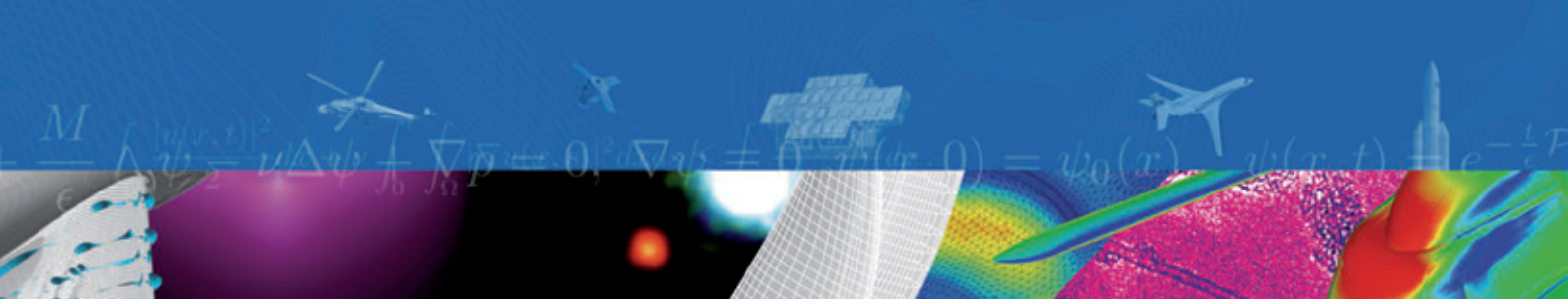


ANNUAL REPORT

2011

ONERA

THE FRENCH AEROSPACE LAB

r e t u r n o n i n n o v a t i o n

Contents

ONERA and the aerospace and defense industry in France

With new players emerging on the global stage, the aerospace and defense industry in France is once again investing, despite the particularly tight financial situation, in basic research to pave the way for products that will hit the market in 2025-2035.

This clearly shows that Research & Technology is a vital component of our industry's competitiveness and development.

Has ONERA made the right choices in terms of basic research over the last dozen years? Will these choices, guided by our scientists, allow us to address industry's key challenges in the coming years?

In a word, "yes". Our business with industry grew 31% in 2011, and contract awards were up 42%. Our skills and expertise clearly match industry's evolving requirements.

For example, last year saw our exemplary partnerships with major industry partners such as MBDA, Eurocopter, Safran and Airbus take important new steps forward.

Ongoing investments in our fleet of wind tunnels are bearing fruit, as we enter a critical period that will prove decisive in determining the fuel consumption and acoustic efficiency of tomorrow's airplanes.

Our proven ability to anticipate, coupled with our high-quality, professional relations with industry, have earned ONERA renewed Carnot certification for our Aerospace Systems Engineering Institute for the period 2011-2016. Whether in terms of innovation, the watchword in preparations for the upcoming European framework program, Horizon 2020, or reindustrialization, a burning issue in France today, this combination of anticipation and excellent relations with industry is the key to our future.

Denis Maugars
Chairman and CEO of ONERA

The leading aerospace and defense research organization in France

ONERA
THE FRENCH AEROSPACE LAB

return on innovation

To maintain our scientific and technical leadership, ONERA invests in fundamental research and spurs innovation. We are developing the defense technologies that will underpin tomorrow's strategic and tactical systems. We are also working on the enabling technologies for tomorrow's commercial aircraft, to reduce fuel consumption and noise, while further improving safety.

ONERA is a multidisciplinary organization that brings together the talents of 2,000 top experts in energetics, aerodynamics, materials, structures, electromagnetism, optics, instrumentation, atmospheric environment and space physics, complex and onboard systems, information processing and long-term design.

We are also Europe's leading center of expertise for aeronautical wind tunnels.

Results-oriented, ONERA conducts research in true project mode, based on professionalism, scientific excellence, impartial expertise and confidentiality. Fully two-thirds of our business comes from commercial contracts with firm deadlines, awarded under competitive conditions. Our annual budget is 244 million euros, including 26 million euros to keep our plant and equipment in perfect shape.

ONERA works for both governments and industry.

Key Figures - 2011

2,100
employees:

1,533 engineers and management staff,

including **258** doctoral candidates

266 interns

23% women

102 new hires,

including **79** engineers and management staff

1,014
papers, including

270
in peer-reviewed publications

1,156
technical reports

57
doctoral theses submitted

€244
million budget
including
€26
million in capital expenditures

€125 million in contracts awarded

€91.6 million in grants

59% contract business

ONERA
THE FRENCH AEROSPACE LAB

Management Commitee

Left to right:
Emmanuel Rosencher,
General Scientific Director;
Thierry Michal,
General Technical Director;
Denis Maugars,
Chairman and CEO;
Véronique Padoan,
Director of Human Resources;
Patrick Wagner,
Director of Computing, Engineering and Testing Facilities;
Michel Humbert,
Director of Business Development and Commercialization.

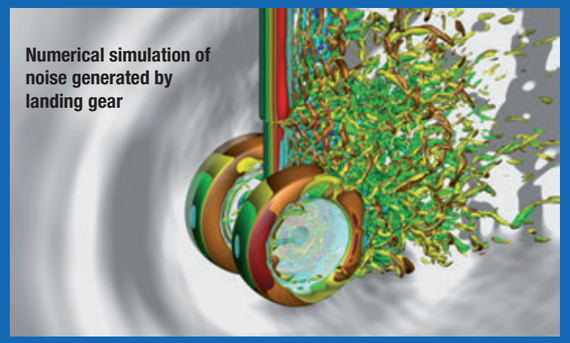
Scientific and Technical Organization

SCIENTIFIC BRANCH	SCIENTIFIC AND TECHNICAL DEPARTMENTS	Share of science/technology workforce
Fluid Mechanics and Energetics	> Applied Aerodynamics > Fundamental and Experimental Aerodynamics > Fundamental and Applied Energetics > Aerodynamics and Energetics Modeling > Computational Fluid Dynamics and Aeroacoustics	**29%**
Physics	> Theoretical and Applied Optics > Electromagnetism and Radar > Instrumentation and Sensing > Space Environment	**22%**
Materials and Structures	> Aeroelasticity and Structural Dynamics > Composite Systems and Materials > Metallic Structures and Materials > LEM: Laboratory for Microstructural Investigations*	**11%**
Information Processing and Systems	> Long-term Aerospace Planning** > System Design and Performance Evaluation > Information Processing and Modeling > Systems Control and Flight Dynamics	**18%**
Computing, Engineering and Testing Facilities (GMT)	> Modane-Avrieux wind tunnels > Fauga-Mauzac wind tunnels > Design, Engineering and Manufacturing > Software Products and Services	**20%**

* a joint ONERA-CNRS unit ** entity working for all ONERA departments

2011 Highlights

January

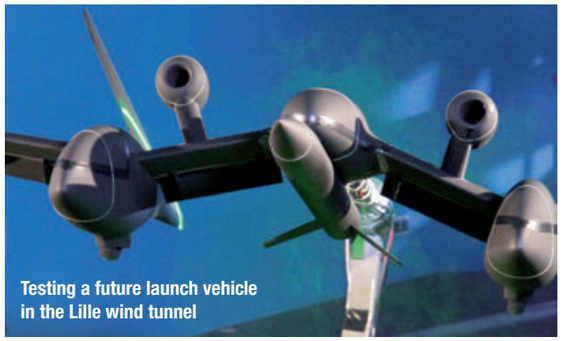


For the Airbus program "Lagoon", ONERA used its elsA aerodynamic software to reproduce the turbulence around a landing gear, in order to predict noise propagation. Comparisons with tests at the F1 and Cepra 19 wind tunnels were very conclusive.

