

Annual Report

# Research Report and Economic Development

2013/2014



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# Research Report and Economic Development 2013/2014

German Aerospace Center (DLR)

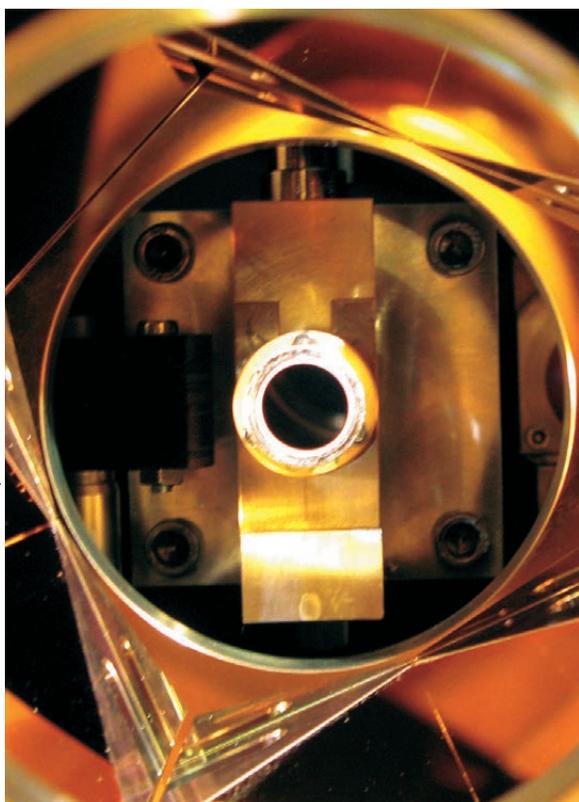
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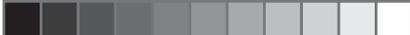
## Research Report

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## Economic Development

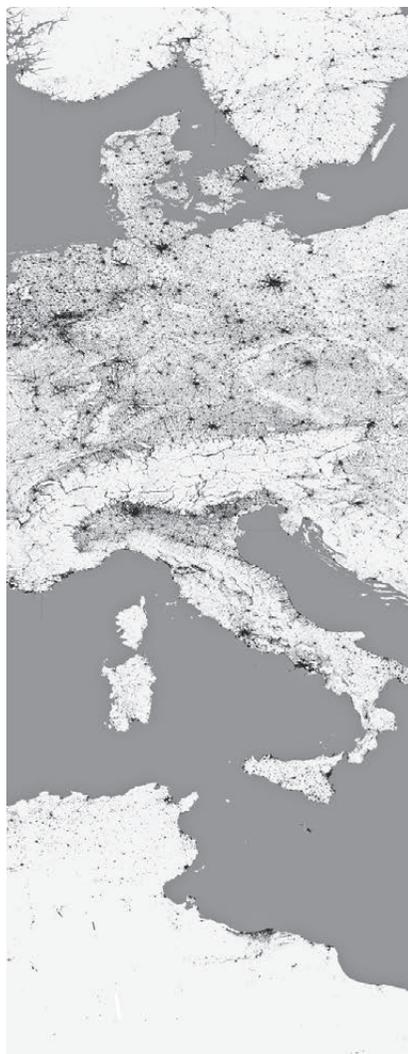
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## Dear Readers,

As the Chairman of the Executive Board of DLR, I am invited every year to compose a preface to the DLR Research Report. This is a challenge due to the difficulty of adequately illuminating the fascinating world of research at the German Aerospace Center in just a few short words.

DLR was again extremely active in all its research and management areas over the past year: our Aeronautics and Space, Energy, Transport and Defence and Security programmes boasted excellent projects and missions, and thus outstanding results. And they did so within the constraints of the stipulations of the Federal Government and the research policy course set by the currently reforming European Commission. Imbued with a confidence based on DLR's broad and globally recognised achievements, we formulated our strategic orientation, entitled Next Generation DLR, and invited our staff to *dare for more DLR*. I hope that this step will succeed in ensuring DLR's viability for the future. Because, in the spirit of Antoine de St. Exupéry: we cannot foresee the future, but we will enable it. This is what DLR's many exciting projects and activities stand for: from flying in the name of research, through the International Air Show ILA in Berlin, to processing vast amounts of data from space. The occurrence of natural disasters

drives DLR to continue its work on early warning systems that can be used around the world, while thanks to our state-of-the-art simulators new assistance systems for pilots provide a very realistic experience of all in-flight processes. Together with our partners we are not only working to improve our climate models, but also on in-flight recording and reduction of emissions from aviation fuels, particularly biofuels.

The DLR satellite team TanDEM and TerraSAR delivered data on, among other things, the precise settlement patterns of humans on Earth. Europe's space freighter, the ATV, took off for the ISS for the last time to supply the space station's crew – a crew that included Alexander Gerst, an ESA astronaut of German nationality. His "Blue Dot" mission represents a particular highlight for German space exploration, both in management and in research. The mission is referred to at several points in this report. For example in the image on the left: it shows a mosaic of Europe comprised of images taken by Alexander Gerst from the ISS and represents an enlarged section of the cover image of this research report, which was compiled entirely from photographs of Earth taken from space and the ISS by astronauts in recent years.

Our planet: a place worth protecting.

The Rosetta probe has been journeying for many years to reach its orbit around the comet 67P Churyumov-Gerasimenko



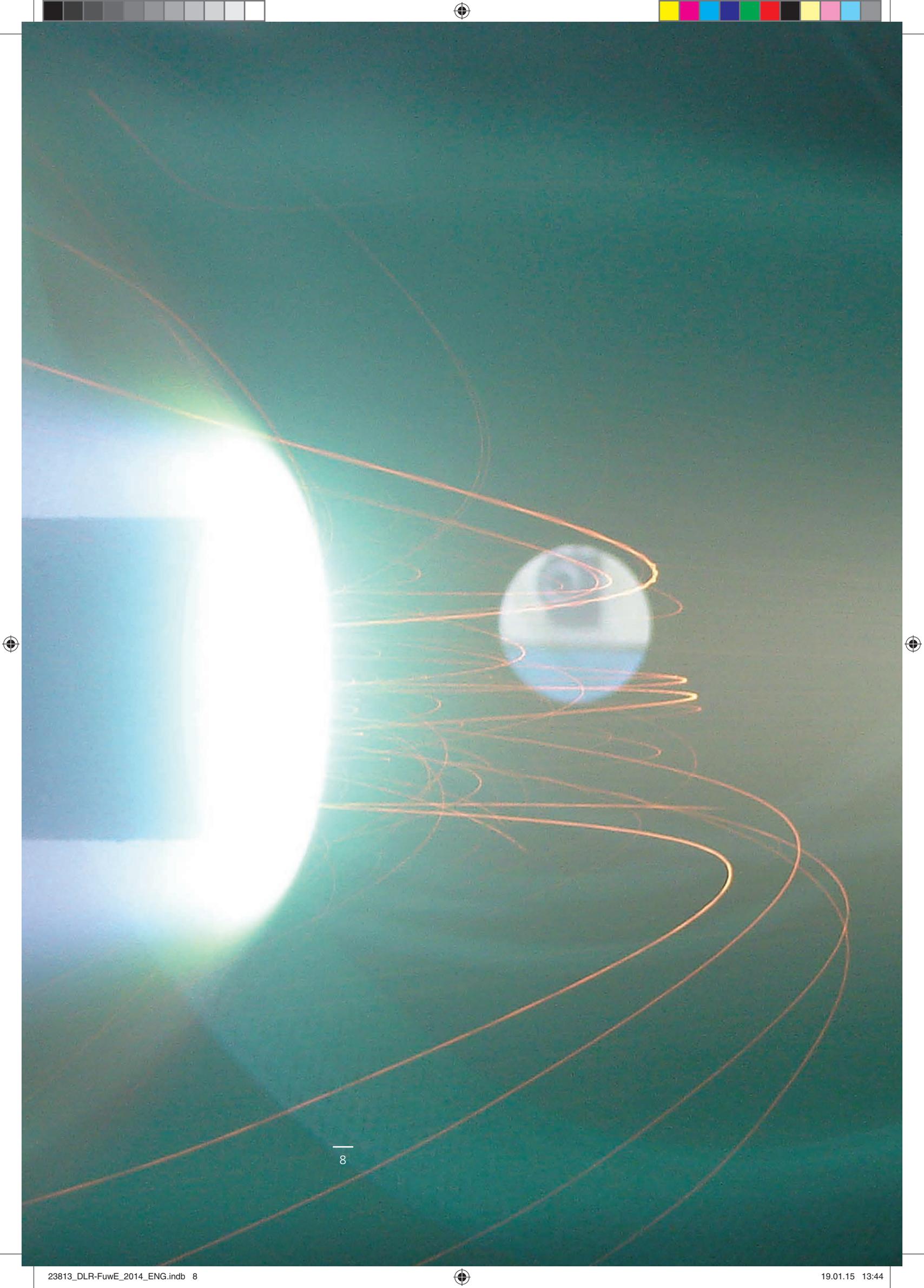
and set down the lander Philae on its surface. Just one of many missions in which DLR is involved.

DLR is an exciting place to work. There is so much more to report from the world of science, and this Research Report and Economic Development proves it.

It's a wonderful document for anyone interested, for our share- and stake-holders in society, business and politics. I wish you all an entertaining and informative read. I believe in our "Knowledge for Tomorrow".

Yours sincerely,

Prof. Dr. Johann-Dietrich Wörner  
Chairman of the Executive Board





# RESEARCH REPORT





# Aeronautics

Aeronautics research today is strongly characterised by international cooperation. DLR is traditionally particularly active at a European level due to its defining role in EREA (Association of European Research Establishments in Aeronautics), its strategic partnerships with France's ONERA and the Dutch NLR, but also due to its active involvement in ACARE (Advisory Council for Aviation Research and Innovation in Europe), where the recent major European research strategies were developed. As the central German research institution in this field, DLR's aim is to take on a defining role in shaping the European Research Area.

Further afield, DLR has lately significantly intensified its cooperations with non-European partners, in particular with NASA. This most recently produced visible results in the form of an initial joint flight measurement campaign examining the use of alternative fuels at the NASA Armstrong Flight Research Center in California in the spring of 2014.

The measurement campaign took place at the invitation of NASA to participate in a research project

initially planned as national in scope. The cooperation was based on long-established contacts between NASA and DLR experts in this field.

The campaign was embedded into the international IFAR (International Forum of Aeronautical Research) network, which formed some years ago on the initiative of DLR and meanwhile represents the most important aeronautics research institutions from 24 member states worldwide. They meet annually for summit meetings to exchange information, formulate joint interests and expand cooperation between members. The above-mentioned campaign is the first concrete project to be embedded into the IFAR context; its integration into this wider framework ultimately resulted in the Canadian NRC also joining the campaign with an aircraft of its own.



## ACCESS-II

### Joint research flights with NASA and NRC to examine the use of biofuels in aviation

The use of biofuels in aviation offers a way of reducing particle emissions and climate effects of condensation trails. Joint flight tests between NASA and DLR to examine this topical research subject took place at NASA's Armstrong Flight Research Center in Palmdale, California in May 2014. The research flights were part of the ACCESS-II (Alternative Fuel Effects on Contrails and Cruise Emissions) project. NASA used a DC-8 and a Falcon HU25, DLR its Falcon 20; a CT-33 belonging to the Canadian NRC was used for specific additional measurements, particularly during the DC-8's climb flight.

The four CFM56 engines of the DC-8 were operated alternately on regular JP-8 aviation fuel and on a fifty percent mixture of conventional kerosene and HEFA (Hydroprocessed Esters and Fatty Acids) biofuel. The Falcon20 and HU25 followed the DC-8 and measured the particle and gaseous emissions in its exhaust plume. The microphysical properties of condensation trails resulting from different fuels were also measured.

Compared to pure kerosene, these measurements showed significantly reduced emissions of sooty particles and sulphur compounds when using the HEFA-kerosene mixture. Differences in the size distribution of the ice crystals in the contrails were also found. Accompanying model simulations to evaluate possible savings in the climate effects of air traffic through the use of biofuels have begun.



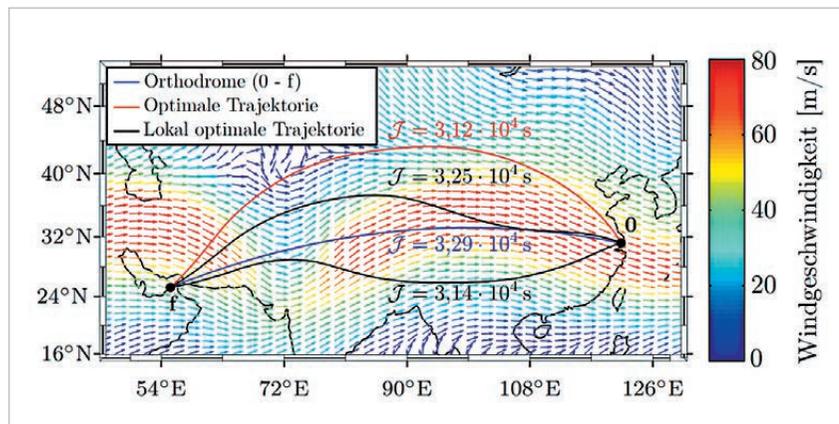
On board its Falcon20, the DLR Institute of Atmospheric Physics measures particles and trace gases in the exhaust plume and contrails of the biofuel-operated NASA DC-8 in the airspace over Edwards Air Force Base in California (photo: NASA)

## North Atlantic connections

### Measures to increase flight efficiency in cooperation with NASA

In air traffic management, the research cooperation on *Route Optimization with Environmental Impact* established with NASA in 2012 has achieved its first results. The aim of this cooperation between the NASA Aviation Systems Division of the Ames Research Center in California and the participating DLR Institutes of Air Transportation Systems, Flight Guidance and Atmospheric Physics is to examine measures to increase the efficiency and reduce the environmental impact of air travel. The research focuses on transatlantic flights and ideally combines and utilises the respective expertise of the involved research centres.

During a four-month research stay of an employee of the Institute of Air Transportation Systems with NASA's Aviation Systems Division, the project partners developed a joint flight movements database for transatlantic flights which integrates flight profile data from the EUROCONTROL Demand Data Repository (DDR) with flight paths from the FAA's Enhanced Traffic Management System (ETMS) in such a way that the respectively highest available flight path resolution in American (National Air Space, NAS) and European (ECAC) air space can be used to generate reference trajectories. An initial paper on the subject was published at AIAA Aviation 2014. During the research stay, the researchers also compared route optimisation algorithms used by the DLR Institute of Air Transportation Systems and by NASA to calculate optimal flight paths under windy conditions in terms of various cost functions (e.g. minimum travel time, minimum cost,



Example of an optimal flight path (red) for a flight from Shanghai to Dubai (westward)

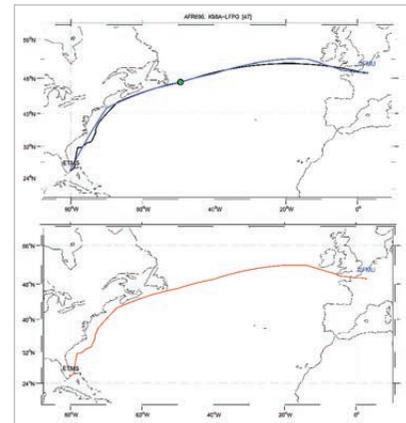


Illustration of flight paths in the flight movements database created by the project. Top: Overlay of two datasets Bottom: Resulting flight path

minimum fuel consumption) in order to gain an understanding of the differences between and assumptions underlying the respective models. For selected flight movements from the resulting reference database, these algorithms based on the principle of optimal control were then used to compare flight paths actually taken with the respective wind-optimised routes in order to determine potential increases in efficiency on these routes. Initial ideas for a joint project with airlines operating on transatlantic routes, such as Lufthansa and United, were developed, and Lufthansa has already expressed a strong interest in participating.

## APNT

### Safety net for civil aviation navigation

Civil aviation navigation is increasingly based on the use of GNSS (Global Navigation Satellite System). To ensure that a safety net is available in the event of GNSS outages, suggestions for ground-based APNT (Alternative Positioning, Navigation and Timing) systems are currently being developed. DLR has shown that the future aeronautical communications system LDACS1 (L-band Digital Aeronautical Communications System, Type 1) is a promising APNT candidate, thus combining communication and navigation uses. DLR is also exploring solutions for the most urgent challenges in APNT development.

Information on the underlying radio channel between ground station and aircraft is of great importance in developing and evaluating ground-based APNT systems. In the autumn/winter of 2013 DLR conducted an extensive flight measurement campaign that successfully meas-

ured the radio channel properties for all relevant flight phases. Based on the measured results, the researchers are currently drawing up a channel model that permits the simulation and evaluation of future APNT systems.

The achievable positioning accuracy depends heavily on the distribution of APNT ground stations. DLR has created a software program for geometric and coverage analysis with which positioning accuracy can be determined as a function of station distribution. Station densities comparable to today's radar monitoring systems would already provide the horizontal positioning accuracy necessary for APNT at flight altitudes of 3,000 metres and above.

Robust and high-precision time synchronisation between the ground stations presents a further challenge for a ground-based APNT system. DLR has developed a range of possible concepts for time synchronisation and tested them in simulations. The tests showed that the developed concepts remain capable of maintaining time synchronisation with the necessary accuracy even if GNSS fails.

# Maiden flight

## ... on the simulator

A mid-range aircraft with forward-swept transonic wings performed its *maiden flight* on April 8, 2014, in the AVES (Air VEhicle Simulator) flight simulator of the Institute of Flight Systems. In an over two-hour test programme, a DLR test pilot examined the flight characteristics of the new configuration, the basic design of which was created by the LamAiR (Laminar Aircraft Research) project conducted by the Institute of Aerodynamics and Flow Technology.



Virtual model coming in to land on AVES

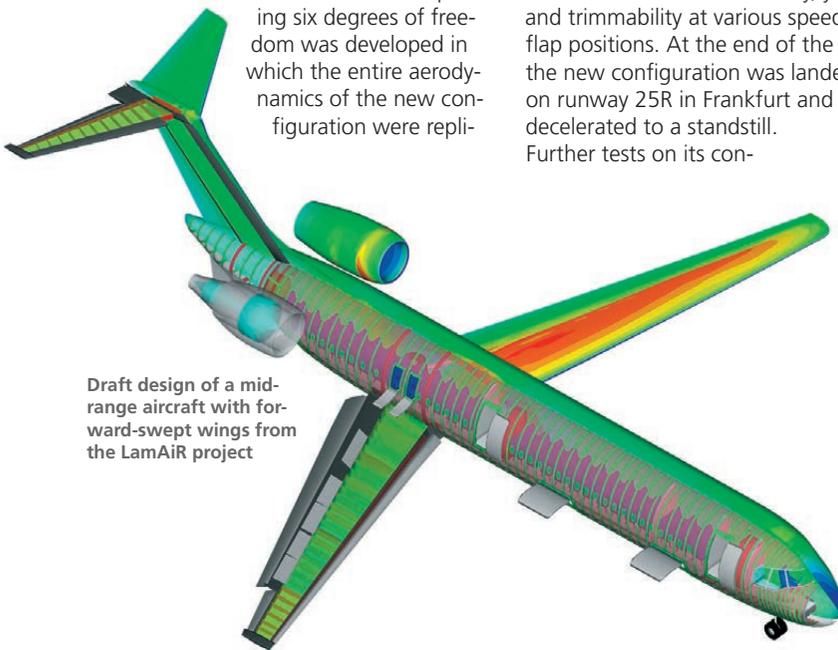
In addition to its forward-swept wings, the Airbus A320-sized configuration is characterised by its two rear engines and T-tail. To begin with, the NumEx project designed and built a wind tunnel model that was measured both statically and dynamically in the DNW-NWB low-speed wind tunnel. From these measurements a real-time capable, AVES-compatible simulation model comprising six degrees of freedom was developed in which the entire aerodynamics of the new configuration were repli-

cated into the post-stall range. Missing models of subsystems such as engines as well as ground handling were adapted and applied from the A320 AVES model.

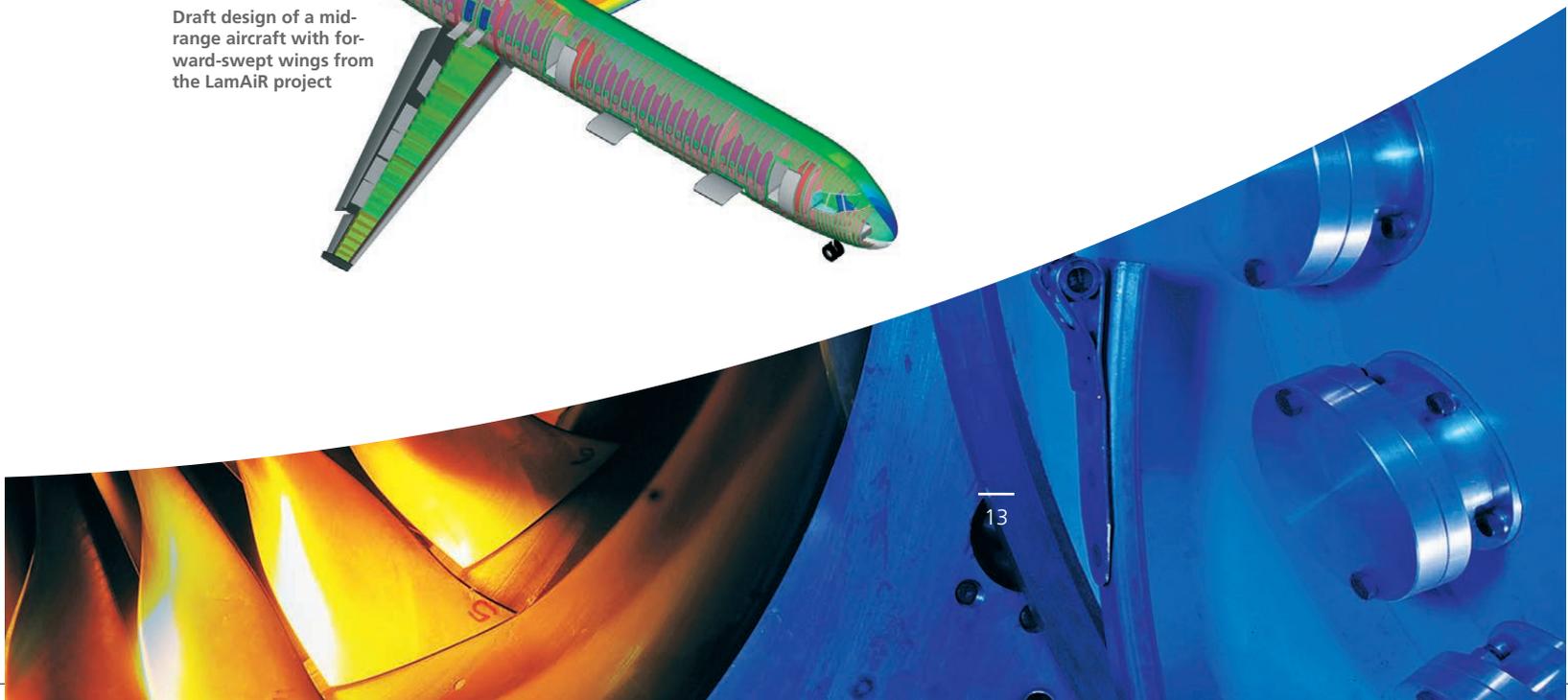
The first simulator test programme included tests to evaluate flight characteristics such as controllability, longitudinal, directional and lateral stability, yawing and trimmability at various speeds and flap positions. At the end of the *flight* the new configuration was landed safely on runway 25R in Frankfurt and decelerated to a standstill. Further tests on its con-

trollability during crosswind landings compared to the landability of an A320 and experiments on the risk of possible super-stall behaviour of the forward-swept wing in connection with the T-tail have meanwhile also been conducted successfully.

The AVES simulator experiments with the DLR configuration represent the successful conclusion of a development chain that comprises preliminary drafts, wind tunnel measurements, numeric simulations and the development of a real-time capable simulation model.



Draft design of a mid-range aircraft with forward-swept wings from the LamAiR project



## Antonov-2 double decker

### Used at DLR for wake vortex experiment

On July 3 and 4, 2014, DLR conducted flight experiments with an Antonov An-2 and a Robin DR 400 at Rheinsdorf airport in Brandenburg in close cooperation with the German Federal Bureau of Aircraft Accident Investigation (Bundesstelle für Flugunfalluntersuchung, BFU), the Federal Aviation Office, the Institute of Flight Guidance and Control at Technische Universität Braunschweig and the company MessWERK. The specific aim of these experiments was to reconstruct the aviation accident in Backnang-Heiningen (BFU 3X134-12), which the Institute of Flight Systems had analysed and evaluated in March 2014. The facts it discovered regarding the danger to general aviation aircraft from An-2 wake vortices surprised the BFU experts and led them to request the validation experiment.

The tests consisted of a visualisation of vortex degeneration and flights into vortices. The degeneration of the AN-2 vortex in ground effect was documented by observing the behaviour of generated smoke during low-pass flights of the AN-2 over the airport. The overflights took place in the early morning hours in very calm weather. It was observed that the vortices retained a high rotational energy at an altitude of approx. 10 metres and a relatively fixed position for sometimes up to 60 seconds after the overflight.

To validate the rolling motion of a DR 400 when flying into a wake vortex, the aviation accident was reconstructed behind an AN-2 at a security altitude of approx. 1200 metres. The position of the



Visualisation of vortex unrolling after AN-2 ground overflight

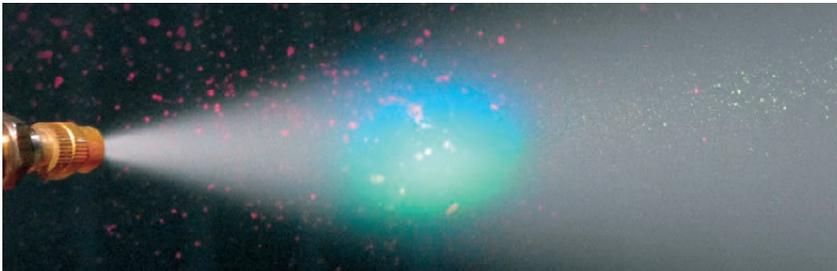
left vortex was marked with smoke which was visible up to a distance of 1000 metres behind the AN-2. On several occasions the DR 400's entry into the vortex caused a severe rolling response in which roll angles of up to 104° were measured. These roll attitudes were reached in less than two seconds and resulted in a loss of altitude of well over 50 metres before the pilot was able to stabilise the aircraft.

Analysis of the flight experiments has confirmed that the calculations regarding the strength of the AN-2 vortices, the prediction of slow vortex degeneration in low-turbulence conditions and the resulting danger to small aircraft were entirely correct. Both the results of the study and their impressive validation through the flight experiment will form major components of the BFU's examination report.

## Guinness World Record

### Heaviest weight lifted with glue

During the *German Aerospace Day* at the DLR site in Cologne on September 22, 2013, the Institute of Materials Research conducted a very special material mechanics test, impressively demonstrating the progress made in researching and developing a new adhesive technology in a world record attempt. A 16.1-ton truck was lifted one metre above the ground by means of two bolts affixed to a thermoplastic polymer by an adhesive area no larger than a credit card; the truck had to be suspended for an hour. The employees of the Mechanics of Materials and Joining Technology department beat the previous world record from 2012 by approximately 6 tons and were officially awarded the new Guinness World Record.



Fluorescence of a pollutant-aerosol mixture (three components) when examined from a distance of 135 metres under UV radiation ( $\lambda = 355 \text{ nm}$ )



Experimental analysis to optimise radiation wavelengths for classifying chemical and biological noxious substances

The new adhesive technology is based on an innovative pre-treatment of the joining areas and shows its potential in particular in combination with high-performance thermoplastics. It is not only significant as a pure joining technology, but also facilitates hybrid lightweight construction with metal-polymer layer systems (laminates, e.g. Glare) such as those used for example in aircraft construction for the fuselage of the A380. Large sections of the fuselage are subject to mainly biaxial loading during flight; the Institute of Materials Research was able to replicate this in experiments using the Institute's biaxial test rig. Not only can the newly developed adhesive technology serve as a basis for developing innovative fibre-metal laminates; it will also

allow their mechanical suitability for innovative fuselage structures to already be experimentally proven during the development process.

Alongside the purely static rigidities, the long-term resilience of the adhesive connections and hybrid components to material fatigue and degradation processes caused by environmental factors are particularly important. In the long term, only developing a fundamental understanding of the effective adhesive mechanisms and deterioration processes under realistic conditions will allow systematic solution approaches for a range of requirements and material combinations to be provided without time-consuming and costly empirical test series.

### Sticky world record



"High-performance products are becoming ever more hybrid, meaning that different types of materials are combined to create solutions with optimal cost-benefit ratios. Joining different materials is however always a challenge to develop the best and most long-lived interface between the materials. With its "Glue" world record DLR has shown that we're at the cutting edge of this field."

**Prof. Dr Stefan Reh**  
Deputy Director of the Institute of Materials Research

## LAIRDIM

### Helicopter-based detection of noxious and hazardous substances

Detecting and identifying hazardous substances early on can save lives – be it in response to threats to civil security from attacks by radical groups, the accidental release of hazardous substances from industrial plants following an accident, or in the event of natural disasters. What these scenarios have in common is that initially neither the type of hazardous substance nor its concentration or spread are known. In addition, the affected local areas are frequently not directly visible or accessible to rescue systems, or the affected areas may no longer be reachable from the ground due to infrastructure damage following natural disasters such as the March 2011 earthquake and subsequent tsunami in Japan.

In order to quickly and comprehensively identify an acute threat, an air-based detection system is an appropriate, and often even the only solution. Early identification of a hazardous substance is the basis for qualified countermeasures from security forces and first responders, and also allows the initiation of appropriate rescue and protective measures for victims and emergency personnel.

The LAIRDIM (Laser-based Airborne Detection, Identification, and Monitoring of biological and chemical hazardous substances) project is developing the fundamentals of a helicopter-borne laser-based detection system to record and identify chemical and biological hazardous substances while achieving the lowest possible spurious trip level. The challenge for the system lies in facilitating eye-safe detection of initially unknown hazardous substances while allowing pilots to maintain a safe distance from the danger zone. To this end the project is developing new detection concepts designed to provide measurements independently of various ambient conditions during fast overflights. UV laser sources are used to evaluate detection procedures such as LIF (laser-induced fluorescence) and Raman scattering. To permit the classification of a vast number of noxious and hazardous substances, detection methods are combined and optimal excitation wavelengths determined to minimise the number of required laser sources. Distinguishability of selected chemical and biological substances at distances between 20 and 135 metres has already been proven.

The complete system is being developed and validated on the DLR optical test range in Lampoldshausen, which offers excellent conditions for scenario-appropriate evaluation of such a system. These tests are carried out both under natural atmospheric conditions and under worst-case scenarios for the detection system (artificial introduction of aerosols and particles); their results permit the derivation of design parameters for a future helicopter-borne laser-based detection system.



ACT/FHS with rescue hoist and sensor to record load oscillation (sensor on hoist arm)

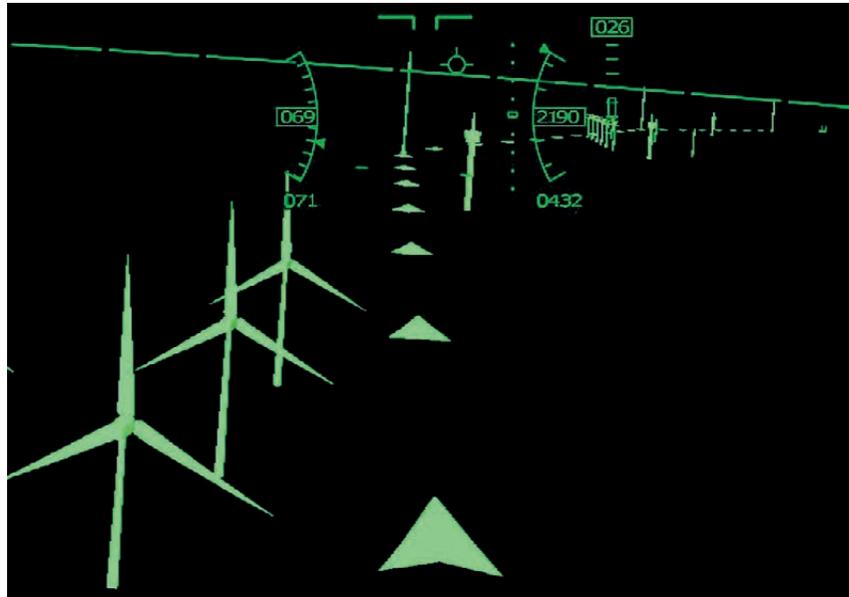
## HALAS

### Flight experiments demonstrate automated slung load stabilisation

Rescue hoists mounted to the sides of helicopters are used during rescue and recovery operations in mountainous areas or on the high seas, during supply flights to offshore wind power plants or oil rigs. The advantage of rescue hoists is that they can be used to set down and pick up persons and objects in inaccessible terrain where helicopters cannot land; load hooks and rope attachments located centrally on the underside of the helicopter, on the other hand, are used to transport large and bulky loads. Regardless of how the slung load is affixed, attaching it creates a coupled system,

thus presenting an additional challenge to the pilot. Alongside his or her main mission and flight control, s/he now also has to control the slung load. This inevitably means a higher workload for the pilot. When transporting slung loads, low-frequency oscillations may occur, and slung loads swinging upwards are a frequent cause of accidents and incidents in slung load transportation. To increase flight safety and reduce the workload of pilots during slung load missions, the HALAS aeronautics research project has developed a pilot assistance system to automatically stabilise slung loads on rescue hoists. In cooperation with industrial partner iMAR Navigation GmbH, DLR has developed a hoist-compatible sensor system to measure load oscillation and

tested this system in flight with the DLR research helicopter ACT/FHS in the spring of 2013. A further test flight campaign with the ACT/FHS and a rescue hoist in the autumn of 2013 demonstrated automated slung load stabilisation with this system and the control algorithms developed at the Institute of Flight Systems for the first time for a pre-specified rope length. Based on the findings from these successful flight experiments, the aeronautics research project SISAL (Sicherheitsrelevante Systeme und Ansätze in der Luftfahrt, Security-relevant systems and approaches in aviation) is cooperating with Airbus Helicopters Deutschland GmbH and iMAR Navigation GmbH to continuously advance this assistance system. The project's activities will focus on including flight characteristics in the system design and evaluating the results through subsequent experiments.



Planned flight path and obstacles (wind generators, pylons, radio towers). Flight status data such as flight attitude, course, speed and altitude are overlaid as a Primary Flight Display.

## HMD

### Helmet-mounted display provides assistance in low-visibility conditions

Helicopter missions in low-visibility conditions potentially involve significant danger. Many accidents occur particularly in low-altitude flight, in darkness or fog, or during landing if dust or snow is swirled up. Helmet-mounted displays that show information directly in pilots' field of vision can help them evaluate the helicopter's bearing and orientation. This is essential because perception and constant maintenance of visual reference points in their surroundings is time-critical and an important basis for securely controlling the helicopter. The Institute of Flight Guidance has developed new display formats for a high-resolution helmet-mounted display with 1920 x

1200 pixels (JedeEye™). The display features a precise measuring system to record the position of the wearer's head, allowing it to display virtual, three-dimensional symbol overlays. The displays were tested and compared to standard instruments in a number of scenarios in a simulation campaign conducted in the spring of 2014 involving 18 pilots of the Federal Armed Forces, the Federal Police and air rescue services. The tests focused on issues relating to attention distribution, flight performance, situational awareness and stress during flight. Psycho-physiological measurements (ECG, skin resistance) were also taken. The data are currently being evaluated. It is already becoming apparent that the intuitively interpretable display requires relatively



The HMD in the generic cockpit simulator GECCO with collimated external view and centre stick for helicopter simulation

little training and improves flight performance by facilitating greater precision in adhering to flight paths and during landing. A patent application has meanwhile been made for the landing display representing drift speed. Feedback on the developed designs was largely positive: fifteen of the eighteen test subjects stated that they found flying with the helmet-mounted display significantly easier than with the standard instrumentation. Flight tests for these display formats in the FHS (EC135) are scheduled to run until the end of 2014.

## myCopter

### Enabling technologies for personal aerial transportation systems

As part of the EU project *myCopter*, DLR's Institute of Flight Systems is involved in designing an air transportation system for personal everyday use (Personal Aerial Transportation System). Based on vertically launching aircraft for the general population, known as Personal Aerial Vehicles (PAV), the Institute is examining how public transport routes can be shifted into the third dimension as a way of counteracting the problem of congested transport routes resulting from the ever growing volume of currently ground-based individual motor traffic.

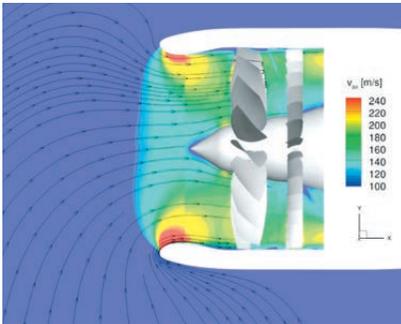


Steering wheel control in the AVES helicopter simulator

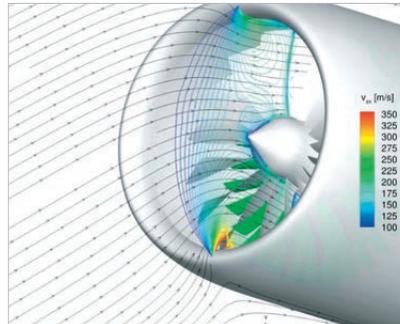
The flight characteristics of these PAVs are being demonstrated using the ACT/FHS research helicopter. An initial PAV simulation has already been implemented at the AVES simulator centre. This method allows not only the flight dynamics of future PAVs, but also new human-machine interfaces to be examined before they are flight-tested. Alongside conventional helicopter operating controls, concepts derived from motor vehicles are also applied: the institute is currently examining the possibility of controlling an upregu-

lated PAV via a steering wheel. The aim of this research is to develop technologies that will make flying helicopters easier, allowing future PAV pilots to safely operate their aircraft in airspace with minimal training effort – comparable to gaining a driver's license.

