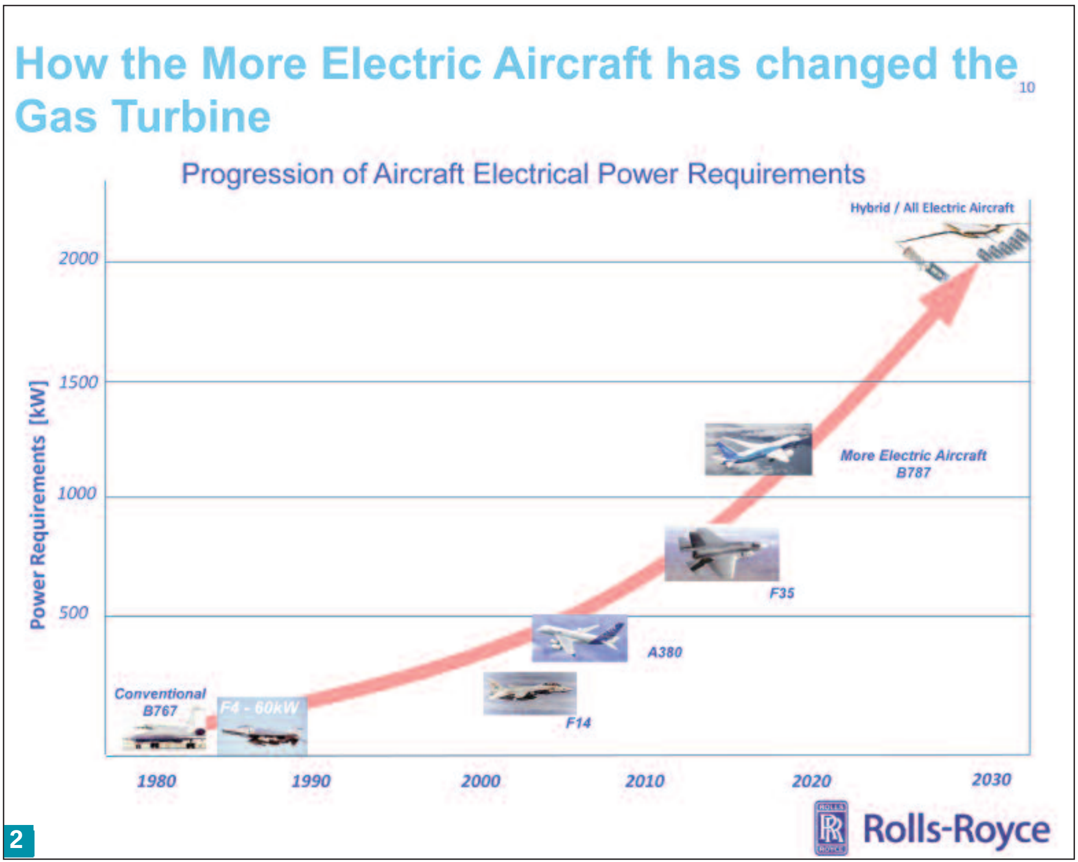

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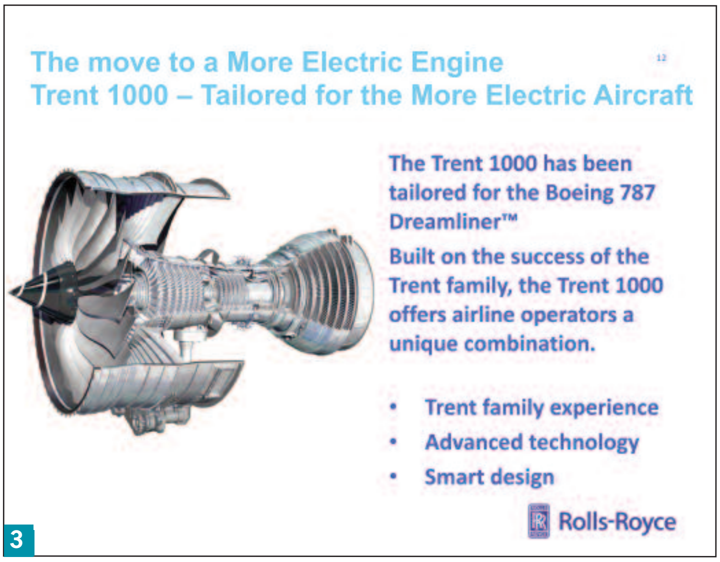

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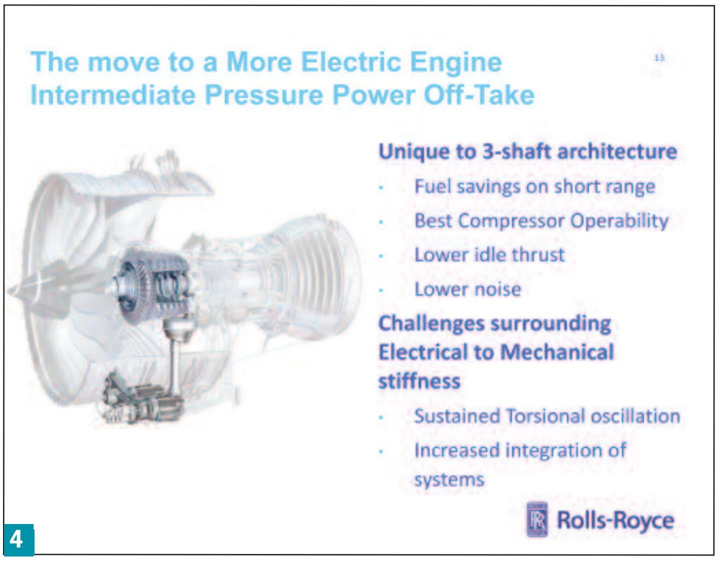

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x3 order of magnitude for technology, all this bearing in mind that the customer will have tolerance zero to programme delay.

THE FUTURE

The key driver the New ACARE Environmental Targets for 2050, relative to 2000: Reduce perceived external noise by 65% - Reduce fuel consumption and CO_2 emissions by 75% - Reduce NOx emissions by 90%. Three potential targets to be sighted are:

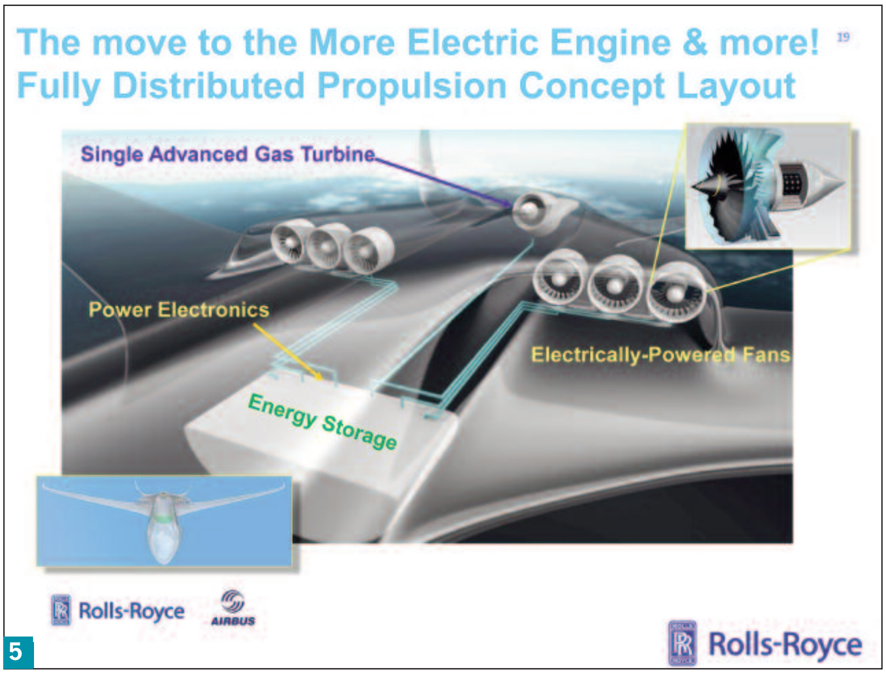
Aircraft movements are emission -free when taxiing;

Air vehicles are designed and manufactured to be recyclable;

Europe is established as a centre of excellence on sustainable alternative fuels.

Within the framework of preparation for the future, Rolls-Royce together with Airbus Innovation and University of Cranfield is working on the DEAP (Distributed Electrical Aerospace Propulsion) project started in early 2013 and running until 2015, which focuses on key innovative technologies aimed at improving fuel economy, reducing exhaust gas and noise emissions, optimising Distributed Propulsion (DP) system architecture and developing Boundary Layer Ingestion (BLI): see figures 5 and 6.

To go more and more further, important progresses are to be performed in superconducting electric machines, power electronics as well as in cryogenic cooling (Figure 7).