High-speed observation of turbulence behind jet noise
For the first time, speed measurements using particle image velocimetry (PIV) in a wind tunnel showed the dynamic interactions between the different turbulence scales, which could be the cause of jet noise in aircraft engines.

Validation of an algorithm for drone-based maritime surveillance
Successful air-maritime tests of ReSSAC drone demonstrator, to validate an algorithm used to monitor surface vessels using laser and camera imaging (Action project).

February

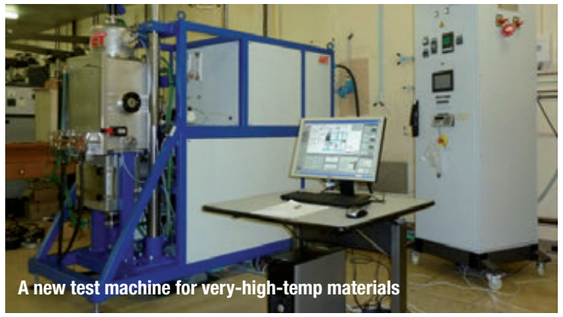


Aerodynamic characterization of the Eole airborne demonstrator (Perseus program) in the L2 wind tunnel in Lille, part of a nanosatellite launcher project by French space agency CNES. These measurements will be used to determine the control laws and evaluate performance.

Blast wave during Ariane 5 liftoff
First firing test at Fauga-Mauzac of a model of the P230 solid rocket motor, designed to reproduce the blast wave during an Ariane 5 liftoff. The propellant grains were adapted to reproduce ignition as realistically as possible. The next step is a series of acoustic measurements on a launch pad built to the same scale of 1/35.

A new X-ray diffraction lab
Two highly innovative instruments provide a closer look at atomic composition and structures, to study the phase changes according to temperature, and determine internal stress conditions. The aim is to enhance the models for structural calculations and analysis of material life.

March

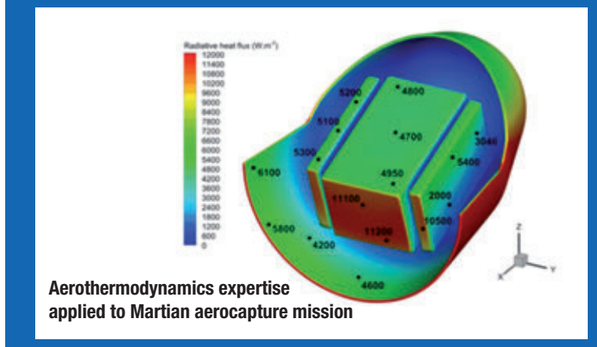


Acquisition of a new creep test machine to measure the mechanical characteristics of materials for very high temperature applications. Tests can be performed up to 1,500°C, under different atmospheres, with applied force of 20 to 1,000 daN.

A new ONERA doctoral candidate award
For the first time, in 2011 ONERA awarded a prize to seven doctoral candidates finishing their theses, based on the quality, originality and scope of their work, their oral report and the number of publications and papers presented at conferences.

An innovative optical diagnosis technique for combustion research
Focused strioscopy is used to visualize a flow with a very small depth of field. Used to observe the combustion of aluminum particles in solid rocket motors, this method helped validate certain models. It offers a host of potential applications.

April

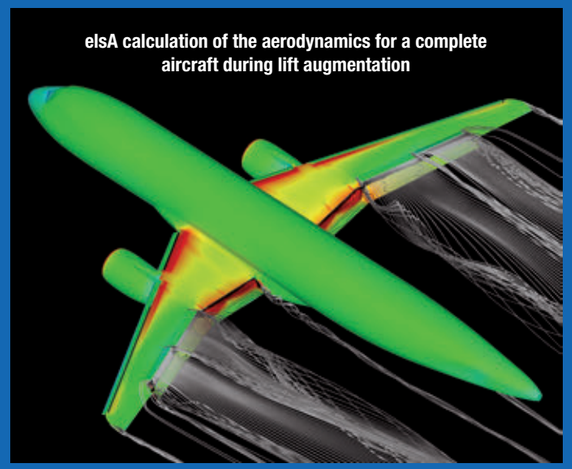


Europe's Aerofast Martian aerocapture project has been completed. ONERA applied its aerothermodynamics expertise to select a concept, using numerical simulation, for the cost-effective orbital positioning of orbiters around Mars.

Reconciling computation time and complex shapes for aeroacoustics
A process based on coupling methods for hybrid meshes in an acoustic propagation calculation demonstrated benefits for industrial applications. It facilitates the integration of complex shapes while also reducing computation costs.

A new tool to characterize the atmospheric radiation environment
A neutron spectrometer developed with French nuclear safety institute IRSN is now in operation at the Pic du Midi observatory in southern France. It measures the dynamics of the atmospheric radiation environment, depending on atmospheric conditions and space "weather", along with the impact on electronic components.

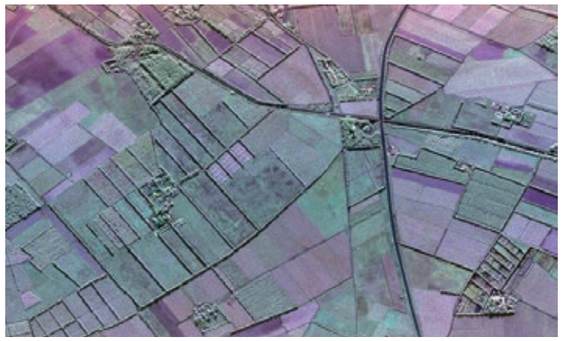
May



In this first, the simulation was based on a mesh comprising some 37 million points, using the Chimère numerical simulation method, grouping various mesh elements describing the nacelles, slats, flaps, spoilers, etc.

Plasma actuators to reduce aerodynamic drag
Promising results have been achieved by the European Plasmaero project using plasma actuators. They avoid massive boundary layer separations, while controlling aerodynamic instability on airfoils, achieving spectacular results in drag reduction and retarding the transition.

June

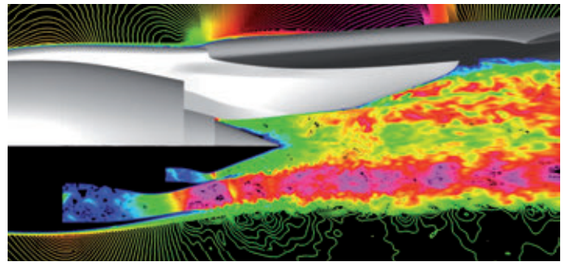


Validation of Ramses-NG airborne system
The qualification flights organized by the Istres flight test center (French defense procurement agency DGA) led to successful first tests of SAR (synthetic aperture radar) imaging on the Ramses-NG, whose radar system was completely revamped. The radar and optical sensors are integrated in two pods underneath the plane's wing.