The project represents a unique combination of technological developments and sociological research with the aim of making everyday use of airspace accessible to the general public.



Fan with shortened intake subject to crosswind flow under take-off conditions



Fan with shortened intake subject to diagonal flow under take-off conditions

## Power25

### Coupled fan and intake design for future UHBR engines with extremely short nacelles

It is expected that increasing bypass ratios will also be features of next- and generation-after-next engines; the resulting increase in nacelle diameter will however initially result in higher frictional resistance and weight. In order to compensate for these undesirable effects, the entire intake is to be shortened, leading to a far more closely coupled system of intake and fan which can no longer be considered or designed separately. Extreme inflow conditions such as those induced by crosswinds in particular will increasingly affect the working range of the fan, and require a holistic approach.

DLR is addressing this issue in the ongoing joint project Power 25. Alongside developing evaluation, design and opti-

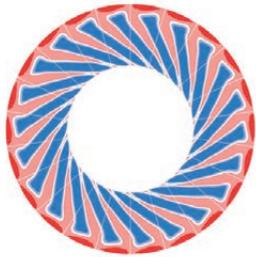
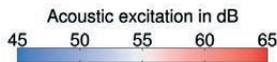
misation methods for the closely coupled fan and intake system, a major focus is on considering different integration scenarios in accordance with the external aerodynamics. In a first step, methods for designing the intake were developed and integrated into the existing design process. In an initial evaluation study, a highly shortened intake was devised and its effect on fan performance characteristics evaluated in comparison to a conventional intake. The fan itself had a comparatively low pressure ratio and was thus representative of future UHBR (Ultra High Bypass Ratio) engines. Further optimisation studies aimed at maintaining fan performance with highly shortened intakes and under highly disturbed inflow are currently underway. Alongside qualifying the design methods, the focus is on using modern simulation methods to efficiently examine air intake-induced interaction effects between fan and disturbed inflow.

## Fan broadband noise

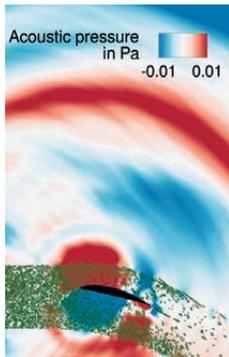
### Successful participation in first international workshop

The Engine Acoustics department in Berlin develops fast, high-precision numerical methods to design turbo machines that are also acoustically optimised. Modelling turbulence-induced noise from the fan is a major topic in the current research landscape. At the initiative of international experts, a benchmark workshop was organised with the participation of the world's leading engine manufacturers, during which research institutions were able to validate their numeric tools using measured data from real test objects. The results were presented at the AIAA Aviation 2014 conference in Atlanta. DLR took part with two simulation calculations.

The first test case was designed to validate the analytical pre-design tool Prop-Noise using data from the Source Diagnostic Test. These are experimental data from NASA that characterise a realistic fan stage aerodynamically and acoustically. The precisely defined measuring



Broadband noise excitation calculated using the analytic pre-design tool PropNoise



Snapshot of the sound field from the RPM/PIANO simulation with turbulent spots

conditions enable a direct comparison between prediction and measured values. PropNoise reproduces the cumulative total sound power with a variance of less than 1 decibel (dB). It also achieves a variance of less than 5dB for sound power spectra across the entire relevant frequency range. The second test case of a pitched blade profile subjected to turbulent flow in a free-field room served to validate the stochastic turbulence modelling tool RPM which is coupled with the acoustic solver PIANO. The blind prediction without parameter adjustments of the sound power spectrum corresponds to the validation data in the relevant frequency range with a variance of less than 5 dB.

Compared to the other international attendees, DLR's simulations proved best at modelling and simulating the broadband noise sources of engine fans. Both the now validated procedures are currently being used in EU projects for acoustic fan design.

## CRISPMulti

### Development and production of a CFRP fan blade



First manufactured CFRP fan blade; the contours of the individual layers are visible on the surface

The concepts for the next generation of aircraft engines will be based on an ever-increasing bypass ratio. In this field of application, counter-rotating shrouded rotors are a promising concept. Since the development of CRISP (MTU-DLR programme from 1985–2000), major advances have been made in various fields of engine development and fan technology. Their use and dedicated multi-disciplinary further development has provided the opportunity to design new optimised CFRP fan blades in the CRISPMulti project. Over the previous year, the aerodynamic behaviour of counter-rotating and traditional fan stages has been extensively examined, determining isentropic fan efficiency represented as a function of the axial Mach number and the total pressure ratio and gleaning significant factors regarding noise emission. The



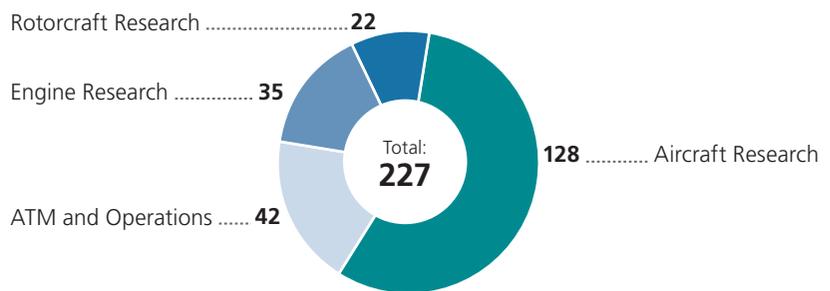
current project at DLR is working to expand the integration and evaluation range to cover aspects such as main dimensions, weight and the effect of the fan on the engine as a whole in order to create a basis for a detailed comparison with the traditional rotor-stator design.

A major milestone in the development of a CFRP fan blade is the manufacturing of an initial prototype based on the interdisciplinary aerodynamic and mechanical optimisation and design work. This is particularly the case in view of a new manufacturing technology that differs from the familiar technologies of the engine industry. The basic idea is to avoid having to individually cut a large number of layers and elaborately drape them into a form, and instead facilitate automated production using what is known as organofoils, which can be produced e.g. with tape layers and already contain the layer structure of the target component. As they consist of thermoplastic material, these organic foils can be worked into the basic blade shape in a hot press. The final contour is created by a milling process; this step ultimately replaces the individual cutting of multiple layers, however at much less effort.

Aeronautics: Revenues in millions of euros	2013 Actual	2014 Planned	2015 Planned
Institutional funding	136	152	156
Third-party funding	79	75	65
<b>Total revenues</b>	<b>215</b>	<b>227</b>	<b>221</b>

**Expected Revenue for the year 2014**

All figures in million euros



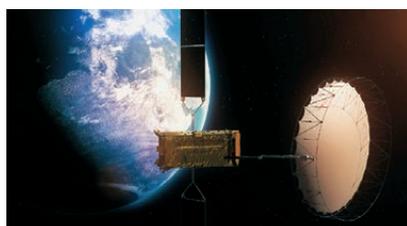


# Space

## Space Administration, Space Research and Technology

The German Aerospace Center (DLR) is where Germany's national and international space flight activities converge. Research is carried out by the DLR space research institutes, whereas policy issues are the remit of the DLR Space Administration, which is responsible for carrying out national and international space-related activities on behalf of the Federal Government. Scientific, technological and operational contributions are made by DLR's own research institutes. The integrated German space exploration programme combines Germany's participation in the programmes of the European Space Agency (ESA), its involvement in EUMETSAT, the National Space Programme, the DLR research and technology programme *Space* and other space-related activities in science and industry. DLR demonstrates its competence and capability by participating in national and international space missions and research projects in cooperation with partners. The following examples provide a brief overview of the highlights and events of the past year.

## Highlights/Projects from Space Administration



Alphasat I-XL

### Alphasat I-XL

#### Communications satellite positioned and LCT successfully tested

Alphasat I-XL was launched on an Ariane 5 on July 25, 2013, and carried to a geostationary transfer orbit. The first Alphasat is a Public Private Partnership between ESA and the satellite communications service provider Inmarsat and forms part of the ESA programme ARTES 8, in which Germany is participating via the DLR Space Administration. Components from Germany ensured the satellite's transfer to its final position in geostationary orbit, are responsible for attitude control and manage the satellite's energy supply. Alongside the commercial payload from Inmarsat, Alphasat I-XL also offers room for technologies to be tested for the first time under space conditions. Of the four payloads included for demonstration purposes, two are from Germany: a star sensor supplied by the company Jena Optronik provides high-precision orbit and attitude information, thus also assisting in the precise alignment of the optical laser communication terminal (LCT). The company Tesat led the development and construction of the LCT as a high-performance data carrier/transmitter – partly in preparation for the European data relay transmission system EDRS. The LCT has sent a laser beam to the ground station as planned, proving that the terminal can be aligned precisely enough to hit a target point from a distance of over 36,000 kilometres.



DLR SpaceBot Cup 2013

### DLR SpaceBot Cup 2013

#### Space robotics competition

On November 11 and 12, 2013, the Supercrosshalle in Rheinbreitbach near Bonn hosted the first competition of its kind in Germany: ten teams from universities, universities of applied science and industry met to test the capabilities of their space robots. After two exciting and eventful days, the DLR SpaceBot Cup ended with no clear winner, but neither were there any real losers: all ten teams were highly motivated and entered innovative technical solutions. The competition sought ideas for intelligent robotics systems that could be used for space exploration but at the same time had high potential for transfer to applications on Earth. The challenge for the *SpaceBot Cup* was based on a typical exploration scenario on a planetary surface: the robotic systems were required to semi-autonomously find, identify and transport objects in difficult terrain in order to finally assemble them into a complete system. The task was complex and very demanding, but ultimately the individual achievements of the teams were of such similar quality that the jury was unable to determine a clear and authoritative ranking.



SWARM

### SWARM

#### Trio of satellites for Earth exploration mission launched

On November 22, 2013, at 1:06 p.m. CEST, the European satellite trio SWARM was launched into space on a Rockot rocket from the northern Russian spaceport of Plesetsk. The satellite mission will conduct high-precision measurements of the Earth's magnetic field and examine processes in the Earth's interior and in near space. Two satellites will be released into a joint orbit at 460 km, while the third will orbit at 530 km. Over a period of four years, they will circle the Earth in swarm-like formations and create the most accurate three-dimensional map of the Earth's magnetic field ever made. The German predecessor satellite CHAMP has already delivered significant results in this area. SWARM is the fourth Earth exploration mission within ESA's *Living Planet* programme.

Germany is responsible for approximately 25 percent of the programme and is thus a leading contributor. The SWARM project office funded by the DLR Space Administration coordinates researchers and data utilisation on the German side with the aim of optimising the project's scientific benefits.



PLATO – artist's impression

## PLATO

### Space telescope selected from among five ESA missions

On February 19, 2014, ESA selected PLATO, a space-based observatory designed to find planets orbiting alien stars, from five suggested missions. PLATO will launch by 2024 at the latest, observe the sky at a distance of 1.5m kilometres from Earth for at least six years, and is expected to discover and characterise thousands of new planets orbiting other stars. Its aim is to find a planetary system that is similar to our solar system; in addition, PLATO will measure the vibrations of stars. The scientific data centre for the mission will be sited at the Max Planck Institute for Solar System Research. DLR scientists will be bringing their experience from the CoRoT and Kepler missions as well as the forthcoming Kepler-2, TESS (NASA) and CHEOPS (ESA) missions to PLATO. The DLR Space Administration is the largest financial contributor to the ESA science programme and is funding the development of the mission's payload and the scientific data centre, among other things.



Dr Gruppe at INNOspace

## INNOspace

### Conferences in Stuttgart and Bremen

The INNOspace initiative funds innovations and promotes the transfer of space technologies to other areas of business and research. The initiative includes conferences, competitions, expert and user workshops, and the travelling exhibition *Space Innovation Expo* designed to present the innovative capacity of space exploration and its contribution to business, society and the environment to the wider public. On December 4, 2013, approximately 90 representatives of companies and research institutions in the space, mechanical engineering and automotive supplies industries came together for the first INNOspace conference in Stuttgart. The conference's moderated workshops presented and discussed technology-related issues and solution approaches from the various industries. Linking space exploration and the maritime economy was the aim of the INNOspace conference held on February 20, 2014, in Bremen under the heading *Space Exploration and Maritime Economy – Innovation through Cooperation*, where over 100 experts from both industries discussed topics such as *services of the space industry for the maritime economy, robotics, new technologies and bionics*, and developed joint strategies for the future.

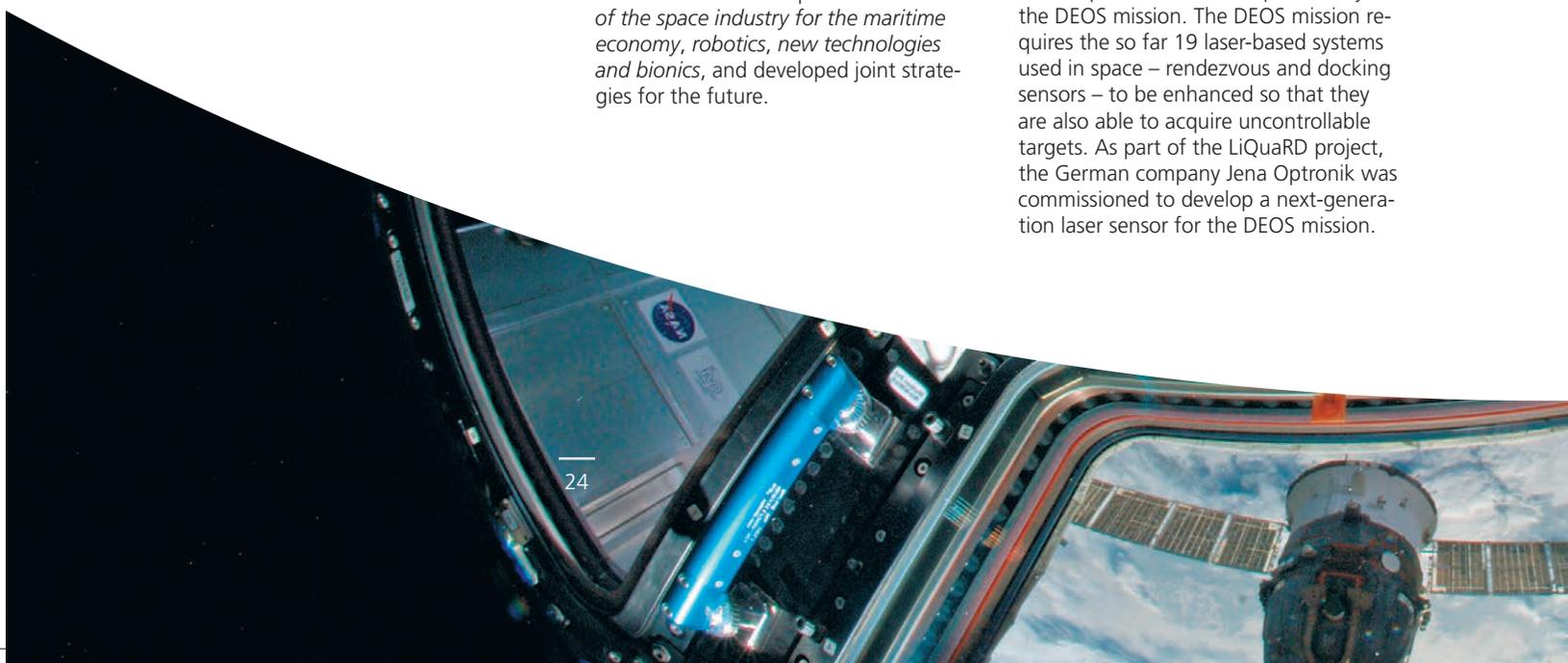


LIDAR sensor in LiQuaRD

## Satellite service

### LiQuaRD successfully tested for DEOS

Thousands of satellites are currently orbiting the Earth – and their numbers are rising. When they break down, these satellites continue to drift uselessly through space until they burn up or are parked on what is known as the graveyard orbit. Solutions for salvaging such satellites from their overcrowded orbits are so far lacking. Solving this problem is the purpose of the German Orbital Servicing Mission (Deutsche Orbitale Servicing Mission, DEOS), which aims to prove that uncontrollable satellites can be safely approached and captured. The LiQuaRD (3D LIDAR Pre-Qualification for Rendezvous and Docking) project has developed a LIDAR sensor with the potential to handle complex rendezvous and even imaging functions in orbit; this LIDAR system will serve as a sensor for DEOS. The next-generation sensor was used experimentally for the first time during the ISS supply mission carried out by the European space freighter ATV 5 and launched on July 29, 2014, which was a milestone for German technology in future space missions and particularly for the DEOS mission. The DEOS mission requires the so far 19 laser-based systems used in space – rendezvous and docking sensors – to be enhanced so that they are also able to acquire uncontrollable targets. As part of the LiQuaRD project, the German company Jena Optronik was commissioned to develop a next-generation laser sensor for the DEOS mission.





Stratospheric balloon – before launch

## Rexus/Bexus

### Rocket and balloon experiments in the seventh and eighth student competition

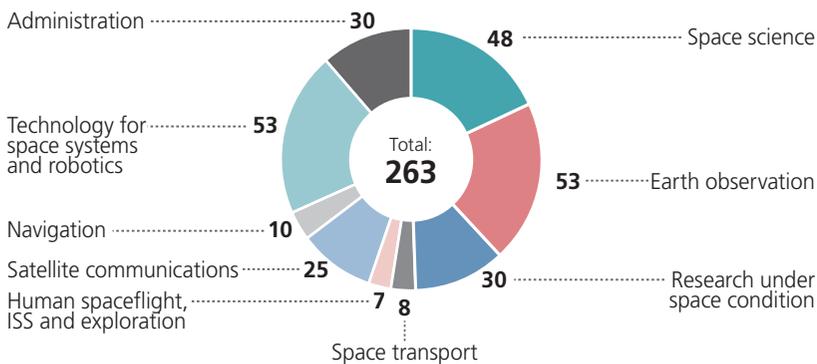
This programme offers students the opportunity to conduct exciting experiments in atmospheric physics, balloon and space engineering, radiation physics

or biology, low-gravity research, remote sensing or communications using stratospheric balloons or research rockets. As part of the seventh competition, the REXUS 15 research rocket launched on May 29, 2014, from the Esrange space centre near Kiruna in Sweden to release measuring probes and mini satellites during its flight. REXUS 16 had launched successfully a day earlier with four further experiments on board. The countdown for the eighth competition has already begun. Following the submission deadline of October 13, students will be notified before Christmas whether their experiment will be included on one of the two BEXUS balloons launching in the autumn of 2015 or one of the two REXUS rockets in the spring of 2016.

Space Administration: Funding budget in million euros	2013 Actual	2014 Planned	2015 Planned
National programme (incl. share of management of BMWi contract)	263	277	277
ESA (BMW/BMBVBS/BMVI)	783	807	811

### National Programme in 2013

All figures in million euros



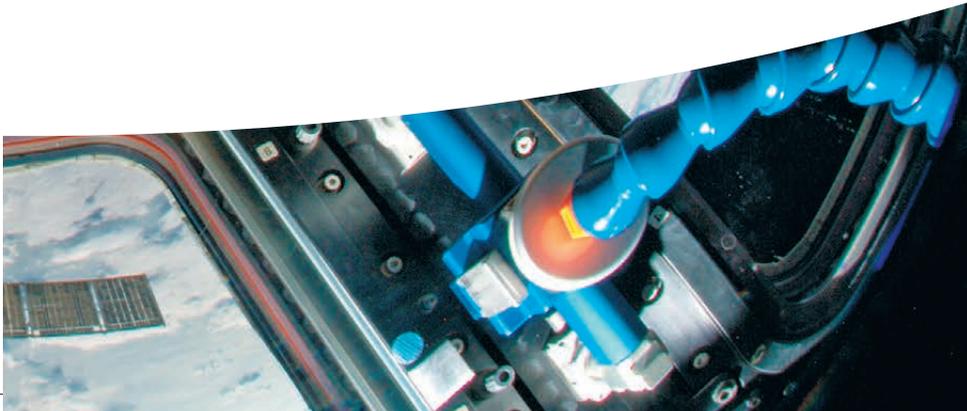
## ISS – very busy!

### Cellbox mission and Columbus Eye reach ISS on commercial Dragon capsule

DLR sent two biological experiments from the University of Magdeburg to the ISS. The Cellbox mission is designed to examine human phagocytes and thyroid cancer cells in zero gravity. NASA cameras for the DLR school experiment *Columbus Eye* were also on board the Dragon spacecraft operated by the American company SpaceX, which launched from the space port in Cape Canaveral (Florida, USA) on April 18, 2014. The four video cameras were attached to the Columbus laboratory by means of a robot arm and have been recording spectacular live images of Earth since May 2014. These images are available to schools, researchers and the general public on the Columbus Eye web portal free of charge.

@ [www.columbuseye.uni-bonn.de/](http://www.columbuseye.uni-bonn.de/)

It was the first time a commercial service provider was commissioned to transport and conduct experiments for DLR. With the Cellbox mission DLR is testing new ways – alongside using the ISS via ESA and via bilateral cooperations – of relatively quickly and affordably offering German researchers opportunities to conduct experiments in space. After 30 days on board the ISS, the Dragon capsule brought the cell cultures back to Earth for analysis.



Joint projects from Space  
Administration and the Space  
Research and Technology division



## “Blue Dot”

### Mission launched successfully



German ESA astronaut Alexander Gerst, Maxim Surayev from Russia and Reid Wiseman from the United States were transported to the ISS on

board a Soyuz carrier rocket in less than seven hours. Alexander Gerst's six-month mission “Blue Dot” began on May 28, 2014, as part of ISS Expedition 40/41. He is the fourteenth ESA astronaut to go into space and the third German on board the ISS.

During his mission, Alexander Gerst will be involved in 100 different experiments on behalf of all ISS partners, including experiments with plasma, robots and metals; for a school project he will move soap bubbles using sound waves.

Experiments in astro- and radiation biology, aerospace medicine and materials science were conducted for the DLR Space Research and Technology programme in the course of the mission in order to gain new insights into e.g. the origins of life, the characteristics of human physiological processes and the properties of materials. An exciting experiment was for example provided by the DLR Institutes of Planetary Research and Aerospace Medicine: in August, blue algae and biofilms were

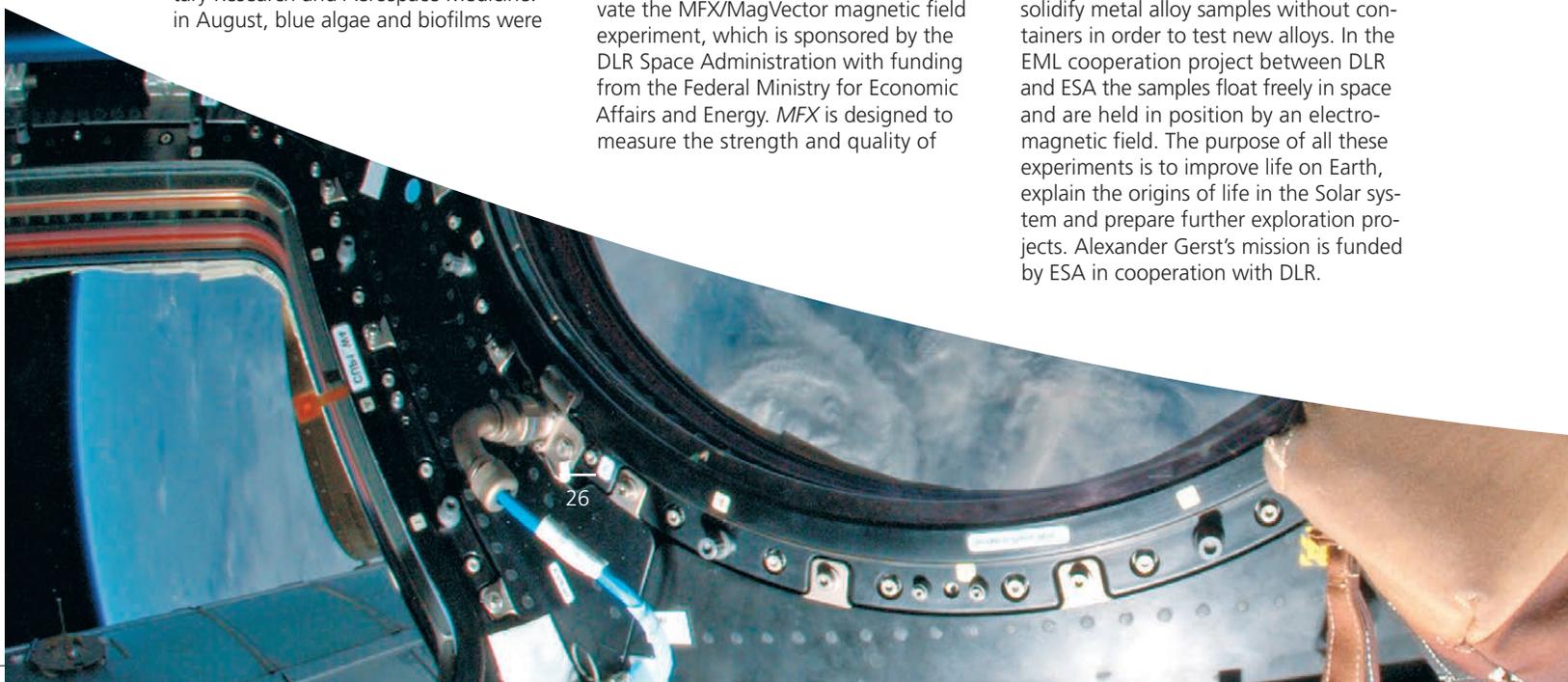
### School competition “Protectors of Earth” with Alexander Gerst on the ISS

DLR and the German ESA astronaut Alexander Gerst invite German primary school pupils in fourth grade to submit entries to the competition “Protectors of Earth – the Blue Planet, Your Mission”, which seeks creative ideas for preserving the Earth. The children are encouraged to independently research information, understand and explain problems and develop solutions. Alexander Gerst, who took off for the ISS on a Soyuz rocket on May 28, 2014, will be accompanying the participating school classes in their projects as an “ambassador from space”. During his mission “Blue Dot – Shaping the Future” he will be sending the pupils regular video messages from the ISS containing information on five habitats: oceans, land, rivers/lakes, mountains and forests. With the help of their teachers, the schoolchildren can pick one of these habitats and submit creative contributions relating to it. Work on the projects will begin on October 15 and end on December 15, 2014, when the results are submitted. The winning school classes will have the opportunity to meet astronaut Alexander Gerst after he returns from the ISS in the spring of 2015.

placed into the EXPOSE-R2 facility on the outer hull of the ISS for one year. These BIOMEX (Biology and Mars Experiment) and BOSS (Biofilm Organisms Surfing Space) experiments are designed to examine whether the organisms could be able to withstand for example ultraviolet radiation, cosmic radiation, temperature fluctuations or simulated Mars conditions, and thus survive on other planets. The results of these space experiments are expected to contribute significantly to explaining the origins of life in the Solar system.

Alexander Gerst will also install and activate the MFX/MagVector magnetic field experiment, which is sponsored by the DLR Space Administration with funding from the Federal Ministry for Economic Affairs and Energy. MFX is designed to measure the strength and quality of

Earth's protective magnetic field within the ISS. In addition, the experiment will be the first to examine the interaction of Earth's magnetic field with an electric conductor and measure it at high resolution. A further key area of the “Blue Dot” mission is human physiology, where a number of complex experiments on dermal ageing and skin protection, nutrition and metabolism, and radiation protection will be conducted. For an experiment in material physics, Alexander Gerst installed and activated the EML (Electro-magnetic Levitator) in the Columbus module and then processed the first samples. The EML high-tech oven is used to melt and solidify metal alloy samples without containers in order to test new alloys. In the EML cooperation project between DLR and ESA the samples float freely in space and are held in position by an electro-magnetic field. The purpose of all these experiments is to improve life on Earth, explain the origins of life in the Solar system and prepare further exploration projects. Alexander Gerst's mission is funded by ESA in cooperation with DLR.



## Copernicus programme

### Sentinel-1A and DFD processing and archiving centre

Sentinel-1A was launched into space from Kourou in French Guiana on a Soyuz carrier rocket on April 3, 2014, marking the beginning of the Copernicus



Sentinel-1A

(formerly GMES) Earth observation programme of the EU and ESA. After a three-month start-up phase the satellite has been routinely delivering data since the middle of the year. With its institute association comprising the German Remote Sensing Data Centre (Deutsches Fernerkundungsdatenzentrum, DFD) and the DLR Institute of Remote Sensing Technology, DLR's Earth Observation Center (EOC) is significantly involved in almost all of ESA's *Copernicus Service Elements*. The EOC also took part in national research and demonstration projects relating to Copernicus.

Based on these projects and a survey of European users, Copernicus has identified six core services: land monitoring, marine monitoring, atmosphere monitoring, emergency management, security and climate change. The EOC was particularly involved in the four latter areas in the corresponding consortia of the 7th EU Framework Programme, in some cases in leading roles. In the current initial phase of the Copernicus core services the EOC is contributing its expertise in particular in the terrestrial services to industrial consortia in the form of geomet-

ric processing and validation of optical data, thereby forming a major component of the operative ground segment of Copernicus.

The PAC (Processing and Archiving Centres) at the German Remote Sensing Data Centre in Oberpfaffenhofen receive approximately three terabytes of raw data per day. At the PAC, these raw data are transformed into digital products using multi-processor systems, archived, and distributed to European and international users via the new 10-gigabit network. The Copernicus core services – analyses of the data on behalf of the European Commission for environmental and security purposes – are among the most important user groups. Sentinel-1A for example delivers data on flooding events, the spread of oil slicks, movements of icebergs or landslides to the nearest millimetre, regardless of weather and time of day. The data are also used by researchers to map the environment and global change, and by commercial companies to create new geoinformation products. Access to the Sentinel data is free and open to anyone. National initiatives are additionally working on creating distribution nodes for national user groups.

However, it takes Sentinel-1A twelve days to fly over every point of the globe. Its identical twin satellite Sentinel-1B, which is to be launched in 2015, will reduce this repetition rate to just six days. Each of the two satellites is expected to supply data for at least seven years. A new communication technology, the optical laser communication terminal (LCT), is being tested on board Sentinel-1A. The LCT will allow far greater data volumes to be sent from space to Earth without lag than was previously possible. Alphasat is acting as a test station for data transfer using the LCT on Sentinel-1A. Sentinel-1A is also the first customer for the planned European *data highway in space*, the EDRS (European Data Relay System).

## Mission update

### Rosetta space probe and lander Philae on course

For the first time in history, Europeans are planning to land on a comet that is believed to carry ancient matter from the dawn of our solar system 4.64 billion years ago. The ten-year journey of the Rosetta space probe will lead us to the roots of the formation of



Rosetta

our planet. After its launch on an Ariane 5 on March 2, 2004, the probe performed multiple swing-by manoeuvres around Earth and Mars before passing the asteroids Šteins and Lutetia. After a 957-day hibernation phase Rosetta was successfully reactivated and taken into operation on January 20, 2014, when the ESA mission control centre in Darmstadt received its first signal at 7:18 p.m. CET.

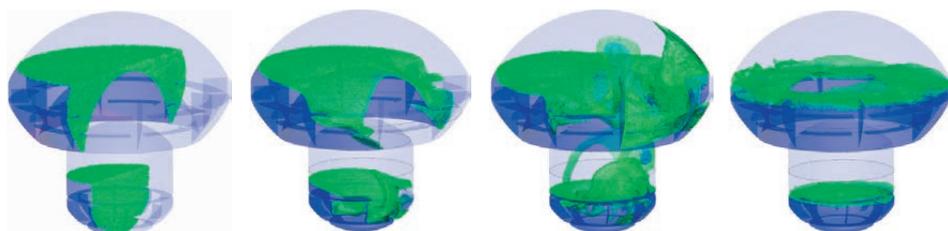
At this point, Rosetta was still nine million kilometres away from its target comet 67P/Churyumov-Gerasimenko. The Philae lander was reactivated by the DLR MUSC on March 28, 2014. Alongside DLR, the Max Planck Institute for Solar System Research (MPS), the Technische Universität Braunschweig and the Universities of Cologne and Mainz are also operating experiments on the orbiter and the lander. Lander Philae was contributed by a consortium consisting of DLR, MPS, CNES and ASI, among others. Project responsibility for Philae lies with DLR, where the lander control centre is also located.

With a contribution of 290m euros, Germany is the most important participating nation in the international ESA mission conducted with contributions from the member states and NASA.

Projects from DLR's Space Research and Technology division

# Ariane upper stage

## Research cooperation examines key technologies



Simulation of propellant slosh in a modified Ariane ESC-A upper stage tank system

The European carrier rocket Ariane is today one of the leading providers of space transportation services on the international market. Germany is responsible for developing and building the rocket's upper stage. Within the Research Cooperation Upper Stage, the DLR Institute of Space Systems is cooperating with the national space industry and universities to conduct complementary research projects in several identified key technologies with the overall goal of strengthening and expanding Germany's competence in rocket upper stages.

The ability to numerically simulate propellant behaviour in all mission phases is of fundamental importance in designing the upper stage and its tank systems. Numeric simulation is an important pre-design tool and provides the ability to analyse critical phenomena such as propellant slosh. DLR is performing further development on its proprietary simulation tool, the TAU code, which is intended to enable calculation of the complex two-phase flow processes in the tank systems taking heat transmission and mass transport processes into account. The first development phase of the code made it possible to successfully calculate and analyse the effect of slosh baffles on propellant motion in an upper stage tank.

# 23

## Activations of the International Charter "Space & Major Disasters"

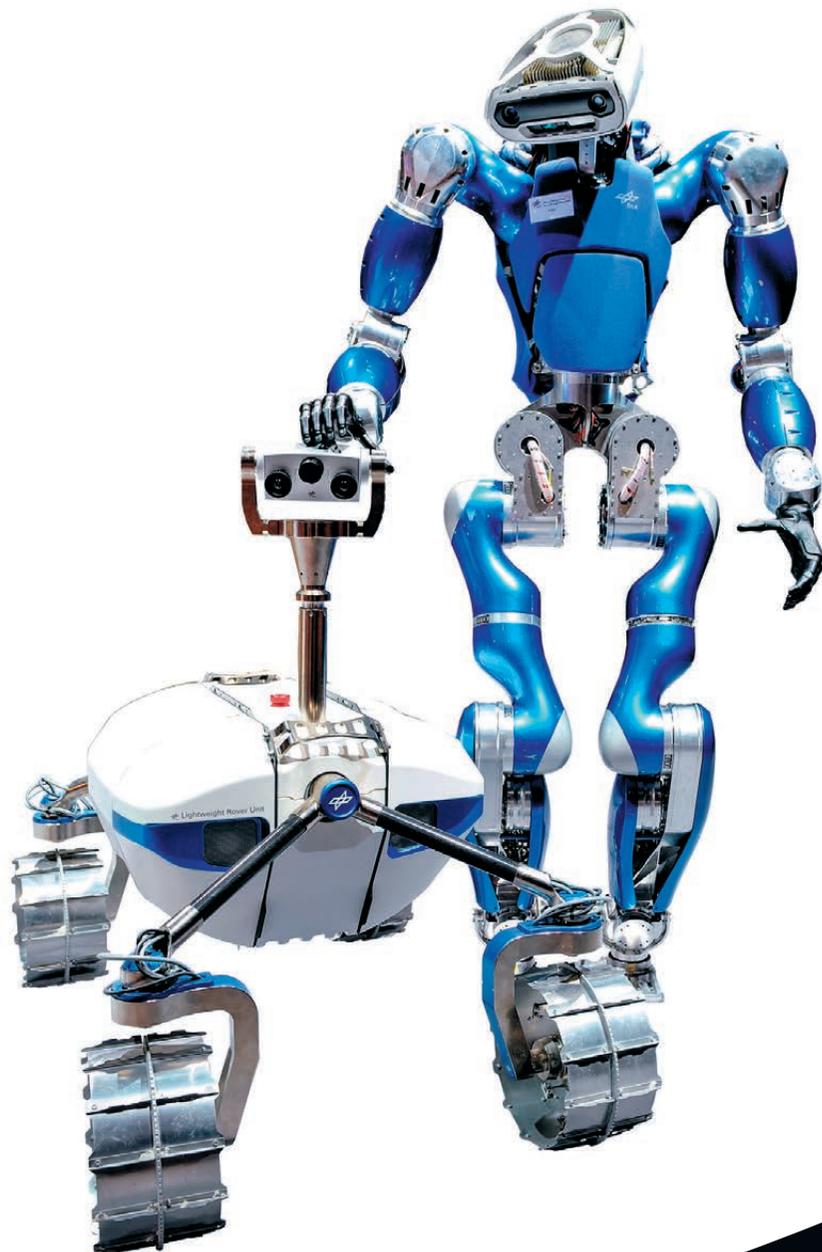


The Charter looks back on a busy period. From August 2013 to December 2013 the Charter was activated a total of 23 times; DLR was able to contribute satellite data for many of these requests (more than 70 TerraSAR-X/TanDEM-X and 200 optical RapidEye datasets in all). Via the Federal Ministry of the Interior (BMI) and the International Charter "Space & Major Disasters", THW activated DLR's Centre for Satellite Based Crisis Information (ZKI) to provide assistance to the Philippines and Vietnam, which were both heavily affected by super typhoon Haiyan. The ZKI worked around the clock to create maps of the disaster areas from satellite images; the analysed and processed images served as a basis for the rescue operations. DLR's six-month chairmanship of the Charter ended in October 2013 and was officially transferred to the Argentinian space agency CONAE during a Charter Board Meeting in Córdoba (Argentina). DLR's involvement however was by no means over: further activations in 2014 occurred due to floods in Argentina, Serbia and Afghanistan and fires in Chile; the severe cyclone Ita in Australia also caused an activation, as did the missing Malaysia Airlines flight MH370, to name just a few further examples.

## Rover

### A prototype that navigates semi-autonomously

The Lightweight Rover Unit (LRU) is the prototype of a semi-autonomous robot for lunar or Mars exploration. It combines multiple state-of-the-art technologies that were developed at the DLR Institute of Robotics and Mechatronics, such as the drive and steering units, the motors of which have already proved their spaceworthiness for five years in the ROKVISS experiment on the ISS. A stereo camera and the multiple award-winning SGM (Semi-Global Matching) process for processing 3-D image data give the robot the ability to spatially perceive its environment. The rover then uses this information to compute maps of its surroundings in order to autonomously travel to pre-defined targets in unknown and difficult terrain, allowing planetary researchers to specify remote targets directly in the camera view without having to worry about implementing the movement. This semi-autonomous navigation represents a decisive technological leap, as communication signals from Earth can take several seconds or even minutes to reach the surface of the nearest celestial bodies, significantly limiting the options for direct remote control. The rover was presented and demonstrated in action for the first time at ILA.