The move to the More Electric Engine & more!
Fully Distributed Propulsion Concept Layout
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Single Advanced Gas Turbine
Power Electronics
Electrically-Powered Fans
Energy Storage
Rolls-Royce
AIRBUS
Rolls-Royce

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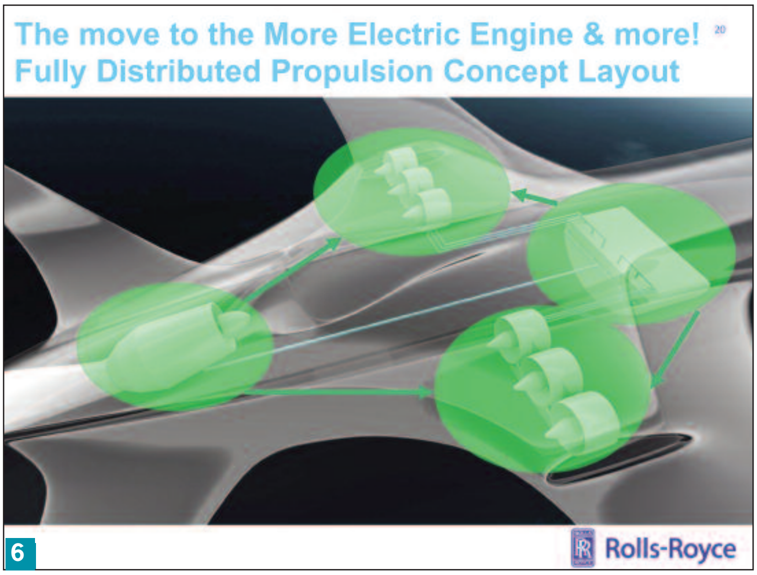
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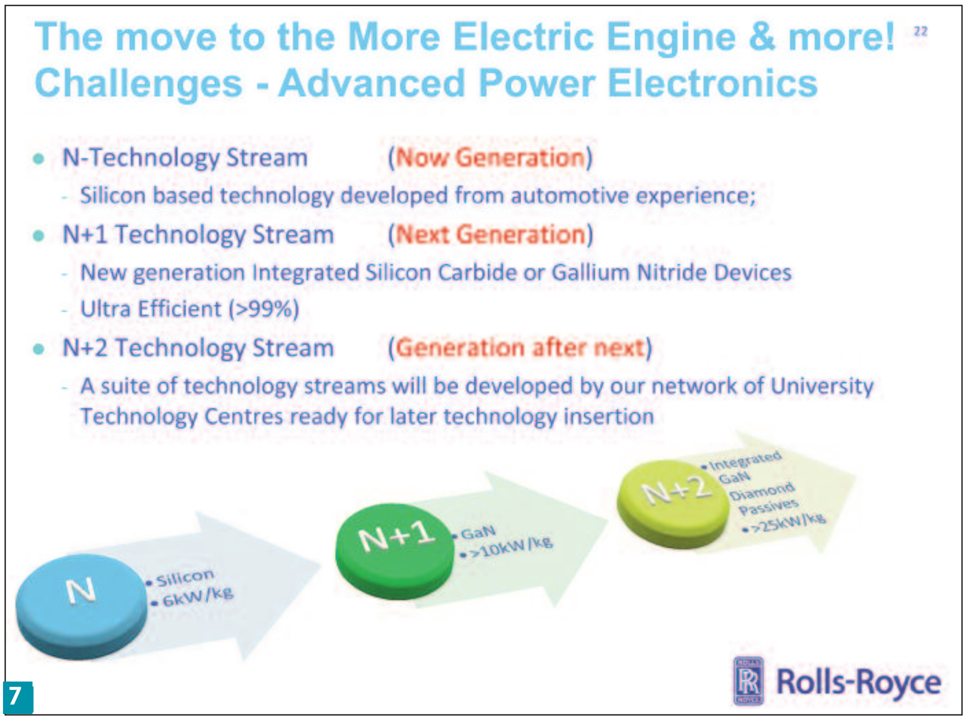
The move to the More Electric Engine & more!
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Challenges - Advanced Power Electronics
• N-Technology Stream (Now Generation)
- Silicon based technology developed from automotive experience;
• N+1 Technology Stream (Next Generation)
- New generation Integrated Silicon Carbide or Gallium Nitride Devices
- Ultra Efficient (>99%)
• N+2 Technology Stream (Generation after next)
- A suite of technology streams will be developed by our network of University Technology Centres ready for later technology insertion
N
• Silicon
• 6kW/kg
N+1
• GaN
• >10kW/kg
N+2
• Integrated GaN
Diamond
Passives
• >25kW/kg
Rolls-Royce

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MALAYSIA AIRLINES MH370 DISAPPEARED A YEAR AGO: WHAT IS THE STATUS OF THE INVESTIGATIONS?

RECALL OF THE TRAGEDY

The Beijing-bound international scheduled flight Malaysia Airlines MH370, with a total of 299 persons (227 passengers and 12 crew members) on board, departed KL International Airport (KLIA) at 16:42 UTC on 7 March 2014. Less than 40 minutes after take-off Air Traffic Controllers lost radar contact with the aircraft – a Boeing 777-200ER registered 9M-MRO - after passing waypoint IGARI. After analysis of satellite data it was discovered that MH370 flight continued to fly over 6 hours after contact was lost. All the available data indicate the aircraft entered the sea close to a long but narrow arc of the Indian Ocean (Figure 1).

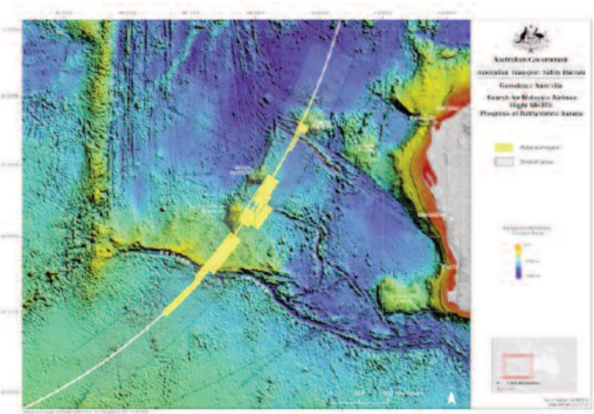


Figure 1

7 MARCH 2015: ICAO RELEASES INTERIM REPORT ON MH370

This interim statement is issued on progress of investigation up to 7 March 2015 and is based on the factual information gathered at this date by the investigation team (record of Air Traffic Control, aircraft maintenance records, simulations to re-construct the aircraft flight profile and system operation, interviews, visits, etc.):
see www.mot.gov.my
This factual information that has been gathered at the date of 7 March 2015 is of an interim nature and new information that may be become available can alter it before the publication of the Final Report.
The Investigation Team is now conducting analysis of the factual information and is considering : airworthiness & maintenance and aircraft systems, Air Traffic Control (ATC) operations from 17:19 UTC to 22:32 UTC on 7 March 2015, cargo consignment, crew profile, diversion from Filed Flight Plan route, organisational and management of Department of Civil Aviation and Malaysia Airlines, satellite communications SATCOM.
Along with these activities, the Investigation Team has prepared Standard Operating Procedures (SOP) and Checklists for investigation in preparation of the recovery of the aircraft once it is located but the search team.
In the months ahead analyses are being conducted to draw conclusions and safety recommendations based on the factual information that have been gathered.
Now it is to be hoped that further and decisive factual information can emerge from the wreckage and flight recorders when the aircraft is located.

MH370 RECOVERY MISSION STATUS

On request of the Malaysian Government, Australia has accepted responsibility for the search for MH370: the Australian Transport Safety Bureau (ATSB) is leading the operations in the southern Indian Ocean.

THE JOINT AGENCY COORDINATION CENTRE MH370 OPERATIONAL UPDATE 1 APRIL 2015

PHOENIX

Phoenix International Holdings, inc. (Figure 2) is under contract to DRB-HICOM Defence Technologies Sdn Bhd on behalf of the Government of Malaysia to search for Malaysia Airlines Flight 370 in the Southern Indian Ocean about 1,500 miles west of Perth, Australia. The vessel used is 'GO Phoenix', an offshore operations vessel. Seafloor search operations were performed from 5 to 16 October 2014, using the 'ProSAS-60 synthetic aperture sonar (SAS) system', a 6,000 m depth rated system. Searches executed in this 11-day period covered 1,405 km^2 of seafloor at water depths averaging 4,100 m.

Figure 2 : Phoenix continues search for MH370

FUGRO

On 10 June 2014 the Australian Transport safety Bureau signed a contract with deep water survey company, Fugro Survey Pty Ltd (Fugro) to conduct a bathymetric survey of the seafloor in the search area for MH370. Fugro's expertise, experience and equipment are playing a key role in the search for MH370. Three Fugro specialist survey vessels,

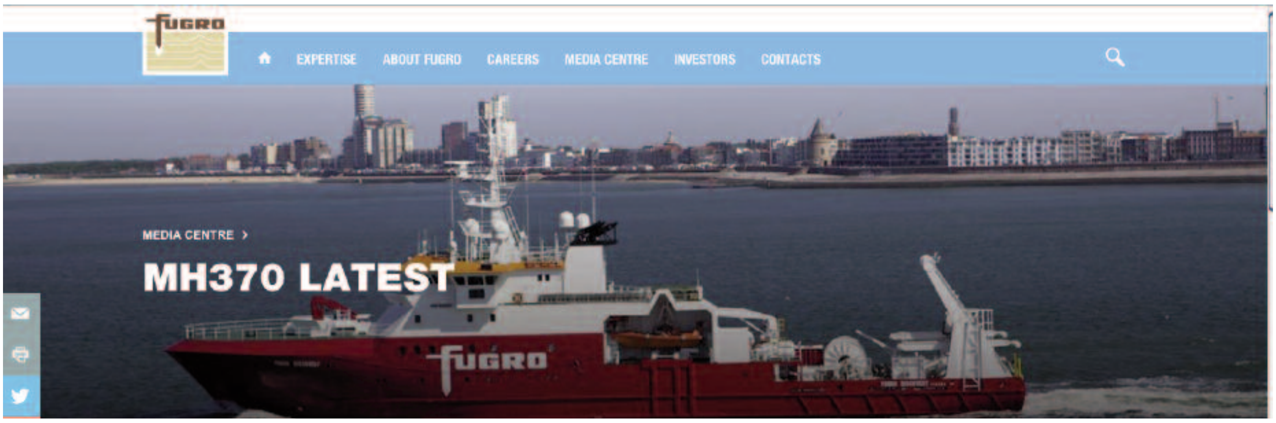


Figure 3

equipped with deepwater search technology, are surveying the search area. The size of the area being investigated, the depth of the water (up to 5,000 m) and extreme weather conditions experienced by vessels and crews make this search a challenging operation (Figure 3).