Higher performance for hybrid propulsion launchers
At the C-Space meetings, students from the ISAE aeronautical engineering school successfully launched their rocket powered by a motor using the latest innovations from ONERA's propulsion lab, in particular thrust control by an onboard computer.

A fiber laser with ultra-short pulses at 2 µm
Emitting in the medium-infrared band, this fiber laser is more reliable, more efficient and less power-hungry. It can be used directly for gas spectrometry, and could have applications in ophthalmological surgery. The laser is a world first, developed through basic research for the French ministry of defense.

July



More accurate calculations of aircraft engine jet flows
A numerical turbulence generator, developed for the elsA software, provides more accurate simulation of the development of jet flows. This innovative development follows the experimental and numerical evidence of the strong influence of engine-generated turbulence on jet flows.

Supersonic combustion in a wind tunnel
First experiment concerning supersonic combustion in the F4 wind tunnel at Fauga-Mauzac. Using a flat plate and insulated gaseous hydrogen injector, this test paves the way for upcoming simulations on supersonic free jet combustion chambers for flights at Mach 8 and beyond.

Successful test of an innovative injector for rocket propulsion
Successful test of an injector using a technology new in Europe – double swirl, with liquid oxygen and methane as propellants. This European first was carried out on the Mascotte cryogenic test rig at Palaiseau. The objective is to reduce launch costs.

August

Characterization tests in Chile of "nightglow" radiation – weak natural lighting in the near-infrared band, due to OH radiation in the upper atmosphere. Infrared imagers and an ONERA spectro-radiometer confirm nightglow as a good light source candidate for night vision devices.

ONERA becomes associate partner in Sesar
ONERA is boosting its commitment to the modernization of air traffic management, as an associate partner in the Sesar project, with three main objectives: ATM-Fusion – integration of drones in traffic; Innovate – validation of ATM system; Magnitude – communication, navigation, surveillance.

September

A new non-destructive test (NDT) method for combat aircraft

Validation in an industrial environment, witnessed by the French air force chiefs of staff, of a non-destructive test method based on laser vibrometry, result of several years of research at ONERA, that does not require any signal processing.

French nanoparticles for propellants
To accelerate the combustion of certain propellants, ONERA is testing mixtures based on metallic nanoparticles. Aluminum-based structures, obtained by chemical synthesis in conjunction with French national scientific research agency CNRS, meet this requirement. Other benefits are better control over grain size and a national supply source.

October

Battle of the battlelabs

The ONERA battlelab was connected to counterparts at French defense procurement agency DGA, manufacturers (Thales, Cassidian, MBDA and eventually EADS/Astrium), the NATO network, etc. System interoperability will enable ONERA and the DGA, for example, to simulate a future combat drone mission.

Sethi, ONERA's airborne radar-optical imaging system
The first optical images, coupled with radar images, were obtained during design tests of an airborne environmental monitoring system. The Sethi pod, the only one of its kind in the world, was fitted with a radar imager, optical camera and hyperspectral camera.

Curved infrared detector for extended field of view
This infrared imager, a world first, was developed as part of a doctoral thesis. It could benefit all applications requiring a wide field of view, including defense (system simplification), astronomy (surveillance and star-mapping telescopes, E-ELT) and healthcare.

November

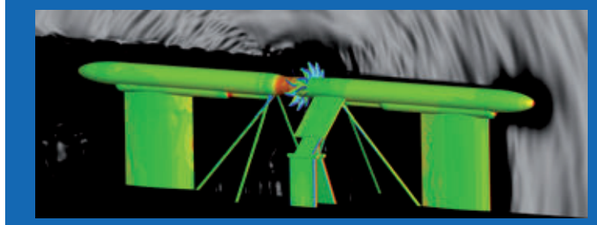
Post-seismic building evaluation

A new application for ONERA's lidar vibrometer seeks to establish a structural diagnosis of buildings after an earthquake, from a safe standoff distance. It offers unrivaled resolution by measuring vibrations with amplitudes of only a few hundreds of nanometers.

Acoustic characterization of wind turbines
ONERA carried out an on-site series of tests of aerodynamic noise sources from wind turbines (under contract to GDF-Suez). The aim is to better understand the link between the noise perceived on the ground and the actual noise produced by the wind turbine.

Design of a new rotor blade airfoil
Working for Eurocopter, aerodynamic design of a helicopter rotor blade airfoil. The new airfoil meets all objectives, within the scope of a contract guaranteeing results and deadlines. Thirty years after the OA2, OA3 and OA4 families, ONERA continues to supply this leading helicopter-maker with its airfoil designs.

December



200 million points for open rotor aerodynamic design
elsA software was used in acoustics research on a counter-rotating open rotor (CROR) type engine to reproduce the effects of installing these dual fans. After comparing results with tests at TsAGI, these calculations using 220 million points were considered conclusive.

Vibration tests for an Eole launch vehicle demonstrator
A series of tests verified the flutter behavior of the Eole airborne launcher demonstrator. Data gathered in these tests will be used on aeroelastic simulations to check that the flutter limits are compatible with the flight envelope.

Radar imaging tests for maritime surveillance
The Sethi multispectral imaging airborne station carried out maritime surveillance tests over the Atlantic. SAR images were acquired from small high-speed boats, under a wide variety of sea conditions. Tests evaluated the radar detectability of this type of target.

Microscope, an ONERA scientific mission, to launch in 2015
Microscope is a fundamental physics mission, designed to test the equivalency principle. Launch by a Vega rocket has been confirmed for 2015.

Scientific Awards

ESA's Special Prize awarded to **Sébastien Deck**, an engineer with the Missiles, Hypersonic, Launchers unit, for his contribution to better understanding airflows around launcher afterbodies, within the scope of the 7th European Symposium on Aerothermodynamics for Space Vehicles.

Amelia Earhart prize awarded to **Caroline Carvalho Chanel**, a doctoral candidate in the Decision-making unit. This award recognizes women from all countries who are earning a doctoral degree in aerospace. Her thesis subject is: "Planning sensor resources for perception in uncertain environments, with possible application on drones."

Sainte-Claire Deville medal awarded to Alphonse Finel, director of the Laboratory for Microstructural Investigations (a mixed ONERA-CNRS lab), during the annual event of the French Society for Metallurgy and Materials (SF2M).

ISAE/www.jpgphotographie.com

2011 Thesis Prize from the ISAE-SUPAERO Foundation awarded to:
Julien Marty, a doctoral candidate in the Turbulence, Models and Forecasts unit,
Stéphanie Roussel, doctoral candidate in the Information Systems and Fusion unit, and
Davide Zuzio, from the Heterogeneous Multiphase unit.

Prize for the best paper at the 45th Symposium on Applied Aerodynamics awarded to Abdelkader Benyahia, a doctoral candidate in the Helicopters, Propellers and Turbomachinery unit, for his paper on: "Transition Prediction in Transonic Turbine Configurations Using a Correlation-based Transport Equation Model."

2011 ODAS Award given to Myriam Kaminski, an engineer in the Composites Mechanical Characterization and Modeling unit for the "best paper written by a young scientist", on "Failure of composite laminates under cyclic loading."

Best Paper Award for Thomas Polacsek and Laurence Cholvy, engineers with the Large Systems Modeling and Analysis unit, for "A Framework to Report and to Analyze a Debate" at the Computer Supported Cooperative Work in Design (CSCWD) conference.