LRU and TORO, the DLR robotics systems, seen here at Automatica





Perspective view of the Krasheninnikov caldera (foreground) and the 3528 metre high Kronotsky volcano rising up in an almost perfect cone. On the horizon to the left is the Klyuchevskaya Sopka volcano, the highest mountain on the Kamchatka Peninsula at 4835 metres.



The robust receiver in operation

## TanDEM-X DEM

### Over a quarter complete

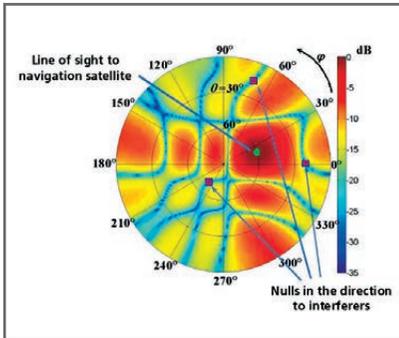
In early 2014 the TanDEM-X mission reached a further important milestone when it completed the first finalised DEM tiles. Final DEM production initially concentrated on areas with benevolent topography for which two passes from a single observation geometry were sufficient. Almost all of Australia and large, mainly flat areas in North America, Russia, Africa and South America (over 25 percent of the global landmass in all) are now available to scientific and commercial users. Processing of the first difficult areas (which require more than two passes) has meanwhile begun. Due to the data acquisition scenario, northern regions, specifically north-eastern Russia with the Kamchatka Peninsula, will be processed first. The global DEM is expected to be complete by the end of 2015.

The two satellites operate remarkably reliably and stably in close formation flight (minimum distance 120 metres). With the exception of gaps in the existing images, data acquisition for the global DEM is largely complete. Processing the massive data volume of more than 2,500 terabytes is a challenge that is taking the IT systems to their technical limits. The highest priority in the TanDEM-X project is to meet the strict quality requirements pertaining to the global DEM. In this context, precise calibration of the bistatic radar interferometer is of particular importance; the need to calibrate the distance between the two satellites to the millimetre or synchronise the two radar instruments to an accuracy of a billionth of a second, where even relativistic effects must be taken into account, may serve as examples. The achieved precision of the system has exceeded all expectations and makes it possible to generate topographical models largely without additional reference elevation data. Only in the final step are the DEMs mosaiced together from the individual images and calibrated to the absolute altitude of ICESat (NASA laser altimeter mission). The differences applied are within the range of a few metres.

## No interference

### DLR is working on robust receivers

Due to the low power of the satellite signals they receive, navigation receivers are sensitive to unwanted or intentional interference from other signals. The DLR Institute of Communications and Navigation is therefore developing receivers for security-critical applications that are especially resistant to such interference. Instead of the traditional navigation antennas that receive signals from all directions above the horizon at almost the same strength, the project uses antenna arrays with four or more receiver elements. By cleverly combining the signals received by the individual elements in the receiver's real-time signal processing unit, interference is filtered out by adaptively steering nulls in the direction of the sources of interference while increasing antenna gain in the direction of the wanted satellite signals. This procedure can suppress interference signals that are over 70dB stronger than the satellite signals, corresponding approximately to the volume of a jackhammer from a distance of one metre compared to the noise level in a very quiet room.



Antenna radiation pattern resulting from adaptive beamforming



An image from the navigation camera shows wash-outs and rocks on the surface of Mars and the RAD on the Rover deck

In addition to suppressing interference, the receiver can also estimate the directions of the incoming interfering and satellite signals from the phase differences between the signals received by the individual antenna elements. This is important in order to e.g. locate interference sources or detect reflected or fake satellite signals that are not coming from the direction of the satellite. Once these incorrect signals have been excluded, the alignment of the antenna can be determined to a precision of  $1^\circ$  by comparing the estimated directions with the known directions of the satellites from an almanac.

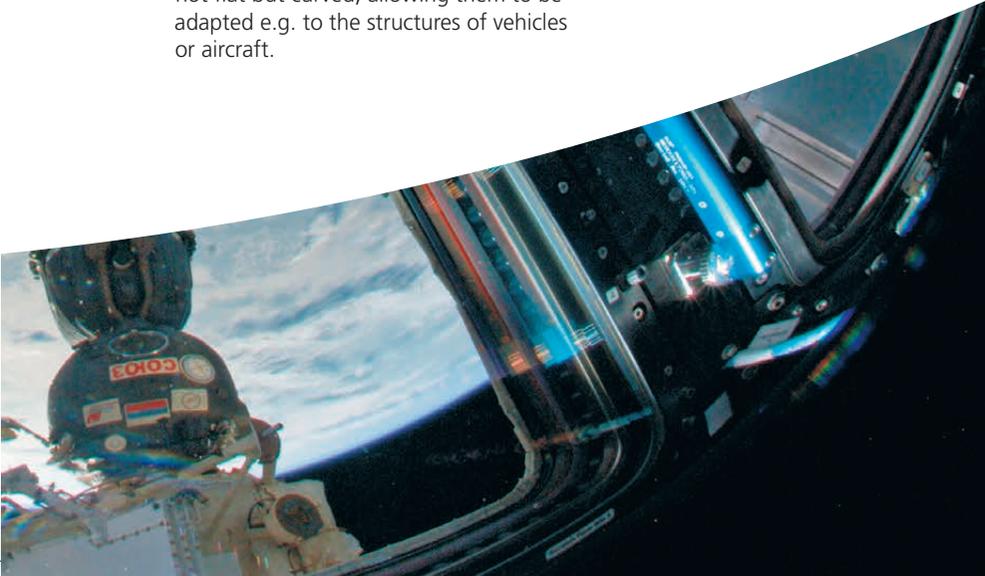
The distance between antenna elements is usually half a wavelength, making the antennas relatively large compared to standard navigation antennas. The DLR institute is therefore cooperating with project partners to develop smaller antennas with decreased element distances and a surface area reduced by a factor of four, which field tests have shown can achieve almost the same interference suppression as the larger antennas. Further work is being done on the development of conformal antennas with surfaces that are not flat but curved, allowing them to be adapted e.g. to the structures of vehicles or aircraft.

## RAD

### Modelling verified on Mars

The Radiation Assessment Detector (RAD) had already conducted radiation measurements for the Mars Science Laboratory Mission (MSL) during its flight to Mars (see 2012/2013 Research Report); once it landed, the researchers of the DLR Institute of Aerospace Medicine were able to successfully continue their measurements on the surface of Mars. The Mars Science Laboratory Mission was the first to measure the radiation environment on the surface of Mars. RAD has been functioning perfectly since its landing two years ago, and continues to deliver measurement data. Models of radiation environments and radiative transfer through materials are used to calculate radiation exposure in planned missions; on-site measurements provide reference values for modelling and are therefore indispensable to verifying

these models. Reliable modelling forms the basis for developing optimised protective measures to reduce radiation exposure on future missions to explore the Solar system. Initial calculations using the model developed by the institute have already been shown to correspond well to the measured data.

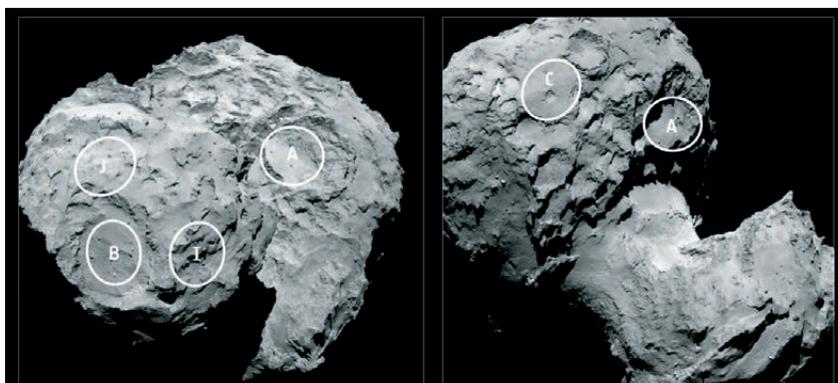


# Rosetta

## A ten-year journey nears its destination

January 20, 2014, was an exciting date for the scientists at the Microgravity User Support Centre (MUSC) and the DLR Institute of Planetary Research: after ten years of flight, the instruments of the Rosetta probe were gradually reactivated and tested. The MUSC is responsible for controlling the probe and selecting a suitable landing site. The images from the OSIRIS camera, for the development of which the Max Planck Institute was responsible and to which DLR has also contributed scientifically, are essential to this process. Since May 2014, these data have provided researchers with information on the shape and properties of the comet and served as a basis for further mission planning.

The scientists at the DLR Institute of Planetary Research are responsible for the use of the ROLIS (Rosetta Lander Imaging System), MUPUS (Multi-Purpose Sensors for Surface and Subsurface Science) and SESAME (Surface Electric Sounding and Acoustic Monitoring Experiment) instruments on the Rosetta lander Philae. ROLIS – the Rosetta lander camera – will deliver images during Philae’s descent and observe the structures of the comet’s surface in four spectral ranges with a sub-millimetre resolution after landing.



Initial selection of landing sites for the Rosetta lander Philae

The MUPUS sensors will measure surface temperature and near subsurface temperature profiles, thermal conductivity of the surface material and the consistency of the cometary matter. SESAME will measure the acoustic and dielectric properties of the comet’s core and its near subsurface structure and provide information on particle strikes.

The VIRTIS (Visible and Infrared Thermal Imaging Spectrometer) instrument, to which the DLR Institute of Planetary Research contributed both scientifically and

with hardware, is located on the Rosetta orbiter. VIRTIS consists of two spectrometer modules to map the comet’s surface temperature and measure the composition of the comet’s surface and coma.

Together with the experiments of other research institutions in Europe and the USA, the totality of these instruments will contribute to a better understanding of comets and – as comets carry very ancient material – allow conclusions to be drawn about the formation of our planetary system.

### Rosetta Lander Project – Philae



Rosetta is the world’s first mission to examine a comet in detail. Philae will moreover be the first probe to land on a comet’s core. The results of this project promise significant insights into the history of our solar system and the origins of life. Philae will land in November 2014 and is expected to send data from the comet’s surface to Earth for several months.

**Dr Stephan Ulamec**

*DLR Institute of Space Operations and Astronaut Training, Project Manager for the Philae Lander*

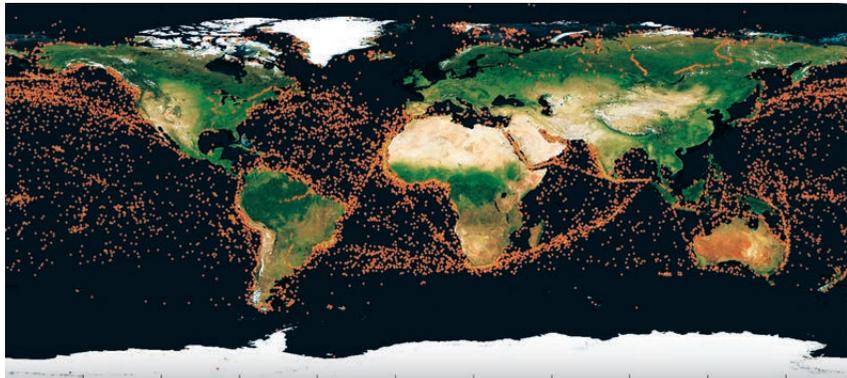
# AISat

## AISat for shipping

The ship identification system AIS (Automatic Identification System) is mandatory for larger vessels in order to increase safety in maritime transport and monitor maritime traffic. The system exchanges static vessel information and dynamic navigation data between ships and base stations on land. However, current systems reach the limits of their capacity in waters with very high levels of traffic. The signals of the vessels overlay each other and can no longer be decoded. In order to guarantee optimal reception of AIS information in high-traffic zones, the Institute of Space Systems in Bremen has developed the nano-satellite AISat-1.

The AISat satellite was launched into space from the Indian space centre Sriharikota on June 30, 2014. Its four-metre helical antenna now receives vessels' AIS signals. Filters and various attenuation levels make it possible to enhance the received signals to such an extent that newly developed signal processing algorithms are able to extract individual messages from overlaid signals. Radio contact was established from day one. Since then, the team has received over 52,000 datasets. In the coming months the experts will fly further test manoeuvres at an altitude of approximately 660 kilometres and compare the data to those of other satellites.

Alongside signal acquisition, the results of this project are designed to help optimise shipping routes, secure sea lanes and characterise maritime waterways. The project is embedded into the research association "F&E für die Maritime Sicherheit und entsprechende Echtzeitdienste" (R&D for maritime safety and corresponding real-time services).

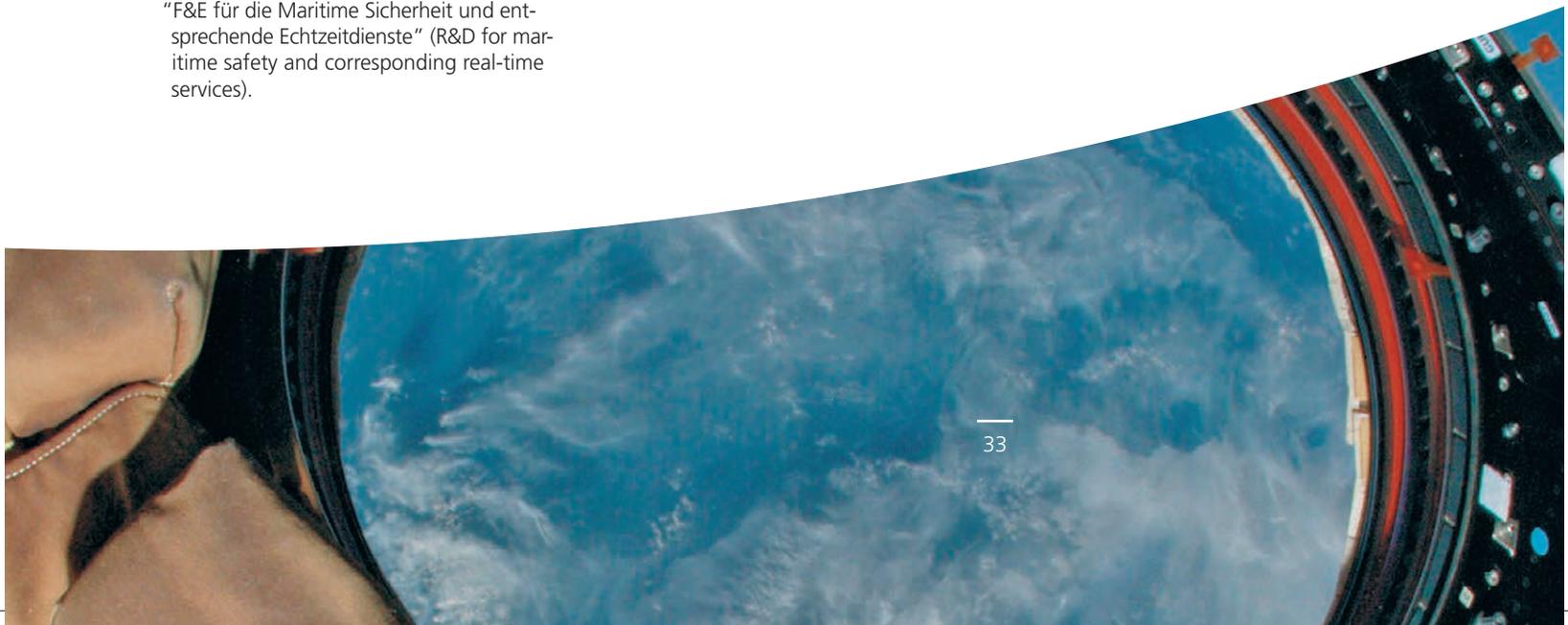
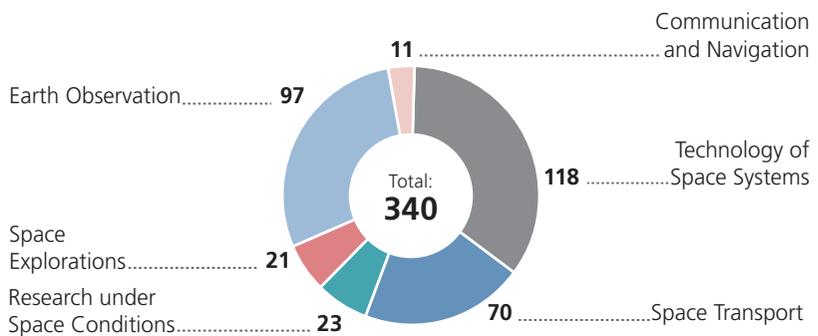


Each dot a ship: tens of thousands of messages from all the seven seas

Space R&T Revenues in millions of euros	2013 Actual	2014 Planned	2015 Planned
Institutional funding	176	179	185
Third-party funding	156	161	162
<b>Total revenues</b>	<b>332</b>	<b>340</b>	<b>347</b>

### Expected revenues for the year 2014

All figures in million euros



# Transport

With its export-driven economy and central transit location in the heart of Europe, transport is an essential sector for Germany. It satisfies individual demand for mobility, provides employment and generates a substantial proportion of economic added value. But transport also has its downsides: accidents claim numerous victims, noise and exhaust fumes harm humans and the environment. Finding the right balance between these factors is one of the major challenges of our time, and the main aim of DLR's Transport programme. The research examines which options exist to shape a transport system in such a way that it remains economically, socially and ecologically sustainable in the long term.

To this end, the Transport programme develops state-of-the-art technologies, concepts and strategies, and uses the expertise of its transport specialists to systematically tap into DLR-internal know-how from the fields of aeronautics, space and energy for transport applications. The joint efforts of 26 institutes are concentrated on three programmatic research areas: terrestrial vehicles, traffic management and the transportation system. The research concentrates on cars, utility vehicles, and next-generation and generation-after-next trains with lower energy consumption, lightweight structures, optimised aerodynamics, increased safety, greater comfort and less noise. DLR increases the effectiveness and efficiency of

infrastructure utilisation with innovative approaches to managing road and rail traffic, shipping and airports. Contributions to traffic management for large-scale events and disasters assist police and emergency services, while an integrated view of traffic development and its environmental effects allows to break new ground in examining transport systems. The DLR Transport programme combines its significant competencies in vehicle and energy research with analyses of user requirements and the development of innovative mobility concepts to deliver a systematic approach to electromobility research. In addition, the programme is dedicated to exploring the wide range of mobility challenges that will arise in the cities of tomorrow. As a service for the national and European community, DLR additionally runs the Clearing House for Transport Data.

The work never loses sight of the overarching goal of DLR transport research, which is to maintain a transport system that is powerful, reliable, secure and at the same time both economically and ecologically sustainable. This is reflected in the wide range of results DLR has achieved; the following pages describe several examples from the 2013–2014 period.

# NGT

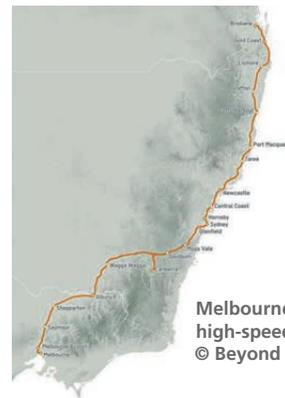
## ... goes international

The response to DLR's work on the Next Generation Train (NGT), the high-speed train of the future, has been excellent from the outset. Interest in the project is meanwhile no longer limited to Germany and Europe: during the reporting period there were numerous enquiries from Asia and Canada, and two twenty-minute TV reports were shown in Egypt and Oman. DLR's work on the NGT was the focus of particularly intense discussion in Australia. Following the visit of a multiple award-winning Australian TV journalist to our Stuttgart site, Australia's ABC News broadcast a high-profile report to coincide with the World Conference on Railway Research (WCRR) in Sydney. Alongside the NGT, the report also covered a study on the feasibility of a high-speed rail link

in Australia which DLR researchers had drawn up in collaboration with Australian colleagues. A major finding of this study was that the almost 1,800-kilometre line, which would connect Brisbane, Sydney, Canberra, Melbourne and other cities on Australia's eastern seaboard, could be built for 30bn AUD less than assumed in an earlier study; the savings could be achieved through a route optimisation that requires significantly fewer tunnels and bridges. This outcome demonstrates that the systemic approach to rail transport is also applicable outside Europe.

The study results were presented at WCRR, as was the DLR idea of a family of high-speed trains for passenger and goods transport, alongside selected work.

Outlined projects included research into pressure distribution under high-speed trains (flying gravel), possibilities of influencing bow waves when entering tunnels and new calculation methods on susceptibility to crosswind.



Melbourne – Brisbane high-speed rail link, © Beyond Zero Emissions



Animation of the Next Generation Train

## PiLoNav

### High-precision and reliable information for ships and trains

DLR's transport researchers not only work on issues relating to road, rail and air transportation; maritime transport is also an important part of their work. Among other things, they are examining how new systems can improve the accuracy and reliability of nautical information to aid safe navigation and help determine traffic situations. On May 7, 2014, the current level of development achieved in the DLR project Maritime Traffic Engineering was demonstrated to representatives of public authorities, industry and research on a test cruise in Rostock. Safely manoeuvring ships under difficult environmental conditions requires information on their precise position and bearing. A whole range of sensors provides the necessary data, which are then processed in a position, navigation and time data processing unit (PNT Unit) developed by DLR. Compared to previous technologies, this process is the first to derive authoritative information on the accuracy and reliability of position and navigation parameters.

New and highly accurate location and navigation systems can make traffic flows safer not only on the high seas, but also on inland waterways and in rail transport, and help meet the steadily increasing demands regarding efficiency and environmental friendliness. How synergies can be utilised across transport modes to meet these challenges was the focus of the BMWi project Precise and Integer Localisation and Navigation in Rail and Inland-water Traffic (PiLoNav), the results of which DLR researchers, industry and research partners presented to the Federal Government on the former government service vessel Mainz on the Moselle.



DLR staff and guests at the demonstration in Rostock

## Transport and the Environment

### Understanding traffic development and environmental effects

In order to understand transport and its effects on people and the environment, scientists have to intelligently connect a whole range of different aspects. The contribution made by DLR's research to this issue was presented on February 26, 2014, in Cologne at a one-day conference to conclude the first phase of the "Transport and the Environment" project, which examines questions pertaining to

how transport arises and develops in the context of its effects on people and the environment, focusing in particular on greenhouse gas emissions and the issue of traffic noise. The project also explores the influence of technical developments and regulatory measures on the transportation system and the demand for transport. The underlying models are combined into a closed chain model for systematic consideration. Beyond examining individual aspects, this allows researchers to perform a unique, holistic analysis and evaluation. In the second phase of the project, which is already underway, the developed models will be further refined and applied to specific issues over the next four years. Possible developments in mobility up to 2040 are to be mapped in various scenarios; there will also be a stronger focus on multi-modal transport behaviour, and relationships between settlement structures and transport will be highlighted.

@ <http://s.DLR.de/0761>

### Sustainable Mobility until 2040



**Prof. Dr Barbara Lenz**  
Director of the Institute of Transport Research

"How can we be sustainably mobile? How can technology help us achieve that? What are the prerequisites for a sustainable transportation system of the future? In an interdisciplinary research association of eleven DLR institutes and other external partners we are developing a model-based toolkit that will not only allow us to examine the development of transportation and its effects on the environment, the economy and society, but also to determine the effectiveness of technologies and political measures."



## eCoMove



Saving up to 20 percent fuel

### Anticipatory and energy-efficient driving

The aim of the EU project eCoMove was to develop driver assistance systems that help drivers save fuel and drive in a more environmentally friendly manner. In collaboration with 31 European partners, DLR conducted research into integrative solutions for energy-efficient driving: optimising routes, saving kilometres and fuel, and improving transport management. The project succeeded in demonstrating that the use of cooperative driver assistance systems can reduce fuel consumption by up to 20 percent, for example through wireless communication with traffic light systems. Drivers are shown on a display how long an upcoming traffic light will remain red; a speed recommendation informs them how fast they need to drive in order to pass the traffic light without having to stop and which gear uses the least fuel at that speed. Alongside visual assistance for drivers the project also examined how drivers respond to haptic information. In test drives, acceleration or delay recommendations were made by means of counter pressure from the accelerator pedal. Some drivers felt that haptic feedback as a sole source of information required some getting used to, but in combination with visual feed-

back via display it was well received. In addition to saving fuel, the speed recommendations from the cooperative assistance system also contribute to safer driving: the test drivers not only had to stop less frequently at red lights, they generally drove at a more even speed and were thus less likely to exceed the specified speed limits.



Test facility for the hydrogen tank

## SSH2S

### Safe and efficient hydrogen storage

In an EU research project in cooperation with seven partners, DLR scientists have developed a tank that can store hydrogen compactly under moderate pressure and ambient temperatures. This new tank in combination with a fuel cell was installed for the first time in a vehicle as an auxiliary power unit (APU). The APU delivered one kilowatt of power and was able to supply the air conditioning system, parking heater and lighting with electricity. The modular hydrogen tank is made up of individual, adjacently affixed tubes and filled with two different metal alloys, the consistency of which is comparable to flour. These storage materials absorb the gaseous hydrogen like a sponge; the hydrogen binds to the storage material, allowing the volatile gas to be stored in a small volume at a pressure of just 70 bar and normal ambient temperatures. The re-

quired storage pressure is significantly lower than of conventional hydrogen tanks, which require the hydrogen to be kept under a pressure of 700 bar. In addition, the new tank stores the hydrogen very safely: even in the event of a leak, the strong bond between the gas and the storage material ensures that the hydrogen escapes so slowly that there is no danger of an explosion. During the project, DLR worked with partners TechnoDelta and Fiat Research Centre to develop the solid matter combined tank, its coupling with the fuel cell and its integration into the vehicle.

## UR:BAN



Half-time presentation of the UR:BAN project

### Assistance systems for urban areas

The half-time presentation of the joint project UR:BAN, in which 31 partners from industry and research are cooperating to develop driver assistance and transport management systems for urban use, was held on May 14, 2014, at the DLR site in Braunschweig. Within this project, DLR is working on Car2X communication, i.e. direct communication between vehicles and the infrastructure. For example, traffic lights can inform vehicles of the remaining duration of the current red or green phase. This information allows cars to adapt their speed and avoid unnecessary abrupt stops, thereby saving energy and at the same time reducing pollution in cities.

In order to examine such complex topics in all their facets, DLR has transformed an entire city into a laboratory for its large-scale research facility AIM (Anwendungsplattform Intelligente Mobilität) in Braunschweig. The facility was officially opened on July 17, 2014. Transport researchers from DLR, other research organisations and companies can now use AIM to develop and test new technologies for safe driver assistance systems and modern and efficient transport management. Within a real urban traffic network, transportation systems can be examined from almost any perspective. Alongside vehicle traffic, the behaviour of cyclists and pedestrians can also be analysed with the help of video cameras and radar systems.

## VABENE++



Research helicopter with new camera system

### New airborne camera system

At large-scale events or disasters, a clear overview of the situation on the ground is essential for rescue workers and command and control centres. The tools used for this purpose in the VABENE++ project include airborne optical camera systems. The previous powerful systems were however so large that they could only be carried by aeroplanes. Now an appropriately adapted, real-time capable camera system for traffic monitoring has for the first time been installed on a helicopter. Helicopters have the advantage that they are very agile and also able to hover at a fixed point above a traffic interchange or a crowd. The new system can be attached very quickly and flexibly to the outside of a helicopter, and is thus also suitable for use on police helicopters deployed at large-scale events or disasters. The camera system consists of three standard cameras; it can capture both vehicles and persons and in addition to still images of the situation also delivers high-resolution videos, which are helpful in particular for



following and analysing the dynamic movements of large groups of people. The images and videos are processed on board the helicopter, georeferenced and transmitted to ground in seconds; the provided data allow traffic control centres to regulate traffic as required by the situation and guide emergency personnel quickly to the site of an incident. The researchers are using a microwave link with a transmission rate of eleven megabits per second for data transmission to the operations centre.



interactiVe test drives in the simulator

action or thought they themselves had responded to the obstacle by swerving. The collaboration with 30 project partners achieved important findings on designing collision avoidance systems. The current research results will also contribute significantly to clarifying unresolved legal issues regarding automation in road traffic.

## interactiVe

### Steering assistance to avoid collisions

In order to avoid suddenly appearing obstacles, drivers have to react very quickly. But their response times are frequently too long to prevent a collision. In the EU project interactiVe, DLR researchers have tested a steering assistance system designed to avoid or at least lessen the impact of such collisions. The results of the research project were presented at a closing event in Aachen/Lommel. The steering assistance system supports drivers by means of an automatic swerving motion. The project conducted three simulator

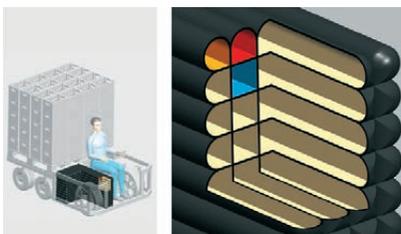
studies and a real vehicle study to examine how test drivers behave in interaction with the steering assistance system. The test drives showed that the collision avoidance assistance system can both help significantly reduce the number of accidents involving suddenly appearing obstacles and reduce the impact of accidents where a collision cannot be avoided. The study participants accepted the support of the steering assistance system very well. Many of the drivers were not even aware of the system's



## German High Tech Champion 2014

### ... with modular delivery van

DLR transport researchers have again won the German High Tech Champion Award presented by the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF). This time, they won the 10,000-euro award for their application-oriented concept of a modular transport vehicle that makes urban deliveries more efficient and environmentally friendly. Both the range and the payload of this innovative vehicle of the future can be adapted as required. This is achieved mainly through more efficient utilisation of the available space. The utility vehicle has a drive module that contains all necessary components, such as an electrical drive train, a modular and



Schematic view of adaptive cellular tank

space-adaptive cellular tank and the power electronics. The cellular tank was developed by DLR's Transport programme. Traditional fuel tanks in automobiles are made of steel and are therefore both very heavy and often awkwardly shaped. The DLR cellular tank on the other hand is very light thanks to the use of fibre-reinforced plastics, can be produced in a wide range of shapes and is nonetheless very safe. Together with the load-adaptable freight module, the DLR utility vehicle concept identifies potential to increase payload and range while at the same time offering significant charge capacity.

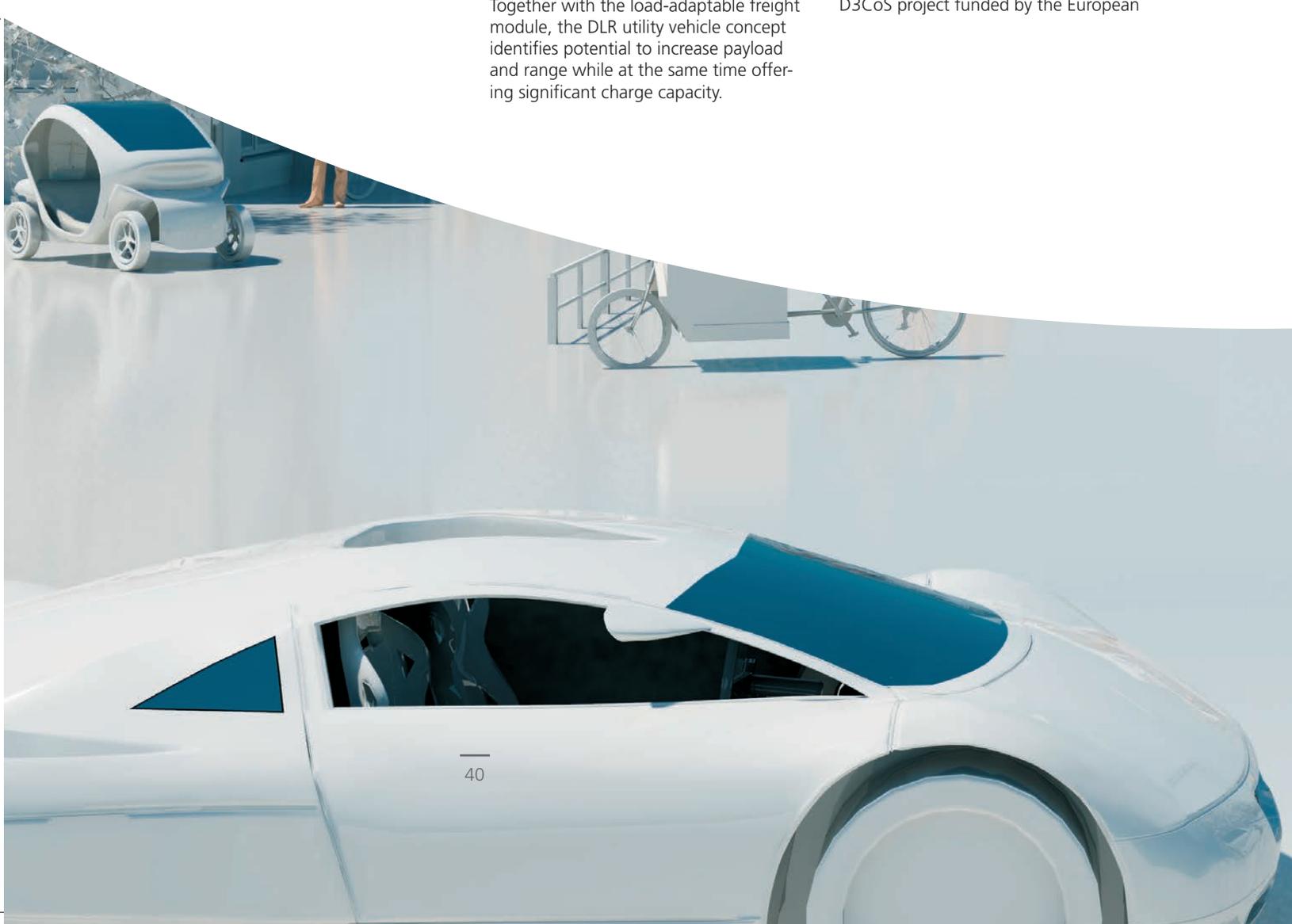
## D3CoS



Gap available, please overtake

### Help changing lanes

DLR researchers have developed a cooperative lane change assistance system to help drivers change lanes on motorways. Assistance systems that provide drivers with additional information or warn them of dangerous situations are already on the market; vehicles that actively communicate and cooperate with each other are however still in the research phase. In the D3CoS project funded by the European



## SimpleFleet

Commission, scientists are currently exploring how cooperative systems could work and what they could look like. Within this project they have developed the lane change assistance system Gap Assist to test scientific methods. Gap Assist is the prototype of a driver assistance system that uses communication between two vehicles. A driver wanting to switch from the right to the left lane activates the electronic assistance system. The system then looks for a vehicle on the left lane whose driver would only have to slow down slightly to create a suitable gap. It sends a request to the other vehicle's system, which checks the feasibility of opening a gap on its part, requests the driver's approval and then communicates its willingness to the requesting vehicle. The left vehicle then slows down; once the gap has opened, it notifies the requesting vehicle, which can then safely change lanes.



Reliable route planning even for very small fleets

### Flexible route determination for small fleets

Reliable route planning in urban transport is a major challenge for companies. Small and medium-sized businesses in particular lack affordable alternatives to existing fleet management systems. DLR researchers have developed a solution to this issue that allows companies to deploy their vehicle fleets in a time- and resource-saving way while allowing for current traffic conditions.

As part of the SimpleFleet research project funded by the European Commission they have developed a fleet management

tool that replicates the current traffic situation and enables flexible route determination in real time. The system is based on traffic data that are drawn from various sources around the clock. These traffic data are supplied by the fleet vehicles themselves, which are equipped with a GPS system, allowing companies to avoid purchasing expensive data from telematics providers and thus making the system attractive even for very small fleets with only a few vehicles.



## Why buy an electric vehicle?

### A Germany-wide survey

Enthusiasm for innovation, a desire to cut down on pollution and affordable operating costs are the main reasons for choosing an electric vehicle. These are the findings of the first representative Germany-wide survey, which was conducted by DLR transport researchers and drew over 3000 responses from owners of electric vehicles. While the profile of private electric vehicle buyers is similar to that of buyers of conventional new and nearly new cars, commercial electric vehicles are used mainly by small businesses. The survey also examined users' driving behaviour, and found that private users are guided by environmental motives not only when buying a vehicle; they also drive in a more environmentally conscious, ecological and anticipatory manner. While private users of battery-operated



Reasons for using electric vehicles

vehicles don't generally drive less than owners of conventional vehicles, they do see limitations when it comes to holiday trips. Cold weather and lengthy charging times are also considered problematic. But the fact that 84 percent of private users would recommend purchasing an electric vehicle and over half of commercial electric vehicle owners even plan to buy additional vehicles demonstrates that electric vehicles have meanwhile attained significant utility value.

## Outlook

The living environment of most people in Europe today is defined by urban areas, which in response to the changing requirements of day-to-day mobility are increasingly becoming test laboratories for innovation and change. At the same time, the immense challenge cities are facing with regard to ensuring sustainable mobility is becoming apparent. New concepts for combining long-term residential choices and daily mobility decisions are needed in order to minimise the negative effects of urban traffic without overly thwarting the population's need for mobility. DLR's researchers are aiming to explain the connections between spatial structures, mobility needs, mobility behaviour and mobility options, influential and control mechanisms of mobility in cities. Based on empirical analyses and with the help of refinements to existing models they are developing solutions for shaping urban mobility and urban areas, the implementation of which combines quantitative and qualitative analyses with modelling and model applications. In the long term this will enable DLR to provide substantiated systemic support to decision-makers in urban, spatial and transport planning.