Fugro Discovery

In October 2014 this vessel commenced deepwater search operations, equipped with side scan sonar, underwater video and aviation fuel detection sensors. Recently in the end of March 2015 it departed the search area to travel to Fremantle for a scheduled resupply visit.

Fugro Equator

In June 2014 this vessel began mapping over 200,000 square km of uncharted seabed using state-of-the-art multi-beam echo-sounder equipment. The resulting bathymetric maps of the southern Indian Ocean's seafloor enabled a defined search to begin. On completion of the bathymetric survey work in December 2014, it was mobilised to conduct underwater search operations and in late January 2015 commenced search activities in the defined area. It departed the search area on 29 March to travel to Fremantle for a scheduled resupply visit.

Fugro Supporter

This vessel is equipped with an autonomous underwater vehicle (AUV) which is used to scan those portions of the search area that cannot be searched effectively by the equipment on the other search vessels. It will depart the search area in early April to travel to Fremantle for a scheduled resupply visit.

UNDERWATER SEARCH STATUS

At the end of March 2015, it could be considered that around 50% of the priority search area had been covered (Figure 4).

AN IMMEDIATE RECOMMENDATION: AIRCRAFT TRACKING EVERY 15 MINUTES

On 4 February 2015 Member States of the ICAO have recommended the adoption of a 15-minute aircraft tracking standard. ICAO Council President Dr Olumuyiwa said:

"This new Standard will be an important first step in providing a foundation for global flight tracking and the future implementation of the more comprehensive ICAO Global Aeronautical Distress and Safety System (GADSS)."

The GADSS concept itself defines a clearer objective for flight tracking, to ensure adequate provision of timely information to support search and rescue operations, recovery operations, and accident investigation, as well as sets out the roles and responsibilities of all stakeholders. The technical side of the means for such tracking is set out in the Aircraft Tracking Task Force's report, which was the task of the IATA (International Air Transport Association) to work on.

AIRLINE TRACKING AND TAMPERPROOF DISTRESS REPORTING ON ICAO AGENDA

An ICAO working group is recommending that new aircraft delivered after 2020 come:

- equipped with a tracking data broadcast system which sends regular position updates to airline operators;
- a flight data recorder which automatically deploys (and floats if on sea) after a crash;
- a tamperproof distress reporting unit which will transmit aircraft position and identification to a global network of rescue coordination centres when unusual attitudes, speeds or accelerations or other triggered events occur.

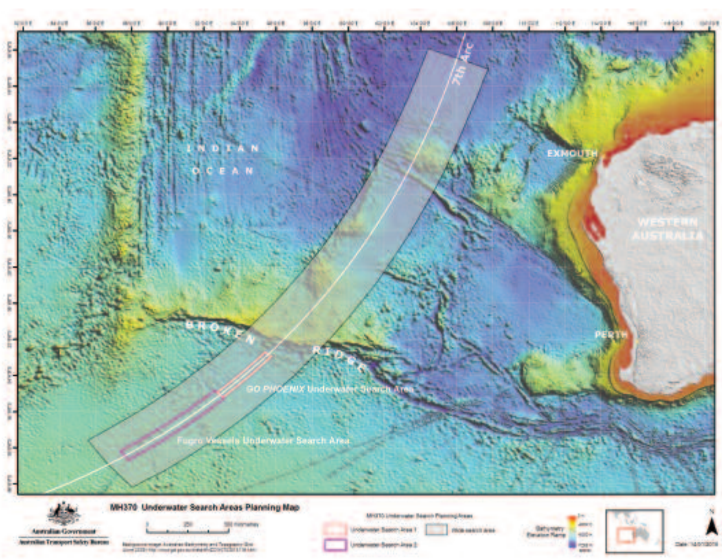


Figure 4

The airborne equipment, coupled with new global information sharing networks for air traffic service providers (ATSPs) and rescue coordination centres is called GADSS: Global Distress and Safety Systems.

Synthesis written by J.-P. S.

THE AIREON PROPOSAL

By Jessie Hillenbrand, AIREON

With a global constellation of space-based ADS-B receivers set to go live in 2017, Aireon will have a global air traffic surveillance capability. Having that data and information will enable the provision of a free of charge emergency response service to pre-registered airlines and ANSPs. This service, known as Aireon Aircraft Locating and Emergency Response Tracking (ALERT) will allow airlines, ANSPs and rescue coordination centers to query the last known position or track of any ADS-B equipped aircraft in a distress or alert phase, anywhere on earth. Unlike other emergency response options, Aireon will not require aircraft operators, States or ANSPs to invest in any additional equipment or subscribe to a contract services. As long as the aircraft are ADS-B equipped, we will be able to see them.

Making aircraft visible in an emergency, anywhere

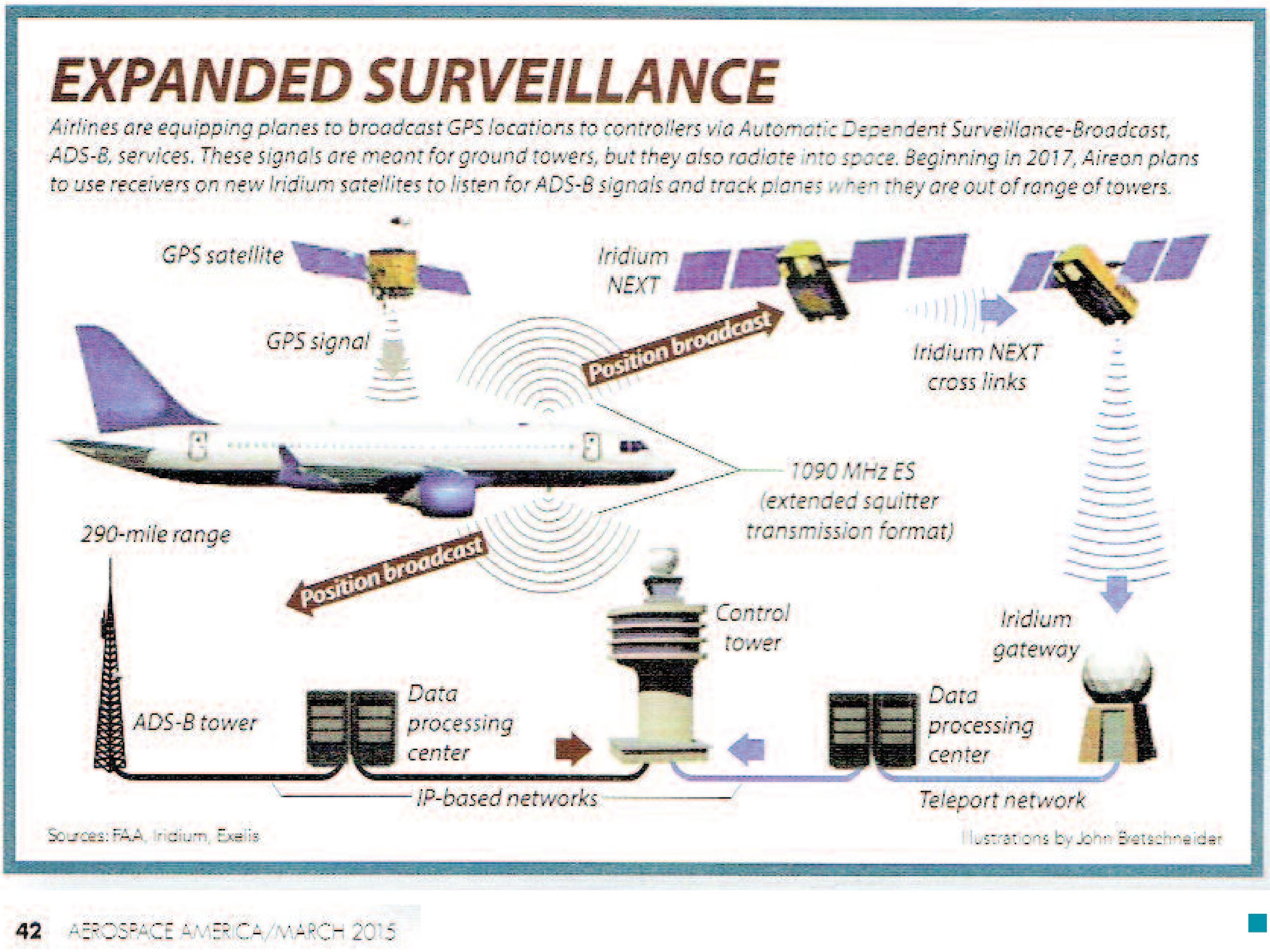
Aireon is leveraging the investments that Iridium made in their new Iridium NEXT constellation by leasing space for Aireon's ADS-B receivers on 66 Low Earth Orbit (LEO) satellites. The LEO satellites will orbit approximately 485 miles above the earth and each satellite will be cross-linked, creating a dynamic network to ensure continuous availability in every FIR on the globe with low latency and update rates suitable for air traffic surveillance.