First person: our researchers and their projects

From basic research to technology transfers, from meeting the current challenges facing commercial aviation to long-term forecasts of tomorrow's air transport system, ONERA's researchers talk about their commitment to these fascinating projects, and express a shared desire to come up with innovative solutions.

ERIC BOUCHAÏB
ACCS APPRAISAL PROJECT MANAGER

It's doubly motivating to act as an expert appraiser on ACCS (Air Command and Control System), a program designed to revamp NATO's air defense system. First of all, this program has very ambitious goals, both technical and operational. For instance, the system has to interface with several hundred other systems, of very different types and technologies. Secondly, the aid we give the DGA in overseeing the installation then commissioning of two ACCS centers in France, gives our appraisal job a very concrete aspect. Our advantages in conducting this project were our analytical independence and dual expertise spanning both technical and operational aspects.

See project details on page 24

RENAUD LECOURT
RESEARCH ENGINEER

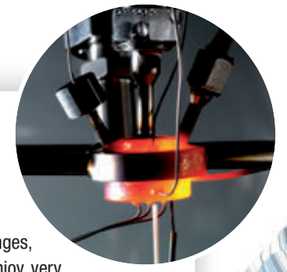
The tests I performed on the Mercato rig in 2011 were the first of their kind! It was the first time that aviation fuels with such a high percentage of alternative fuels (50%) had been tested under difficult conditions, namely ignition at altitude. I'm very satisfied with my contribution to the certification process for this biofuel. With this test rig, we developed a European, or even world-class resource in terms of the results it generated. It also gives ONERA a very flexible and low-cost installation that we can use to test innovative air-breathing propulsion concepts under a wide range of difficult conditions. Furthermore, our partner is now familiar with this test rig and uses it very regularly.

See project details on page 28

MYRIAM RAYBAUT
RESEARCH ENGINEER

The detection of chemical species to analyze the quality of air inside buildings is a major environmental and public health issue. ONERA addressed it by developing the optical parametric oscillator (OPO), a compact device that covers a large number of species. The small company Blue Science & Industry was interested in this technology, and is using two of our patents to develop an interior pollutant detector. Our partnership is an excellent example of how we can commercialize ONERA's parametric source technologies, and encourages us to continue and protect these innovative developments.

See project details on page 40



OLIVIER DESSORNES
RESEARCH ENGINEER,
DECAWATT PROJECT MANAGER

The micro-turbine studied as part of the Decawatt project is a brand-new concept entailing some tough technical challenges, which enabled me to expand my scientific and technical horizons and enjoy very enriching exchanges with my colleagues. The project's strong point was really ONERA's multi-disciplinary capabilities, using the entire research spectrum from fundamental to applied. We started with assumptions on combustion models, design computations and material studies, all the way to the design and production of the parts. Innovation was really the engine for this project, which resulted in two patents.

See project details on page 14

STÉPHANE GICLAIS
STRUCTURAL DYNAMICS ENGINEER

We had a very ambitious and highly motivating goal for this series of ground vibration tests: cut the length of tests in half, while guaranteeing the same quality of results. To meet this goal we had to innovate in all areas, from hardware and software to test methods. I had recently joined ONERA, which has over 25 years of experience in this area, so I participated in my first series of ground vibration tests on large aircraft. What really struck me was the impressive array of resources deployed to ensure that the tests went smoothly, in terms of both human and material resources.

See project details on page 32

CLAUDE LE TALLEC
SPECIAL ADVISOR, DRONE SYSTEMS AND
PPLANE PROGRAM MANAGER

Coordinating a design project for a fully automated personal airplane like PPlane is interesting from several points of view. First, it enables us to extrapolate the results of our work on today's drones and the air transport system. Next, it bolsters our position as a respected contributor to forecasts on tomorrow's air transport system, meeting European citizens' long-term expectations for mobility and environmental protection. Thirdly, on a more personal level, managing a European project is always very interesting, because you have to learn to manage people from different cultures, with a variety of working methods.

See project details on page 38

Exploratory research to shape the future

ONERA DECAWATT

ONERA creates technological breakthroughs to build foundations for medium and long-term developments. One of our main tools to achieve these goals is our federated research projects, which combine the broad-based skills of our researchers to tackle promising scientific subjects. Here's a closer look at the Decawatt project which aims to develop a brand-new technology:

A 10 CC GAS TURBINE DEVELOPING 100W OF POWER

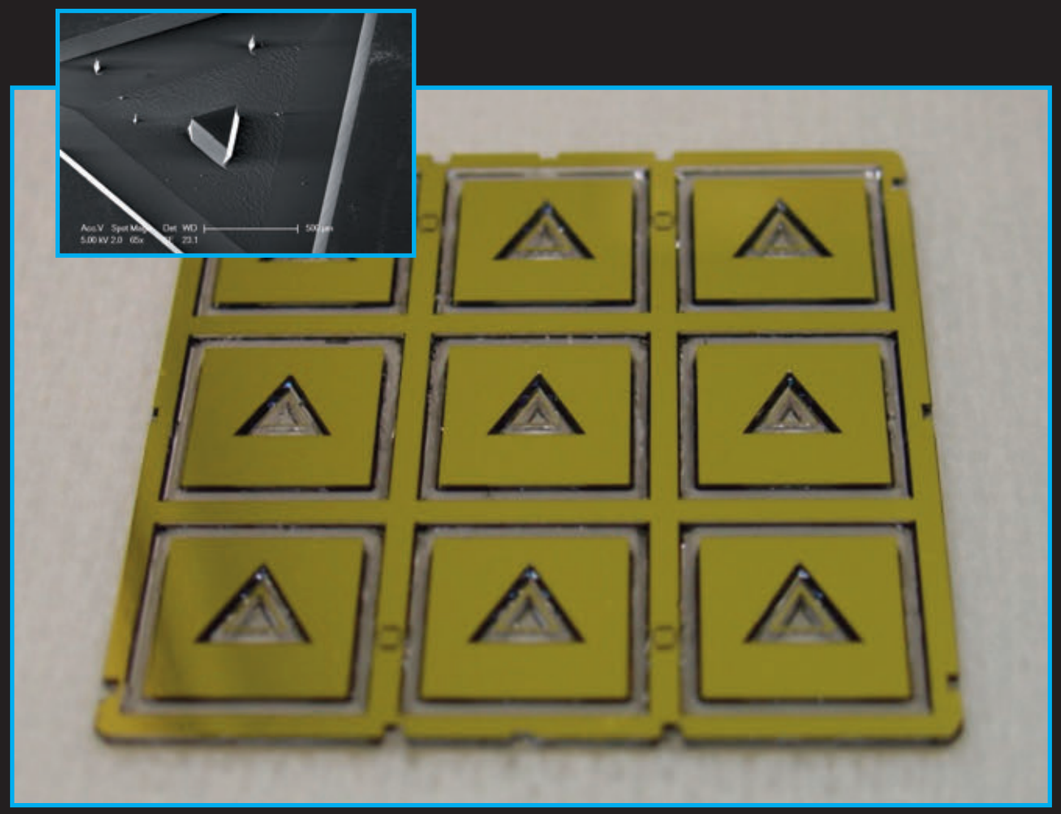
To develop this micro-turbine, the only one of its kind in this power class, ONERA's departments have risen to a number of scientific and technological challenges, entailing significant risks.