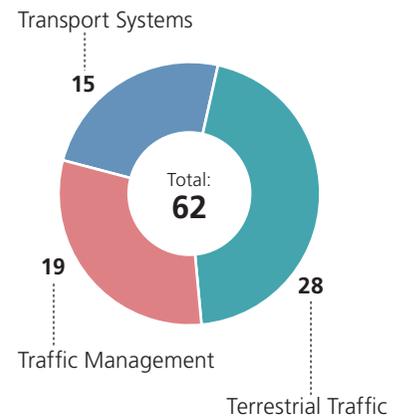


Transport: Revenues in millions of euros	2013 Actual	2014 Planned	2015 Planned
Institutional funding	45	46	49
Third-party funding	21	16	18
<b>Total revenues</b>	<b>66</b>	<b>62</b>	<b>67</b>

DLR believes that transport development and control options and their effects on the environment, economy and society can only be examined through an integral approach. To this end the variously oriented institutes are combining their competences and generating extensive synergies. The Transport programme has specifically expanded its portfolio over the past year by taking up work on noise generated by road traffic and its effects on humans. Based on many years of expertise on the generation, measurement, spread and effect of rail and air traffic noise, research in the Transport programme will create an end-to-end methodology for the three aforementioned modes of

transport along the entire chain of effects over the coming years. The scope of DLR's transport research, which currently aims mainly to create prognoses and scenarios, will be expanded to include operational aspects, primarily in road and rail traffic and in public transport. DLR's competencies in transport economics are also to be expanded further. A stronger involvement in structural health monitoring, which entails monitoring and evaluating the condition of transport infrastructures and buildings, is currently being assessed.

Expected revenues for the year 2014



All figures in million euros





## Energy

The transformation towards a sustainable energy system can be significantly aided by technological progress and a better understanding of energy systems in general. Publicly funded energy research is especially committed to the aims of the energy transition policy, and DLR sees itself as an active and effective supporter whose research is conducted fully in the service of these aims. DLR energy research concentrates on environmentally friendly, efficient and affordable energy supply and storage at an energy-economically relevant scale. We deal with topics relating to efficient and environmentally friendly power generation; thermal, electrochemical and chemical energy storage; and analysis and development of the energy system as a whole. The breadth and diversity of the competencies of the DLR institutes offers a particular competitive advantage in this respect, as this range of skills permits complex issues to be examined in a multi-disciplinary fashion and offers the benefits of a wide range of synergies. The high standard and productivity of DLR energy research is indicated by the fact that a significant proportion of its funding comes from industry and government research programmes. The Helmholtz Association's Energy research field was successfully evaluated in early 2014; the resulting funding recommendations are currently under discussion.

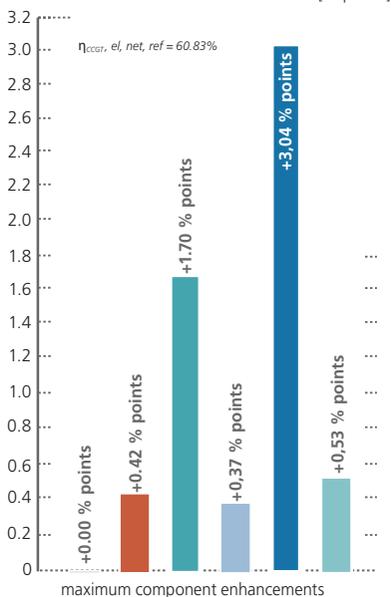
# Security of supply

## Stationary and combined cycle gas turbines

Due to the significant increase in naturally fluctuating renewable energies such as wind and solar power, state of the art conventional power plant concepts are essential to ensuring security of supply. Under these circumstances, the operating requirements for conventional power plants change significantly, necessitating highly flexible systems that offer high load gradients in response to the increasing need for balancing power. They also have to feature adequate output capacities and moreover be especially efficient across a broad operating range. Combined cycle gas turbine (CCGT) plants are particularly suited to providing fossil fuel support for the energy transition in Germany and meeting these new operating requirements.

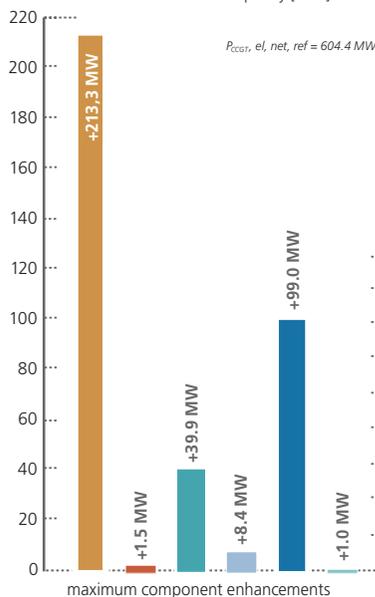
The Institute of Propulsion Technology is specifically examining the potential of various technologies to enhance gas turbines by analysing how the systematic further development of compressor and turbine aerodynamics, lean premix combustion and turbine cooling can affect power plant performance. Thermally highly resistant turbine blade materials and a higher combustion temperature through new burner technologies are crucial to increasing power plant efficiency. To meet the rising demand for energy, power plant capacity has to be increased; this is achieved in particular by raising the air flow rate through the compressor. Overall, the results of this work show that an increase in the effectiveness of combined cycle gas turbines of up to 7 percent can realistically be achieved in the coming decades through consistent enhancement of gas turbine components, almost doubling the capacity of CCGT plants to reach the output class of coal and nuclear power plants. However, future research will also explore the potential of smaller gas tur-

Increases to electric CCGT net effectiveness [% points]



- Compressor mass flow rate
- Compressor effectiveness
- Combustion temperature
- Flame tube temperature
- Blade temperature
- Turbine effectiveness

Increases to electric CCGT net capacity [MW]



### Performance increase through enhanced components

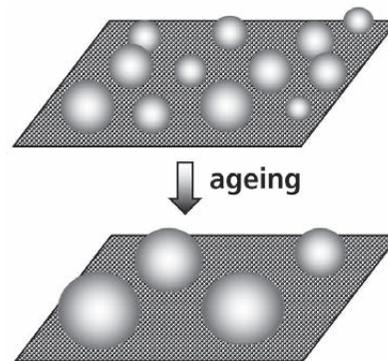
biners and examine aspects such as increasing the partial load efficiency and operating flexibility of CCGT plants.

## Fuel cells

### Modelling for longer lifecycles

40,000 hours – that's how long the life-cycle of a stationary fuel cell should be. This presents a major challenge to manufacturers. A promising fuel cell type for stationary applications is the direct methanol fuel cell (DMFC).

In the EU project Premium Act, DLR researched effective methods to predict the ageing of DMFCs. The work focused on the fuel cell catalyst, which consists of platinum nanoparticles applied to a



Systematic view of the ageing of a catalyst in a DMFC: growth of platinum particles

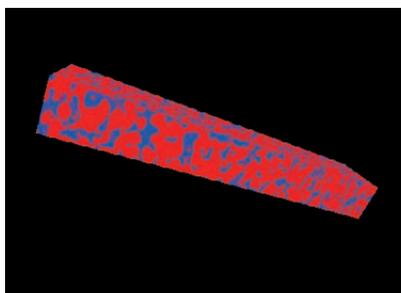
carbon carrier. During DMFC operation, the structure of this catalyst material changes (particle growth), resulting in a reduction in fuel cell capacity. In order to better understand this deterioration process, physical models were developed that enable researchers to simulate the changes in particle size and the cell's resulting loss of capacity on a computer. The ability to predict cell ageing this achieves is the first step to improving durability through the selection of an appropriate operating strategy.

The recently launched follow-up project Second Act will examine such strategies and develop the model further.

## HEMCP

### DLR's contribution to the Helmholtz Energy Material Characterization Platform

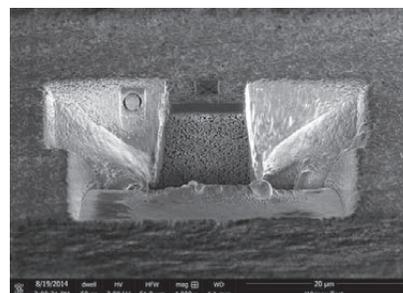
As part of the BMWi joint project HEMCP, the DLR Institute of Materials Research acquired a Dual-Beam Focused Ion Beam/



3-D model reconstructed from several individual images (red: WHIPOX matrix particles, blue: pores)

Scanning Electron Microscope (FIB-SEM). The project began on July 1, 2013, with a funding volume of €870,000, of which €805,000 alone were spent on the basic device. The system is now operational.

A FIB-SEM is one of the most versatile tools available for materials research. It combines a scanning electron microscope with an ion column. The ion beam can remove sample material and achieve structuring of the sample surface in the range of less than 10 nm. The second electron beam allows simultaneous observation of the surface, enabling the ion beam to be very precisely positioned. The FIB-SEM has already found multiple applications in the course of the institute's energy research activities; of particular note are examinations of the WHIPOX



Individual image from a series of tomographic slices of WHIPOX ceramic matrix for three-dimensional volume reconstruction

fibre ceramic, materials for solar water splitting and manganese oxide based layers for supercapacitor electrodes.

The damage-tolerant fibre ceramic WHIPOX consists of a matrix of porous aluminium oxide embedded in aluminium oxide fibres. In the energy sector, WHIPOX is to be used for hot gas path components in gas turbines. The mechanical properties of WHIPOX require a precise understanding of its microstructure. In this respect, the structural resolution of the new procedure is significantly superior to comparable procedures.

A further, related use of the FIB-SEM is the preparation of thin sections for examination in the transmission electron microscope. This technique was applied in the research on energy-relevant materials for solar water splitting and for supercapacitors.



# FLOX<sup>®</sup>

## Combustion chamber system tested in gas turbine for the first time

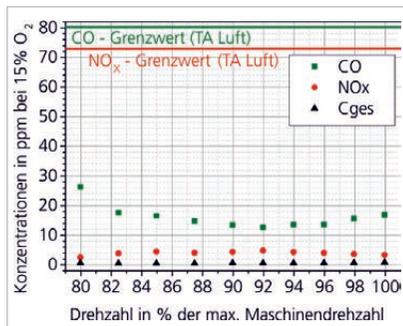
Alongside high efficiency and reliability, the requirements of future power plants include the ability to use fuels from a range of raw materials such as biomass, refuse or other residual matter. This fuel flexibility creates significant challenges for the combustion systems in gas turbines. The DLR Institute of Combustion Technology is therefore developing combustion chambers based on the FLOX<sup>®</sup> principle that enable gas turbines to meet the new requirements associated with the energy transition. The FLOX<sup>®</sup> concept, which was originally developed by the company WS Wärmetechnik for industrial power plants, uses an intensive mixing process in the combustion chamber to achieve highly stable and low-emission combustion. DLR researchers have developed this principle further for use in gas turbines, integrating and successfully testing a FLOX<sup>®</sup> combustion chamber system in a gas turbine for the first time. The work was funded by the Federal Ministry of the



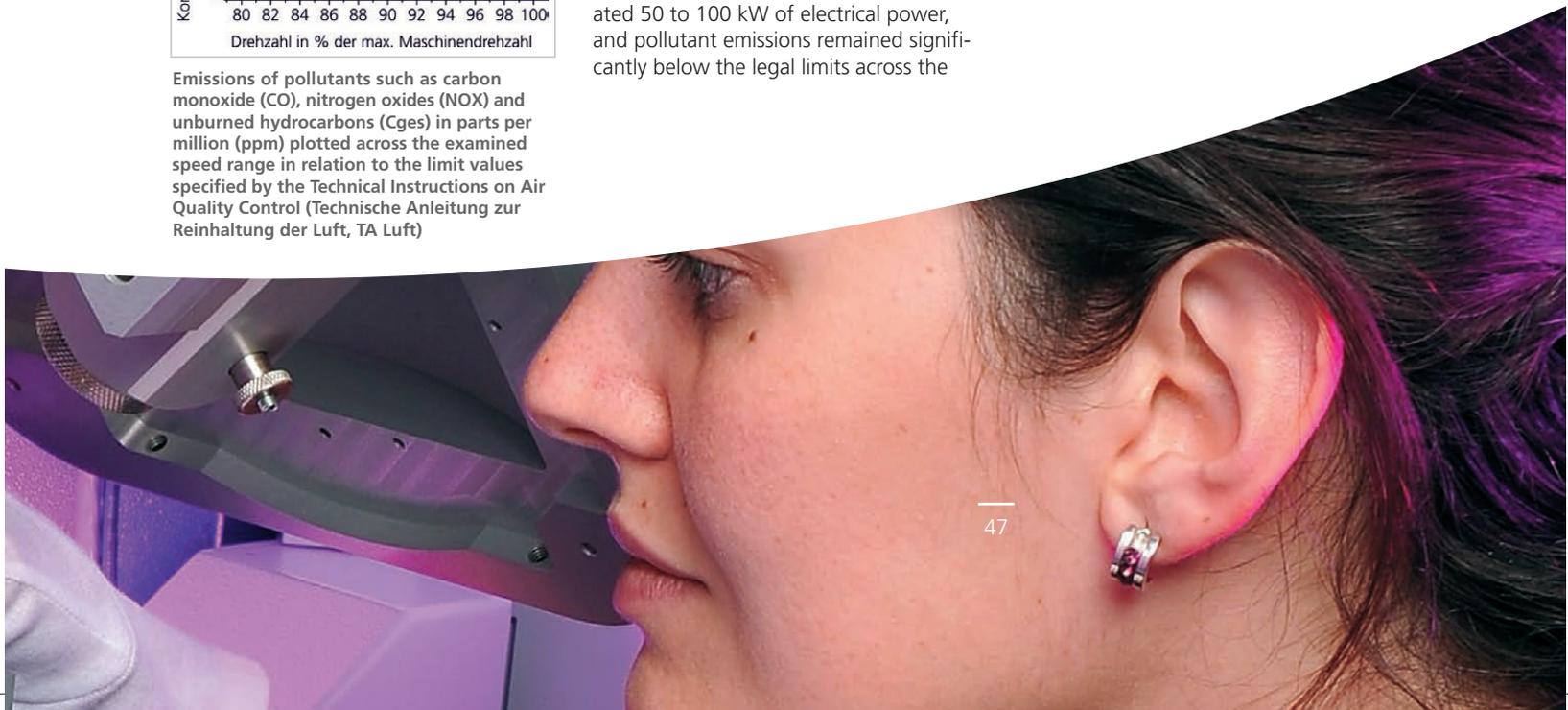
Installation of the wood gas FLOX<sup>®</sup> combustion chamber system in the Turbec T100 micro gas turbine

Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit, BMU) as part of the DeHoGas project to develop a sustainable wood gas power plant with a connected micro gas turbine cogeneration system.

entire operating range. In addition, efficiency was increased significantly by reducing combustion chamber pressure loss to under 4%. In summer 2014, the wood gas FLOX<sup>®</sup> combustion chamber system was integrated into a demonstration plant for long-term use; the plant was developed in cooperation with EnBW AG, the Institute of Energy and Environmental Technology e.V. and the University of Offenburg.



Emissions of pollutants such as carbon monoxide (CO), nitrogen oxides (NOX) and unburned hydrocarbons (Cges) in parts per million (ppm) plotted across the examined speed range in relation to the limit values specified by the Technical Instructions on Air Quality Control (Technische Anleitung zur Reinhaltung der Luft, TA Luft)





Jülich Solar Tower

## Jülich Solar Tower

### Test receiver taken into operation

The Institute of Solar Research has taken a new receiver test system into operation on the tower of the Jülich solar power plant. A receiver is the part of a solar power plant where the concentrated solar

radiation is transformed into heat. The test system is approximately half-way up the solar tower on a research level integrated into the tower. The new generation of solar receivers developed under leadership of DLR is designed to transform solar energy into heat and electricity far more efficiently and thus make the technology more affordable.

Reflected by over 2000 mirrors, the solar rays hit the radiation receiver on the tower power plant. In the explored approach, the solar rays are then absorbed by a porous ceramic element and transformed into heat. The heat energy is transferred to air taken in from the surrounding area; as it flows through the receiver, this air is



heated up to 700 degrees Celsius and conducts the energy into a power plant process. The solar receiver operates especially robustly because it uses ambient air, which is always available; it is ideal for use in dry regions with lots of sunshine. This open volumetric receiver principle is already used by the main receiver at the top of the 60-metre tower in Jülich.

The solar thermal test power plant in Jülich, which operates at an electrical capacity of 1.5 megawatts, was used to demonstrate the functionality of the overall system for the first time in a power plant. The new test system will now be used to further develop this principle by employing the new test receiver in several research and technology projects over the next two years.

The research will mainly involve testing finer pores in the cellular structure of the ceramics and examining ceramic materials with a sponge-like structure. Both these options offer very large surface areas to effectively transfer the heat to the air flow. The use of new materials such as metal alloys, with which even finer porous structures could be produced, will also be explored.



Laboratory test bed on heat transformation for a temperature range of 80–200°C

## Efficient industrial processes

### Use of process exhaust heat

The efficient use of exhaust heat flows is an important component in increasing the efficiency of industrial processes. Currently, this is mainly achieved through appropriate heat integration in the sense of cascading use of thermal energy. However, this type of heat integration has its limits – on the one hand if the heat and the demand for heat do not exist at the

same time; this time gap can be bridged through the use of thermal energy stores.

On the other hand, in many cases the temperature level of the heat flow is too low for a useful reintegration into the process. At this point a heat transformation that raises the temperature back to



a usable level is helpful. The Institute of Technical Thermodynamics has developed a process that allows thermal upgrading of an exhaust heat flow, and was able to successfully demonstrate this process in the laboratory.

The principle is based on a reversible gas-solid-reaction between salts and steam. It can be applied either in continuous operation or in a combination of

heat transformation and thermal energy storage. The energy for upgrading can either be taken directly from the exhaust heat or provided through intelligent utilisation of differences in concentration. A temperature increase of 50 kelvins for the low-temperature exhaust heat that is

generated in vast amounts in the chemical industry was demonstrated in an industrial process. Optimised reactor concepts will be the next step. Using different reaction systems will open up other temperature ranges for industrial process heat transformation in the future.

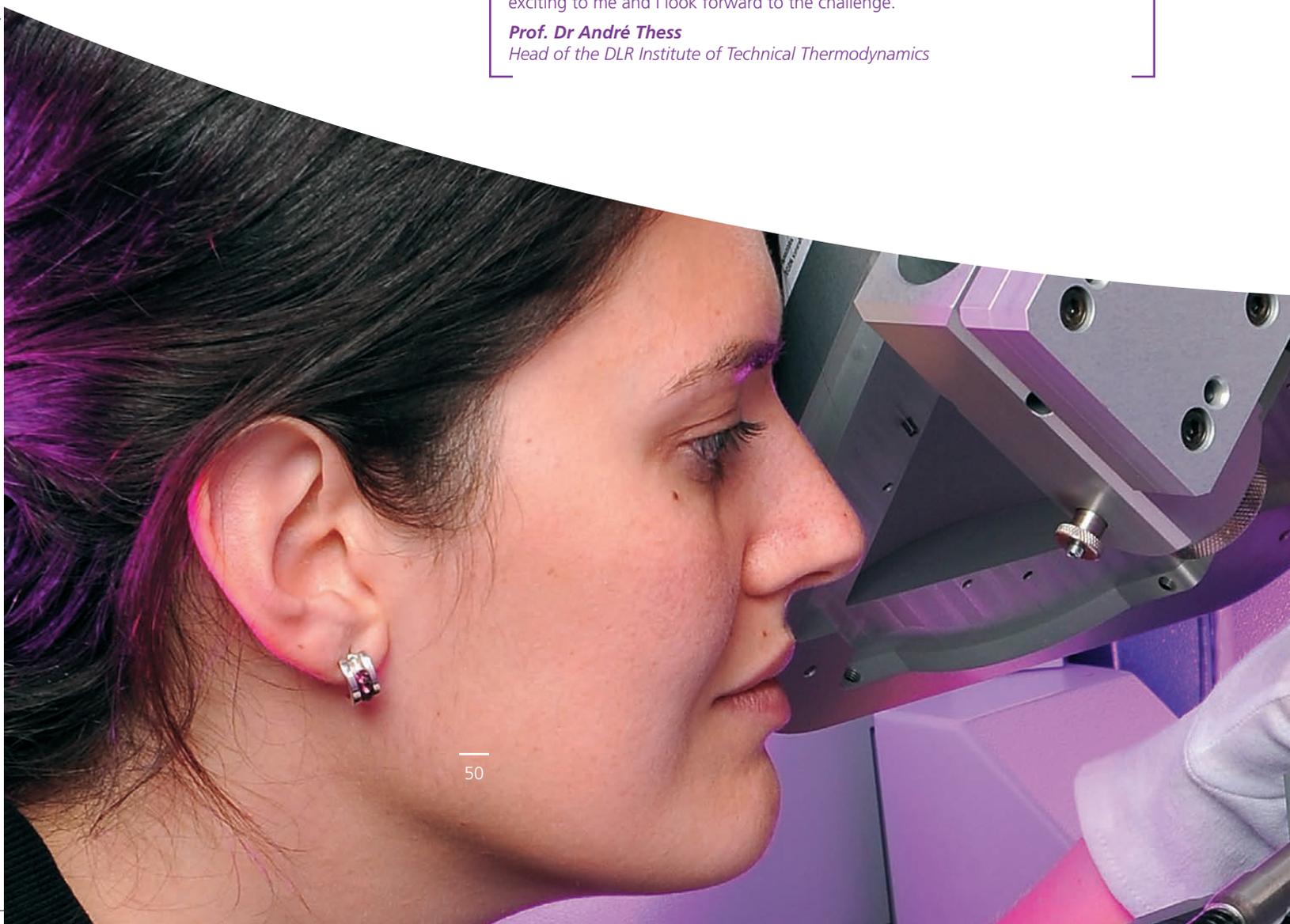
### New management at the Institute of Technical Thermodynamics



Even before I officially started working at DLR I had many discussions with my future colleagues. I'm very lucky to be able to collaborate with so many talented and dedicated energy researchers. Our institute is tasked with developing efficient and resource-saving technologies to store and transform energy – ranging from heat stores through batteries to fuel cells and electrolyzers. Our aim is to contribute with our research to facilitating the restructuring of our energy supply towards greater sustainability. We also conduct system analyses to examine how this technological change affects business, the environment, society and politics. This comprehensive approach is very exciting to me and I look forward to the challenge.

**Prof. Dr André Thess**

*Head of the DLR Institute of Technical Thermodynamics*

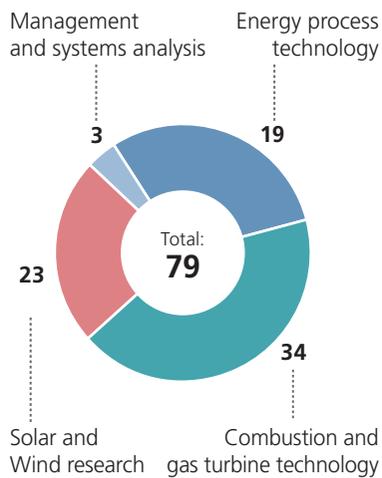


## Outlook

The energy transition is entering a new phase. The introduction of renewable energies has so far been characterised by feed-in tariffs and economies of scale without considering steering aspects. The focus is now no longer on the amount of energy uncontrolledly fed in, but on intelligently implementing further expansion to ensure that a secure and affordable energy supply is maintained. For research this means concentrating more strongly on system-related aspects. At the technological level, the most significant factor is the interaction between the wide range of intelligently controlled devices supplying and consuming electricity; but to further shape the energy transition decision-makers will also require tools enabling them to make the right decisions with regard to the specific properties of the various technologies.

Energy: Revenues in millions of euros	2013 Actual	2014 Planned	2015 Planned
Institutional funding	26	29	30
Third-party funding	45	50	53
<b>Total revenues</b>	<b>71</b>	<b>79</b>	<b>83</b>

Expected revenues for the year 2014



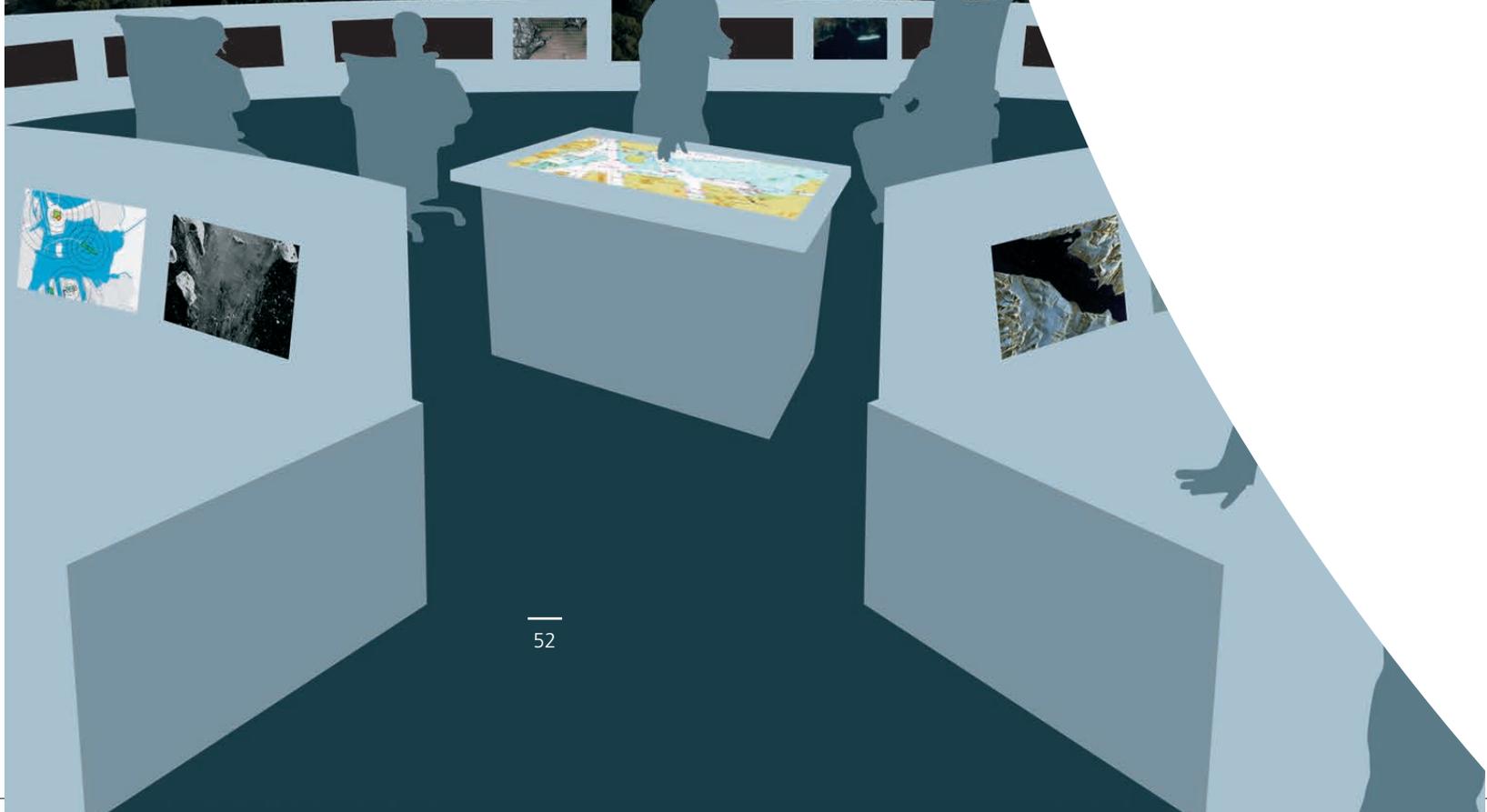
All figures in million euros





# Defence and Security

DLR's Defence and Security programme plans and controls research and development activities relating to defence and security in coordination with partners from government, academia and industry. The interdisciplinary field of Defence and Security links core competencies from the established DLR programmes Aeronautics, Space, Energy and Transport. In the course of their security-relevant projects, more than 20 DLR institutes and facilities contribute to developing, testing and evaluating technologies, systems and concepts and to developing capacities for assessing and analysing security-relevant applications. DLR has comprehensive *end-to-end*



systems expertise in satellite-based and airborne platforms as well as competencies in significant system areas such as sensor technologies, Earth observation and communications. With the available satellites and the associated facilities, data gathering infrastructures and numerous research aircraft necessary for their operation, its various recording and analysing methods and special simulation environments, DLR is in a position to contribute to the protection and monitoring of critical infrastructures for crisis and disaster management, border security and protection against terrorism and organised crime. Experiences from the *dual use* sector further round off the profile of the core competencies of DLR. In security research, DLR is networked nationally, across Europe and around the world. Its research activities support Germany's position in European and international competition. The strategic alignment of DLR's cross-departmental Defence and Security programme is determined against the backdrop of a future European security and defence policy, while also taking into consideration capability profiles defined at an international level and aimed at protecting the population and ensuring peace.

The objective of DLR's security research is to develop strategies to protect basic European values against threats such as organised crime, terrorism, natural disasters and industrial accidents. Its main research areas

also include developing and enhancing security systems, analysing existing infrastructures, in particular border crossing points, and developing emergency strategies. This work is conducted against the background of a free, equitable and safe Europe and with a view to protecting the privacy and civil rights of individuals. The following European key research areas are derived from this long-term objective:

- Civil defence
- Security of infrastructures and supply
- Intelligent monitoring and border security
- Ability to restore security in the event of a crisis

Of these, DLR mainly works on the security of infrastructures and supply and on the ability to restore security in the event of a crisis, with the aim of contributing to the above-mentioned key areas through its research. In addition, DLR provides procedures and facilities for demonstrating, testing and evaluating relevant technologies; these are designed to serve advisory purposes and maintain and expand analysis and evaluation capacities for political decision-makers and state users (Federal Criminal Police Office, Federal Office of Civil Protection and Disaster Assistance, Federal Office for Information Security etc.).

In addition, DLR manages the activities and coordinates the research of the DLR research association *Maritime Security* with the aims of bundling and expanding existing competencies to aid maritime security and identifying new and innovative approaches to effectively and efficiently handling maritime security tasks. The overarching goal of these activities is to conduct interdisciplinary, application-oriented basic research in order to support end users mainly in public authorities in meeting their broad and challenging range of responsibilities.

In the field of defence, departmental research forms a bridge between science, society and politics. Its main tasks are advisory and research-based work for the Federal Ministry of Defence (Bundesministerium der Verteidigung, BMVg) as a basis for the ministry's administrative and political decisions. DLR's defence research contributes significantly to these in order to meet the needs of the Federal Armed Forces for military capabilities and close gaps in those capabilities over the medium and long term.

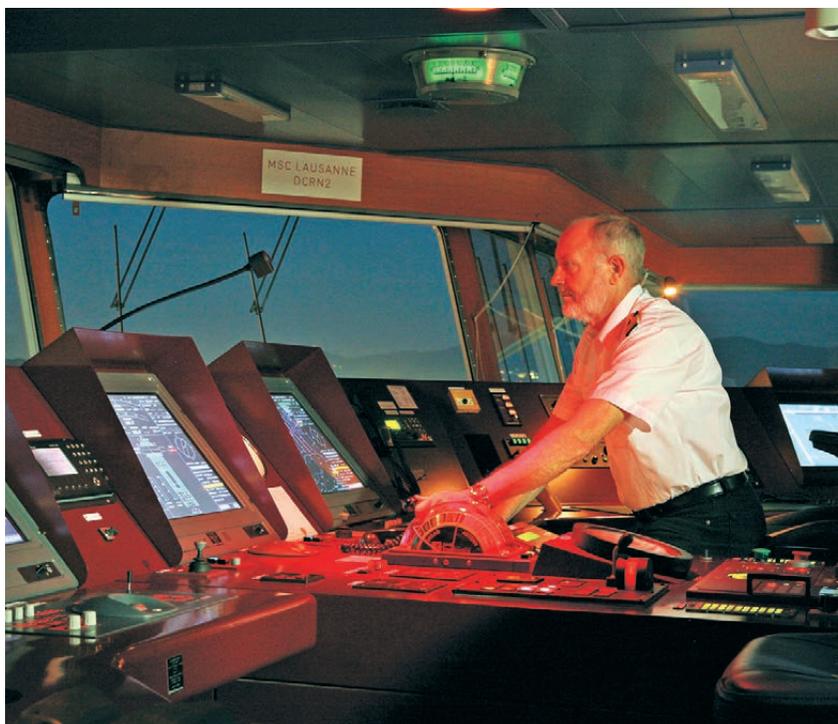
This requires DLR to provide both quickly accessible scientific competencies and the ability to work continuously on longer-term issues. Defence technology research is always based on existing research results (add-on principle) and employs dual-use technologies.

## Maritime Security

### New procedures to aid safe navigation and reliably determine traffic situations at sea

In order to improve the accuracy and reliability of nautical information, researchers at the Institute of Communications and Navigation are working on new systems to aid safe navigation and reliably determine traffic situations. The researchers demonstrated the level of development so far achieved in these new systems to representatives of public authorities, industry and research on a test cruise in Rostock on May 7, 2014.

Safely manoeuvring a ship from dockside to dockside under difficult environmental conditions requires information on its precise position and bearing. The necessary data is provided by a whole range of shipboard sensors. Before these data reach the ships' display systems, they are processed in a position, navigation and time data processing unit (PNT Unit) developed by DLR. Compared to current technology, this system is the first to enable the derivation of information on the accuracy and reliability (integrity) of positioning and navigation parameters. To test the PNT system, the first operationally available add-on system to support high-precision navigation applications using global satellite navigation systems with integrated reliability assessment was taken into operation in the Rostock research port during the four-year project

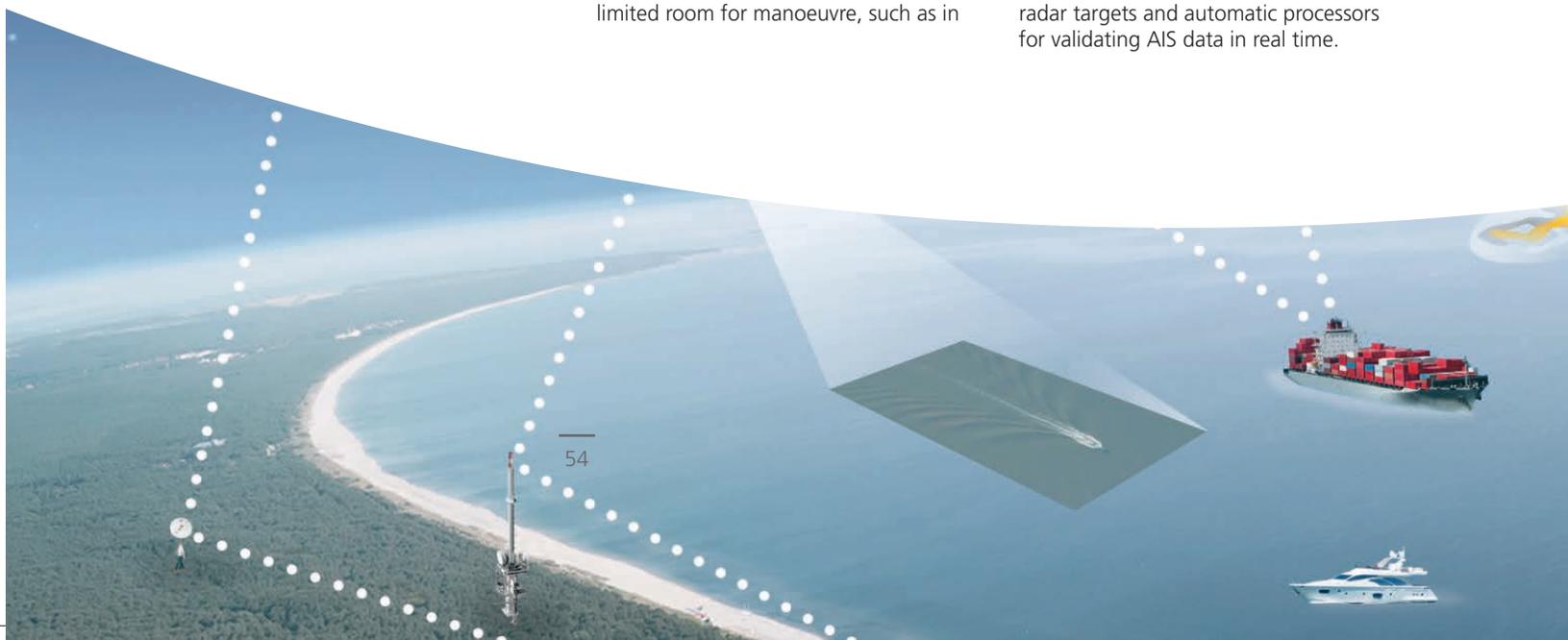


View of a modern ship's bridge, which could in future also house a PNT system including technologies developed at DLR

period. Integrating such a land-side add-on system makes it possible to detect interferences in signals from global navigation satellite systems (GNSS) and support manoeuvres such as automated docking with precision requirements of under 10 centimetres.

Reliably recording and displaying the current traffic situation at sea on the other hand is crucial to preventing collisions and groundings. This is important particularly in areas with high traffic volumes and limited room for manoeuvre, such as in

the North Sea or the Baltic. Here too the motto is that only separate and independently operating data sources can provide a basis for reliably surveying and assessing the traffic situation. With this project DLR researchers have now created a basis for merging data from ships' radars with those of the Automatic Identification System (AIS), which uses ship data, to generate a more reliable image of the traffic situation. To this end, the project developed both methods for automatic identification and tracking of dynamic radar targets and automatic processors for validating AIS data in real time.

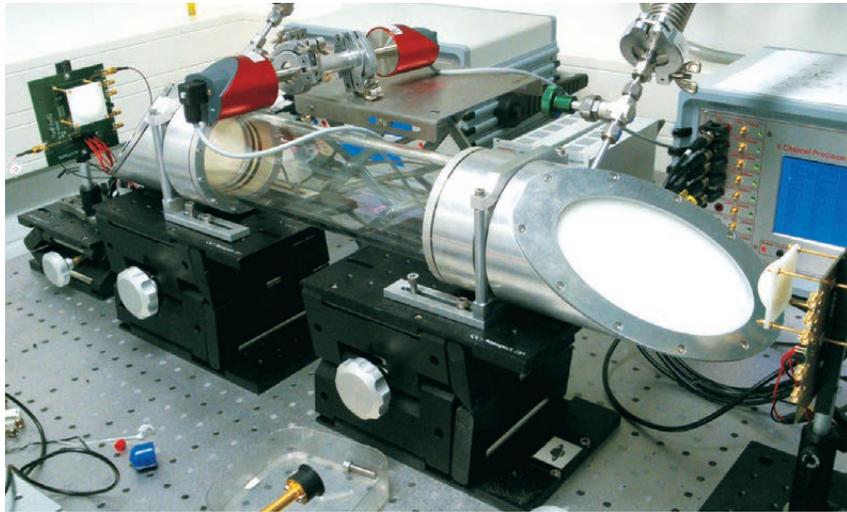


## Gas spectroscopy

### New system enables detection of toxic gases

Scientists at the DLR Institute of Planetary Research and the Leibniz Institute of Innovations for High Performance Microelectronics (IHP) have succeeded in developing a compact and affordable sensor system for gas spectroscopy in the 245-gigahertz (GHz) range. The system allows poisonous gases to be detected early on. In the security sphere it can for example be used to prove the presence of toxic gases.