Each satellite contains a highly sensitive receiver, designed to collect ADS-B transmissions and interact with Iridium's mesh network of receivers, satellites and antennas, making the system highly available, redundant and dependable.

Aireon's flexible receiver design takes full advantage of the upcoming ADS-B transponder mandates around the world ensuring compatibility with all1090 ADS-B versions currently in use. This will allow airlines to maximize the benefits of their investment in this technology.

Aireon's space-based ADS-B surveillance will introduce improved predictability to any air traffic system and provide 100% global surveillance.

ALERT is a free service with no contract required. This service will be available 24/7 and will have an emergency call center operated by the Irish Aviation Authority at their facility in Ballingrane, Ireland.



THE EDA ANNUAL REPORT 2014

THE ANNUAL REPORT 2014 OF THE EUROPEAN DEFENCE AGENCY HAS APPEARED IN THE BEGINNING OF 2015. THE PRESENT ARTICLE HIGHLIGHTS THE MAJOR INFORMATION DATA IT CONTAINS.

« The logic for greater pooling of defence efforts and resources is compelling, and largely uncontested: but the difficulties of translating that into concrete action are only too familiar. In the EDA we have a valuable instrument of which much is expected. »

Federica MOGHERINI
Head of the Agency and High Representative of the Union for Foreign Affairs & Security Policy/ Vice-President of the European Commission
Written answers to the European Parliament
Brussels, 6 October 2014

A YEAR OF IMPLEMENTATION

"Last year was an important one for the European Defence Agency, and not only because it celebrated its 10th anniversary. As I am just taking office as Chief Executive, I first want to extend my congratulations to the Agency's teams and to Claude-France Arnould, who all put a lot of time and effort into delivering on the taskings set by Member States.

In 2014, EDA especially focused on the implementation of the guidance and taskings provided by the December 2013 European Council, with a particular focus on the four key capability programmes identified by Member States (see page 7). In this regard, the launch of negotiations with industry regarding the acquisition of a multinational fleet of multirole air-to-air refuelling aircraft on the basis of common requirements was a major milestone.

Other cooperative projects also yielded tangible results, demonstrating the clear added value of defence cooperation at the EU level. Together with Member States, the Agency continued to organise multinational exercises aimed at improving the readiness of European aircrews that will be better prepared when they deploy to future operations. In 2014 alone, more than 70 fixed-wing and rotary-wing aircraft took part in EDA-organised live-flying events, involving around 200 European aircrew.

With a view to strengthening European defence industry, and in order to address the effect of the decline in European defence spending in research & technology (R&T), EDA focused its efforts on activities generating R&T projects, dual-use research and is supporting the Commission in setting up the Preparatory Action on CSDP-related research (see page 13). New incentives have also been proposed in order to facilitate the launch of the cooperative defence programmes that our industrial base needs in order to thrive. VAT exemption has been granted to several EDA projects and is now a major incentive for Member States to commit to collaborative projects. Significant progress was also achieved in the field of standardisation and certification.

As tasked by the European Council, the Agency and the European External Action Service prepared a draft Policy Framework for systematic and long-term cooperation, which was endorsed by Defence Ministers in November. The Agency has also submitted proposals for a pooled procurement mechanism in order to facilitate cooperative acquisition and support of defence equipment.

2014 was the first year during which the Agency operated under its new organizational structure, which will better serve the needs and interests of Member States. Over the course of the year, this new structure was slightly fine-tuned in order to reflect some emerging priorities, such as the Agency's role as military coordinator for the deployment of SESAR. Meanwhile, cooperation with external stakeholders such as Eurocontrol, OCCAR, EASA, NATO or the European Space Agency were strengthened.

I believe it is safe to say that 2014 was a busy year for EDA. However, I am already looking forward to the many challenges ahead, with a view to the next European Council that will again put the spotlight on defence issues. This is a rendezvous we cannot miss. Under the guidance of Federica Mogherini, the new Head of the Agency, I will make sure to focus on the continued involvement of our organisation in support of Member States."

Jorge DOMECQ
EDA Chief Executive

SIX MAIN CHAPTERS IN THE ANNUAL REPORT 2014

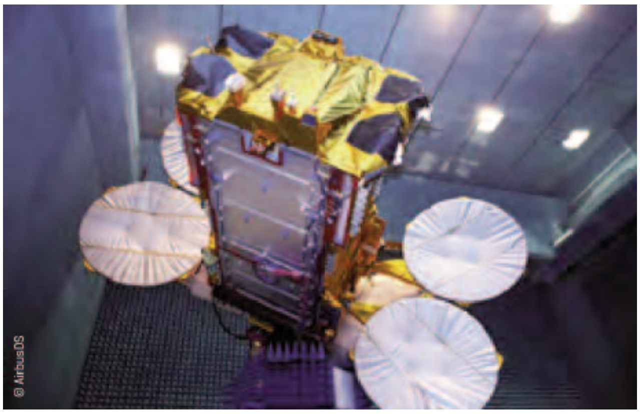
1. KEY CAPABILITY PROGRAMMES

Four key programmes which were identified by the 2013 European Council have made significant progress in 2014: (1) the Air-to-Air Refuelling, (2) the Remotely Piloted Aircrafts System, (3) Satellite Communications and (4) Cyber Defence.

• **Air-to-Air Refuelling (AAR):** an industrial solution has been identified in December 2014 on the basis of a common requirement. Negotiations have been engaged with Airbus Defence & Space for the purchase of A330 MRTT (Multi Role Tanker Transport) aircraft, with a contract award expected end 2015 and an initial operating capability mid-2020.

• **Remotely Piloted Aircrafts System (RPAS)**: Germany, France and Italy have set up a working group to analyse operational and technical requirements and to assess options for a future MALE (Medium Altitude Long Endurance) RPAS programme, an initiative actively supported by EDA, through a number of collaborative activities interested European Member States concerning air traffic insertion, airworthiness certification, RPAS flight crew training and licensing requirement.

• **Satellite Communications:** the Common Staff Target for the next generation of Governmental Satellite Communications was endorsed the Steering Board on 4 November 2014. The Preparation Phase of a potential future cooperation programme will be completed by the end of 2015. Besides the 'EU Satcom Market' for pooled procurement of commercial Satellite Communications continues to grow since it became operational in 2012.



• **Cyber Defence:** a major milestone was the contribution the Cyber Defence Policy Framework, tasked by the Council and approved at the end of 2014. The Cyber Defence Research agenda was further coordinated with the European Commission and the European Space Agency.

A REVISED CAPABILITY DEVELOPMENT PLAN

On 8 October 2014 the Steering Board endorsed the revised Capability Development Plan (CDP) as a key driver for future capability improvement. A list of priority actions emerging from this CDP was established.

2. COOPERATIVE PROJECTS: (1) Maritime Surveillance, (2) Counter IED (Improvised Explosive Devices).

3. SUPPORT OPERATIONS: (1) Support to Procurement, (2) Exercising and Training.

Support to Procurement: support to EU and CSDP operations was an important task of EDA in 2014.

Exercises and Training: in 2014 EDA organised many education and operational training activities across its Directorates: more than 70 fixed-wings and rotary-wing aircraft took part in in EDA-organised live-flying events, involving about 200 European aircrews.

4. PREPARING FOR THE FUTURE: (1) Research & Technology, (2) Certification, (3) Standardisation, (4) SESAR.

Research & Technology: The European Council invited EDA and the EC to work closely with Member States in order to develop proposals for dual-use technologies. Work has progressing well in 2014 with a focus on different areas such as Key Enabling Technologies and the development of micro and nano-electronics.

Certification: EDA is focusing on RPAS certification. RPAS is an opportunity to align civil and military certification requirements as far as it possible.

Standardisation: Member States' military airworthiness authorities are harmonising their requirements for aircraft maintenance and certification through the corresponding forum within EDA.

Single European Sky Air Traffic Management Research (SESAR): EDA facilitates the coordination of the military views with the objective to ensure that the military's interests are taken into account . This activity is coordinated by the EU Military Staff, NATO and EUROCONTROL.

5. FOSTERING COOPERATION: (1) Fiscal measures, (2) Pooled procurement.

As tasked by the European council, EDA has developed proposals to incentivise cooperation mainly through fiscal measures and pooled procurement. During the November 2014 Steering Board, Defence Ministers welcomed the progress accomplished as a basis for further works.

6. CONTINUED PARTNERSHIPS: (1) With third parties, (2) with ESA, (3) with OCCAR, (4) with EUROCONTROL, (5) with NATO, (6) with the US.

On 27 March 2014, the EDA's Annual Conference attended by more 500 high-level participants brought an increased level of focus and political support for European defence cooperation.