Work on this project expanded our understanding of new areas, giving ONERA a head start. For example, our researchers optimized the size of the micro-turbine and selected the exact materials used, identifying an alternative solution to silicon. They validated the combustion of propane in a miniature combustion chamber, and also the methods needed to design this type of system. Furthermore, the originality of this work spurred the interest of the scientific community and enhanced international recognition of ONERA.

ONERA needed six years of research to develop a micro-turbine prototype 10 million times smaller than an A380 engine, which should be ready to generate its first watt of power at the end of 2012. This compact energy source could play a pivotal role in a number of applications, including robotics, microdrones and soldiers in tomorrow's digital battlefield.

A partner in tomorrow's research programs

A major research player in France, ONERA conducts joint research projects submitted to the National Research Agency (ANR) for selection on the basis of excellence. The innovations developed by these ambitious scientific and technological projects strengthen the international competitiveness of France's scientific research.



Within the scope of ANR's "Blanc" program, ONERA participated in the ARQOMM project, to enable a macroscopic mechanical oscillator to reach quantum speed. We designed a quartz micro-resonator, weighing just 20 micrograms and operating at 3.5 MHz, that demonstrated the qualities of ultra-stability needed to show its fundamental quantum state, which would be a world first. This new resonator concept, now patented, also augurs well for advances in MEMS (microelectromechanical systems) time bases, since it is compatible with collective engraving techniques, a specialty at ONERA. These time bases could be used in GPS type receivers, or other applications requiring stable timing.

The ARQOMM project came to an end in 2010, but was extended through the Minotore project, launched in December 2011, for which ONERA is developing the resonators.

ONERA RENEWS CARNOT INSTITUTE LABEL IN 2011

On April 28, 2011 ONERA was announced as one of the 34 winning candidates for the Carnot Institute 2 label. Already selected during the first phase of the Carnot Institute project, launched in 2006, ONERA once again confirms its investment in joint research with other players, especially from industry, in its specialty of Aerospace Systems Engineering.

The renewal of ONERA's status as a Carnot Institute (for the Aerospace Systems Engineering unit) also reaffirms our ability to simultaneously carry out basic research, which refreshes our scientific and technological skills, and contract research to meet industry requirements.

Projects financed by the Carnot network increase ONERA's capacity for contract research. For example, the Wireless and SAO projects are designed to improve wind-tunnel testing by generating more precise experimental results, enabling engineers to reduce design margins.

SAO (Soufflerie Assistée par Ordinateur): computer-aided wind tunnels
The aim of the SAO project is to reduce the margins of uncertainty in experimental testing, calling on progress in computational fluid dynamics (CFD) to integrate the disturbances inherent in wind-tunnel measurements.
Wireless: Wind tunnel Innovative Rapid Experimental Endeavor for Smart Sensors
The Wireless project seeks to improve wind-tunnel tests by miniaturizing instrumentation attached to the model, and limiting wiring between the model and measurement systems, using fiber-optics and wireless transmissions.

ONERA's unifying and stimulating role was reaffirmed in the agreement signed with the National Research Agency in 2011, which set the objective of expanding partnerships with academia and with the Fraunhofer Institutes in Germany.

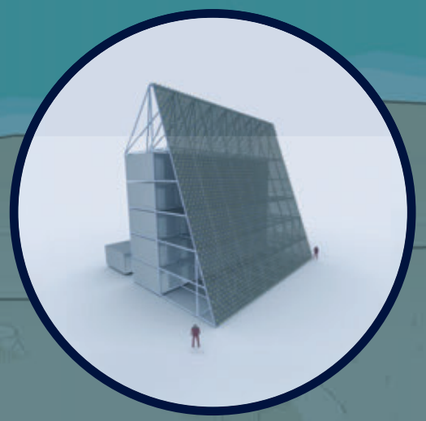
BALLISTIC MISSILE DEFENSE

A very-long-range radar demonstrator, from ONERA

At the 2010 Summit in Lisbon, NATO decided to develop a ballistic missile defense (BMD) capability to protect the populations and territories of European allies, in response to the proliferation of weapons of mass destruction. France, in its White Paper on Defense and Security published in 2008, expressed a need to develop an early warning and detection capability, based in particular on a very-long-range radar, that would be interoperable with NATO's intended BMD radar. French defense procurement agency DGA chose ONERA and Thales in 2011 to jointly develop a demonstrator for 2015.

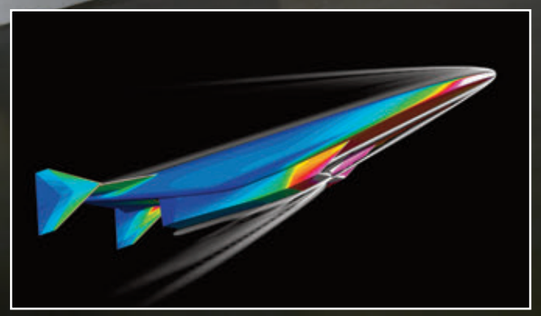
ONERA, which groups all areas of expertise needed for BMD systems, performed the initial design studies for this radar with Thales. It would be transportable, with a single active surface providing 120° surveillance of threats. The development of this radar would benefit from ONERA's proven innovation, experience and design skills.

The French Senate recognized ONERA's role as expert by consulting us for the 2011 report drawn up by the foreign affairs, defense and armed forces commission on ballistic missile defense.



Tomorrow's hypersonic propulsion system under test

ONERA has all the skills, expertise and resources needed to study and design new propulsion methods. In particular we have shown our capabilities through the LEA program, carried out since 2003 with MBDA on behalf of French defense procurement agency DGA.
The aim of this program is to design an experimental vehicle with a dual mode ramjet engine, then build and test prototypes in flight to verify whether the development method can produce a vehicle capable of operating in the speed range from Mach 4 to Mach 8.



The LEA program entered its final phase in 2011, with construction of prototypes and demonstration of their flightreadiness based on ground tests, prior to the actual flight tests, planned for 2014 and 2015. A key phase in this process is ground combustion tests of a full-scale LEA vehicle under Mach 6 flight conditions: the S4 wind tunnel in Modane was therefore specially modified to handle the model.

The LEA program seeks to demonstrate the propulsion budget of this experimental vehicle to a sufficient degree of accuracy, a prerequisite for any development of an operational missile using hypersonic propulsion.

Improving intelligence in urban environments through optronics

One of the strategic functions highlighted in the French White Paper on Defense and Security is "knowledge and anticipation" (or "knowledge-based security"), including the intelligence aspect. ONERA is conducting research to meet this challenge, in particular contributing our expertise in optronics through the DUCAS (Detection in Urban scenario using Combined Airborne imaging Sensors) project, on behalf of the European Defense Agency.

The DUCAS project is designed to evaluate the contribution of a combination of hyperspectral imaging and high-resolution space imaging for defense applications in urban environments. It is being carried out in partnership with teams from Germany, Belgium, Italy, the Netherlands, Norway and Sweden.

A series of ground and airborne measurements was performed in Zeebrugge, Belgium in June 2011. ONERA was in charge of organizing and carrying out the measurements to establish ground truths. These measurements are in turn used to check the calibration of airborne sensors and validate the algorithms used for atmospheric correction and image processing.