Millimetre wave absorption spectroscopy is a well-known laboratory technique that is used in laboratory molecular spectroscopy and in radio astronomy to absolutely determine the concentration of specific molecules. The devices were previously unwieldy and very expensive due to their radiation sources and the size of the detectors. In recent years, commercial radiation sources based on multiplying microwave frequencies have however become available. These systems are compact, but still expensive due to the complex manufacturing process they require. The IHP has succeeded in developing prototypes of a transmitter and receiver with an integrated antenna in SiGe technology that operate in the 238 GHz to 252 GHz range. As they are designed in SiGe technology, these components are compatible with the manufacturing process established in the semiconductor industry and can be produced affordably. DLR has integrated this transmitter and receiver into a full system for the spectroscopy of toxic



Laboratory set-up of the gas spectroscopy system developed at DLR

gases and implemented highly sensitive detection techniques into the sensor system. Early and highly sensitive detection of such gases is crucial in the event of terrorist attacks on transportation systems, but also during chemical accidents. The researchers were able to demonstrate that dedicated analysis software also enables automated identification of different components in complex gas mixtures. The affordable production process for the sensor system opens up a wide range of

potential applications. A compact version of the sensor system would also be suitable for use on unmanned aerial vehicles or in robotic exploration.

## Mount Everest

### First flight with power glider and 3-D camera

A German team comprised of pilots from the Mountain Wave Project (MWP) and researchers from the German Aerospace Center has achieved a premiere on the world's highest mountain. They were the first to fly along 8848-metre Mount Everest in a power glider – with a special 3-D camera on board. The innovative camera system developed by DLR's Defence and Security programme forms the basis for a high-precision model of the Nepalese Everest region with a resolution of up to 15 centimetres. These images will help predict landslides and flooding caused by glacier lake outbursts. The MACS 3-D special-purpose camera, which was developed and constructed at DLR, is installed in a purpose-built pressure-free instrument container under the wing of the Stemme power glider contributed to the expedition by the Faculty of Aerospace Engineering at the Aachen University of Applied Sciences. The camera has to withstand the extremely low temperatures over the Himalayan peaks – below minus 35° Celsius during the current flight – without losing functionality. The DLR special-purpose camera was therefore put through a number of endurance tests before the mission, including tests in a vacuum chamber, at medium altitudes

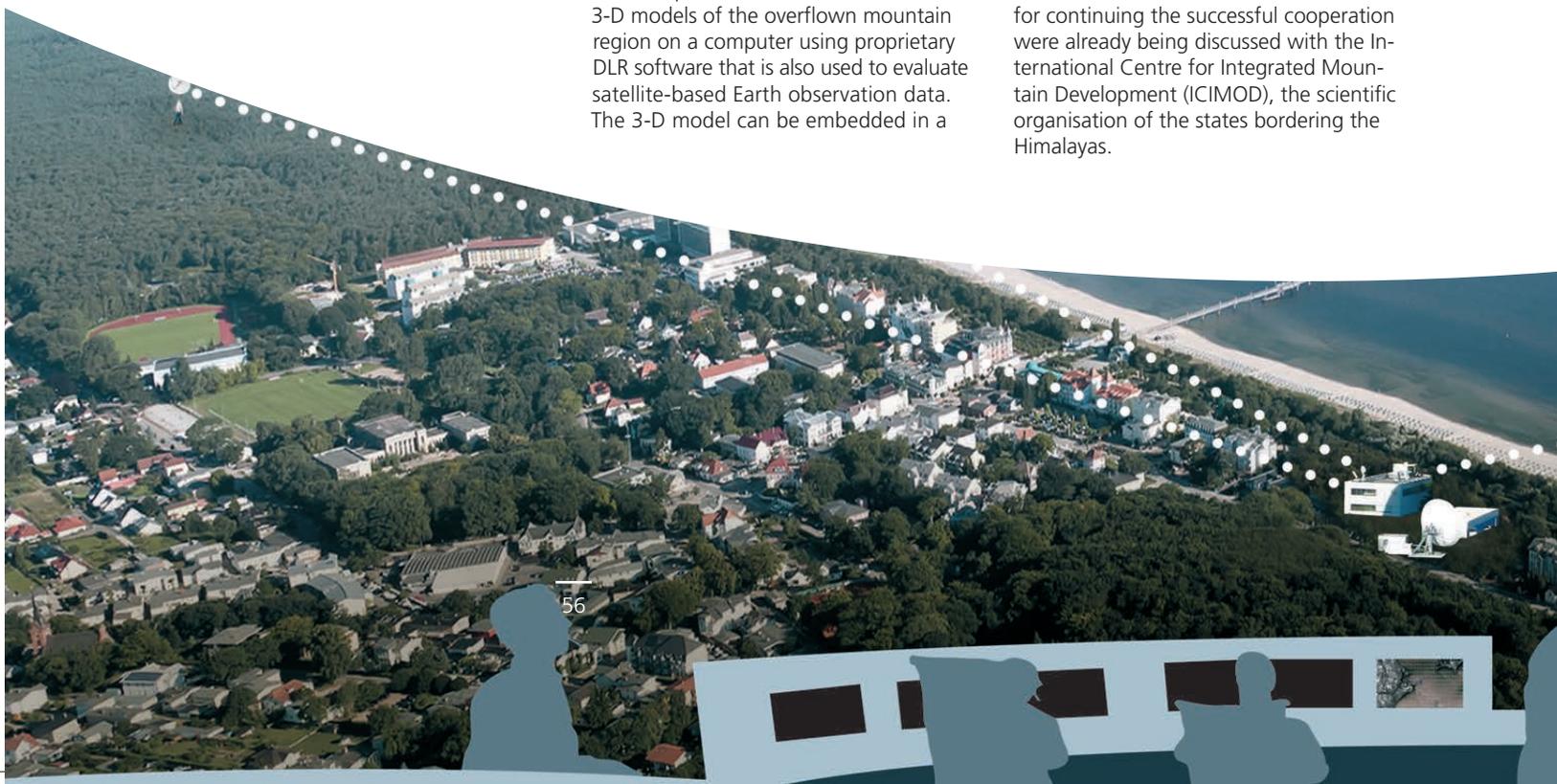


Long-distance view over the Himalayas. Centre: Mount Everest At right: DLR special-purpose camera MACS in a camera container under the wing of a Stemme S10 VTX.

over the Alps and under unusual lighting conditions. The camera system's imaging technology is designed especially for the particularities of alpine regions. Three laterally inward-angled camera heads provide a viewing angle of 120 degrees and make it possible to capture steep mountainside structures at high resolution. The images are then processed into detailed coloured 3-D models of the overflowed mountain region on a computer using proprietary DLR software that is also used to evaluate satellite-based Earth observation data. The 3-D model can be embedded in a

geographic information system (GIS), enabling analyses and assessments of the threat potential of steep mountainsides and extensive glaciers in difficult-to-reach mountain regions integrating geological, hydrological and meteorological data.

Shortly after the successful research flight at Mount Everest, initial results and ideas for continuing the successful cooperation were already being discussed with the International Centre for Integrated Mountain Development (ICIMOD), the scientific organisation of the states bordering the Himalayas.



## Outlook

In maritime security, five projects and a large-scale investment measure were launched by the Maritime Security research association in January 2013 for a duration of three years. Alongside enhancing procedures and systems to improve maritime navigation and communication, developing new satellite-based real-time systems is a key aspect of this research. In the BMBF-funded, DLR-led joint project *Echtzeitdienste für die Maritime Sicherheit – Security* (Real-time services for maritime security, EMSec) launched in January 2014, work will focus more heavily on researching and testing systems to merge and integrate various sea-, air- and satellite-based data. By providing maritime situation reports in unprecedented clarity, with better data and real-time availability, these systems will for example enable end users in public authorities to respond better and more efficiently to security-critical situations such as storm floods, collisions or maritime disasters.

In civil defence research, DLR will collaborate in 2015 with partners from the Jülich Research Centre (FZJ) and the Karlsruhe Institute of Technology (KIT)

on a cross-HGF and DLR-led project to explore a scenario on the security of the power supply system of the future. The expansion of renewable energies is causing a fundamental, structural change in the energy supply system. As part of the suggested scenario, DLR will be examining the effects of a large-scale and longer-term blackout and methods to assess and select appropriate countermeasures. Questions will include for example how long the functionality of important critical

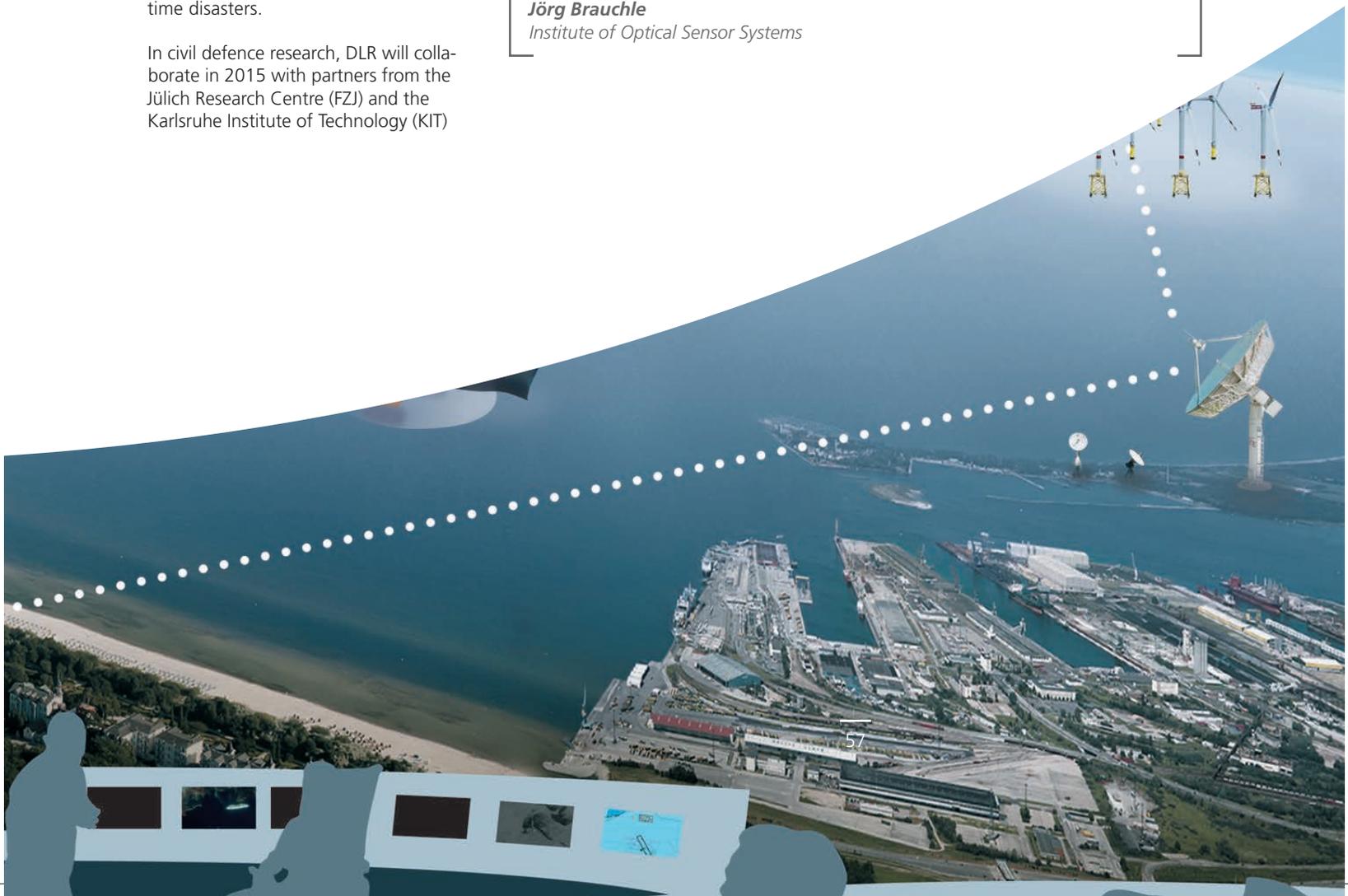
infrastructures (e.g. public transport, hospitals, airports) can be maintained in order to facilitate the evacuation of persons from the endangered area. The work also aims to develop planning methods and tools that will make it possible to provide a high level of security – even under unfavourable conditions – for a city of the future.

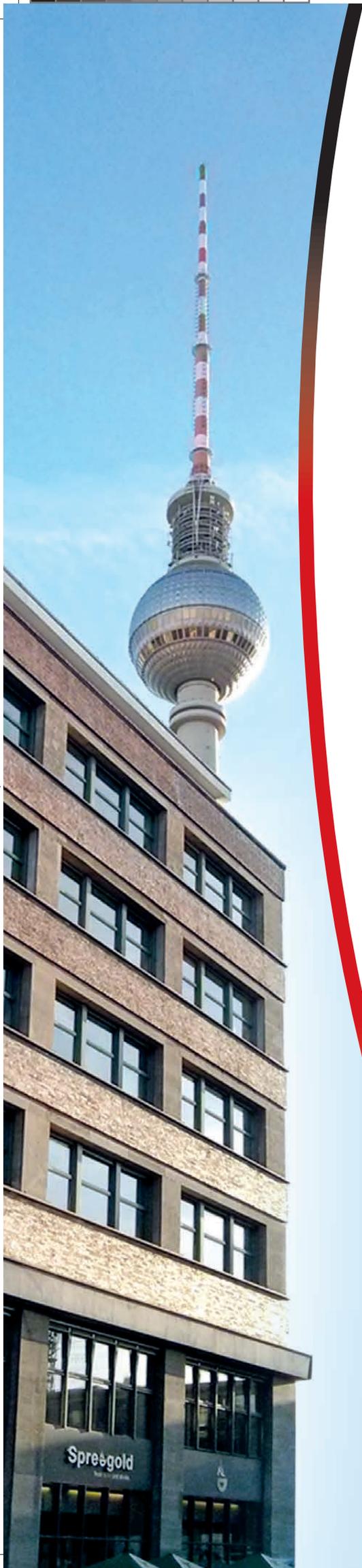
### Creating safety with DLR technology



**Jörg Brauchle**  
Institute of Optical Sensor Systems

Landslides and flash floods in the Himalayas frequently result in the loss of dozens of lives in Nepal. With the innovative aerial images from the mission in the Himalayas, the camera developed by DLR provides a technology that ensures optimal data for high-resolution 3-D models even of extreme landscapes. Models like these form the basis for analyses and assessments of potential risks to the population.





# Project Management Agencies

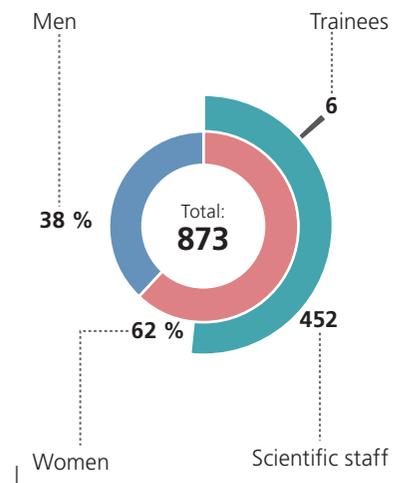
## The Project Management Agency in DLR

Education and scientific progress help us find answers to current societal challenges and form the foundation of our knowledge-based economy. Ensuring that Germany achieves its full potential as a location for education, research and innovation requires complete management of the underlying processes at policy, programme and project level. In this field the Project Management Agency in DLR (PT-DLR) offers a wide range of services to assist stakeholders from politics, science and business as well as education providers – universities and vocational training providers in particular – in developing and implementing nationally and internationally oriented strategies and initiatives. The expertise of PT-DLR's staff comprises all scientific disciplines and all important societal and economic fields of action, focusing mainly on interdisciplinarity, internationality and innovation.

In 2013, the Project Management Agency in DLR supervised 8764 scientific projects from the fields of healthcare, innovation, environment, culture, education, key technologies, European and international cooperation, managing a total funding volume of €1.1bn. With 873 employees, it is one of Germany's largest project management agencies and the only one to deal with such a broad range of topics.

For approximately 40 years the Project Management Agency has been strategically advising its clients on designing funding programmes and instruments and providing specialist and administrative support for funded projects. It conducts accompanying analyses and evaluates the outcomes of programmes and projects. The Project Management Agency in DLR supports the communications and public relations of its clients, and is especially proficient in European and international relations: it opens up networking opportunities for German institutions by, for example, ensuring a high level of participation in important

**Project Management Agency: Employees in 2013**



European and international programmes and initiatives, and assists its clients in their responsibilities in European and international institutions, organisations and bodies.

Increased cross-departmental collaboration and personnel mobility enable the Project Management Agency to conduct its work even more effectively and efficiently. In 2013/2014 it specifically opened up new areas of business and expanded its range of services. It created the Inclusion project group as an example of an interdisciplinary working group, thereby gaining the Federal Ministry of

Labour and Social Affairs as a new client. It was also successful in acquiring contracts for National Points of Contact, e.g. the NKS KMU for the Federal Ministry of Economic Affairs and Energy (BMWi). In addition it now manages the national coordination bureau for the Intergovernmental Platform on Biodiversity and Ecosystem Services (Federal Ministry of Education and Research (BMBF)/Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety) as well as the ESFRI/large-scale facilities for basic research in natural science support office for the BMBF, and is also implementing the Clean Water project office in Shanghai for them.

It has further gained the Federal Joint Committee, the highest decision-making body of Germany's joint self-government of physicians, dentists, hospitals and health insurance funds, as a new client. In the field of healthcare research it acquired the project management contract for the research programme Non-coding RNAs from the Baden-Württemberg Stiftung. It was commissioned by the BMBF to manage its Teacher Training Quality Initiative; it is also supporting the process to create a roadmap for research infrastructures, which includes conducting economic evaluations for large-scale projects.

BMWi was particularly interested in PT-DLR's Innovation key area, and commissioned PT-DLR to act as the project man-

Projects and funds managed in 2013	Number of projects	in millions of euros
Health research	1698	221.5
Education research, integration, gender research*	1645	344.4
Environment, culture, sustainability	1534	215.3
Information technology	1202	127.0
European and international cooperation	1114	44.8
Technical innovation in business	806	99.0
Innovative capacity and research transfer	739	44.9
Years of Science	26	5.2
<b>Total</b>	<b>8764</b>	<b>1102.1</b>

agement agency for its Innovation Vouchers (go-Inno) funding programme. In its Internationality key area the Project Management Agency collaborated successfully with multiple clients, providing the organising office for the German-Chinese Innovation Platform for the BMBF and receiving four new contracts from the European Commission.

The hallmarks of the Project Management Agency in DLR are competence, reliability, confidentiality and quality of processes and procedures. To ensure delivery of these it has developed a sophisticated quality management system that is DIN EN ISO 9001 certified. In December 2013, the Project Management Agency celebrated its 15th anniversary: it was the first German project management agency

to receive the ISO 9000 certificate from DQS, Germany's leading certification body for management systems, in 1998. In 2013 the effectiveness of its quality management system was confirmed by a repeat assessment conducted by an external certification company. This quality management system is now being complemented by the creation of an environmental management system in order to promote – and require – sustainable working. To launch this process, the Project Management Agency took part in the Ökoprofit project of the city of Bonn.

For more information, please see

@ [www.pt-dlr.de](http://www.pt-dlr.de)

## Environmental and climate protection with benefits



On September 3, 2014, we received the *Ökoprofit-Betrieb* certificate from Johannes Remmel, Minister for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia. Together with the Space Administration, we participated in this ecological project for integrated environmental technology with our building on Königswinterer Straße at our Bonn site. The aim was to promote sustainable management and thus reduce costs and save resources. In this context we explored environmental issues such as energy, waste disposal, water, waste water and noise.

For us this certificate is an important step towards attaining a formal environmental certification such as the international environmental management standard DIN ISO 14001 or the EMAS (Eco-Management and Audit Scheme) developed by the EU.

**Dr Norbert König**  
Head of the Project Management Agency in DLR



## Project Management Agency for Aeronautics Research

The Project Management Agency for Aeronautics Research (PT-LF) supports the Federal Ministry of Economic Affairs and Energy (BMWi) in implementing the German Aeronautics Research Programme (LuFo), and the states of Bavaria, Hamburg, Lower Saxony and Brandenburg, which complement the federal programme with their own development programmes and projects.

Following the Federal Government's publication of its Aeronautics Strategy, which combines the activities to create a powerful and environmentally friendly air traffic system, an important first step towards its implementation has been taken with the first call for proposals in LuFo V. The overarching goal is to create internationally competitive conditions for the aeronautics industry and its research partners to aid them in maintaining and strengthening their positions in an intensifying global competition.

In the field of civil research funding, the first call for proposals for LuFo V has further stabilised the high funding level of approx. 150m euros annually, giving all participating research partners in the *Ecologically Efficient Aviation* funding line, the traditional, cooperative research projects of the *Technology* funding line and the *Demonstration* funding line sufficient

planning security to implement their ideas along the entire innovation chain from basic research to demonstrating technologies that are ready for use.

The Federal Government thus provides companies, large-scale research institutions and universities conducting aeronautics research with the funding framework to develop urgently required technologies to application readiness. Alongside supporting ongoing funding projects, PT-LF's work in the reporting period focused on readying projects in all three funding lines of the last call for proposals in LuFo V-1 for approval and on conducting preparatory work for the next call for proposals, LuFo V-2.

Like the Federal Government, the federal states also maintained their efforts in the field of aeronautics research at a high level. The funding announced for the coming years will allow the participating federal states to effectively flank the activities of the Federal Government. PT-LF manages the majority of regional aeronautics research activities in the states of Bavaria, Brandenburg, Hamburg and Lower Saxony, which set funding priorities complementing those of the federal programme to strengthen regional aeronautics clusters and supplier landscapes.

The aeronautics research activities of the Federal Government and the federal states are embedded in the European Framework Programme. In order to ensure coordinated activities at regional, national and European levels, PT-LF has on behalf of BMWi assumed the role of national point of contact for the field of aeronautics research in the 7th EU Framework Programme for Research and Technological Development and its successor programme Horizon2020.

In the current, third funding phase, the activities of the EU project AirTN (Air Transport Net) are being continued by the AirTN-NextGen project. After more than eight years as coordinator of AirTN, PT-LF is handing its managing role over to Italian partner CIRA in the current funding phase. The AirTN-NextGen network now consists of ten core partners from nine countries, among them PT-LF and currently 16 associated partners who aim to jointly continue making significant contributions to international aeronautics research.

All partners in AirTN-NextGen accept the necessity of coordinating national programmes and funding mechanisms. In view of continuing funding issues affecting research programmes in some AirTN partner countries, the importance of effectively coordinating national research efforts remains high. The necessary funding instruments and mechanisms largely exist within AirTN and have meanwhile been repeatedly tested. Beyond the acknowledged excellent cooperation with the Austrian research programme TAKE OFF, it is intended to further expand cross-programme cooperations in LuFo with our core partners in the future. In addition, PT-LF is again supporting the BMWi within GARTEUR (Group for Aeronautical Research and Technology in Europe), the oldest research network of the leading European aviation nations and core of AirTN.

As a project management agency for the BMWi, PT-LF has succeeded in maintaining its central position as a service provider and knowledge bearer in the field

<b>Project Management Agency for Aeronautics Research: Revenues and funding budget in millions of euros</b>	<b>2013 Actual</b>	<b>2014 Planned</b>	<b>2015 Planned</b>
<b>Revenue</b>			
Third-party funding	4.5	5.5	5.8
<b>Funding budget</b>			
Federal Ministry of Economic Affairs and Energy	123.1	157.0	157.0
Ministry of Economics Free State of Bavaria	2.6	20.4	6.4
Ministry of Economics Brandenburg	1.6	0.9	0.8
Hamburg Department of Economics	4.2	3.3	2.0
Ministry of Economics Lower Saxony	10.0	2.8	0.0

of aeronautics research at EU, national and regional levels and is therefore in a position to support the BMWi in its efforts to provide coordinated and efficient support for aeronautics research in Germany and prevent duplicate funding. This special role is unique among comparable institutions in the European partner countries.



Wissen für Morgen

# DLR SCIENCE SLAM

DLR





# ECONOMIC DEVELOPMENT

# Results

## Third-party Funding

DLR's income from third-party funded projects increased significantly in the 2013 business year. Compared to 2012, it rose by 29.7m euros to now approximately 449m euros – meaning that it once again amounted to over 400m euros. Third-party funding thus made up 53 percent of DLR's overall budget, the same percentage as in the previous year. This very positive result is due to increased orders across almost all funding providers and in part to increased grants.

In contrast to the trend in recent years, DLR saw the revenue from German businesses grow by 6 percent, corresponding to an increase of 4.6m euros; the most important client here in 2013 was the Airbus Group.

Revenues from projects with international clients also developed positively; their share of DLR's overall revenue however remained steady at 21 percent and thus at the same level as last year due to the largely positive overall development. DLR particularly saw increases in the income from projects with foreign government agencies. DLR also achieved positive growth in its projects with international institutions, ESA and the EU in particular.

Revenues from EU projects increased from 26.8m euros in 2012 to 30.1m euros, and thus remain high; DLR's success rate for EU applications (seen over the past three years) has increased from 30 percent in 2012 to 36 percent in 2013. This is all the more remarkable as with 133 EU projects DLR only applied for half as many EU projects in 2013 as in previous years. Therefore the EU at the same time comparatively approved a higher number of projects. The proportion of coordinated projects reached a new high at 28 percent. These developments are almost certainly due to the 7th EU Framework Programme coming to an end; the start of the new framework programme Horizon2020 next year will show whether this trend continues.

Last year's trend also changed for projects with the European Space Agency ESA. The income from ESA projects has increased slightly, by 2 percent. The test bed activities at the Lampoldshausen site continue to contribute significantly to this result. DLR has also seen a slight increase in revenues from companies abroad.

Overall, the income from direct project funding has decreased slightly. There was

Third-party funding	2011	2012	2013
Total revenue from third-party funding	436m euros	419m euros	449m euros
Proportion of overall revenue from third-party sources	55 %	53 %	53 %
Earnings trend in revenue from R&T activities in Germany	-5 %	-2 %	6 %
Percentage of earnings from foreign clients (profit volume)	21 %	21 %	21 %
Revenue from EU funding	26.1m euros	26.8m euros	30.1m euros
Success rate of EU applications (accepted/submitted)	31 %	30 %	36 %
Coordinator quota on approved EU projects	18 %	16 %	28 %

an increase in grants from the Federal Government, but on the other hand our income from direct project funding from the federal states fell. At federal level there was a positive trend in particular in grants from the Federal Ministry of Education and Research and other federal funding providers, whereas project funding from the Federal Ministry of Economic Affairs and Energy was reduced in the 2013 reporting year.

In project funding from the federal states, the main funding providers were North-Rhine Westphalia, Bavaria and Lower Saxony; among these, grants from the Free State of Bavaria increased significantly.

## Research

Scientific quality is one of the most important criteria at the German Aerospace Center. Alongside the levels of third-party funding acquired, significant indicators of this quality are the scientific findings made public in journals, presentations and lectures. Their number varies from year to year, attributable mainly to the nature of project work, to staffing fluctuations and to time spent preparing proposals.

In the reporting period, the number of publications in peer-reviewed journals reached a new high. The number of other peer-reviewed publications also increased significantly, however this figure for the first time also includes peer-reviewed abstracts. The number of completed Diplom theses has again fallen; this appears to be due to the further increased number of completed Bachelor theses (258 in 2013, 127 in 2012). Of particular note is the unusually high level of appointments to higher education institutions; the number of submitted dissertations has also seen a significant upward leap.

Research-related results	2011	2012	2013
Publications in peer-reviewed journals	721	656	781
Appointments to universities	17	15	29
Lectureships	295	289	304
Diplom theses	542	438	385
PhD theses	105	109	135

## Technology Marketing

Demand from politics, society and industry to validate and effectively transfer new technologies from research to the development of innovative products, services and procedures remains high. DLR therefore continues to pursue the validation and development of inventions into innovations in accordance with its motto of 4\*I – Invention, Innovation, Interaction and Internationality.

In order to effectively, efficiently and transparently support this technology transfer, the Technology Marketing department develops and implements processes and tools to aid the associated core tasks.

These include:

- Efficient ideas management with a DLR-wide ideas portal and regular ideas competitions
- Innovation projects to validate, advance and transfer technologies
- Strategic Innovation Partnerships between DLR and business under the brand name *Science2Business/Sc2B*
- Management of intellectual property rights and licences
- Advice and support for start-up companies spun off from DLR

→ Direct points of contact in the regional offices of DLR's Technology Marketing for DLR institutes and facilities and the regional business community

→ Business-oriented PR to strengthen DLR's profile as a competent technology partner

### Examples of Successful Technology Marketing

In the period from June 2013 to June 2014, 41 innovation projects were carried out in cooperation with DLR institutes and facilities. A further 14 ideas for innovation projects are already under discussion.

Science2Business® (Sc2B®) stands for strategic innovation partnerships between businesses and DLR. DLR added seven new partners (Südzucker, T-Systems International GmbH, Rhenus Lub, Wirtschaftsförderung Raum Heilbronn, ASA German Space Academy, Wirtschaftsförderung Leverkusen, PVA TePla AG) to contractually regulated strategic partnerships. 12 cooperation projects have so far been initiated and carried out within these partnerships, and preparations for five further projects are underway.



The ideas competition IDEA AWARD 2014 *\_connected\_mobility\_* was launched in January 2014 to initiate new ideas for innovation projects to shape mobility. 20 ideas were submitted as the basis for new innovation projects.

Co-funding for two projects was acquired from the Helmholtz Validation Fund in 2013; three further projects were submitted as full applications for 2014.

**Successful technology transfers via innovation projects**

As part of a Strategic Innovation Partnership with Westfälische Provinzial Versicherung AG (Provinzial), the innovation project *Geoinformationsprodukt zur Bewertung der Exposition gegenüber Starkregen und Sturm* (Geographic information product to assess exposure to heavy rain and storms) was launched with the aim of delivering a commercial geographic information product that assesses

the probability and extent of environmental damage from exposure to severe weather events. This product will in turn serve as a basis for offering a service to insurance companies that enables them to draft insurance policies for specific objects in a more geographically targeted manner with regard to the aforementioned hazards.

An innovation project with industrial partner SCOTTY Group GmbH is working to bring the *Advanced System for Teleguidance Diagnosis* developed and patented by DLR to series production. The idea is to use telemedical technologies to improve the quality of medical ultrasound examinations performed by examiners with limited experience in sonography. This product will bridge an important skills gap in medical care in sparsely populated areas.

The MIRO-Lab, a permanent cooperative laboratory, was developed by the *MIRO-Lab* project supported by the Helmholtz Validation Fund. Based on the assembled components, this lab can cooperate with

clinics and industry to develop advanced applications and indications for surgical robotics. The results of the project have been licensed to an industry partner. The *Cellular Tank* project co-funded by the Helmholtz Validation Fund is described in the Transport section.

The innovation project *Vector21 Weltweit* is extending the VECTOR21 software package to meet additional customer needs. The model maps the influence of exogenous scenario boundary conditions such as CO<sub>2</sub> restrictions for new vehicle fleets, oil prices, taxes, subsidies and levies on end customers' purchasing decisions. Buyers use fixed and variable costs to determine the total cost of ownership and thus which vehicle/fuel/drive concept is the most economic for them under the given conditions. A range of customers are using or have used the VECTOR21 model in its current version with Germany as the core area, among them both publicly funded projects (BMBF, EU) and companies such as Daimler, Audi and DHL.

**What is the aim of Science2Business®?**



Science2Business® (Sc2B®) stands for strategic innovation partnerships between businesses and DLR. The aim of this partnership between research and industry is to jointly prepare and implement future applications and future technologies that can then be brought to market by companies as products, services or procedures. The cooperation creates an optimal development environment by carefully synchronising research and innovation development. Sc2B® partners benefit from access to technologies, knowledge

and resources held by DLR. In this way, the Sc2B® cooperation model pursues a new approach to implementing innovations.

**Dr Ute Gerhards**  
Technology Marketing, responsible for Science2Business®



### Company Start-ups

Company start-ups remain an important tool for technology transfer. DLR activities in this area focus on preparing company founders for their entrepreneurial activities through the university start-up networks in Cologne and Munich and on validating the technologies in question for transfer to the corresponding companies. The company start-ups are supported with assistance from the Helmholtz Enterprise Fund, which now also provides management support from experienced business people. Funding is also available for companies whose business is based on DLR technology but which are founded by DLR employees together with external entrepreneurs. The most effective start-up concepts have shown themselves to be those where preparations for business operations are already made while the associated innovation projects work towards technological maturity.

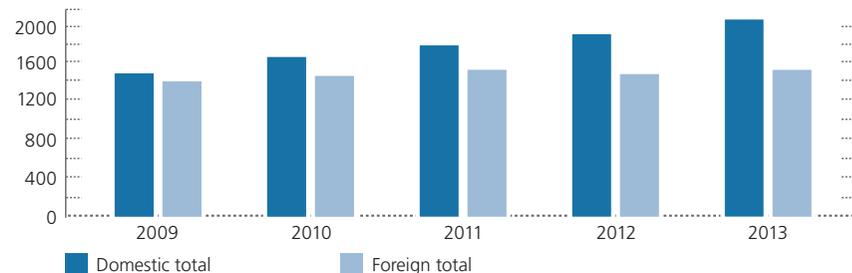
A good example is the development of Aero\_DesignWorks in Cologne, which tested the performance of software developed by the Institute of Propulsion Technology for industrial applications in a pilot project and is now cooperating with this institute to offer engineering services to increase product efficiency at a quality previously unavailable on the market. From the Institute of Robotics and Mechatronics, the company Kastanienbaum will produce control software for future lightweight construction robots based on an entirely new operating philosophy. It overcomes limitations to the use of robots in collaborative situations with humans through control software that reliably prevents injuries to staff. This robot control technology already meets the requirements of tomorrow's industry 4.0 world today. Its straightforward programming technique is designed to enable SMEs to automate their production with lightweight construction robots in order to lastingly improve their competitiveness.

The founding of Spectrum ARC is also intended to improve the competitiveness of European companies. Spectrum ARC will offer radiation and load tests to qualify components and materials intended for use in satellites and instruments for space applications; the aim is to qualify European products for these areas of application and reduce the space exploration sector's significant dependency on supplies from American manufacturers, known as hi-rel parts. As a service provider, Spectrum ARC offers its skills to the industry and makes use of the radiation sources available at the various Helmholtz Centres to irradiate assemblies and components.

At 284, approximately the same amount of invention disclosures were made in 2013 as in the previous year.

Every year, the German Patent and Trade Mark Office publishes a list of the fifty most active patent applicants in Germany. DLR was the only Helmholtz institution on this list in 2013, ranked 23rd with 253 applications (2012: 25th with 226 applications). The only other research institution on the list is the Fraunhofer Gesellschaft in Munich, ranked 14th. DLR's excellent place in the ranking issued by the German Patent and Trade Mark Office clearly proves that DLR has significantly furthered the state of the art in its research areas in 2013.

### Proprietary rights in Germany and abroad



### Intellectual Property Rights

The field of intellectual property rights and licenses involves building and maintaining the DLR intellectual property rights portfolio and managing all commercial marketing agreements, including licensing. At the end of 2013, DLR's intellectual property rights portfolio encompassed approximately 3640 property rights (patent applications and patents in Germany and abroad, including EP and PCT applications) and was thus larger than ever before in the history of DLR.

### Licences

In 2013, licensing generated revenues of approximately 14.6m euros; income from licensing was thus approximately three times as high as in the previous year 2012 (5.1m euros) and therefore at its highest level in the history of DLR. This level will not be sustainable in the coming years as it includes a very high one-off payment for a technology transfer. The significant income from licensing shows that technologies developed by DLR are in demand and have a high marketing potential.



## Visionary Projects competition

“Knowledge for Tomorrow” – this is the motto Prof. Wörner, Chairman of the Executive Board, has coined for DLR in recent years. In order to maintain the pioneering role in research and development we have to ensure continuity in invention and innovation. Visionary ideas for future technologies are needed if we are to remain at the forefront of technical and scientific progress.

For this reason DLR holds a competition for Visionary Projects every three years. This *Visionary Projects* competition is designed to uncover the scientific and creative potential of DLR’s employees. Its aim is to encourage younger employees in particular to submit exciting suggestions from the DLR research programmes Aeronautics, Space, Transport, Energy and Security. Participation is open to both individuals and groups. The competition seeks



Attendees at the final presentation of the Visionary Projects competition 2012–2013 with managers and members of the DLR Executive Board

new ideas with the potential to become reality in the next 15 to 20 years. Selection criteria include societal, scientific and economic relevance, the feasibility of the intended technology, and its application and benefit for DLR. Depending on the outcome of the supported research, the vision may later be incorporated into DLR’s programmes.

2014 was a *Visionary Projects* year. The results of the 2012–2013 competition were presented to the public in April. Towards the middle of the year, a new call for proposals was issued. The new visions will be selected by the end of the year – this time non-publicly; the new funding period will begin in 2015.



# Structure and Organisation

## Technical Infrastructure

Sustainability remains the main focus of the entire Technical Infrastructure (TI) organisation and is reflected in various fields of activity: further development of the environmental management system, further development of the integrated TI management system, strengthening of DLR risk management system and realignment of DLR security, knowledge management, development of key performance indicators and an intensive exploration of the topics of energy management and area management in working groups. The Executive Board project to *identify potential savings* had a major influence on implementing the resource-saving utilisation of consumables and raw materials in TI. Based on this very comprehensive project, various activities to reduce electricity consumption in TI were implemented during the reporting period, including the DLR-wide campaign *Denk dran!*, or "Remember!".