Abstract written by J.-P. S. from EDA information

THE INTERMEDIATE EXPERIMENTAL VEHICLE (IXV) OF ESA

PERSONALITY INTERVIEW

A FEW WEEKS AFTER THE ESA 'IXV' EXPERIMENTAL SPACEPLANE SUCCESSFUL RESEARCH FLIGHT – 11 FEBRUARY 2015 – JEAN-PIERRE SANFOURCHE, EDITOR-IN-CHIEF OF THE CEAS QUARTRELY BULLETIN, HAS INTERVIEWED GIORGIO TUMINO, ESA 'IXV' PROJECT MANAGER.

Jean-Pierre Sanfourche: Could you please, to start our discussion, briefly recall us the birth process of the IXV (Intermediate eXperimental Vehicle) project?

Giorgio Tumino: To well understand the origin of this project, it is important to refer to the ESA Assessment Study on Experimental Vehicles, issued in September 2002, concluding an important work conducted by ESA, whose objectives can be summarised as follows. In the beginning of the 21st century, launch, re-entry and reusability issues related to future launch vehicles, manned-space vehicles activities and future science missions were receiving renewed attention. A number of in-flight experimentation and demonstration activities had been proposed to ESA, so it appeared necessary to harmonize them and to produce a 'Comprehensive Assessment' of all existing programmes for Experimental Space Vehicles in Europe considering the different main aspects: programmatic, technical, industrial policy and costs. On the basis of the proposals evaluated, three different experimentation levels – or classes of vehicles – were clearly identified:

Class 1, 'Flying Test Beds' for experimentations aiming at focusing on design tools validation, dedicated to a single discipline and thus, not concept or system representative;

Class 2, 'Intermediate Experimental Vehicle' for experimentations aiming at focusing on integration at system level of key technologies;

Class 3, 'Experimental Vehicles' aiming at validation of a combination of technologies and system design capabilities.

J.-P. S. – I assume that this Assessment Study had been conducted within the framework of the so called FLPP (Future Launchers Preparatory programme), is not it?

G.T. – No, the Assessment Study had been performed in the period 2001- 2002, under the lead of the ESA Directorate of Technical and Operational Support (D/TOS) with the involvement of ESA programmes directorates (e.g. Launchers and Human Space-flight), when the FLPP was not yet existing. Then, the Assessment Study results fed part of the FLPP, when it started its activities in late 2004. From 2004 to 2008, detailed studies aimed to precisely define the 'Class 2' Intermediate eXperimental Vehicle (IXV) were pursued until a point where it was possible to take the decision to effectively give the green light for the development of the IXV and its flight. Although it took some time to prepare and freeze the IXV mission and system baseline, you may observe that considering its very high level of complexity, the time which has elapsed between the kick-off meeting and the mission execution is more than satisfactory:

- Kick-Off Meeting in early 2009;
- PDR (Preliminary Design Review) in end-2009;
- CDR (Critical Design Review) in May 2011;
- Integration in 2013;
- ETC (Environmental Test Campaign) at ESTEC in May-July 2014;
- FRR (Flight Readiness Review) in November/December 2014;
- Successful mission performance on 11 February 2015.

J.-P. S. – What is the place of 'IXV' within the FLPP Programme?

G.T. The IXV is not part of FLPP since a while now, and together with PRIDE, the Programme of Reusable In-orbit Demonstrators in Europe, constitutes a stand-alone programmatic line with a programme office within the ESA Directorate of Launchers, with the intention to allow Europe to mature a routine access and return capability.

PRIDE takes aim at the acquisition of industrial and technology competencies in Europe necessary to develop: (I) first, reusable launchers stages able to compete with future commercial markets; (II) robotic space exploration vehicles (among others planet sample return projects); (III) space transportation (cargo and also astronauts).

J.-P. S. – What are the European States participating in IXV mission?

G.T. – Seven nations active 100% partners since 2003 (kick-off meeting): Belgium, France, Ireland, Italy, Portugal, Spain and Switzerland. In addition two nations have supported the project from 2003 to 2008: Germany and The Netherlands (NL) (Figure 1).

J.-P. S. – I assume that for conducting such a mission, it has been necessary to set up a large permanent staff at ESA?

G.T. – Not at all, the ESA team is composed of approximately ten ESA full time people only! This team was also integrating competences from other ESA directorate and establishments (ESRIN, ESOC, ESTEC) for the coordination and conduction of the tasks performed by a high number of parties coming from industry, technology research and fundamental science.

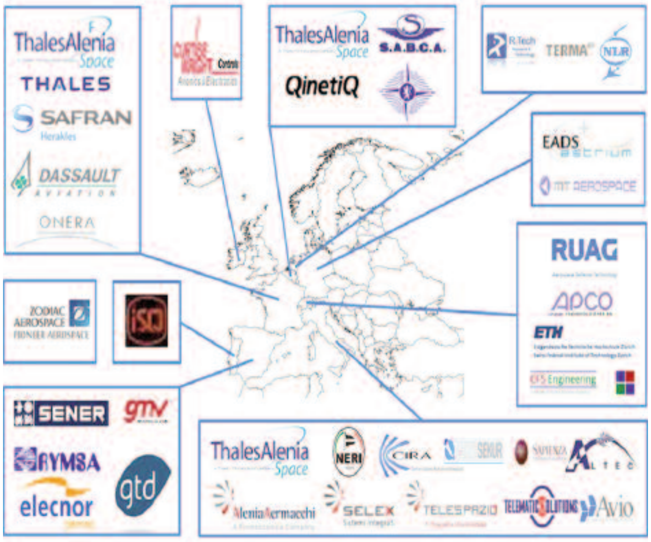


Figure 1. Among major IXV intervening parties

J.-P. S. – Let's come back to IXV itself: what are its objectives, in a more precise manner?

T.M. – IXV is a unique in-flight demonstrator, which is a compromise between the simple re-entry capsule and the winged space plane (space shuttle). It is a lifting body using the Vega launcher, an un-winged space-plane formula constituting a first in the world.

The objective of IXV demonstrator is double:

- **At System Level**, to provide the shape design of a fully European space plane capable of a controlled re-entry ;
- **At technology level**, to develop expertise and demonstrate in-flight qualification in three basic areas: (i) high temperatures protection systems (TPS); (ii) Guidance, Navigation & Control (GNC); (iii) models for aerodynamic behaviour and aero-thermodynamic phenomena predictions for uncertainty reduction and therefore minimization of the risks involved.

The hereafter description sheet allows better understand the project's rationale.

The highest IXV mission objective was to develop European system and technological know-how for "return from space", a cornerstone to enable future ambitious plans in the field of reusable launchers stages, return from orbital infrastructures, planetary return missions.

The IXV strategy was not only catching-up with respect to international partners, but also stepping ahead, performing the "intermediate" step, from the ARD capsule flown in 1998 towards ambitious space transportation systems applications, by verifying critical system and technologies aspects in conditions fully representative of a return from LEO with several "Firsts".

Therefore the IXV mission has pioneered:

- worldwide, a full reentry from orbital speeds with an un-winged lifting-body (integrating the simplicity of the capsules and the performances of the winged bodies for cross-range, down-range, and precision landing);
- worldwide, a full reentry from orbital speeds with large advanced reusable ceramic matrix composites hot structures (increasing the reusability and reliability with respect to other existing solutions);
- in Europe, a full reentry with combined use of rockets and flaps for flight control (increasing the controllability and maneuverability for precision landing with respect to the flown ARD capsule);
- in Europe, a full reentry with advanced aerothermodynamics experiments through a wider corridor than the ARD capsule. ■

J.-P. S. - Do you estimate that we have acquired sufficient background to appreciate the basic images, data and figures obtained from the IXV mission?

G.T. – The figure 2 provides you with all major sensors active during the flight. As regards the technology and science data, they are presently under processing by many experts spread over Europe. I am pleased to precise here that we have got 100% of the flight telemetry data as well as the recorders' data (infrared cameras included).

The In-flight Experimentation integrated more than 300 conventional and advanced sensors, with infra-red camera, to reduce the design uncertainties for re-entry applications, today requiring significant design margins at the expenses of payload capabilities.

J.-P. S. - What are the next major milestones to come now? Is already a second IXV mission planned?

G.T. – The first workshop to assess the IXV data will take place before the coming Summer 2015.

J.-P. S. – At what time horizon do you see the first mission of a European Reusable Launcher?

G.T. - It is quite clear that the reusable launcher stages are among our first interests. When the first launch? Your question is very difficult, but we are already working on a reusable orbital demonstrator within the ESA PRIDE (Programme for a Reusable In-orbit Demonstrator for Europe) and I think that a date around 2020 for its first launch could be considered as reasonable target.

J.-P. S. Among long-term perspectives, do you think that a European manned space vehicle project could be envisaged (Europe is the only major Space Power which has not the capability to launch man in space)?

G.T. - Today there are no consolidated plans to develop a European manned space vehicle, in particular if considering also the need to develop a European man-rated launch system in parallel. For this reasons we are working bottom-up on the maturation of the technologies for atmospheric re-entry to get ready preparing the technological ground and making more feasible future plans in this direction.

J.-P. S. – May I ask you to conclude our talk to express your wishes for the future of this exciting adventure?