All data collected during these tests was then processed by ONERA, in charge of this part of the project along with its partners. The DUCAS project is scheduled to be completed in 2014 and will give the European Defense Agency information about the effectiveness of combining hyperspectral and high-resolution space imagery to improve intelligence in urban environments.

At the same time, through these tests ONERA was able to form a users group for a future hyperspectral demonstrator, Sysiphe, now under development.

Fostering the interoperability of air command and control centers

NATO has decided to revamp its fixed and mobile air operations command and control centers by installing a single integrated system that will cover mission planning, scheduling and control. The Air Command and Control System, or ACCS, is designed to be interoperable with national weapon and detection systems, in an environment dominated by the need for coordination and communications between armed forces, allies and civil/military commands.

ONERA is working with the DGA and the French air force to integrate the two ACCS centers[1] in the current French SCCOA[2] aerospace operations command and control system. We are basically involved in two areas:

- Technical and operational evaluations to help assess the impact of these systems on current command structures, and paving the way for the technical and operational validation of the ACCS systems.
- Participation in a security study which should show that the French ACCS centers integrated in an SCCOA environment are reasonably safe and will not contribute to the emergence of a catastrophic event.

To bolster our operational expertise, ONERA called on the specific knowledge of a former test pilot, radar mechanic and air traffic controller.

The results of this work help the DGA and the air force better understand the challenges, difficulties and risks entailed by the commissioning of the ACCS centers in France.

[1] Two ACCS centers are now being installed in France (Lyon Mont Verdun and Tours/Cinq-Mars-la-Pile), out of the 15 ACCS centers to be deployed in Europe.
[2] SCCOA: Système de Commandement et de Conduite des Opérations Aérospatiales.

Testing the performance of tomorrow's engines

Less fuel, less pollution, less noise: all imperative goals for the next generation of commercial airplanes. One of the solutions being considered by the aircraft industry for tomorrow's single-aisle jets is the open rotor engine, characterized by its two counter-rotating fans outside the engine. At ONERA, we contribute our unrivaled fleet of large wind tunnels to study the performance potential of this revolutionary technology, and help manufacturers make the right choices early in the game.

Tests on the Hera propeller test stand, designed by ONERA for Snecma, with a 1/5 scale dual rotor model, kicked off in 2011 at the large S1MA wind tunnel in Modane. Set to continue until 2013, or even longer, this unprecedented series of tests seeks to verify the aerodynamic and acoustic performance of a non-shrouded turbine engine. Results have to be equivalent to current turbofans – but with fuel consumption reduced by about 35%! However, keeping noise to acceptable levels is a major challenge. ONERA has invested more than 15 million euros, in a public-private partnership, to perform the full range of these aerodynamic and acoustic measurements.

The results of these experiments should confirm the decision by manufacturers to develop an open rotor engine that could start powering commercial aircraft in about 2025.

Testing biofuels before certification

Given the steady growth in air traffic and the increasing scarcity of natural resources, developing an alternative fuel to replace the conventional Jet A1 is a major challenge for the aviation industry. ONERA is contributing to this effort by coordinating the baseline study dubbed SWAFEA (Sustainable Way for Alternative Fuel and Energy in Aviation), whose results were published by the European Commission in 2011. We also showed that our test rigs could make a major contribution to developing certification procedures for fuels that were candidates to replace Jet A1.

In 2011 ONERA tested a biofuel that was a 50/50 mixture of Jet A1 and hydrogenated vegetable oil. Tests were carried out on the Mercato test rig, the only one of its kind in Europe, since it enables optical measurements on models reproducing the conditions for the ignition and re-ignition of jet engines and turboshaft engines at high altitude. These tests showed icing of the fuel, blocking the injector during ignition, which means this fuel could be very dangerous in flight.

These results led authorities to review the certification of this biofuel. Standard analyses based on specifications for aircraft fuels had not demonstrated this type of problem.

Studying aeroacoustics to reduce aircraft noise

ONERA is heavily involved in efforts to reduce aircraft noise, a critical goal for the air transport industry. Since 2005 we have coordinated Iroqua, a French research initiative on aircraft acoustic optimization, which brings together the major players in this area.
We call on cutting-edge numerical simulation and experimental systems to conduct our research, including the Cepra 19 wind tunnel at Saclay, in the greater Paris area.

Industry considers the Cepra 19 anechoic wind tunnel a strategic asset in aeroacoustic studies. Purpose-designed for these tests, the Cepra 19 facility is used by industry in its research to reduce aircraft noise, especially during takeoff and climb, as well as holding patterns, approach and landing. Aeroacoustic noise is generated by several different sources, including the engine, jet and fan, and of course the aircraft itself, especially when lift augmentation devices are deployed or the landing gear is extended.

The wind tunnel's size and its large-diameter free test sections enable the testing of aircraft models up to 1/11 scale, with low-speed airflow at up to Mach 0.38. Our researchers use this wind tunnel to identify, locate and characterize all noise sources, comparing this experimental data with that from numerical simulations.

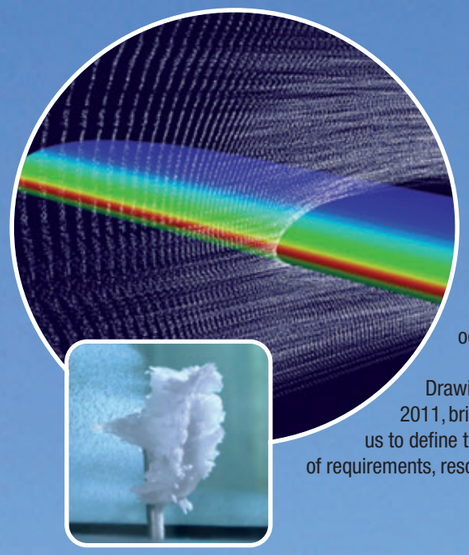
For the last few years, and up until at least 2014, the wind tunnel has a very busy schedule, confirming its major role in industry's efforts to reduce noise. In 2011 it was used to test the aeroacoustic performance of Snecma's new Silvercrest engine, designed for large cabin, long-range business jets. Starting in early 2012, it will also be used for acoustic validation tests of the new Airbus A320neo.

Optimizing ground vibration tests for greater flight safety

To earn certification, any new aircraft has to undergo a number of tests. One of these is ground vibration tests, showing that there is no risk of the aircraft being destroyed in flight because of vibrations. In 2011 we carried out a series of tests using 650 accelerometers to improve our test methodology.

During a long series of tests in March-April 2011, we performed measurements on an Airbus A340-600 that had already undergone vibration tests on its rollout in 2001. This plane was therefore used as a validation testbed for Airbus's new test environments, as well as for the hardware and software from ONERA and its German counterpart in this effort, the Aeroelasticity Institute at DLR Gottlingen. The overall aim is to increase the productivity of industry testing. Investigations were also carried out within the scope of the OGT (Optimization of Ground vibration Testing) research project.

Calling on the experience built up through these tests, and ONERA's new technical capabilities, we can provide an effective response to specifications for future aircraft dynamic identification tests, starting with the A350 XWB 900, scheduled to begin testing in early 2013.