The *SpaceLIFT* building erected by Construction Management at the Bremen site was one of the first research and laboratory buildings ever to be evaluated according to the criteria of the German Sustainable Building Council (DGNB), and was awarded a bronze certificate.

Saving resources and protecting the environment, maintaining economic efficiency while meeting high scientific standards – these are the challenges that must be met when planning and constructing research buildings. DLR's new laboratory building not only contributes significantly to sus-



Exterior view of the building in Bremen

tainable construction, but also sets standards and will serve as a model for future construction projects. Sustainability has meanwhile become a well-established factor in the construction of office and administrative buildings, whereas there are currently no relevant standards for research and laboratory buildings.

According to the Federal Environment Agency, approximately 40 percent of consumed energy is used to heat, ventilate, cool or illuminate buildings. But energy efficiency is not the only goal of sustainable construction. The DGNB assessment catalogue is very complex and combines criteria in five main groups: ecological, economic, socio-cultural, functional, technical and process quality. The individual measures are not considered in isolation but within their overall context; the DGNB evaluation takes the entire lifespan of a building into account, from planning through construction to demolition. The carbon dioxide emissions balance for example covers the entire lifecycle of all construction materials; in general, a lifecycle of 50 years is assumed for all materials.

Alongside ecological criteria such as using HFC-free insulation foams or avoiding wood products from tropical or boreal



Inside *SpaceLIFT*

forests, the building's internal layout was determined according to economic aspects. The main factor in this respect was keeping the pipe systems for the materials required in the laboratories, such as water, helium or nitrogen, as short as possible to ensure centralised supply.

The socio-cultural and functional quality of the *SpaceLIFT* building also received a positive evaluation: an accessible gallery circling the first floor allows visitors to see into the laboratories and thus offers insights into the scientific work of the DLR researchers, while a *Martian landscape* in the grounds serves as an original eye-catcher and creates a pleasant working environment for the DLR staff in Bremen. Object Management is establishing itself in TI with over 220 employees. A regional manager for the West region was employed as of September 1, 2013, completing recruitment for the regional manager posts; a head of department was subsequently appointed and took up post on January 1, 2014. Alongside developing the organisational structure, the process survey in Facility Management (FM) is also being advanced by various groups working across sites and topics, such as the Masterplan, Service Management Tool, Businesses and Facilities and Site



Quality and Product Assurance	2011	2012	2013
Number of accreditations	11	10	9
Audits performed	45 %	72 %	82 %
Space Administration supporting projects	26	33	38
INS success rate	0.67	1.64	0
TNS success rate	1.29	1.39	0.89

Management working groups. Over the past year, further new working groups began their work: the Area Management and Rental Management working groups. Of great importance is the Energy Management working group. This group, which took up work in the autumn of 2013, was expanded to include employees from various other DLR departments. It provides direct specialised support to DLR's *Denk dran* campaign, which is aimed at all DLR employees and intended to remind them to save energy in the workplace. Measures included distributing door hangers to all offices and providing

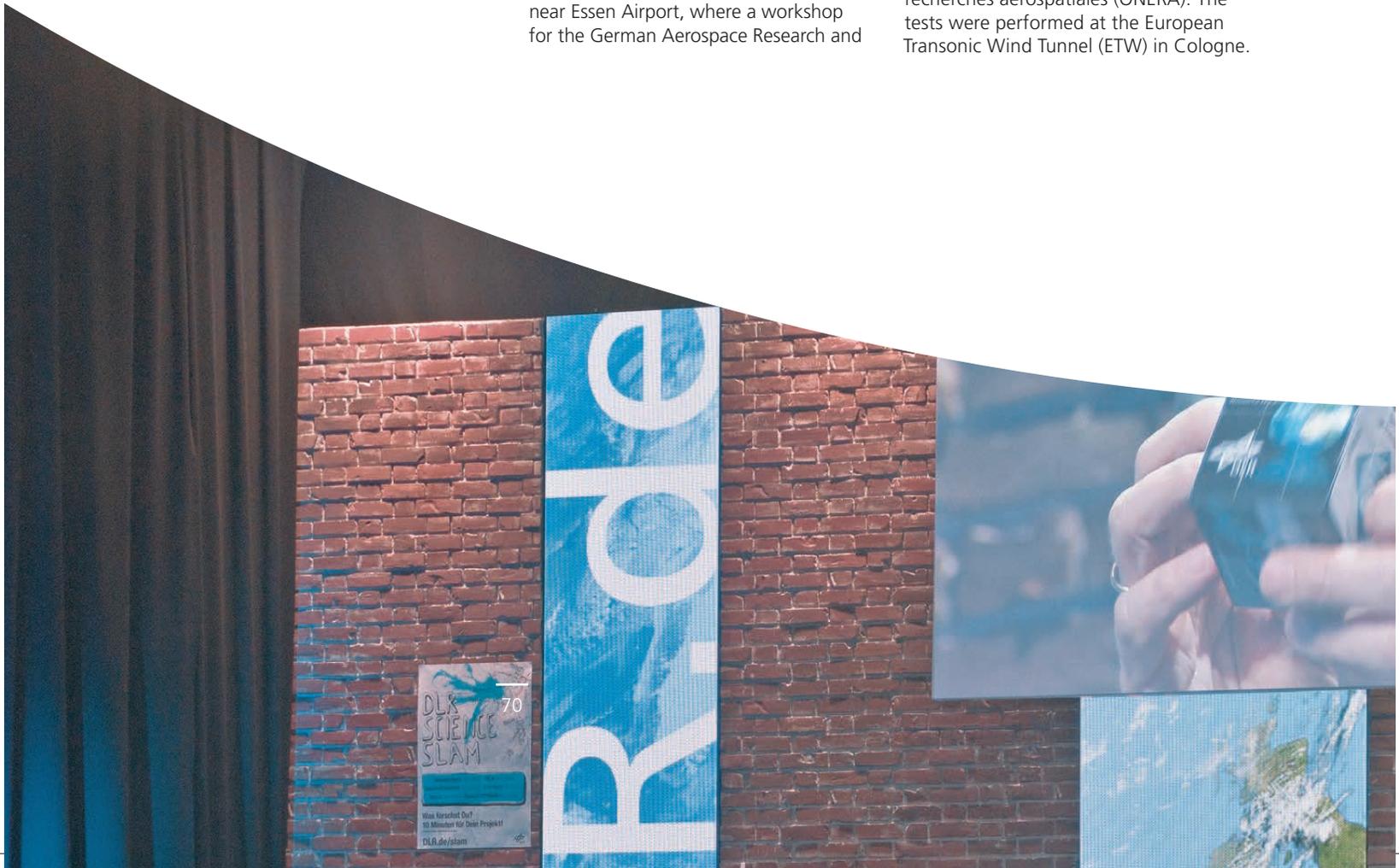
specialist advice to the intranet page accompanying the campaign.

The organisation successfully implemented a visitor management system as a subsection of the Service Management tool and introduced a central service number for local affairs at the Augsburg, Stuttgart and Oberpfaffenhofen sites. The introduction of a comprehensive system is currently being planned and promoted.

In February 2014, the Technology Systems House (TSH), which became part of DLR Cologne in 1963, celebrated its 50th anniversary. 190 employees and 160 trainees work for the Technology Systems House today. It all began in Mülheim an der Ruhr, near Essen Airport, where a workshop for the German Aerospace Research and

Testing Establishment was opened in 1959. It moved to DLR, which had been located in Cologne-Porz since 1959, on October 1, 1963. Since then, vocational training, designing and constructing experimental technologies for the researchers have not only belonged together, they have also been interacting most propitiously. Many industrial mechanics, electricians and engineers began their careers as trainees at the Technology Systems House, which meanwhile has branches at six DLR sites: in addition to Cologne, TSH can be found in Bremen, Braunschweig, Göttingen, Oberpfaffenhofen and Stuttgart.

An excellent example of the outstanding support services provided by TSH is *DeSiReH* (Design, Simulation and Flight Reynolds Number Testing for Advanced High Lift Solutions). TSH was responsible for the construction and the majority of the manufacturing of a cryo-enabled high-lift wing model. Design and construction of the model were commissioned by the DLR Institute of Aerodynamics and Flow Technology; other project partners included AIRBUS, ETW and the Office national d'études et de recherches aérospatiales (ONERA). The tests were performed at the European Transonic Wind Tunnel (ETW) in Cologne.



# Quality Management, Product Assurance, Standards

## Quality management

DLR is one of Europe's best research institutions. With this status come highest standards for the quality of the scientific results and technological developments. Assuring that quality is an important corporate policy objective; to this end DLR employs a holistic and company-wide systems landscape that plays a major role in DLR's overall strategic and operative alignment and is an indispensable success factor for reliable quality in research.

DLR's intentions in implementing its management system are to continuously enhance its competitiveness and customer retention, to further improve its legal position, and to increase the efficiency by standardising the operating and management processes across institutes and facilities.

The international quality standard for management systems, DIN EN ISO 9001, was specified as the minimum standard for DLR institutes and facilities, and all institutes and facilities across the board are expected to qualify for certification soon. By the end of the reporting period, 34 facilities had established quality management systems, while a further 17 are currently in the process of setting them up. Certificates for management systems are the result of an audit by an independent third party, generally the accredited certifying board.

The Deutsche Akkreditierungsstelle (DAKKS) is the appointed national organisation responsible for accreditations; accreditation is a formal recognition of technical competence. Certification and accreditation are the basis of and frequently a prerequisite for approval by public authorities, which can also be issued by the respective authorities themselves. DLR holds all three forms of approval.

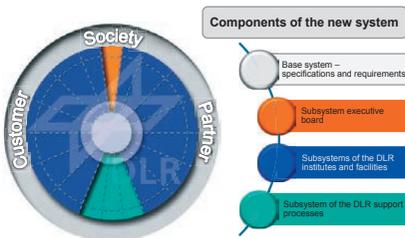
Over and above the minimum standard, several subsystems have integrated and achieved certification in sector-specific standards (VDA 6.2, ISO 13485, OS-HAS 18001, ISO 14001, DIN ISO 27001). DLR furthermore has accredited laboratories at the Institutes of Space Systems, Vehicle Concepts and Transportation Systems (RaisiTe®) and holds approvals from the Federal Aviation Office for its Design Organisation and in Flight Operations.

Certification and accreditation are becoming increasingly important to successfully acquiring third-party funding.

DLR currently employs 23 internal auditors; a further 37 are now in training in order to expand the basis for performing internal audits by increasing the number of qualified DLR personnel.

All institutes and facilities have a quality representative or named contact in the Working Group of Quality Representatives (AKQ). The existing DLR management systems are currently being further modernised and expanded. This integrated approach and the inclusion of a wide range of management topics such as environment, occupational health and safety, IT, risk management, compliance and ethics are designed to identify and utilise synergies.

The DLR Management System



**Product Assurance**

In early 2013 a German-Russian joint project took the electronic gas sensor system E-Nose into operation on the International Space Station ISS. In a further experimental phase, measurements are to be carried out in hard-to-reach areas of the space station. In preparation for this mission, the use of the E-Nose will be tested on a parabolic flight in October 2014.

In a recently suggested further application for the E-Nose, measurements will be performed for molecular gas analysis of respiratory air and the results ultimately used as an online health monitoring system for early identification of medical issues among the station crew.

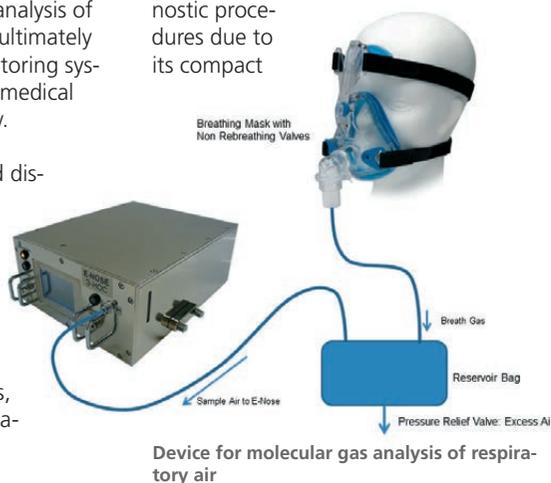
Infections and their associated diseases present particular diagnostic and therapeutic challenges even for modern medicine. The (further) development of specialised analytical platforms, particularly to quickly and reliably identify (potentially) pathogenic germs, is therefore essential. Only reliable

diagnoses enable the initiation of life-saving and targeted antibiotic chemotherapies or preventative measures such as decontamination procedures. Based on the previous positive and promising experience of respiratory gas analysis, the benefits of this method lie mainly in the fact that it is non-invasive (e.g. requires no blood samples to be taken) and allows repeat measurements at any time and with almost unlimited frequency. Electrochemical sensor arrays like E-Nose represent an analytical platform in respiratory gas diagnostics that avoids the disadvantages of established diagnostic procedures due to its compact

requirements and limited use of consumables. Benefits that make the use of the E-Nose for diagnostic purposes ideal both in clinical medicine and under logistically restrictive circumstances in space.

This further development of the E-Nose will in future make it possible to diagnose infections, but also to examine other illnesses such as renal insufficiencies, lipometabolic disorders, respiratory failure due to pneumonia, the effects of UV radiation on skin, radiation-induced changes to the composition of respiratory air and a range of tumours directly by analysing respiratory air.

A first step in this experimental phase will measure the markers for oxidative stress by performing measurements with the ISS crew before and after Extra-Vehicular Activity (EVA). Fast and reliable detection of oxidative stress states is extremely important for medical and security reasons. E-Nose could contribute significantly to online monitoring in this area in future.



size, portability, simple application, automatable analysis, low maintenance re-

**Standardisation**

The rapid innovation cycle of technical developments requires not only market-oriented research, but also strategic instruments that effectively spread new technologies and potential areas of growth on the global markets. Alongside patents, norms and standards are also such instruments. Norms and standards are therefore increasingly being integrated into research and innovation processes in Germany and Europe.



DLR institutes in the fields of space exploration, aeronautics, energy and transport have been participating in the funding initiatives "Innovation with Norms and Standards" (INS) and "Transfer of Research and Development Results through Standardisation" (TNS) of the Federal Ministry of Economic Affairs and Energy since 2007 and 2010 respectively. These activities are performed concurrently with research and development in the institutes and facilities and coordinated by the Standards department. The aim is to achieve better commercial utilisation of DLR research and development results for the benefit of society, actively support cutting-edge technologies, and increase technology transfer between industry and research.

Since the beginning of its participation DLR has submitted a total of 49 standards-relevant projects. Due to a careful selection of project topics in terms of their relevance and societal importance, an above-average number of projects were awarded to DLR compared to other applicants. The average success rate for both funding programmes is 1.18 for the entire period.

DLR experts are additionally involved in over 60 different national, European and international standards committees, where they hold seats in the research areas of space exploration, aeronautics, energy and transport. Their many activities there include serving as chairpersons for the DIN standards committees NA 131-06 (Space) and NA 131-10 (Interoperability

of Information, Communication and Navigation Systems) and leading the German delegation for the international standards committee ISO/TC 20/SC 13 (Space).

#### Qualifying EEE components for space flight

EEE components account for up to 30 percent of the hardware costs of a space flight system and comprise active and passive electronic, electrical and electromagnetic components. Their use and operating environment present particular challenges in terms of reliability, lifecycle and resistance to vibrations, radiation and temperature. EEE components therefore have to be appropriately qualified.

50 percent of the strategic components that are crucial to the performance and reliability of space flight equipment or systems are manufactured in the USA and subject to US export restrictions, also known as ITAR (International Traffic in Arms Regulations). As a result, the availability of EEE components for national space exploration projects is severely limited. The ITAR restrictions mean that systems with strategic US components may not be supplied to certain countries, which makes cooperations between DLR and other space nations difficult or even impossible.

In order to increase the availability of these components from European sources, DLR defines and implements the national Technological Development and Qualification Programme for EEE Components and works with national component manufacturers to develop and qualify these components based on the standards and specifications developed in cooperation with the European partners in the European Space Components Coordination (ESCC). These measures have succeeded in reducing dependency on US exports from 70 percent to 50 percent in recent years.

DLR has an annual total budget of approximately 2.4m euros to conduct evaluation and qualification projects for EEE components, which allowed eleven component projects to be funded in 2014.



# Sustainability, Environmental Protection, Safety

## Sustainability

Sustainability is a major topic for DLR. As reported in the previous year, a DLR-internal project to implement corresponding measures has been launched. The project team, in which all relevant departments are represented, was established under the management of Mr Hamacher's division of the Executive Board in 2012 and meets at regular intervals to determine basic points, targets, performance indicators and measures. Implementing these is the responsibility of the DLR institutes and facilities.

In general, DLR projects are expected to explicitly cover sustainability aspects, and such aspects are also to be included in target agreements with the institutes.

Examples of sustainability research include:

- Projects on sustainability in space. Avoiding space debris and extending satellite lifecycles is currently a major topic at DLR.

- Research to develop energy storage technologies (see Energy chapter)
- Supporting customers and stakeholders by providing information and advice in crisis situations

Examples of sustainable working and research include:

- The environmental management system in parts of DLR
- Considering sustainability in construction and renovation projects
- Sustainability is also taken into account in procurement, e.g. the call for tenders for electricity specified that providers are only permitted to supply electricity from *renewable energy sources* and must be able to demonstrate a TÜV Süd EE01 or equal certification.

Societal aspects of sustainability are currently strongly in evidence in the fields of HR development, diversity and equality and in compliance management (see p. 98). The economic, ecological and social

aspects of sustainability are thus taken into consideration both strategically and operationally.

## Environmental Protection

Environmental management has been further strengthened in DLR; it is embedded within the DLR management system alongside the quality management system, and has been expanded by creating the role of environmental management officer. Successful environmental audits were conducted in the Technical Infrastructure organisation and at the Lampoldshausen site. In addition, the Project Management Agency in Bonn participated successfully in the Öko-Profit project run by the city of Bonn and the Siegburg region. This project of the municipalities in Germany and Austria represents the first major steps towards environmental management as per EMAS/ISO 14001. Its aims are to ensure legal security, collect data on the environment and energy, implement derived improvements and achieve potential economic savings.

### Sustainability codex within DLR



**Dr Jutta Graf**  
Responsible for Sustainability and Open Access at DLR

DLR has resolved to apply the German Sustainability Code. A responsible member of staff has been appointed for each section of the code, who reports to the project team; the project team in turn reports to the Executive Board. Sustainability is part of DLR's Strategy and its Guidelines. The sustainability guidelines are *Research for Sustainability* and *Sustainable Research and Working*. A separate sustainability report is currently being prepared.



DLR's environmental aspects and their effects were for the first time systematically recorded and evaluated for a number of institutes and facilities, such as Technical Infrastructure, in order to gain a complete overview of the major environmental aspects, their effects and risks. This procedure follows the recommendations of the Federal Environment Agency and the ISO 14001 and EMAS standards. A system of performance indicators was also developed in accordance with the recommendations of the Federal Environment Agency; these follow the specifications of the new ISO 14001:2014 and EMAS. The aim is to measure and evaluate environmental effects and impact, performance and status indicators and environmentally relevant processes in order to take suitable measures. Performance indicators will also be reviewed and compared in order to support the process of continuous improvement and make it measurable and transparent.

In October 2013 the working group on Energy Management was formed to systematically examine the topic of *energy management in DLR*. The group's work focuses on short-, medium- and long-term measures to identify potential savings, increase energy and resource efficiency in DLR and reduce energy costs. As a rapidly effective measure, TI in cooperation with DLR Communications initiated the *Denk dran* campaign both to save energy by changing user behaviour and to integrate the subject of *energy efficiency* into the employees' everyday work. In order to systematically and permanently introduce holistic and sustainable energy management in DLR, the Energy Management working group has developed a concept to introduce a pilot scheme in the energy management system as per DIN EN ISO 50001 in the form of a Bachelor thesis; its aim will be to gather

experience in order to subsequently derive recommendations.

**Safety**

DLR Safety (SIH) has increasingly shifted its focus onto advising and assisting managers in performing risk assessments as per the specifications of DGUV Regulation 2 and the Occupational Safety Act. With this measure SIH is responding to the demands of many managers who are increasingly requesting this support.

This change to DLR Safety's service portfolio was welcomed by all DLR managers during the reporting period. DLR Safety thus sees its approach confirmed and will further extend its offers of support for managers while ensuring that the interests of employees below management level are not neglected. The department's activities in this respect focus in particular on the topics of health and safety briefings and delegation of responsibilities.

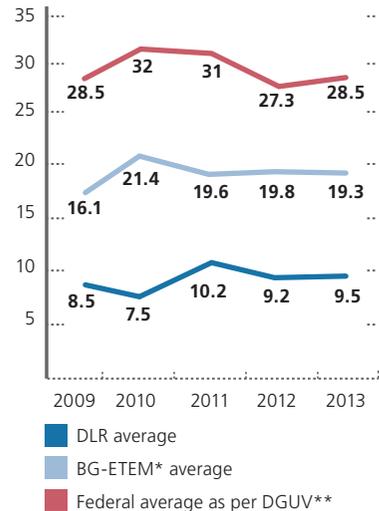
A total of 73 notifiable accidents took place at DLR in 2013, of which the majority (48) were directly connected to work. The remaining accidents (25) occurred during business trips or while travelling between home and the workplace. DLR again suffered no fatal incidents.

The average working time lost per accident again fell in 2013, to 12.7 days. Serious injuries with long convalescence periods (> 10 days) were comparatively rare. The entirely work-based accidents were mainly falls and tripping accidents with effects on the entire musculoskeletal system, and cuts.

The *accident ratio per 1000 persons* is an indicator designed to facilitate comparisons between accident figures at different

**Accident trends at DLR**

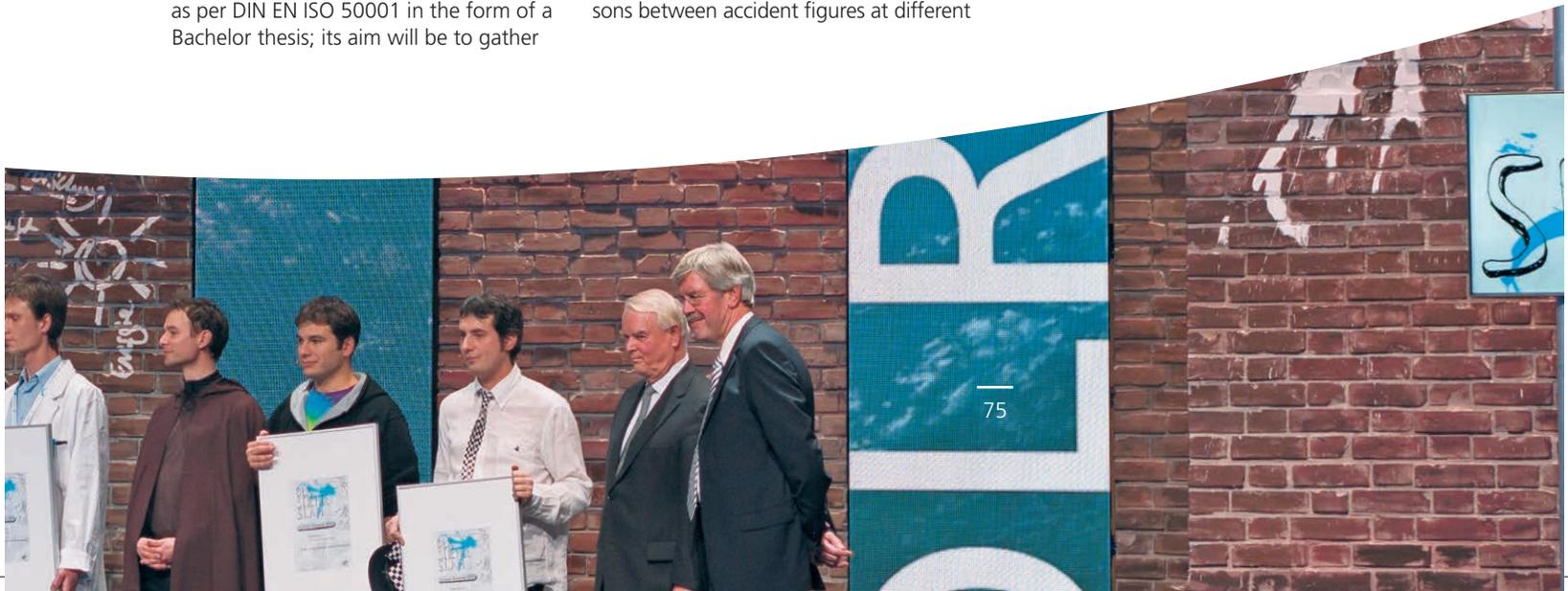
1000 person accident rate (working and commuting accidents per 1000 members of staff)



\* German professional association representing the Energy, Textiles, Electric Industries and Media Productions  
 \*\* DGUV: Umbrella organisation, German Social Accident Insurance

companies. In 2013, this indicator was 9.5 at DLR, remaining at the same level as in the previous year (2012: 9.2).

For comparison, the "accident ratio per 1000 persons" recorded by the trade association "Energie Textil Elektro Medien-erzeugnisse" (Energy, Textiles, Electricity and Media Products, BG-ETEM) among its members amounted to 19.3 in 2013 (19.8 in the previous year), while the Germany-wide average (according to DGUV) rose from 27.3 in 2012 to 28.5 accidents per 1000 insured persons in 2013.





## Political and Economic Relations

Former NASA administrator Daniel Goldin once said during a visit to DLR, "I spend 90 percent of my time on Capitol Hill." Excellent relationships with policy-makers are essential for science and research institutions. Building and maintaining these relationships creates continuity into the future – a continuity that is indispensable in negotiating the competing interests of democracy with its short decision-making/voting cycles and R&D challenges that demand long-term thinking and implementation. DLR's political and business relationships therefore fall within the remit of the Chairman of the Executive Board, and were expanded in the reporting year to include, among other things, the parliamentary levels of the federal states in which DLR operates sites. The core element of effective political work is and always has been direct, interpersonal communication – in confidence where necessary. DLR conducts such communications in a variety of forms: individual negotiations and background talks as well as formats aimed at certain groups such as the successful *DLR Meets...*, *DLR in Dialogue* and *Parliamentary Evening* events, *site information visits from members of federal and state parliaments*, and the *Parliamentary Day (ILA)*. DLR also informs policy-makers directly during fact-finding visits from members of federal,

state and European parliaments to DLR sites and on informational trips to present our R&D topics and the objectives of the Space Administration, the latter e.g. on journeys to spacecraft launches.

This (specialised) information to policy-makers is flanked by state of the art multi-media tools to ensure that even politicians who are less involved in our areas of activity are familiarised with DLR in an easily comprehensible, brief yet well-founded manner. In the reporting year DLR created several videos/3-D films for this purpose and introduced a new format called *Standpoints* which even allows policy-makers to take the opposite route and bring their messages to DLR. Alongside the Aerospace parliamentary group, a main target group among policy-makers are those concerned with issues of energy, transport and security. A range of separate activities was dedicated to these various groups during the reporting year; in a year of major space missions (Blue Dot, Rosetta), the Aerospace parliamentary group was of course also heavily integrated into DLR's politics-oriented activities. Still relatively new but highly successful are crossover activities aimed at policy-makers and featuring content related to DLR's

political topics; examples include the *Art Levitates* project, participation in various exhibitions and cooperations with publishers.

Overall, we again significantly and successfully expanded its contacts to policy-makers during this reporting year; however, consciously choosing not to list individual activities here, as direct consultations remain the key to success in political marketing and political advisory.

For more information, please visit

@ [www.DLR.de/pw](http://www.DLR.de/pw)



# Helmholtz Association of German Research Centres

## Programme-oriented funding

Programme-oriented funding is the means by which large-scale research institutions in Germany receive their institutional funding from the funding providers in the federal and state governments. To this end the 18 independent member centres have come together to form the Helmholtz Association. The international evaluations for the third five-year funding period have been completed; implementation of the recently evaluated activities in the six research areas can therefore begin in 2015. These activities are aligned to research policy stipulations from the funding providers. In the evaluations, the individual centres both compete and cooperate with each other. DLR as the only centre with research in aeronautics, space and transport is the sole competitor in the associated research field, while in the Energy research area DLR is in competition with seven centres, among them FZJ, KIT, GFZ and HZB.

Alongside organising the process of programme-oriented funding, the Helmholtz Association is tasked with joint lobbying on issues relating to the Association. One example is the joint presence at the signing of the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities in 2003. In the future, publications from the Association are without exception to be accessible free of charge insofar as this does not expressly conflict with agreements with publishers or other parties. DLR currently holds over 77,000 publications in its electronic repository ELIB (<http://elib.dlr.de>), and encourages DLR employees to make full-text versions of their publications available to the public.

## Initiative and Networking Fund

The Initiative and Networking Fund offers the President of the Helmholtz Association a tool with which to initiate commitments of the Association in connection with the Research and Innovation Pact. During the reporting period, DLR was able to acquire funding for two international cooperations with Canada and China; DLR also submitted two successful applications relating to technology transfer. In the field of employee sponsorship DLR attracted funding for two post-docs, one doctoral candidate award and one work-shadowing opportunity at an external company.

# National Networks

## Collaborations with universities

DLR's university collaborations not only ensure that programmatic research optimally utilises available resources, but also promote joint training of young, highly qualified employees for industry and academia. This cooperation benefits both DLR and the universities: for universities, the cross-disciplinary competence and technical infrastructure available in DLR form an important component of numerous research projects, while DLR is ensured access to the next generation of researchers. Close personnel-based connections formed by appointing DLR institute directors jointly with universities have proved particularly beneficial; selected management positions at DLR institutes are also increasingly being filled through joint appointment procedures.

Within the scope of the Excellence Initiative, collaboration between universities and DLR is becoming increasingly important. Funded by the Helmholtz Association, DLR maintains institutionalised cooperations with selected universities under the name DLR@Uni which are designed to promote more intensive networking and go beyond expert research cooperation in joint scientific projects.

National and European networks	2009	2010	2011	2012	2013
DFG participations	34	38	32	35	33
Sponsorship agreements	41	32	33	38	41





Negotiations on a future cooperation between DLR and FFG on the use of the European Earth observation system Copernicus. Seen here are Ing. Posch, FFG (centre); Mr Schreier, DLR (2nd right); Dr Rockwitz, DLR (2nd left).

### Cooperation with the Austrian Aeronautics and Space Agency (ALR) in the Austrian Research Promotion Agency (FFG)

Based on the bilateral framework agreement, a meeting to discuss research cooperation took place on February 18, 2014. The meeting focused on cooperation interests and opportunities between DLR and Austrian stakeholders. The two agencies also exchanged information on their respective space programmes, the structures and ministerial responsibilities of these, and discussed key European issues such as the ESA Ministerial Council 2014 and Horizon2020. A meeting of the steering committee was agreed and took place on November 7, 2014.

Both sides showed interest in discussing a future cooperation on the use of the European Earth observation system Copernicus, and met at the Oberpfaffenhofen site for this purpose on June 4, 2014. The idea of intensified collaboration is currently being further explored.

Each year, the DLR institutes supervise approximately 1000 postgraduate students working on their PhD theses, while almost 400 students complete their Diplom theses at DLR facilities. The number of DLR researchers holding lectureships has increased in recent years; 2013 set a new record with now over 300 lectures, tutorials, seminars etc. at universities and universities of applied science.

### Collaboration with the Fraunhofer Gesellschaft

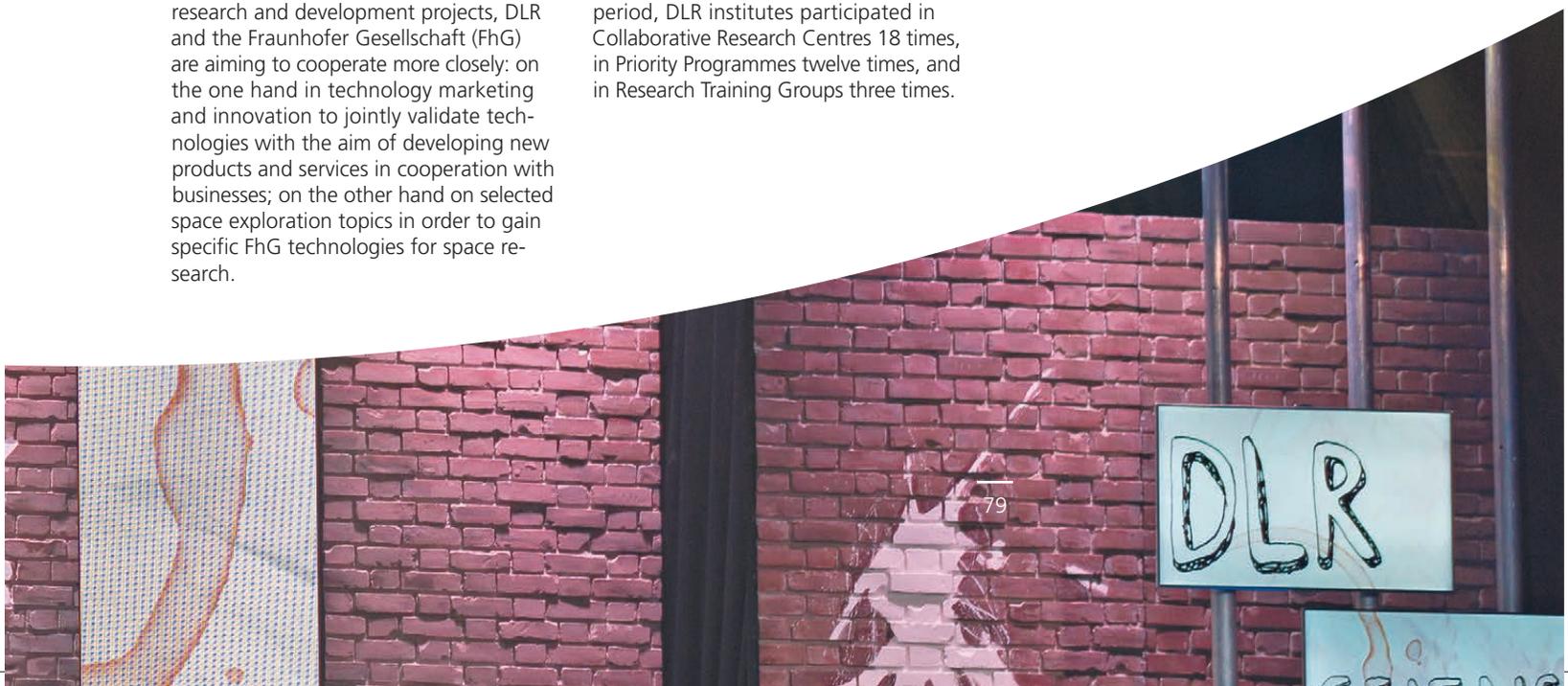
Beyond the ongoing wide range of joint research and development projects, DLR and the Fraunhofer Gesellschaft (FhG) are aiming to cooperate more closely: on the one hand in technology marketing and innovation to jointly validate technologies with the aim of developing new products and services in cooperation with businesses; on the other hand on selected space exploration topics in order to gain specific FhG technologies for space research.

### Participation in DFG programmes

Integration into the programmes of the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) is an important measure of the quality of DLR's research work. DFG's Coordinated Programmes support extensive interdisciplinary networks of researchers dedicated to a wider subject area: Collaborative Research Centres focus on excellence in research, while Priority Programmes are designed to develop expertise and Research Training Groups train high-calibre young scientists. During the reporting period, DLR institutes participated in Collaborative Research Centres 18 times, in Priority Programmes twelve times, and in Research Training Groups three times.

### Sponsorships

Sponsorships are a useful tool to facilitate rapid technology transfer through individuals. Industrial companies contribute half the cost of training young researchers who work in fields that are of equal interest to DLR and these companies. In 2013, DLR supervised a total of 41 sponsorships; this represents a slight upwards trend.





DLR New Year's Reception in Brussels

## European Networks

### DLR in Brussels

The launch of the Horizon2020 programme in December 2013 was the central theme of DLR's New Year Reception held under the motto "Research for Innovation – Ready for New Horizons". The former research site of the Institut Pasteur, acquired, renovated and remodelled as a diplomatic representation by the Free State of Bavaria in 2001, formed the perfect backdrop for DLR's Brussels New Year Reception held at the joint invitation of Prof. Wörner and Dr Schleicher of the Bavarian Ministry of Economic Affairs. Over 200 high-ranking representatives of European institutions, industry, business, research and DLR met where Nobel Prize Laureate Jules Bordet worked 100 years ago to discuss research and innovation in a modern Europe.

### Horizon2020

Following the formal adoption of the legal documents by the European Parliament and the Council in late November 2013, the Commission published the first calls for proposals on December 10, 2013. DLR submitted multiple applications to the first calls for proposals for Horizon2020 (Aeronautics: 63, Space: 73, Energy: 9, Transport: 15, Security: 1). Approximately half the submitted applications in which DLR is participating have gone through to the second stage of the two-stage

procedure in Aeronautics, Transport and Energy; the full applications for these proposals are currently being prepared, and will be evaluated once more in the autumn. The Commission announced its intention to release the results for applications in one-stage procedures (mainly in Space and partly in Aeronautics and Transport) in late August/early September; the results were therefore not yet available at the time of writing.

### Cooperation with CNES

On July 30, 2013, the first technically oriented meeting at Executive Board and programme director level took place with the new CNES President Jean-Yves Le Gall in Cologne-Porz. The main points of discussion were advance coordination on subjects on the agenda of the ESA Council of Ministers in 2014, the progress made in the bilateral cooperation projects MERLIN (Methane Remote Sensing LIDAR Mission) and MASCOT (Mobile Asteroid Surface Scout), and the development of ESA-EU relations.

DLR is providing the LIDAR payload for the bilateral climate mission MERLIN (Methane Remote Sensing LIDAR Mission) while CNES is contributing the bus systems. The new satellite concept with its expanded platform was successfully evaluated in a System Requirements Review, or SRR, in November 2013. The qualification concept and schedule were adjusted to minimise possible risks during the development phase; the satellite launch is now planned for 2019.

The DLR lander MASCOT is part of the Japanese sample return mission Hayabusa-2, which will take off for the c-type asteroid 1999JU3 in late 2014. CNES will contribute



Jean-Jacques Dordain (ESA) and Prof. Wörner (DLR) sign the MoU extension on collaboration in space robotics

the power subsystem, part of the telecommunications system including antenna development, descent and landing mission analysis, and the MicrOmega (optical microscope and NIR hyperspectral camera) tool. MASCOT has successfully passed all environmental and function tests since autumn 2013; the flight model was finally delivered to JAXA in summer 2014.