G.T. - I have dedicated a significant professional effort to realization of this fantastic mission, from its conception to its realization. The objective was to see Europe growing in this

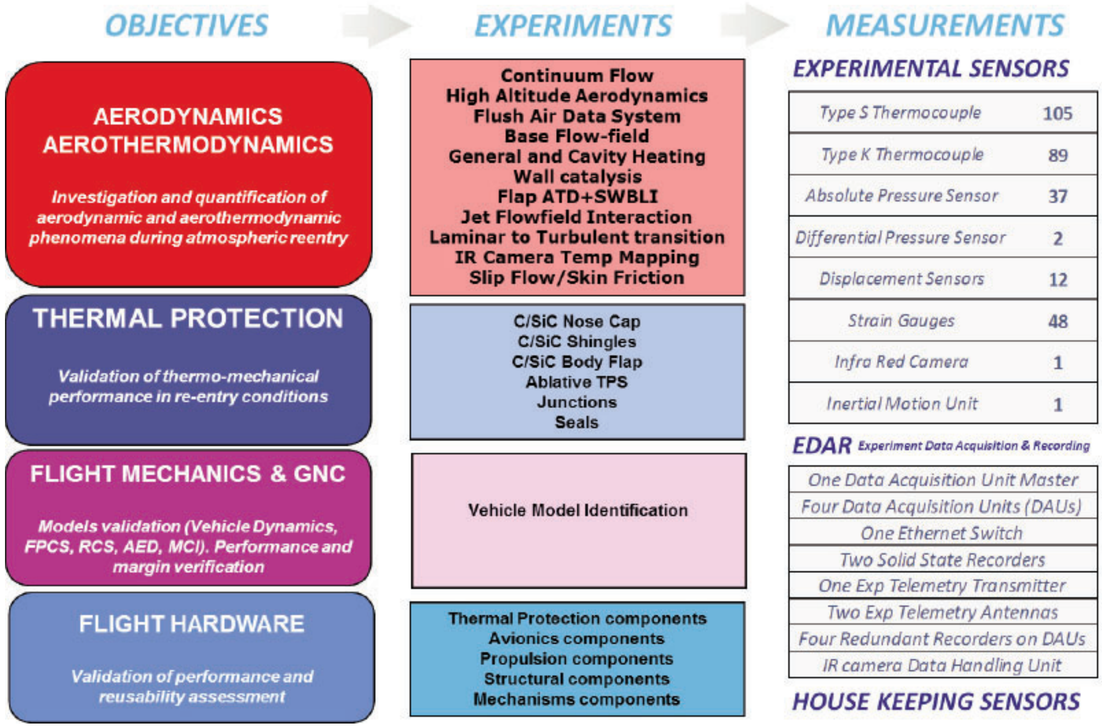


Figure 2

direction effectively with a concrete flight experience and to enable future ambitious plans. I could not be happier of the extraordinary results of the mission, and of the momentum created in Europe around the mission perspectives for the future!

J.-P. S. – Thank you very much, and on behalf of the CEAS Trustees, I am pleased to congratulate you for this IXV mission outstanding performance.

Giorgio Tumino graduated at the University of Rome "La Sapienza" in Aerospace Engineering cum laude. Initially in 1995 he joined ESA Technical Directorate at ESTEC in Noordwijk (The Netherlands) working first in the areas of aerothermodynamics and propulsion, and then in the area of high temperature materials and thermal protection systems. In 2004 he moved to ESA Headquarters in Paris to join the Directorate of Launchers to work on the IXV mission early conception. Now he is heading the IXV and PRIDE programme office.

TECHNICAL SHEET OF THE INTERMEDIATE EXPERIMENTAL VEHICLE 'IXV'

General characteristics

- Length: 5 m
- Wingspan: 2.2 m
- Height: 1.5 m
- Empty weight: 480 kg
- Loaded weight: 1,900 kg with propulsion module


Vega VV04 IXV Liftoff 11 February 2015

Design

IXV used a lifting body arrangement with no wings and two movable flaps for re-entry flight control.

The airframe was based on a traditional hot-structure/cold-structure arrangement, and is supported on-orbit by a separate manoeuvring and support module similar to the Resource Module intended for Hermes.

The avionics were controlled by a LEON2-FT microprocessor, and interconnected by a MIL-STD-1553B serial bus.

Power: Batteries

Mission

- Launch date: 11 February 2015, 13:40:00 UTC
- Launch vehicle: Vega VV04
- Launch site: European Spaceport, Kourou (French Guiana)
- Landing site: Pacific Ocean, just west of the Galapagos
- Islands
- Regime : Suborbital
- Range: 7,500 km
- Maximum speed: 7700 m/s
- Maximum altitude: 412 km

Vega VV04 fully assembled in its mobile gantry © ESA–M. Pedoussaut, 2015

IXV floating and waiting for recovery
© ESA–Tommaso Javidi, 2015

Checking IXV for residual hydrazine © ESA

IXV separated from Vega at altitude 340 km and continued up to 412 km.

As it descended, it decelerated from hypersonic to supersonic speed. The entry speed at 7.5 km/s at altitude 120 km, it created the same conditions as those for a space vehicle returning from LEO.

IXV glided through the atmosphere before parachutes deployed to slow the descent further for a safe splashdown in the Pacific Ocean.

The Mission Control Centre at the Advanced Logistics Technology Engineering Centre (ALTEC) of Turin (Italy) monitored the IXV during the flight, receiving flight and instrument data from the ground network stations (Gabon, Kenya and Nos Aries recovery ship).

Re-entry was accomplished in a nose-high attitude (like the Space Shuttle) with manoeuvring accomplished by rolling out-of-plane and then lifting in that direction in the same manner as an airplane.

Landing was accomplished by parachutes ejected through the top of the vehicle.

Recovery was accomplished by the Nos Aries ship.

IXV coming home
© ESA

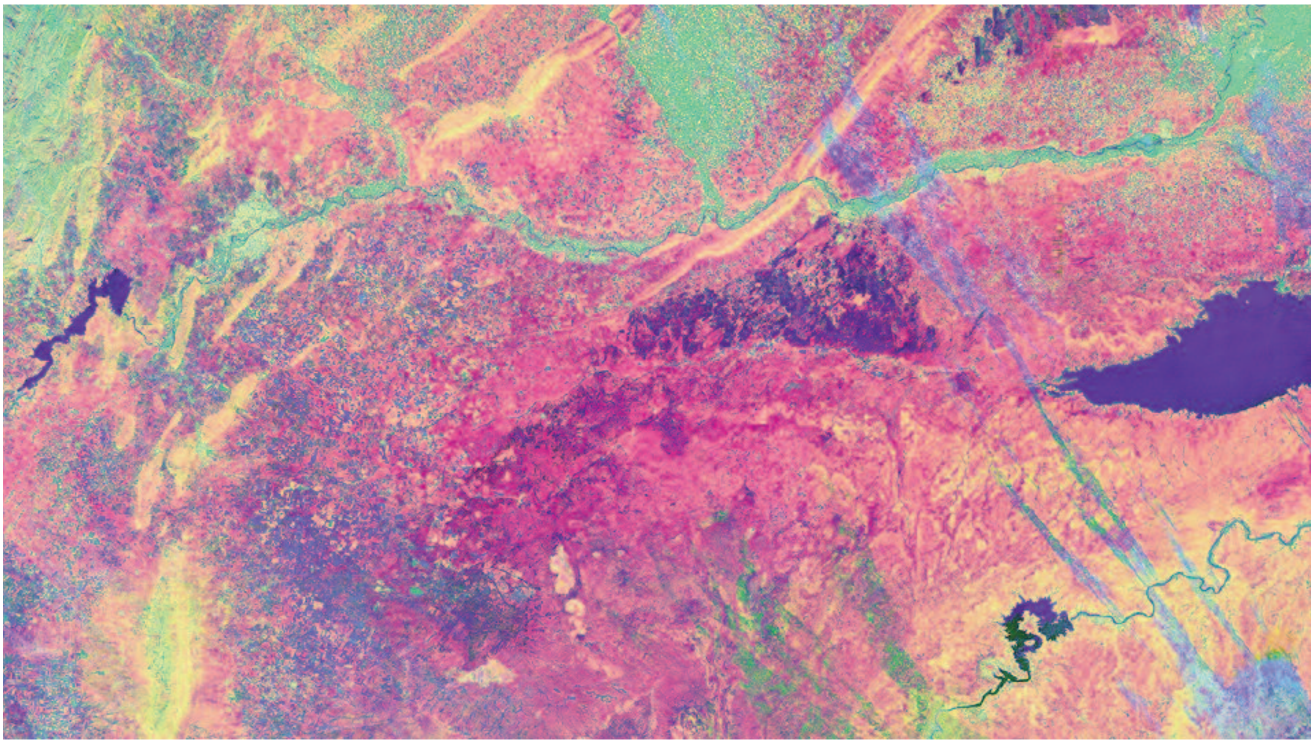
COPERNICUS

SENTINEL-1: IN THE END OF MARCH, HAVING ORBITED EARTH MORE THAN 5300 TIMES, WHILE PROVIDING RADAR VISION FOR EUROPE'S COPERNICUS PROGRAMME, THIS SATELLITE – THE FIRST OF COPERNICUS PROGRAMME – HAS COMPLETED A SUCESSFUL FIRST YEAR.