ONERA is one of today's benchmark research organizations for icing, recognized worldwide. We have teamed up with NASA and the Federal Aviation Administration (FAA) in the United States since the mid-1980s, and also act as an expert for the Society of Automotive Engineers (SAE) to define the resources needed to confirm compliance with new certification rules. We were one of the first research organizations worldwide to develop computation methods to model the accumulation of ice, plus anti-icing and deicing methods, and to develop numerical methods and tools to predict performance degradation on fixed and rotary-wing aircraft.

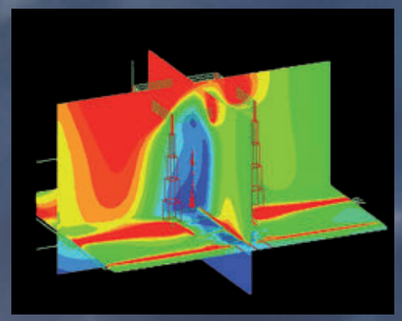
Drawing on this position of leadership, we organized a conference on icing in October 2011, bringing together the leading figures involved with this problem. This conference allowed us to define the expectations of the different stakeholders involved, and to define a shared vision of requirements, resources and priority actions needed in the coming years to meet safety requirements.

Icing is of course one the most dangerous phenomenon for any type of aircraft. It can have a very strong impact on the airframe, the engine or the propellers, in flight or on the ground. The unpredictable weather and pollution conditions seen over the last dozen years have created even more complex events that must be taken into account. This issue concerns most stakeholders in the aviation sector, from aircraft, engine and equipment manufacturers to airlines and airports. They have to counter icing problems by using deicing or anti-icing systems. At ONERA, we have the skills and tools needed to understand and predict this phenomenon and help them cope with the new and more stringent certification regulations.

Fighting icing through enhanced understanding

Lightning protection for launchers

ONERA has long been a consulting expert on space programs, including contributions to the launch complexes for the Ariane rocket. We are now leveraging this expertise to define a method for the lightning protection of the Soyuz and Vega launch pads.



In addition to material damage, lightning can also seriously impact electronic systems. In 2011, an ONERA team made two trips to the Guiana Space Center in French Guiana, to qualify the lightning protection system for the Soyuz and Vega launch complexes. This was the culmination of theoretical studies that had kicked off back in 2006, and involved the preliminary design of launch site protection systems by 3D numerical simulation.

The meshes were defined by the Alice software developed by ONERA. Tests in 2011 involved injecting current into the four protection pylons and measuring the induced electromagnetic effects. These measurements verified the system's compliance with specifications.

At the same time, this mission also reinforced ONERA's position as a leader in designing methods for the lightning protection of launch sites.

pplane
THE PERSONAL PLANE PROJECT

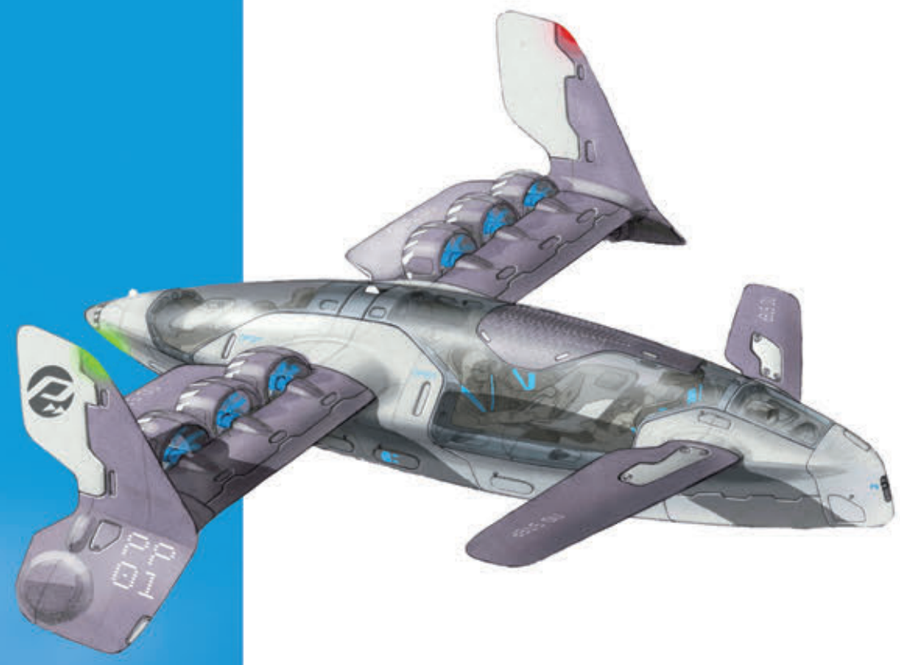
The PPlane project was launched by the European Commission in 2009 as part of its long-term research program. Coordinated by ONERA, PPlane brings together research centers, universities and industry. This design concept for a personal transport vehicle addresses a very concrete concern, namely the steady rise in European road traffic and the resulting congestion. By introducing an intermediate aerial link in this chain we can reduce congestion and also give new European countries an alternative for the development of their transport systems.

Our researchers took a very close look at not only the technical aspects, but also social and environmental factors to come up with a good idea of what a personal plane could look like. At this point, it is clear that electricity is the only energy source that would allow us to build an airplane that generates neither noise nor pollution. The propulsion technologies exist, but we still don't have the onboard electricity generation and/or storage technologies that would double or triple the capacity of current batteries, without making the whole system too heavy.

Over and above the technical aspects, an equally important point studied was how to ensure that the maximum number of people could fly the plane, in total safety. It would have to be as automated as possible, with a remote pilot, and this is where ONERA's previous work on drones came in very handy. Such a high degree of automation would go hand in hand with changes in current air traffic control systems, needed to control the growing traffic.

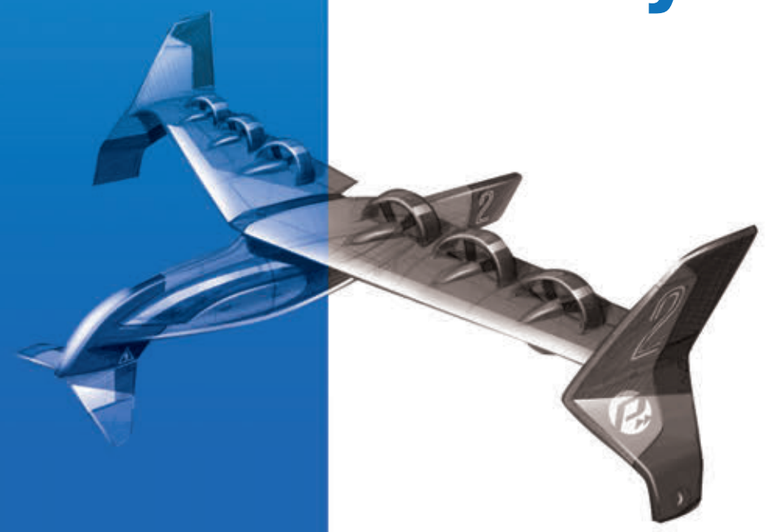
Thanks to the PPlane project we can already identify the most promising paths to offer this type of air transport by 2050 or so, a transport mode that would be economically viable, socially acceptable and friendly to the environment.