The annual meeting of the programme directors responsible for research and technology, Dr Hubert Reile for DLR and Thierry Duquesne for CNES, took place on September 5, 2013, at DLR's Oberpfaffenhofen site. The main topics of discussion were Earth observation, communication/navigation, space science, robotics, propulsion systems, space systems and carriers and the European research programme Horizon2020. The purpose of these meetings is to facilitate regular exchanges of information and to identify new possibilities for cooperation.

#### Cooperation with ONERA

The ONERA-DLR Aerospace Symposium ODAS 2014 took place from June 11 to 13 in Cologne; it focused mainly on the presentation and discussion of innovative materials and processing techniques.

#### Cooperation with ESA

At ILA Berlin in May 2014, DLR Chairman of the Executive Board Prof. Wörner and ESA Director General Jean-Jacques Dordain extended the Memorandum of Understanding on cooperation in space robotics signed in June 2010 for a further three years until the end of 2016. DLR is one of the world's leading robotics institutions; its Robotics and Mechatronics Centre (RMC) is managed in a strategic

partnership as an ESA reference laboratory. The main focus is on assistance robotics, particularly what is known as telepresence, and methods of on-orbit servicing and robotics for exploration missions.



## European Groups

### Space exploration in Horizon2020

The European space industry has submitted a position paper for the next work programme 2016–2017 in order to draw attention to its topics for the next call for proposals. In contrast to aeronautics, transport and energy there is currently no independent body representing the national space research institutions to the Commission. In order to be able to position itself in a similar manner to the space industry, DLR has begun negotiations led by Prof. Wörner with other national space research institutions with the aim of developing a joint strategic position.

In the interests of European space policy from the EU side the Competitiveness Council adopted *Conclusions towards a shared EU-ESA vision for space fostering competitiveness* on May 26, 2014.

### Joint Technology Initiatives (JTI)/ Public Private Partnerships (PPP)

Following their adoption by the Council, Parliament and the Commission in the spring of 2014, the Joint Technology Initiatives and Public Private Partnerships (Innovation Package) recommended last year were officially launched at the Joint JTI Launch Event and the first calls for proposals published.

DLR has already been appointed head of the Technology Evaluator in Clean Sky 2, and will apply for membership in the other areas of Clean Sky 2 and the other JTIs/PPPs (Shift2Rail, SESAR 2020, FCH-2) in the course of the current calls for proposals.

### ACARE/Flightpath 2050

At ILA 2014, ACARE held a workshop to celebrate the 75th anniversary of the invention of the jet engine. After the welcome speech by Prof. Wörner, representatives of engine manufacturers were joined by MEP Holger Kraemer and Dr Lehmann as a representative of the Federal Environment Agency to discuss the opportunities and challenges facing the aviation engines of the future with the approximately 50 attendees. On June 26, 2014, the ACARE General Assembly discussed and prioritised ACARE's next steps in a meeting chaired by Mr Hartman (Air France-KLM), Prof. Dr Wörner and Mr Ventre (SAFRAN). Alongside the basic responsibility of accompanying the implementation and advancement of the Strategic Research and Innovation Agenda in the ACARE working groups, ACARE intends to approach the

newly elected members of the European Parliament and the new Commissioners taking office in November in order to embed ACARE and the subject of aeronautics in the political arena. The General Assembly also adopted the first ACARE annual report.

### AET – Association for European Transport

The Association for European Transport (AET) is one of the leading European organisations in the transport sector and with more than 350 members from 35 countries maintains a broad network in research, industry and administration. In its function as host of the multi-modal European transport Conference (ETC), AET has appointed three DLR transport researchers to its Programme Committees: Prof. Wagner of the DLR Institute of Transportation Systems has joined the Traffic Management and Traffic Engineering Programme Committee, Dr Heinrichs of the DLR Institute of Transport Research became a member of the Planning for Sustainable Transport and Land Use Programme Committee, and Dr Scheelhaase of the DLR Institute of Air Transport and Airport Research joined the Transport Economics and Appraisal Programme Committee. In addition, Dr Piehler, Head of the DLR Transport Programme, was elected to the AET Council in October 2013.

### EREA – Association of European Research Establishments in Aeronautics

On December 3, 2013, EREA Chairman Prof. Henke welcomed around 150 guests from the European Parliament, the European Commission, industry, research and member states at the annual EREA reception.

The EREA board also coordinated the further procedure for implementing the EREA Future Sky Joint Research Initiative, accepted CSEM (Switzerland) as a further full member and elected Mr Kaspar (VZLU) as the new EREA chairman. Prof. Henke will assume the post of deputy chairman as scheduled and in this capacity will manage and act as main point of contact for the Future Sky JRI within EREA. Based on an arrangement negotiated by the EREA board, a consortium lead by NLR with strong involvement of the EREA members developed and submitted an EU application for a coordinated safety programme in Horizon2020 as the first Future Sky topic.

#### **EERA – European Energy Research Alliance**

EERA was established as a non-profit organisation (AISBL – Association Internationale Sans But Lucratif) on April 8, 2014 and its new management (Chair: Hervé Bernard, CEA (FR) and Deputy Chair: Teresa Leao, LNEG (PT)) confirmed.

On the following day, EERA held its 2014 Annual Congress in Brussels, attended by 200 interested parties from science, politics and industry. EERA took advantage of the occasion to celebrate its legal founding and sum up its successful work over the past five years. The congress also focused on the role of EERA in European energy research; this issue was discussed in several panels with high-ranking participants from politics and industry.



Left to right: Stefaan de Mey, Eurisy Secretary General; Dr Roswitha Grümman, DLR member of the Eurisy Council; Colin Hicks, Eurisy President

#### **ECTRI – European Conference of Transport Research Institutes**

ECTRI is heavily involved in shaping the European Research Area. As an active representation of 24 leading European transport research institutions with multi-modal focus it is particularly invested in accompanying the 8th European Framework Programme, Horizon2020. ECTRI's efforts are currently directed at identifying priorities and preferences for research topics in the transport sector and communicating these to the European Commission before the second Transport Work Programme 2016–2017 is concretised. An important preparatory element is the analysis of the results of the first call for proposals not only in terms of content but also in terms of experience of the new administrative procedures.

Under the management of Dr-Ing. Christian Piehler, Head of the DLR Transport Programme, an ECTRI task force is examining both retrospective and prospective aspects. An initial position paper was completed in July 2014.

#### **Eurisy**

The main target of Eurisy is to bridge the gap between space applications and potential users in local and regional administrations and small and medium-sized businesses. Providing examples of successful applications is an important tool in this endeavour. To this end the brochure series Satellites Going Local – Sharing Good Practice included issues on Water and Digital Society in 2013 and 2014. The new website now also allows users to systematically access application examples online. The annual Members' Day took place on December 6, 2013, and focused on discussing priorities for 2014, future space applications and the possible role of Eurisy. In addition to Eurisy members, representatives of industry and other

organisations such as Eutelsat, Astrium Geo Services, UNESCO and OECD were also involved. DLR is a member of Eurisy and represented in both the General Assembly and the Eurisy Council; the Eurisy Council at ILA 2014 was hosted by DLR.

@ [www.eurisy.org](http://www.eurisy.org)

### Transport Research Arena 2014

“Transport Solutions: from Research to Deployment – Innovate Mobility, Mobilise Innovation!” was the motto of the Transport Research Arena (TRA) held in April 2014 in Paris. On behalf of the European Commission, this bi-annual conference brought together leading scientists and research managers with representatives of industry, administration and politics in order to discuss the predominant lines of research in ground-based transport over the coming years. DLR maintained a high profile at the event with numerous lectures, hosted talks and participation in panel discussions. TRA 2014 also provided a suitable setting for the 5th International Conference on Women’s Issues in Transportation (WIIT). Prof. Barbara Lenz, Head of the DLR Institute of Transport Research, and Dr-Ing. Christian Piehler, Head of the DLR Transport Programme, were involved in preparing and managing the conference.

## International Cooperation

### Brazil

DLR has been cooperating with Brazil’s national aerospace centre DCTA on the use and development of sounding rockets for over 40 years. During visits to Brazil, DLR representatives discussed the status and progress of the ongoing projects with DCTA and the Brazilian space agency AEB. In late July 2013, Prof. Henke, Head of the DLR Aeronautics Programme, visited DCTA and the company Embraer to explore options for more intensive collaboration in aeronautics research. These contacts were further intensified during the reporting period when Prof. Levedag, Head of the Institute of Flight Systems, accompanied the Prime Minister of Lower Saxony and President of the Bundesrat, Mr Weil, on his visit to Brazil.

There are approaches to collaborating with the national space research and remote sensing institute INPE on several projects, including “Fire Prevention, Control and Monitoring of Bush Fires in the Cerrado”. The purpose of this collaboration is to evaluate infrared data from the German TET satellite.

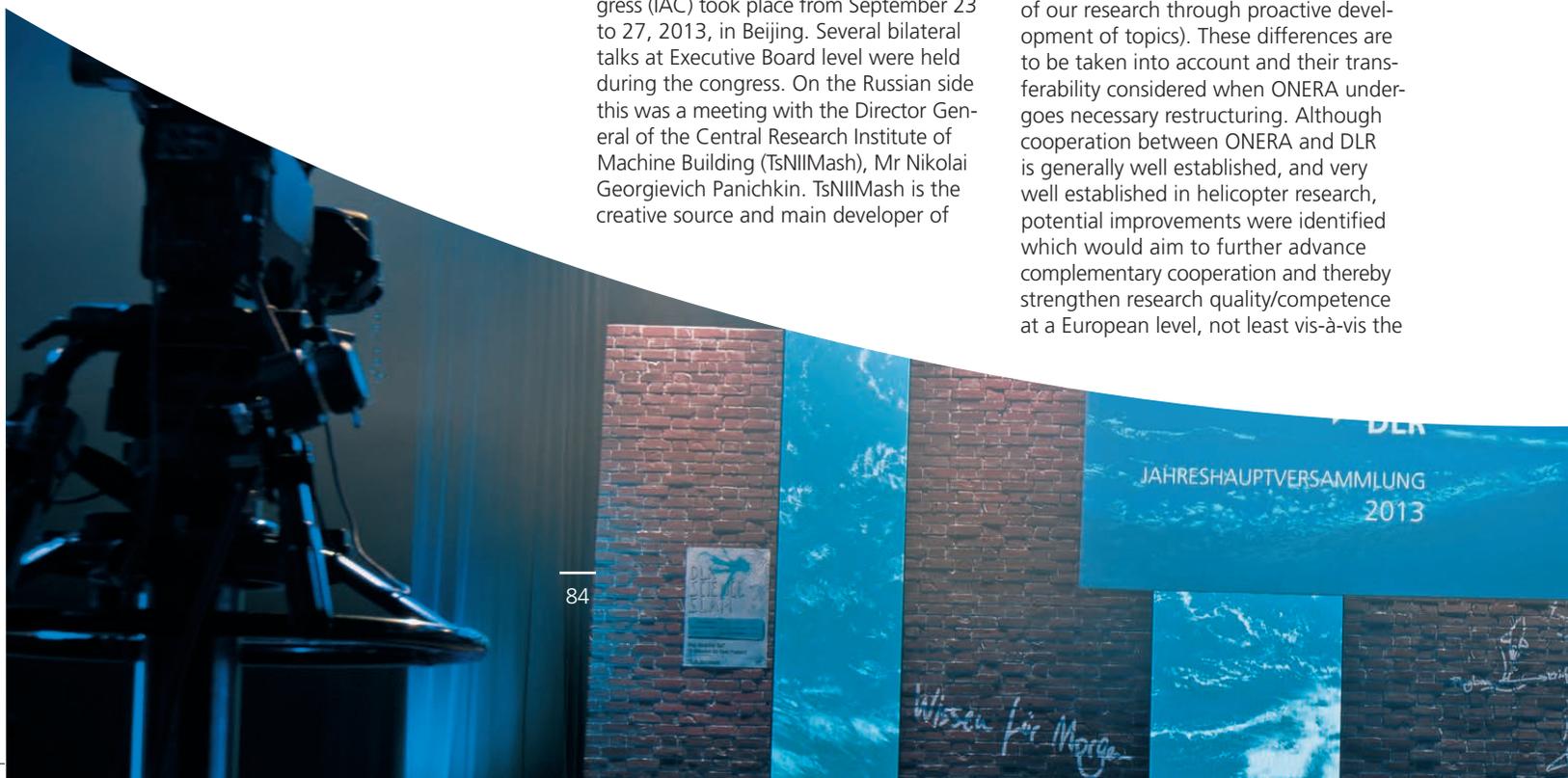
### China

The 64th International Astronautical Congress (IAC) took place from September 23 to 27, 2013, in Beijing. Several bilateral talks at Executive Board level were held during the congress. On the Russian side this was a meeting with the Director General of the Central Research Institute of Machine Building (TsNIIMash), Mr Nikolai Georgievich Panichkin. TsNIIMash is the creative source and main developer of

the Russian space exploration strategy. On the Chinese side there were meetings with the Deputy Administrator of the China National Space Administration (CNSA), Dr Hu Yafeng; the Director General of the China Manned Space Agency, Dr Wang Zhaoyao; Mr Yin Liming, Director General of the China Great Wall Industry Corporation (CGWIC) which markets Chinese launch services and commercial satellite projects; and Prof. Dr Guo Huadong, Senior Member of the Chinese Academy of Sciences and Director of the Institute of Remote Sensing and Digital Earth (RAD). The 27th CAE-DLR Joint Committee Meeting, chaired by Mr Hüners, took place on May 22, 2014, as part of ILA 2014. After the meeting, the Chinese delegation continued its programme with a visit to Oberpfaffenhofen.

### France

In mid-January 2014 a French delegation consisting of representatives of the DGA (Direction générale de l’armement) and the French Embassy in Berlin visited the DLR sites in Cologne and Braunschweig. The delegation’s purpose was to gather information on key strategic areas of aeronautics research in order to gain a clear picture of our research activities compared to those of ONERA. In the discussions, the strengths of DLR became apparent and were appreciated by the guests (especially the modern research facilities, the greater flexibility due to a higher turnover of researchers, greater control of the direction of our research through proactive development of topics). These differences are to be taken into account and their transferability considered when ONERA undergoes necessary restructuring. Although cooperation between ONERA and DLR is generally well established, and very well established in helicopter research, potential improvements were identified which would aim to further advance complementary cooperation and thereby strengthen research quality/competence at a European level, not least vis-à-vis the





The DLR delegation with Prof. Wörner and Prof. Dittus in Japan

USA. A welcome next step in this direction would be regular exchanges between institute directors and a meeting between the Executive Boards as soon as the new ONERA management has been appointed.

### Japan

The concept of DLR's strategic cooperation with Japan was further expanded in the past year. The main currently planned topics are Earth observation (X/L-band radar, hyperspectral, data analysis e.g. for disaster response, optical laser communication), exploration (asteroid mission Hayabusa-2), ISS use, space research (e.g. space robotics, test satellites, launchers), various aeronautics research topics and promotion of German-Japanese industrial cooperation. At IAC in Beijing in September 2013 a DLR delegation led by Prof. Wörner met with a JAXA delegation led by JAXA President Dr N. Okumura to further advance the above-mentioned cooperation between DLR and JAXA in the fields of Earth observation, ISS, exploration and other topics in space and aeronautics research.

The Japanese company Mitsui visited DLR in September 2013 to discuss possible cooperation projects relating to the use

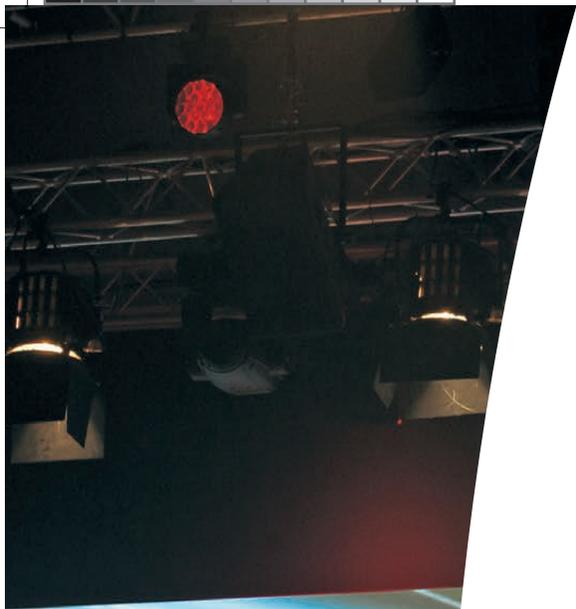
of Earth observation data. The annual trilateral JAXA-DLR-ONERA aeronautics research meeting took place in February 2014 in Nagoya, Japan; the parties discussed current and new aeronautics projects in the key areas noise, helicopter and engine research. Also in February 2014, a JAXA delegation visited DLR to discuss the possibility of closer collaboration in the field of small satellites with the corresponding DLR experts. In April 2014, Prof. Wörner and Prof. Dittus travelled to Japan to speak with the Japanese partners about intensifying the cooperation. In this context an MoU between DLR and the Japanese National Institute of Information and Communications (NICT) regarding optical laser communication was signed. Both nations are active in this field; it is hoped that closer collaboration will allow the utilisation of synergy effects.

Dr Gruppe travelled to Japan in June 2014 with an industrial delegation to promote cooperation between German

and Japanese industry; this initiative met with a very positive response from the Japanese side, and intensive exchange was agreed for the future.

Cooperation specifically between JAXA and DLR has been further intensified through the cooperation project Hayabusa-2, the purpose of which is to closely examine an asteroid, and the associated exchange of personnel. Alongside exploration, cooperations between DLR and Japan also focused on Earth observation. Japan is the largest customer for X-band radar data; in the field of disaster management/Earth observation the joint preliminary phase A study for a possible joint L-band radar mission (Tandem-L) was successfully concluded. Thanks also to the DLR office in Tokyo, DLR gained several new cooperation partners in Japan, among them Japan Railway System, Mitsui, IHI and Fuji Heavy Industries.





### Canada

At IAC 2013 in Beijing the DLR Space Administration signed a framework agreement with the Canadian Space Agency (CSA) on scientific and technological cooperation in space exploration. Concurrently, the DLR Space Administration and the Canadian Space Agency CSA developed a coordinated call for proposals designed to assist Canadian and German firms in developing products and services based on merging X- and C-band data. This call for proposals will be published in the autumn of 2014. In the autumn of 2013, Prof. Dittus visited CSA, the Canada Centre for Mapping and Earth Observation (CCMEO) and other partners in space research and space applications. Discussions focused on current and future possibilities for cooperation on the complementary German and Canadian radar satellite missions and their associated applications.

### Mexico

A contract to hand over the DLR ground station in Chetumal was agreed with the Mexican space agency AEM. The mutually beneficial agreement covers further cooperation on the use of the ground station and is intended to further intensify DLR's partnerships with Mexican research institutions.

### Netherlands

Cooperation between the NLR (National Aerospace Laboratory) and DLR has a long tradition, especially in aeronautics. Examples are wind tunnels or the MoU on fibre reinforced composites. NLR is very interested in expanding this cooperation in space exploration and to this end visited the DLR sites in Cologne, Bremen and Oberpfaffenhofen. Various fields of cooperation were identified during these visits and elaborated on in follow-up meetings.

The topics discussed were joint development of small satellites, on-board data processing and Earth observation. Regarding many of these ideas Horizon2020 was identified as a suitable funding programme for joint activities.

### Poland and the Czech Republic

In September 2013 and April 2014 DLR carried out multi-day bilateral industry conferences with partners in Poland and the Czech Republic. The events facilitated the initiation and/or expansion of cooperations in space exploration between companies from the respective countries. Prof. Wörner opened the Polish-German industry symposium under the motto *Working Together – New Perspectives for Industry Co-Operation* together with Ms Trzaskalska-Stroińska, the ESA delegate from the Polish Ministry of Economics. Over three days, the symposium brought over 40 representatives of mainly small and medium-sized space exploration companies together in Munich, Oberpfaffenhofen and Bremen to assess new prospects for industrial collaboration (business-to-business), not least within ESA. The opening event of the Czech-German Industry Days was a reception at the German Embassy in Prague on April 22, 2014. Prof. Wörner and Dr Gruppe attended on behalf of DLR. The next day, following the opening speech from Karel Dobeš, Deputy Minister at the Czech Ministry of Transport, approximately 50 companies gave short presentations on their competences and cooperation interests. In B2B meetings arranged beforehand, the mostly small and medium-sized businesses then discussed possibilities for cooperation in greater depth. In all, approximately 60 companies and around 100 people attended the event.



Dmitry Anatolyevich Medvedev speaks with Prof. Wörner, Dr Gruppe and Olga Trivailo at the DLR booth. A model of the Space Liner, a study by the DLR Institute of Space Systems, is seen in the background.

### Russia

DLR again had its own booth at the International Aviation and Space Salon MAKS 2013. In the run-up to MAKS, the Summit of the International Forum of Aeronautic Research (IFAR) took place from August 24 to 27, 2013, at the invitation of the Central Aerohydrodynamic Institute (TsAGI). It was attended by leading representatives of 22 of the 24 international IFAR member organisations. The now traditional bilateral DLR-TsAGI young researchers' workshop was this year held as part of IFAR and with international participation as the Conference of Young IFAR Researchers. The highlight of the IFAR Summit was the meeting with Russian Prime Minister Dmitry Anatolyevich Medvedev at the MAKS booth at TsAGI. On August 27, Prof. Wörner once again had the honour of welcoming the Prime Minister of the Russian Federation to the DLR booth. Mr Medvedev was accompanied by his Minister of Defence, Mr Sergey Kuzhugetovich Shoigu, and Mr Shoigu's first deputy. The most important result of the meetings and discussions at the salon was in the field of space exploration the signing of Russia's accession document to the "International Charter Space and Major Disasters" by the First Deputy Head of Roscosmos, Mr Oleg Petrovich Frolov. German-Russian cooperation in aeronautics and space exploration was advanced in a large number of talks. Three members of the DLR Executive Board, Prof. Wörner, Dr Gruppe and Prof. Henke,

presented programmes of their own at MAKS. Prof. Dittus also travelled to Moscow with a DLR delegation to attend the COSPAR conference in August 2014. Various informal visits and bilateral meetings took place during the conference, for example with the President of the SkolTech university, Prof. Edward Crawley; the Rector of the Moscow State University of Geodesy and Cartography – MIIGAIK, Prof. Mayorov; and the Deputy Director General of the leading Russian space exploration company RKK Energia, Mr Alexander Derechin. At ILA 2014 the Executive Board held bilateral talks with leading representatives of the Russian space exploration industry and space research sector. Of particular significance



The delegation from Saudi Arabia meets Prof. Dittus and important DLR space exploration representatives during its visit to DLR

was the meeting between Dr Gruppe and Mr Igor Komarov, Director General and Chairman of the Board of the newly created United Rocket and Space Corporation URSC, a holding company designed to bring together Russia's entire space industry and increase its competitiveness.

### Saudi Arabia

Various delegation visits further strengthened the contacts with the King Abdulaziz City for Science and Technology (KACST) in Saudi Arabia. At KACST, approximately 2500 employees conduct research into topics relating to aeronautics and space exploration, energy or materials science. In September 2013, the Vice President of KACST, Prince Turki Al Saud, visited the DLR site in Cologne. Prof. Wörner and Prof. Dittus in turn visited Riyadh in June 2014. In addition, the launch event of the joint research cooperation mSTAR (Space-Time Asymmetry Research Testing Lorentz Invariance in Low-Earth Orbit) took place in Riyadh in March 2014. The mSTAR project will test the special theory of relativity with a precision that cannot be achieved in Earth-bound experiments: it will examine the dependence of the speed of light on the speed of the observer by comparing two different optical clocks. The DLR Institute of Space Systems in Bremen is developing one of the clocks and will integrate the payload into the satellite bus designed by KACST. Further project partners include Stanford University, NASA Ames and ZARM.



DLR in South Africa

### South Africa

In March 2014, a DLR delegation headed by Prof. Wörner travelled to South Africa to conduct very interesting meetings with the South African space agency SANSA, CSIR (Council for Scientific and Industrial Research in South Africa), DST (Department of Science and Technology), university research institutes and industry representatives. The aim was to reinforce the excellent working relationships particularly with SANSA and further expand the existing cooperations. To date, bilateral cooperation is furthest advanced in remote sensing and the operation of ground stations. The discussions were very constructive; interests were developed further and follow-up activities beyond the existing cooperation framework agreement were negotiated. Numerous joint interests in space and transport research were also identified, particularly with CSIR. The shared interests in transport research are in the fields of transport and the environment and vehicle



Participants in the Turkish-German Round Table on Space

concepts and materials (especially light metals); these interests were discussed and concretised in a draft MoU which is now ready to be signed.

### South Korea

At IAC in Beijing, the DLR Chairman of the Executive Board, Prof. Wörner, and Dr Seung-Jo Kim, President of KARI (Korea Aerospace Research Institute) extended an agreement to cooperate on satellite applications. A visit of the DLR Chairman of the Executive Board with a delegation of DLR and industry representatives in April 2014 further intensified the personal exchange with KARI and ADD (Agency for Defense Development), and numerous new fields of cooperation were identified.

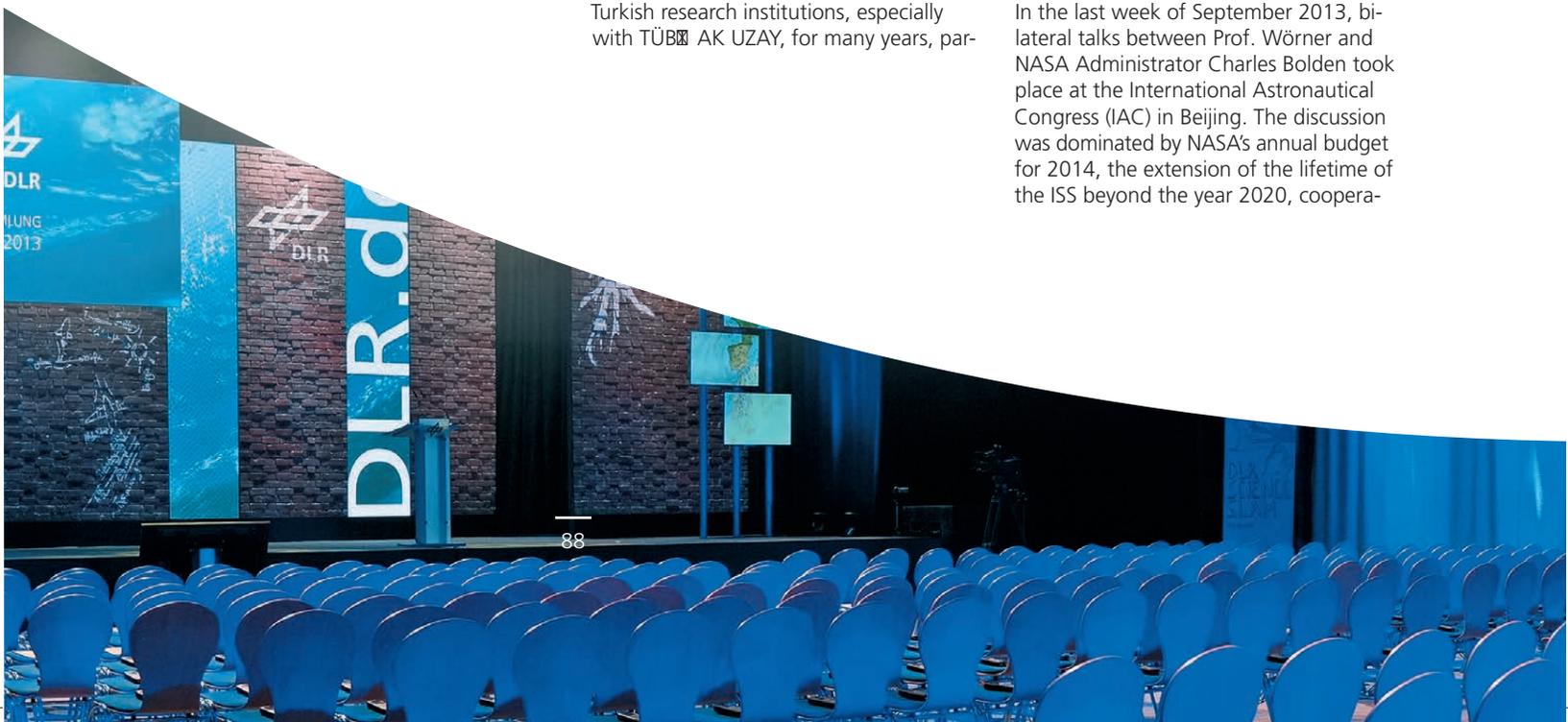
### Turkey

Turkey is pursuing long-term, ambitious goals with its space programme. In 2004 the Supreme Council for Science and Technology (SCST) adopted a space programme for the years 2005 to 2014. DLR has conducted regular exchanges with Turkish research institutions, especially with TÜBİTAK UZAY, for many years, par-

ticularly in the fields of materials research and Earth observation. Turkey as a NATO partner is also among the fastest growing economies in the world and an attractive, up-and-coming market for companies in the space and aviation industry. All these were good reasons to choose Turkey as the partner country for the ILA Berlin Air Show 2014. In all, approximately 40 exhibitors from Turkey attended. DLR took the opportunity to hold a Turkish-German Round Table on Space with the Turkish Ministry of Transport, the Turkish Undersecretariat for Defence Industries (SSM), TÜBİTAK and the German Aerospace Industries Association (BDLI). Invitees included Turkish and German representatives of research, business and politics. The aim was to get to know each other better and explore options for cooperation. With 60 participants the event was very well attended. In addition to direct industry contacts, specific topics for cooperation were also discussed on the research side which will be further advanced in the coming months.

### USA

In the last week of September 2013, bilateral talks between Prof. Wörner and NASA Administrator Charles Bolden took place at the International Astronautical Congress (IAC) in Beijing. The discussion was dominated by NASA's annual budget for 2014, the extension of the lifetime of the ISS beyond the year 2020, coopera-



tions in aeronautics and various scientific space missions. The talks continued during the DLR Christmas Party in Washington in December 2013.

Prof. Dittus travelled to the USA in autumn 2013 and early 2014 to discuss ongoing and new cooperation projects originating from the October 2013 US-German Aerospace Round Table (UGART) with various NASA centres and commercial partners. As part of a fact-finding trip to Denver and Los Angeles in October 2013 Dr Gruppe visited the US industry partners for the future space transporter SLS/Orion as well as Space X, Virgin Galactic and the Sierra Nevada Corporation in order to gain an up-to-date view of the prospects of commercial space transportation (CST) and the resulting opportunities for the German space industry. In late 2013 a delegation led by the Energy Programme Director, Dr Milow, visited the National Research Laboratory (NREL) and Sandia Laboratories. The existing relationships in the field of solar research were expanded and explored in more detail for the field of wind power. NREL and Sandia Laboratories have extensive experience in wind power plant research, from which DLR can benefit in some areas. The results of the negotiations with Sandia include a design for the future DLR wind power test rig that will complement US test rigs. The good relations with NASA suffered a setback in early March 2014 with the announcement that NASA no longer intended to finance the joint SOFIA project from 2015. Following a massive intervention by the German side in cooperation with the involved local partners in the USA, the situation as of August 2014 is that SOFIA will continue to run for at least two more years.

In mid-March 2014, Prof. Henke travelled to the West Coast of the USA to discuss ongoing and possible new aeronautics

projects with NASA Ames and US companies. The talks went very well, and more intensive cooperations in aeronautics between DLR and its US partners can be expected in the future. In May 2014, NASA Administrator Charles Bolden attended ILA in Berlin and took the opportunity to meet with the Federal Ministry of Economic Affairs and Energy and several times with DLR. The main focus of these meetings was on the further operation of SOFIA and the extension of the ISS until 2024. At the same time, the NASA Associated Administrator for Aeronautics, Dr Jaiwon Shin, also attended ILA and participated in several meetings to intensify the collaboration between DLR and NASA in aeronautics.

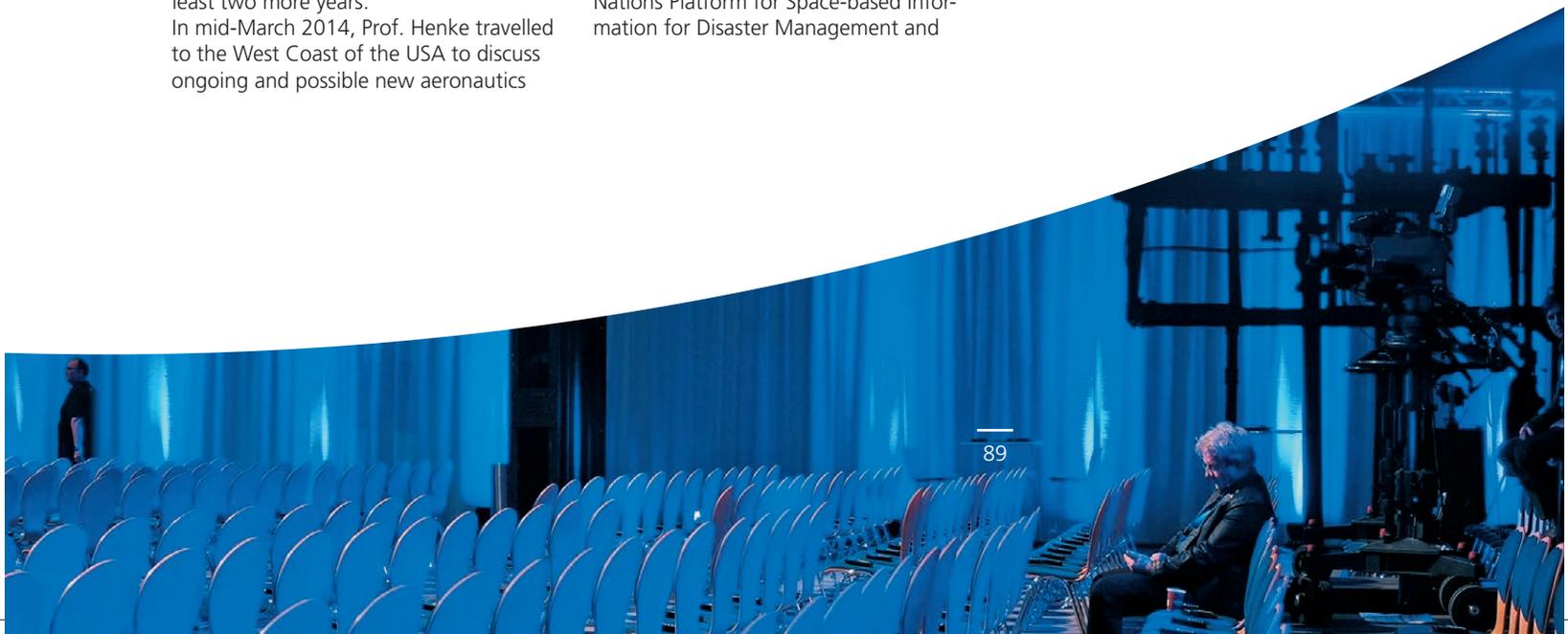
#### United Arab Emirates

The United Arab Emirates (UAE) are increasingly investing in space exploration and are planning to establish a space agency. For this reason a delegation of the committee that is to support the UAE government in founding this agency visited the Space Administration in Bonn in June 2014. Dr Gruppe described the experiences and structures of DLR as a national space agency and offered further advisory support in setting up the agency.

#### UNCOPUOS

At the request of the German Ambassador to the United Nations in Vienna DLR held a UN Expert Panel in Cologne in October 2013. 23 experts from DLR, the University of Cologne, ESA, the Federal Foreign Office and the Federal Ministry of Economic Affairs and Energy came together to discuss topics such as space debris, space weather, Near Earth Objects, the United Nations Platform for Space-based Information for Disaster Management and

Emergency Response (UN SPIDER) and the further development of space law. With the Legal Subcommittee Meeting of UNCOPUOS in March 2014, Simonetta Di Pippo was appointed Director of the United Nations Office for Outer Space Affairs. During the same meeting Prof. Schrogl was elected chairman of the Legal Subcommittee for two years. One key point of this meeting was the German initiative to restructure the Legal Subcommittee Meeting agenda in order to more effectively separate and schedule the work. Due to continuing concerns from some member states no consensus has yet been achieved. During the Scientific and Technical Subcommittee of UNCOPUOS in February, Prof. Lämmerzahl of the Center of Applied Space Technology and Microgravity (ZARM) held a DLR-funded presentation on cooperation between ZARM and UNOOSA titled *DropTES – a new Fellowship Program of UNOOSA at the Bremen Drop Tower*. This programme provides funding for student experiments in the drop tower. On the recommendation of the Action Team 14 *Near-Earth Objects*, the International Asteroid Warning Network (IAWN) and the Space Mission Planning Advisory Group (SMPAG) were established. IAWN as a virtual association of research institutions observes Near Earth Objects. SMPAG is comprised of representatives of the space agencies to develop an international response to the threat from Near Earth Objects; DLR is one of its founding members. The Action Team 6 *Public Health* has achieved remarkable progress. This team examines





UN expert panel on October 21, 2013, at DLR Cologne.  
At centre (left to right): Prof. Wörner, Ambassador Scharinger, Dr Gruppe.

the added value of space technology for preventative healthcare and for emergency responses in remote areas and developing countries. The working group *Long-term Sustainability of Outer Space Activities* consolidated its guideline recommendations on topics such as space debris, space weather, legal conditions and sustainable development on Earth. As this work is progressing very slowly, the group's mandate was extended until 2016.

Widely noted was the presentation of the second volume of the English-language standard work on space law, the *Cologne Commentary on Space Law (CoCoSL)*, which is drafted under the leadership of

DLR and the University of Cologne. The four-year work of the working group on *National Legislation Relevant to the Peaceful Exploration and Use of Outer Space* was successfully concluded with the adoption of resolution 68/74 by the UN General Assembly in late 2013. The joint initiative of Canada, the Czech Republic and Germany on the *Compendium on Space Debris Mitigation Standards adopted by States and International Organizations* was also successfully brought to a close. The compendium has been managed by UNOOSA since 2014 and is available to the public.