The satellite carries an advanced radar to provide an all-weather, day-and-night supply of images of Earth's surface. Just weeks after its launch from Europe's Spaceport in French Guiana, its imagery was already being used to assist in emergency responses. Some of its first images were crucial in helping authorities in Namibia and the Balkans decide how to respond to a serious floods – both while the satellite was still in its early commissioning phase.

Sentinel-1A's began supplying data operationally in October. Within days, experts began using the data to monitor the marine environment. This included the production of ice charts, showing the details of ice conditions in a variety of regions, including the warnings of icebergs drifting in shipping routes to alert vessels.
Over the year, Sentinel-1A has also been used to monitor ice loss from ice caps and ice sheets, such as the Austfonna ice cap in Norway's Svalbard archipelago. The first dedicated campaign observing the Greenland ice sheet was completed in March 2015.
Additionally, its data have been used to map ground movements related to earthquakes in the US's Napa Valley, as well as movements from the Fogo and Villarrica volcanoes.
The plethora of results that make Sentinel-1A's first year such a success wouldn't be possible without the rapid data dissemination and the Copernicus open access policy.
To date, more than 6000 users have registered to access the 83 000 online data products. Since the data became available in October, over half a million downloads have been made so far – the equivalent of about 680 terabytes of data.

To assist with data processing, product reading and analysis, the Sentinel-1 Toolbox is being used by over 1000 users in 70 countries.



Iraq and Eastern Turkey

This image combines two scans from Sentinel-1A's radar on 3 and 15 October 2014 over Iraq and Eastern Turkey. Colours come from the combined coherence and intensity information and show a wealth of information on the landscape. Assigning certain colours to certain features on the ground requires a more detailed analysis.
© Copernicus data (2014)/ESA/PPO.labs/Norut by SEOM InSARap

J.-P. S. from information provided by ESA

WITH THE SUCCESSFUL LAUNCH OF GALILEO SATELLITES 7 AND 8 ON 27 MARCH THE DEPLOYMENT OF THE GALILEO CONS - TELLATION IS RESTARTING!

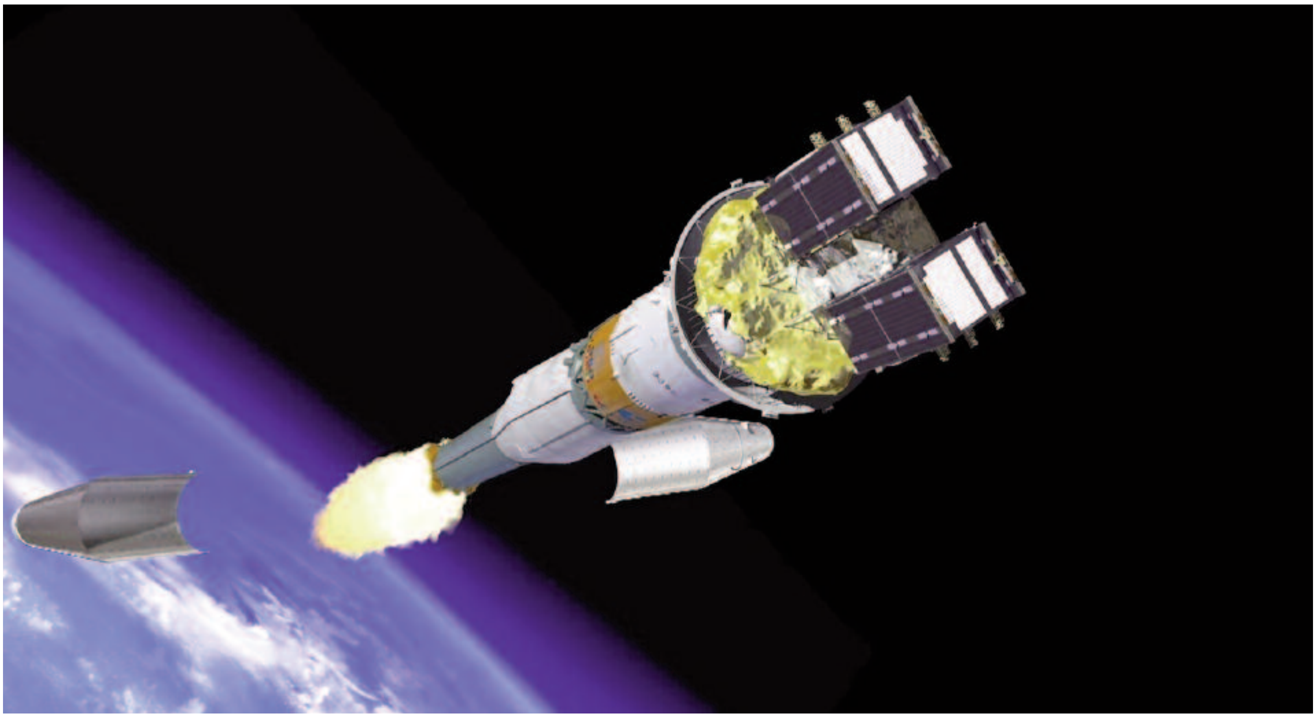
Galileo 7 and 8 (Full Operational Capability satellites) lifted off on 27March 2015 at 21:46 GMT from Kourou on top of Soyuz rocket.

All the Soyuz stages performed as planned, with the Fregat upper stage releasing the satellites into their target orbit close to 23,500 km altitude about 3 hours 48 minutes after liftoff. The two satellites, following initial checks, are going to be handed over to the Galileo Control Centre in Oberpfaffenhofen (Germany) and the Galileo in-orbit testing facility in Redu (Belgium) for testing before becoming operational, by mid-year.

The new pair joins the six satellites already launched: In-Orbit Validation (IOV) satellites 1 & 2 (October 2011) and 3 & 4 (October 2012), plus the Full Operational Capability (FOC) satellites 5 & 6 (August 2014).

Note: *the launch of 7-8 was initially set for late 2014 but was suspended pending investigation of the anomaly in the Soyuz's upper stage that left FOC Galileo 5 and 6 in an incorrect, lower orbit. The origin of the anomaly, a freezing of the hydrazine propellant line, has been corrected, allowing deployment to resume.*

Four more satellites are in testing or final integration and scheduled for launch in the end of 2015. It can be said that we are approaching the cruise mode of production.



Galileo satellites launched@Arianespace

J.-P. S. from information provided by ESA

YEAR 2015

5-7 May • **IATA** – 2015 Cabin Operations Safety Conference – Paris (France) – Le Méridien Etoile – www.iata.org/events/

11-13 May • **ESA** – ASTRA 2015 – 13th Symposium on Advanced Space Technologies in Robotics and Automation – Noordwijk (NL) – ESA/ESTEC – www.congrexprojects.com/2015-events/15a07/

12 May • **RAeS** – Human Factors in Engineering – The next generation -Engineering Innovation Day 2015 – Cranfield (UK) – Cranfield University Vincent Building Auditorium – www.aerosociety.com/Events/

13-14 May • **FSF** – BASS 2015 – 60th annual Business Aviation Safety Summit – Weston, FL (USA) – Bonaventure Resort and Spa – www.flightsafety.org

18-20 May • **ARA** – Atmospheric Re-entry Conference – Arcachon (France) – Palais des Congrès www.avantage-aquitaine.com

18-20 May • **ESA** – TRISMAC 2015 – Frascati (Italy) – ESA/ESRIN www.congrexprojects.com/2015-events/trismac2015/general

18-22 May • **ESA/CNES** – 2nd SMOS Science Conference - Soil Moisture Ocean Salinity satellite data applications – Madrid (Spain) – ESA/ESAC – www.smos2015.info/

19-21 May • **EBAA/NBAA – EBACE 2015** – Geneva (Switzerland) – Palexpo Geneva International Airport – www.ebace.aero/

25-27 May • **22nd St-Petersburg International Conference on Integrated Navigation Systems** – Saint-Petersburg (Russia) – www.Elektropribor.spb.ru

02-03 June • **RAeS** – Delivering Weapon Systems Effects Contrast piloted/remotely-piloted platforms - Malvern (UK) – QinetiQ Malvern Technology Centre – St Andrews Rd – www.aerosociety.com/Events

02-03 June • **EUROCONTROL/ERA – Forum** – Safety and Automation in Aviation – Brussels (Belgium) – EUROCONTROL/HQ – www.skybrary.aero/index.php/Portal:Automation_and_Safety

02-05 June • **ESA** – Sentinel-3 for Science Workshop – Venice (Italy) – Palzzo del Casino – Lido – www.seom.esa.int/S3forScience2015/

07-12 June • **ESA/ANDOYA SPACE CENTRE – 22nd ESA Symposium on Rocket and Balloon Programme** – Tromso (Norway) – www.pac.spaceflight.esa.int – www.pac.spaceflight.esa.int

8-10 June • **ESA** – XMM-Newton 2015 Science Workshop – Madrid (Spain) – ESA/ESAC – www.xmm.esac.esa.int/

09-10 June • **NATO/EUROCONTROL** – NEASCOG/37 : ATM Security Conference, Workshop and Exhibition – Brussels (Belgium) – EUROCONTROL/HQ – www.eurocontrol.int/neascog-37

09-10 June • **RAeS** – Future Challenges in Flight Simulation – London (UK) – RAeS/HQ – www.aerosociety.com/Events