PPlane Project 2010 – Illustrations: Antony Villain, Stéphane Janin - Spaadbirds Team



One of ONERA's core missions is studying tomorrow's air transport systems. For example, we coordinate the European program PPlane, which is exploring the concept of an automated personal plane carrying several passengers, that could be piloted by almost anybody. The challenge is to contribute an air component to tomorrow's multimodal transport organization, to support greater flexibility and faster travel.

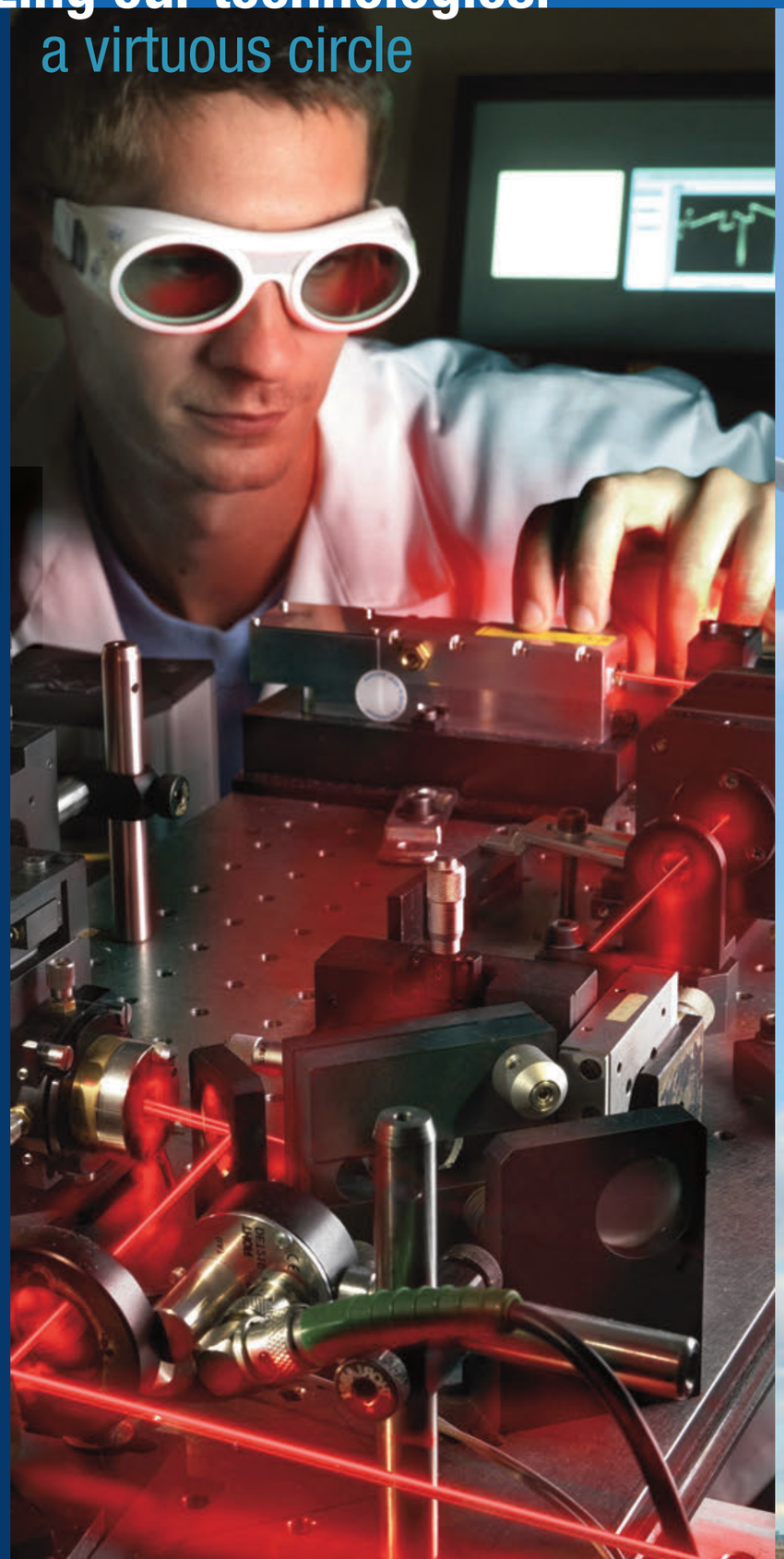
From dream to concept, a personal plane for everybody!



Commercializing our technologies: a virtuous circle

The company Blue Industry & Science will use ONERA's patents on optical parametric oscillator sources to develop new applications, such as the analysis of air quality inside buildings.
This ONERA technology transfer started in 2010 and was covered by a licensing agreement signed in June 2011.

ONERA is a pioneer in the development of the new generation of miniaturized instruments designed to detect gases using infrared spectroscopy. Our optical parametric oscillators (OPO) cover the entire spectrum (from 1.5 to 4 µm) for most industrial pollutants and greenhouse gases (VOC, NOx, COx, etc.). The performance of these OPOs is also compatible with the development of generic yet sensitive multi-species gas sensors for various applications, including industrial security, air quality analysis, reduction of engine emissions, and fundamental spectroscopy experiments. Starting in June 2012, Blue Industry & Science will be offering an unrivaled range of transportable interior pollutant detectors, easy to use and capable of measuring multiple pollutants in real time.



Leveraging our expertise to protect citizens

Wind turbines may disturb weather radars, which limits where they are installed. ONERA is using its expertise in radars to better understand, simulate and reduce these disturbances. Our work extends to the characterization of absorbent materials to make turbine blades "stealthy".

Sipré, developed by ONERA, is a phase in a research program on this subject launched by the French Ministry of Ecology, Energy and Sustainable Development. It is designed to come up with refined models of the radar disturbances caused by wind turbines, to better understand the phenomenon and define solutions to reduce it. Using Sipré data, meteorologists and property developers can hold discussions on a more scientific basis.

In 2011 ONERA carried out an experiment near a weather radar site and a wind farm to validate the software by collecting data in the field.

ONERA also offers solutions to decrease the observability of wind turbine blades, using sound-absorbing materials in the blades, as part of the Eodis project that started in September 2010. To evaluate the best way of integrating these materials, ONERA performed measurements and holographic imaging analysis in one of its anechoic chambers, usually used to test the stealthiness of aircraft and missiles!

IFAR | INTERNATIONAL FORUM FOR AVIATION RESEARCH

ONERA organized the second International Forum for Aviation Research (IFAR) during the 2011 Paris Air Show. Founded in 2010, IFAR is a voluntary collaboration forum to foster exchanges between aviation research organizations, in response to rising global demand for more Research & Technology. IFAR seeks to support its members in applying their research objectives. Participants in the 2011 IFAR meeting, representing 20 aviation research organizations from around the world, approved the IFAR Charter and five new members. They also validated the framework program, with a particular focus on climate change and noise reduction. This major forum further consolidated ONERA's leadership in acoustics research.

http://www.ifar.aero/

ONERA's international presence has underpinned the support provided since 2009 to industrial partners carrying out sales & marketing in Brazil.
We are mainly involved in preparing proposals for the defense and security markets.
This support took on concrete form in 2011 as part of an innovative contractual framework, setting up an ambitious long-term technology transfer, with a major player in the French aerospace industry.

Aerospace partners
Members of EREA

EREA
Association of European Research Establishments in Aeronautics

Associate members

Belgium — VKI
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ONERA provides basic and applied research and services
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THE FRENCH AEROSPACE LAB

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