09-11 June • **3AF/SEE** – ETTC 2015 – Toulouse (France) – Centre de Conférences Pierre Baudis – www.ettc2015.org

09-12 June • **3AF** – 11th International Conference on Missile Defence – Barcelona (Spain) – Palay de Congressos de Catalunya – www.missile-defence.com - www.3af.fr

10-12 June • **EASA/FAA** – EASA/FAA International Aviation Safety Conference – Brussels (Belgium) – www.easa.europa.eu

15-19 June • **ESA** – 12th International Planetary Probe Workshop (IPPW-12) – Cologne (Germany) – Hyatt Regency – www.planetaryprobe.eu/

15-21 June • **SIAE/GIFAS**– International Paris Air Show 2015 – Le Bourget (France) – www.siae.fr/

16-17 June • **ESA** – European Ground System Architecture Workshop (ESAW) – Darmstadt (Germany) – ESA/ESOC – www.congrexprojects.com/2015-events/15a06/introduction

16-19 June • **AIAA** – 7th International Conference on Recent Advances in Space Technologies – RAST 2015 – Istanbul (Turkey) – www.rast.org.tr

22-25 June • **SAE International** – International Conference on Icing of Aircraft, Engines and Structures – Prague (Czech Republic) – Hotel International Prague – www.sae.org/events/icing/

22-26 June • **AIAA** – AIAA AVIATION 2015 – Dallas, TX (USA) – AIAA Aviation and Aeronautics Forum and Exposition – 16 specialized conferences among which the 21st AIAA/CEAS Aeroacoustics Conference – www.aiaa.org/Event/

24-26 June • **ACI Europe** – 25th ACI Europe General Assembly – Prague (Czech Republic) – Hilton Prague www.aci-europe-events.com

28 June-2 July • **TsAGI/CEAS/AIAA – IFASD 2015** – 16th International Forum on Aeroelasticity and Structural Dynamics – Saint Petersburg (Russia) – Solo Sokos Hotel Palace Bridge – www.ifasd2015.com/

29-30 June • **ERCOFTAC** – 11th Conference on Synthetic Turbulence Models – Lyon (France) – ECL Ecully www.ercoftac.org/

29 June-3 July • **EUCASS** – EUCASS 2015 – Krakow (Poland) – www.eucass2015.eu/

6-9 July • **AIAA** – 20th AIAA International Space Planes and Technologies – Glasgow (UK) – Strathclyde University, Technology and Innovation Centre – www.aiaa.org/hypersonics2015

12-16 July • **AIAA** – International Conference on Environmental Systems – Bellevue, WA (USA) – www.depts.ttu.edu/ceweb/ices

27-29 July • **AIAA** – AIAA Propulsion and Energy 2015 Forum and Exposition + 51st AIAA/SAE/ASEE Joint Propulsion Conference + 13th International Energy Conversion Engineering Conference - Orlando, FL (USA) – www.aiaa.org/

9-13 August • **AAS/AIAA** – 2015 Astrodynamics Specialist Conference – Vail, CO (USA) – www.spaceflight.org/docs/2015_astro.html

13-16 August • **TAWAIN** – Taipei Aerospace Defense Technology Exhibition – Taipei (Taiwan) – www.tadte.com.tw

20-23 August • **CHINA** – Shenyang International Air Show – Faku Caihu Airport – Faku Shenyang Liaoning (China) – www.aero-shenyang.com

31 August-02 September • **AIAA** – AIAA SPACE 2015 Forum and Exposition – Pasadena, CA (USA) – www.aiaa.org/

01-04 Sept. • **ERF 2015 – DGLR/CEAS** – Munich (Germany) – www.erf2015.de www.erf2015.dglr.de

07-09 Sept. • **ECCOMAS** – 5th ECCOMAS Conference on Mechanical Response of Composites – Bristol (UK) www.bristol.ac.uk/composites/

07-10 Sept. • **AIAA** – 33rd AIAA International Communications Satellite Systems Conference and Exhibition – ICSSC-2015 – Gold Coast (Australia) – www.satcomspace.org

YEAR 2015

07-11 September • **CEAS – CEAS 2015 Conference** – Delft (NL) – www.ceas2015.org

16 Sept. • **RAeS** – Conference Future Trends in Certification if Advanced Technology Structures – Bristol (UK) – National Composites Centre – Bristol & Bath Science Park – www.aerosociety.com/Events

22-25 Sept. • **3AF/AIAA** – ANERS 2015 – Aircraft Noise and Emissions Reduction Symposium – La Rochelle (France) www.3af.fr

23-24 Sept. • **RAeS** – Conference Flight Crew Instruction, Selection, Skills & Supply – London (UK) - RAeS/HQ www.aerosociety.com/Events

23-24 Sept. • **3AF/AIAA/CEAS** – X-Noise/CEAS Workshop - La Rochelle (France) – www.3af.fr

07-08 October • **RAeS** – President's Conference 2015 – UAS + Detect & Avoid workshop – London (UK) - RAeS/HQ www.aerosociety.com/Events

12-16 October • **IAF** – IAC 2015 – 66th International Astronautical Congress - Jerusalem (Israel) – Congress Centre www.iac2015.org/

12-16 October • **ESA** – Exploring the Universe with JWST – Noordwijk (NL) – ESA/ESTEC – www.congrexprojects.com/

13-14 October • **Aviation Week** – MRO Europe 2015 Conference and Exhibition – London (UK) – ExceL London www.mroeurope.aviationweek.com/euro15/public/

20-23 October • **EC – AERODAYS 2015** – "Aviation in Europe – Innovating for Growth" : the 7th edition of the Aeronautics Days, the flagship event in Europe for Aviation R&TD - London (UK) www.adsfarnborough.co.uk/aerodays-2015/ www.aerodays2015.com

20-25 October • **SEOUL**– Seoul International Aerospace & Defense Exhibition 2015 – Seoul (South Korea) – Seoul Airport, Seongnam Air Base – www.seouladex.com

23 October • **RAeS** – Greener by Design Conference – London (UK) - RAeS/HQ – www.aerosociety.com/Events

28 October – 01 November • **CHINA** – AERO Asia 2015 – Zhuhai, Guangdong (China) www.aero-expo.com/aero-en/Visitors/News/AERO-Asia-2015.php

08-12 November • **Dubai**– Dubai Air Show 2015 – Dubai (UAE) – Dubai World Central – Al Maktoum, Jebel Ali – www.dubaiairshow.aero

09-13 November • **COSPAR**– COSPAR 2015: 2nd COSPAR Symposium – Foz do Iguaçu (Brazil) – Congress Centre – www.events.eoportal.org/web/

11-12 November • **RAeS** – Flight Simulation Conference – London (UK) - RAeS/HQ – www.aerosociety.com/Events

25-27 November • **ASTech** – 1st Metallic Materials and Processes Industrial Challenges – Deauville (France) – www.pole-astech.org

26-27 November • **RAeS** – Predicting the fatal flaw in aviation safety – Airways Training Centre - Crawley West Sussex RH 10 9LX – www.aerosociety.com/Events

London, 20 – 23 October 2015

"A perfect place to see what European research and innovation efforts can accomplish and to stimulate cross-border working to find innovative ways for Europe to remain a global player"

***Maire Geoghegan-Quinn**, EU Commissioner for Research and Innovation (Madrid, 2011)*

What is Aerodays?

Aerodays is the European flagship event in Aviation research and innovation taking place once during each EU Research Framework Programme.

Designed to present strategic perspectives for Aviation, including research and innovation. The goal is to share achievements of collaborative research and innovation in Aeronautics and Air Transport within Europe and in world-wide international co-operation.

Who takes part?

The last Aerodays 2011 in Madrid welcomed over 1400 delegates including government officials, key decision makers from industry, researchers, engineers, academics, students and journalists.

Conference themes for 2015

Throughout the four day event, there will be 4 key themes addressed resulting from Europe's Vision for Aviation 'Flightpath 2050':

- ***Greening of aviation*** - if carbon emissions continue to rise, they could contribute up to 15% of global warming within 50 years. The industry needs to deliver technology solutions at an increasing rate to mitigate the impact
- ***Competitiveness of industry*** - innovation and technological leadership is the competitive differentiator for European industry. With emerging players vying for market share, technology that optimises energy use and maximises efficiency, quality and reliability will be the keys to success
- ***Efficient and seamless mobility*** - aviation is key to connectivity through transport; adding value through business and the general public. Aviation technologies will help ensure the sector is an integral, seamless node for the future
- ***Breakthrough innovations*** - the potential of zero-carbon flight has been demonstrated. Autonomy has potential for safety and efficiency. Smart materials are yet to be produced on an industrial scale. These and other exciting breakthroughs need to be discovered and adopted to enable future generations to fly.

Some good reasons why you should be at Aerodays 2015!

- It's a forum for senior policy-makers and researchers to debate and discuss
- It's a platform for the sharing outputs from world-leading technology programmes
- Get a comprehensive overview on technological developments in aviation
- Take part in networking and social forums to increase connections and interaction within the aviation sector
- Learn in a master class programme on partnering and collaborating in EC consortia
- It's a place to incentivise and motivate young scientists and engineers
- There's the opportunity for school children to engage with aviation technology and developments

For information and to register interest visit: www.aerodays2015.com

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