#### International Space University (ISU)

DLR is involved in the International Space University (ISU) which trains students from around the world and from a range of disciplines for the space industry. The ISU is a relatively young university (1987) that

offers two one-year degree courses: Master of Science in Space Studies and Executive Master of Business Administration. Its popular Space Studies programme can be completed in just three months. DLR is involved in designing the courses, firstly through DLR's representation on the Board of Advisors in the person of Prof. Dittus and on the Board of Trustees, and secondly by organizing secondments of DLR lecturers, offering internships at DLR to ISU students and providing financial support for DLR employees who wish to participate in the programmes.

#### UN SPIDER

In an informal meeting between Prof. Wörner, Ms Di Pippo, a representative of the Federal Ministry of Economic Affairs and Energy and the head of the UNOOSA office at the UNCOPUOS Main Committee, the importance of UN SPIDER and its office in Bonn was underlined by all parties. It was agreed that DLR, the Federal Ministry of Economic Affairs and Energy and the UN SPIDER office in Bonn will work together to plan a high-profile large-scale international conference in 2015 to focus on further developing the results of the 3rd World Conference on Disaster Risk Reduction in Sendai, Japan, in March 2015. The Chairman of the Executive Board of DLR held a related talk in the COPUOS plenary on DLR's contributions to global challenges, focusing on humanitarian applications, which became the main subject of discussion at the evening reception at the residence of the ambassador. The UN SPIDER office in Bonn will continue to receive financial support from the Federal Ministry of Economic Affairs and Energy, and DLR will extend its close cooperation by, among other things, seconding an employee there. In February, UN SPIDER held the 5th coordination meeting of the meanwhile 16 Regional Support Offices (RSOs) around the world.



The RSOs determined to collaborate more closely not only regionally, but also with regard to preparing applications such as for the EU programme Horizon2020 in the future. The significantly revised UN SPIDER portal has also been available in Spanish since the spring; additional French and Russian versions are planned.

@ [www.un-spider.org](http://www.un-spider.org)

### International Space Exploration

On January 9, 2014, the US State Department held the International Space Exploration Forum (ISEF) in Washington in continuation of the international dialogue on space exploration following the conference in Lucca (Italy) in 2011. Government representatives from 33 countries, the European Commission and ESA attended. Alongside the Federal Ministry of Economic Affairs and Energy, DLR members of the Executive Board Prof. Wörner and Dr Gruppe were involved. The attendees

were largely agreed that space exploration with the long-term goal of crewed Mars exploration represents one of humanity's greatest challenges. At the same time, they emphasised the importance of the benefits of exploration activities: innovation and increased knowledge contribute directly to economic growth and societal progress.

Both international cooperation and international competition are major elements in this process. The International Space Station ISS represents an important intermediate step in space exploration. The next dialogue on space exploration at a political level will be hosted by Japan in 2016 or 2017. On January 10, 2014, the International Academy of Astronautics (IAA) organised the Heads of Agencies Summit on Exploration, which was attended by 32 representatives of space agencies. Prof. Wörner presented DLR's view on exploration. The participants re-

iterated the results of the ISEF event the previous day and additionally emphasised that a shared consensus is necessary for efficient, long-term and sustainable space exploration and use. The work of the International Space Exploration Coordination Group (ISECG) provides a good basis for achieving this consensus.

## Why is DLR participating in the OECD Space Forum?



Space exploration activities are increasingly being evaluated according to their benefit to society and their economic effects. This is stipulated by the Federal Government's space strategy. But how can these effects be assessed and, if necessary, quantified? Space exploration is multi-disciplinary, which frequently makes it difficult to trace the fact that products and applications are ultimately based on space technologies. These are precisely the issues the OECD Space Forum is working to address. DLR is supporting the OECD through its membership in the Space Forum, and taking advantage of this opportunity to shape analyses and studies.

### **Dr Roswitha Grümman**

*Head of Department, European Space Politics and Special Affairs, represents DLR at the OECD Space Forum*





## People

Staffing levels in DLR continued to rise in 2014. Of the 7730 people employed in DLR, 57.5 percent work in research. The proportion of female staff remains constant at 30 percent; 17 percent of management roles are held by women. The staffing figures also testify to DLR's training commitment: the number of doctoral candidates at DLR has increased slightly (from 947 to 1005), as has the number of trainees during the reporting period (from 253 to 268).

- Team workshops on organisational development (e.g. change management, strategy development, leadership and collaboration, customised training for teams)
- Mentoring to individually promote and develop new talent as they take on new roles, e.g. professional, project-related and/or disciplinary management responsibilities
- Talent management to identify high potentials with excellent achievements and retain them for DLR by fostering cross-disciplinary competencies with the aim of preparing them for management roles
- DLR\_Graduate\_Program, the DLR programme for doctoral candidates (see p. 96 ff.)

## Human Resources Development

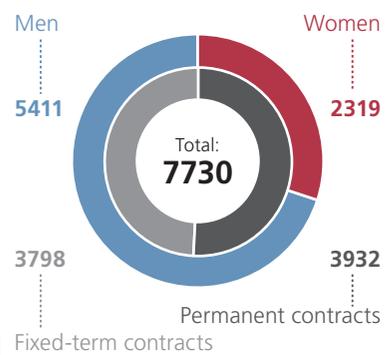
The HR and Organisational Development department at DLR determines the training requirements of all employees and develops tools, measures and programmes to help them achieve their potential and increase their motivation. These activities dovetail DLR's overall alignment with the development needs of its employees by on the one hand developing and maintaining employees' professional, methodical, social and interpersonal skills while on the other hand providing timely and extensive training to prepare employees for new challenges individually and within their teams. As a supporting process, the HR and Organisational Development department contributes significantly to the DLR management system.

Alongside advice on all issues of further training, HR management and support, HR and Organisational Development offers programmes and products for specific target groups within DLR:

- Differentiated HR development offerings for managers and junior managers
- Management feedback to optimise leadership and collaboration
- Coaching for managers, employees, and small groups

In addition, DLR's HR and Organisational Development department provides local and cross-site education and personal development programmes focusing on

DLR Personnel in 2013



social and management-related skills as well as language courses and IT training. The department also cooperates closely with DLR Occupational Health for example by offering training and courses to promote good health. In the field of further training and seminars, a total of 653 events were held in 2013. Each employee used an average of 1.92 days for these internal further training options; for the entire staff

this amounts to 14,867 training days. 66.7 percent of employees took part in at least one human resources development programme, HR development programme for managers, or one of the 117 team and organisational development workshops.

In project management, which is one of the key areas of internal training, 148 employees took part in the comprehensive compact course alone; a further 47 participants gained a basic project management qualification, while another 21 employees used the seminars to prepare for PMP® certification.

Supporting junior managers in the acute situation in which they take on management responsibility is the declared aim of the mentoring programme. A new class of the DLR Mentoring Programme began in June 2014 with 13 young talents who are taking on new challenges by assuming their first management role or comparable responsibilities. As a result of the redevelopment of DLR's HR policy and the associated changes to the requirements profile for managers in DLR, the soft skills assessment tool used in mentoring was also adapted accordingly and

Staff	2011	2012	2013
Employees	7046	7385	7730
Scientific staff employed by institutes and facilities	3569	3744	3913
Junior researchers	51	47	45
Doctoral candidates (internal/external)	879	947	1005

## Management Development Programme



**Dr Karsten Roth**  
Head of Human Resources Development in DLR

In 2013, the DLR Executive Board adopted a new HR policy to concretise the DLR Guidelines. Both guiding documents necessitated an update to DLR's management development programme. The HR and Organisational Development department first defined a general requirements profile for managers in DLR which describes the main social, methodical and personal requirements to prepare employees for leadership positions in DLR.

Based on this requirements profile, we then adapted and will continue to adapt our seminar offerings for managers in DLR.



Participants in the first DLR-wide Talent Management Programme

used for the first time in April of this year for the class of 2013.

The dialogue between the Executive Board and 76 high-potential employees and new talents took place for the ninth time in late July 2014. Alongside the established elements, new methods of networking were applied for the first time, and the exchange with the Executive Board was intensified through a moderated closing debate in the style of a reverse approach that discussed possibilities for change from the viewpoint of the young managers.

Since June 2013, all interested DLR employees can apply for one of the 25 places in the DLR Talent Management Programme. In all, 75 employees from all DLR sites applied. The candidates who met the formal requirements were invited to take part in potential analyses

HR Development and Mobility	2011	2012	2013
Training days per employee	2.0	1.9	1.9
Mentoring pairs	10	11	11
Postings abroad (months)	518	449	499

lasting several hours. In the end, the steering committee awarded 22 places on the DLR Talent Management Programme.

A comprehensive potential analysis that included tests, interviews and development centres was conducted in December 2013 to determine the individual development needs of the participants in the Talent Management Programme. The derived measures in the key areas cross-disciplinary skills, management

skills and personal development were discussed with the candidates' line managers in person in order to include their experience of the respective employees and their circumstances.

After the opening event, which took place in February 2014 with the involvement of the Executive Board and managers, the group met in Oberpfaffenhofen in May for its first workshop. In addition to the individual development measures such as seminars, coachings or sponsorships, which the participants will attend in accordance with their development plans, two further joint workshops will be held this year.

## Human Resources Marketing

In summer 2013, the central HR Marketing Department carried out its second large-scale market survey after 2009. The survey was conducted in the form of an online questionnaire sent to approximately 4600 participants on behalf of DLR. The respondents were not aware who had requested the survey; the results were scientifically analysed. Respondents included engineering, computer science, mathematics and physics students and recent graduates in these subjects.

In order to participate, the students were required to be familiar enough with the research institutions they were assessing to form an opinion on them. The outcome of the survey is very positive: students consider DLR the most attractive employer among research institutions. DLR is also ranked as the most respected German research institution by people acquainted with German research institutions – ahead of the Fraunhofer Gesellschaft and the Max Planck Society. It is therefore unsurprising that 81 percent of respondents who are already familiar or very familiar with DLR are also considering applying, and of these, almost two thirds would choose to work at DLR over other, competing offers. They associate DLR with interesting work, exciting products and a unique infrastructure in the fascinating world of aerospace, energy and transport research. Further confirming a trend that was already emerging in 2009, the survey found that alongside the exciting job content, today's students also value other

factors highly: they want to be able to pursue their own interests and implement their own ideas, and they want leeway – opportunities that research institutions such as DLR can offer to a greater extent than other employers. This is one of the reasons why they are by far the more attractive employers: the survey shows that students clearly prefer research institutions over industrial companies and universities, seeing them as more unique and also more appealing. Approximately one third of respondents prefer the mixture of basic and applied research – a combination that only DLR can offer.

To further embed and reinforce this perception in its target group, HR Marketing is pursuing three lines of action in its communications work:

Internal and external implementation of employer brand positioning: ensuring that job advertisements are correctly placed and attractively worded remains crucial to drawing sufficient applicant numbers. DLR therefore continues to focus on implementing the text and image design guidelines for the employer branding and the manual for designing DLR job advertisements. HR Marketing also contributes corresponding training content to convey the details of our employer brand positioning in internal management training programmes. The pilot phase for DLR exit interviews, which are being tested in cooperation with Human Resources Development at the Oberpfaffenhofen site in order to learn how departing employees see DLR, has been extended. Experiences from the programme to date lead DLR to expect that exit interviews will be implemented across DLR once the pilot phase has ended this autumn.

Raising the profile of DLR as an attractive employer: DLR's jobs portal remains competitive. As a next step, DLR is planning

## DLR: an attractive employer



Independent rankings show that DLR is perceived as highly attractive and was able to significantly increase its reputation as a preferred employer, even and particularly compared to its direct competitors. In a major survey by news magazine Focus, DLR took first place among research institutions and was therefore ranked a *top national employer 2014*.

**Christian Jensen**  
Head of Central HR Marketing DLR

the development of an application for mobile end devices; implementation will begin in the summer of 2014. The first of a series of corporate videos was completed successfully and to the great satisfaction of the involved institute and published on the jobs portal and other relevant Internet channels. Further institutes have expressed an interest in similar videos.

Supporting the institutes in recruiting staff: DLR's group of cooperation partners from the field of Internet portals was expanded, and the cooperation with the selected online job site continued successfully. DLR is seeing a trend in user and applicant behaviour that if confirmed would make it seem worthwhile to expand the attention to further online job sites. Alongside numerous reports in print and online media, during the reporting period Human Resources Marketing attended 14 higher education fairs, the Hanover Trade Fair and the Berlin Air Show ILA, participated in four careers events and three open days, and visited ten universities as part of the ESA Promotion Tour. The event series DLR\_Student\_Insight was continued very successfully in November 2013 at the Braunschweig site.

## Education and Outreach

DLR combines its education and outreach activities in a holistic concept called DLR\_Campus, which addresses all relevant target groups along the education chain, from children, youths and teachers to students and doctoral candidates.

The first DLR\_School\_Lab was opened in the year 2000 in Göttingen – and was fully booked from the start. There are now twelve DLR\_School\_Labs – eight at DLR sites and four at partner universities; the latest opened in November 2013 at TU Dresden. In all, these laboratories for school pupils are introducing over 30,000 young people a year (as of 2013) to the *fascination of research*. And it has been proven that a visit to the DLR\_School\_Lab can increase pupils' interest in natural science and technology well beyond the day of the visit.

The feedback DLR received on its teaching materials we regularly send out to approximately 4000 secondary





Prof. Wörner speaks with young managers

schools across Germany was also very positive. Following an out-of-print, but now re-issued publication on Energy and a booklet on research in zero gravity, the DLR\_School\_Info on aeronautics is currently in preparation. In early 2014, a special edition on the Solar system issued in cooperation with noted textbook publisher Klett MINT was sent to several thousand primary schools. What all DLR\_School\_Info booklets have in common is that they provide age-appropriate information on DLR topics and offer teachers numerous suggestions for their lessons, e.g. in the form of experiments in which pupils can also participate.

The DLR youth portal on the Internet – called DLR\_next – is very popular among young people. As this target group is increasingly also using mobile devices to surf the web, DLR\_next has now been released as an app with exciting news from DLR research and two special features that indicate when the ISS can be seen in the sky and which stars are currently visible at the user's location. Android Magazine rated our app one of the *50 most brilliant free apps* in 2014.

@ [www.DLR.de/next/](http://www.DLR.de/next/)



Participants in the DLR\_Graduate\_Program

Further activities in the youth sector this year included school competitions, teacher workshops, arranging work experience opportunities, organising the Girls' Day event, and more. The DLR institutes and facilities supervise numerous university students during internships, degree theses or summer schools.

The DLR\_Graduate\_Program now boasts around 600 participants, meaning that well over half the doctoral candidates at DLR are taking advantage of this free further training offer. The programme com-

plements the academic supervision, which continues to be provided by the institutes, and teaches cross-disciplinary skills and qualifications: How do project management and funding acquisition work? How does one present at international conferences? Time management, team leadership, scientific ethics – in small groups, the doctoral candidates acquire a high-quality skills profile that serves both their work at DLR and their further careers. Several opinion polls conducted in 2013 as part of a self-evaluation of the programme

### Education activities within the ISS mission "Blue Dot"

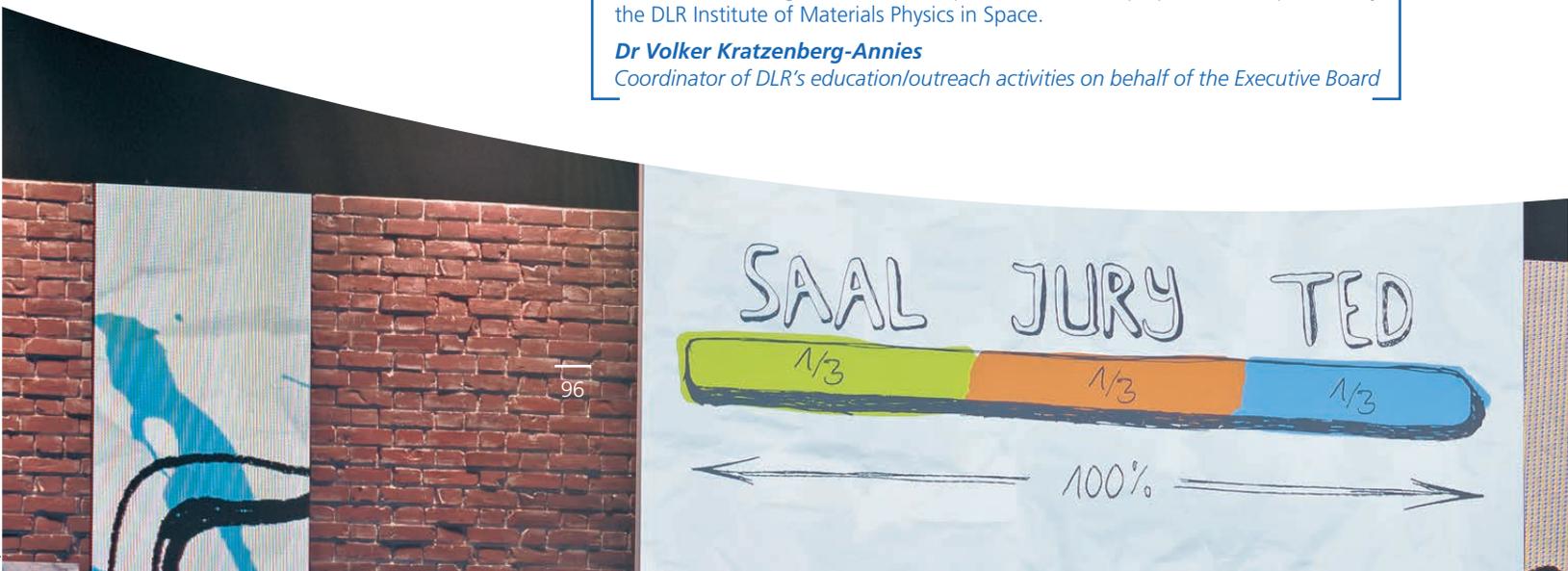


A German ESA astronaut on the ISS – that's a rare opportunity. So it's all the more important to use the public interest in Alexander Gerst's Blue Dot mission to interest young people in research! "Blue Dot" is therefore accompanied by an extensive education programme in cooperation with ESA, DLR institutes and the DLR Space Administration. One of the highlights was the Germany-wide ideas competition *Aktion 42* in cooperation with the young researchers' competition *Jugend Forscht*, in which school pupils were invited to submit suggestions for ISS experiments. The winning experiment

on the behaviour of soap bubbles in zero gravity was conducted by Alexander Gerst on the ISS in June 2014 to great interest from the media. The experiment, which was also interesting from a scientific point of view, was prepared and supervised by the DLR Institute of Materials Physics in Space.

**Dr Volker Kratzenberg-Annie**

Coordinator of DLR's education/outreach activities on behalf of the Executive Board



## German Staff at ESA

confirmed that the seminars and workshops have the right focus: it garnered numerous positive assessments from both the participants in the programme and the interviewed institute managements. And a survey of external decision-makers from industry and research showed that the DLR\_Graduate\_Program teaches precisely the soft skills that are expected of graduates alongside their academic qualifications. The DLR\_Graduate\_Program is also part of the cooperations within DLR@Uni, where together with similar offerings from the university partners it forms the basis of a joint support programme for young researchers.

The doctoral candidate council that has existed within DLR for several years is meanwhile also firmly established. Alongside with a number of institute directors it was also involved in the creation of the doctoral supervision guidelines adopted by the Executive Board in February 2013, which outline best practice in supervising doctoral candidates and thus formulate highest standards of supervision across DLR.

German staff at ESA – a comparison

Member states	Number of employees	Employees [%]	Financial contribution [%]
Germany	375	18.7	22.4
France	433	21.6	21.7
Italy	393	19.6	11.6
UK	216	10.8	8.7
Spain	185	9.2	4.3

Only 25 percent of the contributions to the launcher programme were taken into account in calculating the respective funding contributions.

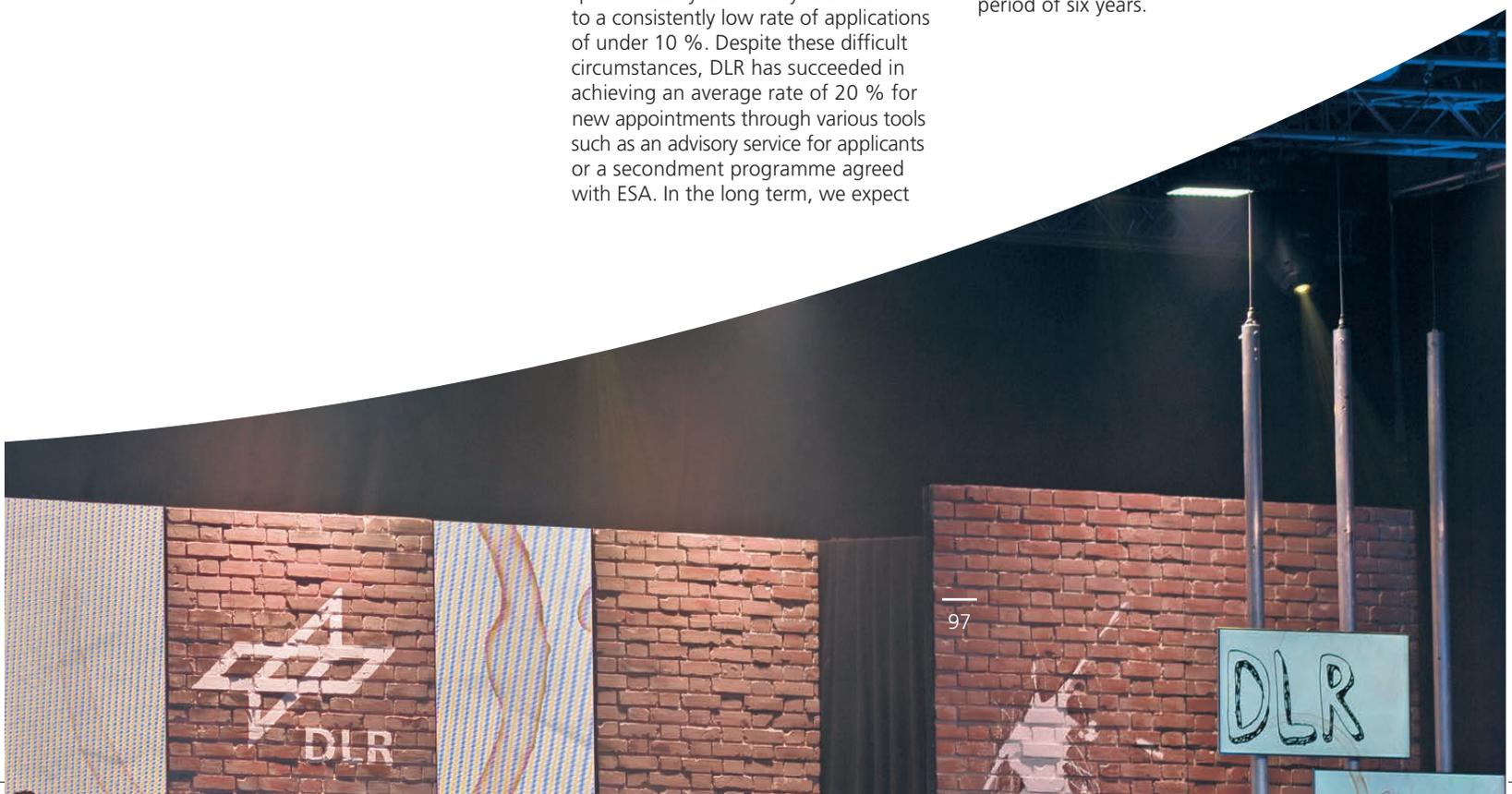
At the end of 2013, ESA retained a total of 2234 employees, 2,004 of them in the salary groups commensurate with *high-level employment*. The proportion of German employees in *high-level employment* was 18.7 % at that time, and thus remained well below Germany's funding contribution of approximately 22 %. By contrast, Italy is significantly overrepresented in relation to its funding contribution.

The main reason that German staff are underrepresented at ESA are the comparatively high salaries in the German aerospace industry. Over the years this has led to a consistently low rate of applications of under 10 %. Despite these difficult circumstances, DLR has succeeded in achieving an average rate of 20 % for new appointments through various tools such as an advisory service for applicants or a secondment programme agreed with ESA. In the long term, we expect

the German Trainee Programme (GTP), which was established in 2010 and sees approximately 20 university graduates annually trained at ESA sites, to contribute significantly to increasing the proportion of German personnel.

The GTP fellowships are funded from the national space budget of the Federal Ministry of Economic Affairs and Energy.

The election of a new ESA Director General is expected for late 2014. There has been only one German Director General since ESA was founded in 1975: Prof. Reimar Lüst, who held the post for a period of six years.



## Diversity and Equal Opportunities

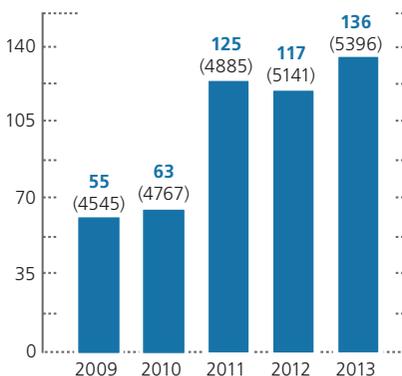
Excellent achievements in research, administration and management need excellent conditions. In an environment made increasingly dynamic by societal change, the future of DLR depends on gaining the brightest minds and enabling employees to explore their potential.

The aim of DLR's diversity strategy is to establish equality regardless of age, sex, ethnicity, cultural background, ways of working and thinking or personal circum-

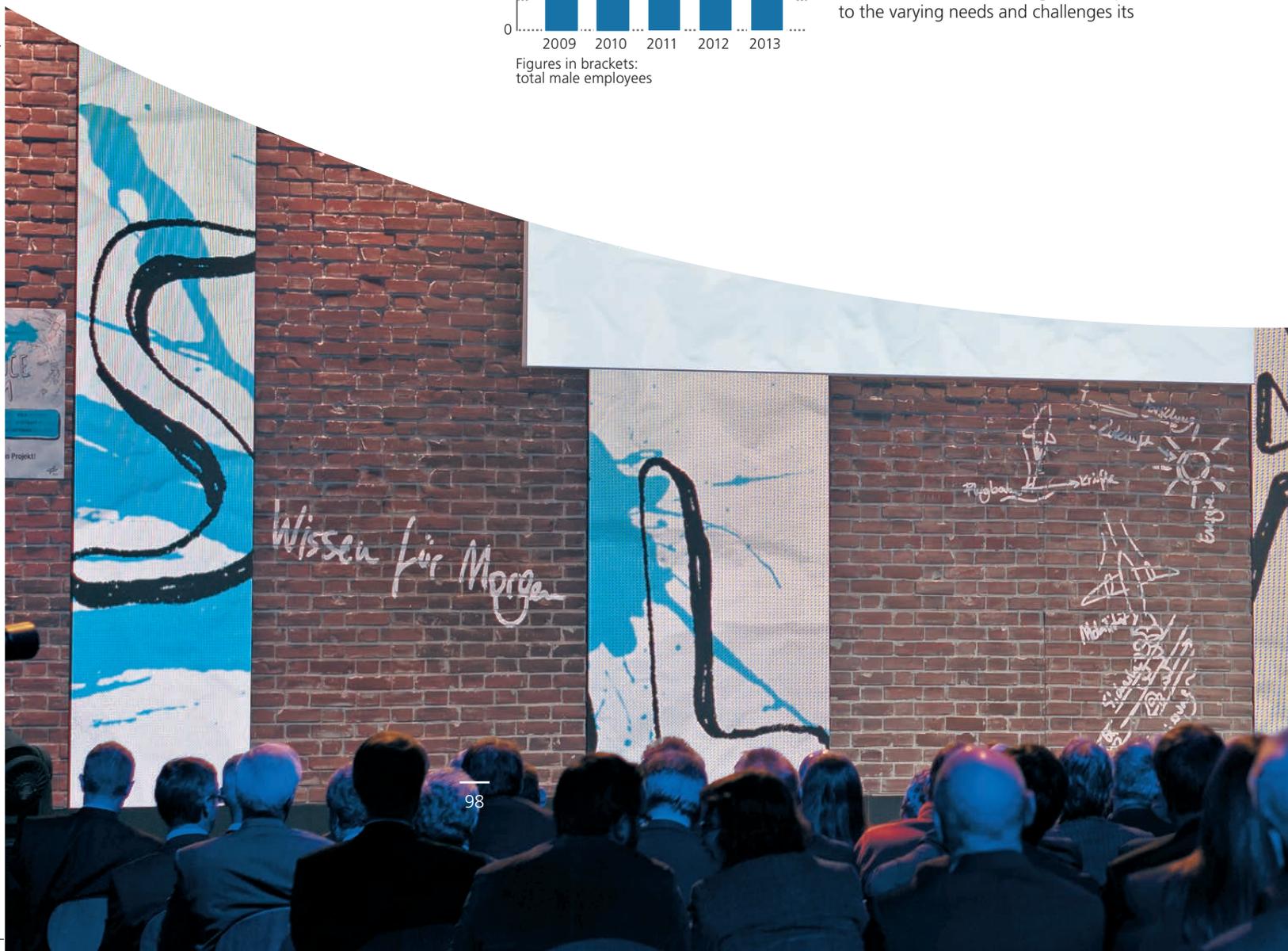
stances. Following the founding of the Diversity and Equality department in April 2013, the increased use of its services by employees and managers indicates a growing awareness of this issue. One of

the key topics managed within the remit of the Chairman of the Executive Board in close collaboration with HR is an appropriate work-life balance, including greater consideration of the challenges accompanying various life stages. Raising the proportion of women in research and research-related areas and increasing the number of men who take parental leave are crucial in this respect. An informal networking platform is being developed to aid retention for example of young mothers and fathers during the doctoral phase, of employees with family members requiring care, and of anyone seeking contact ahead of or following a period abroad, as well as to maintain ties with former employees. DLR is making use of an intense internal and external dialogue to respond to the varying needs and challenges its

**Fathers on parental leave**



Figures in brackets:  
total male employees

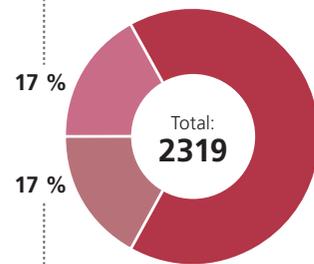


employees face at various times of their life. Advisory and support services are being continuously developed in order to facilitate the best possible work-life balance; examples include the extension of childcare offerings, expanded information for prospective fathers, for single parents, on family-oriented management

and the increasingly important issue of elder care. DLR is proactively integrating topics relating to work-life balance into talks with national, European and international partners in order to ease entry into DLR and its partner organisations in various phases of life.

**Proportion of Women in DLR in 2013**

Women in management roles



Scientific staff

**Diversity Charter**



By signing the Diversity Charter DLR is making an internal and external commitment to a culture of mutual respect and appreciation. This entails an obligation to create the conditions that will allow these values to be shared and brought to life. Joining the Charter underlines the strategic realignment which in extension of the traditional idea of equality acknowledges the diversity of society and makes use of its inherent potential.

**Andrea Boese**

*Head of Diversity and Equal Opportunities*





What began in 2010 as a project for Occupational Health is today an established responsibility of the HR and Legal department and firmly embedded in the strategic aims of the Deputy Chairman of the Executive Board. DLR Occupational Health supports the development and optimisation of business processes and structures to ensure that work, conditions and behaviour in the workplace are conducive to good health. The department's activities address issues such as physical and emotional stress in the workplace or DLR's corporate culture.

Alongside numerous health days for employees, a professional point of contact providing support for psychosocial issues was established at the Braunschweig site in the form of a one-year advisory pilot project for staff and managers. DLR Occupational Health also supported young employees with its first ever two-day workshop designed specifically to encourage our trainees to develop active lifestyles, initially at the Cologne site. Embarking on a career is a phase of transformation that frequently involves changes in lifestyle and as such to the basis for maintaining

one's health. A cross-site training event for the addiction counsellors at DLR was established as a regular event in order to maintain the capacity to provide competent support for "Addiction within the company" in the future. The cross-site measures centrally planned and organised by DLR Occupational Health ensure quality, compliance, evaluation and sustainability in the hands of health experts.

*"Health is not everything. But without health, everything is nothing."*

*Arthur Schopenhauer*

# Future Development of DLR

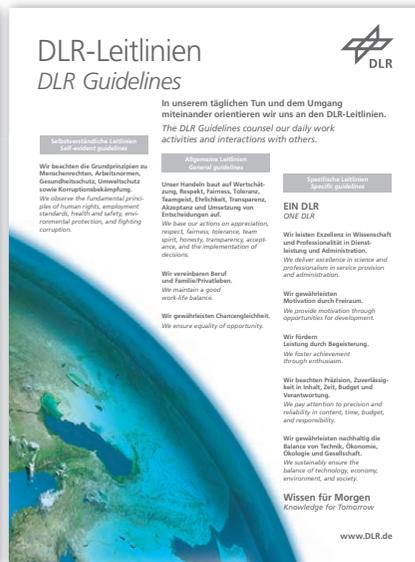
Including its various precursor institutes, the German Aerospace Center looks back on an over 100-year tradition – a tradition that obligates in two ways: on the one hand DLR has to consider the immediate relevance of its work to current issues, on the other hand it is DLR's responsibility to advance projects that reach far into the future and carry through to a new generation.

Next Generation DLR is described in detail in the following documents:

The Corporate Strategy with the sections Status Quo, Conditions, Positioning and Consequences, as well as the Next Generation Governance paper and the foundation of all DLR activity, the DLR Guidelines. The Next Generation Governance paper is not part of the Next Generation DLR document at this time as it is currently being drafted under the premise that *structure follows strategy*.

DLR's Corporate Strategy describes the overarching ideas that are tied neither to specific goals and milestones nor to specific circumstances (e.g. budgets); of course these overarching ideas are transposed into long-, medium- and short-term goals and milestones in the various programmes that allow for various circumstances and are documented in separate papers.

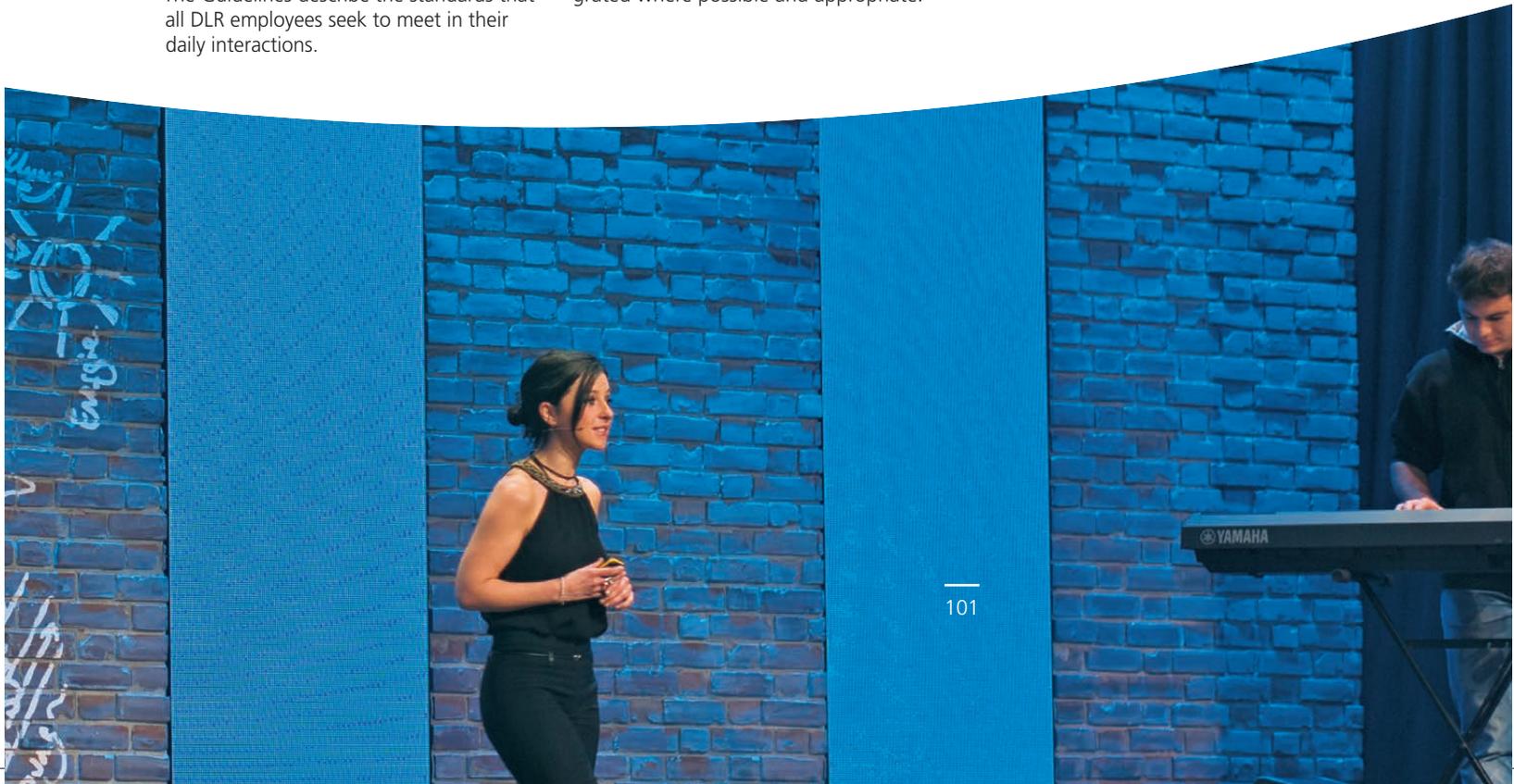
The Guidelines describe the standards that all DLR employees seek to meet in their daily interactions.



The Corporate Strategy and the DLR Guidelines are the result of a lengthy process in which both DLR-internal and external ideas were gathered and processed. The formulated statements were discussed internally in several circles – by the Executive Board, the second management tier and on the site tour with all employees. In addition, the Senate Committee and the Senate were informed of these statements and commented on the submitted text. Recommendations from the various stakeholders have been integrated where possible and appropriate.

The paper published on July 18, 2014, as a result of these deliberations sets out clear expectations regarding the direction in which we aim to advance DLR.

The documents can be found here  
 @ <http://s.DLR.de/133v>







# FACTS & FIGURES



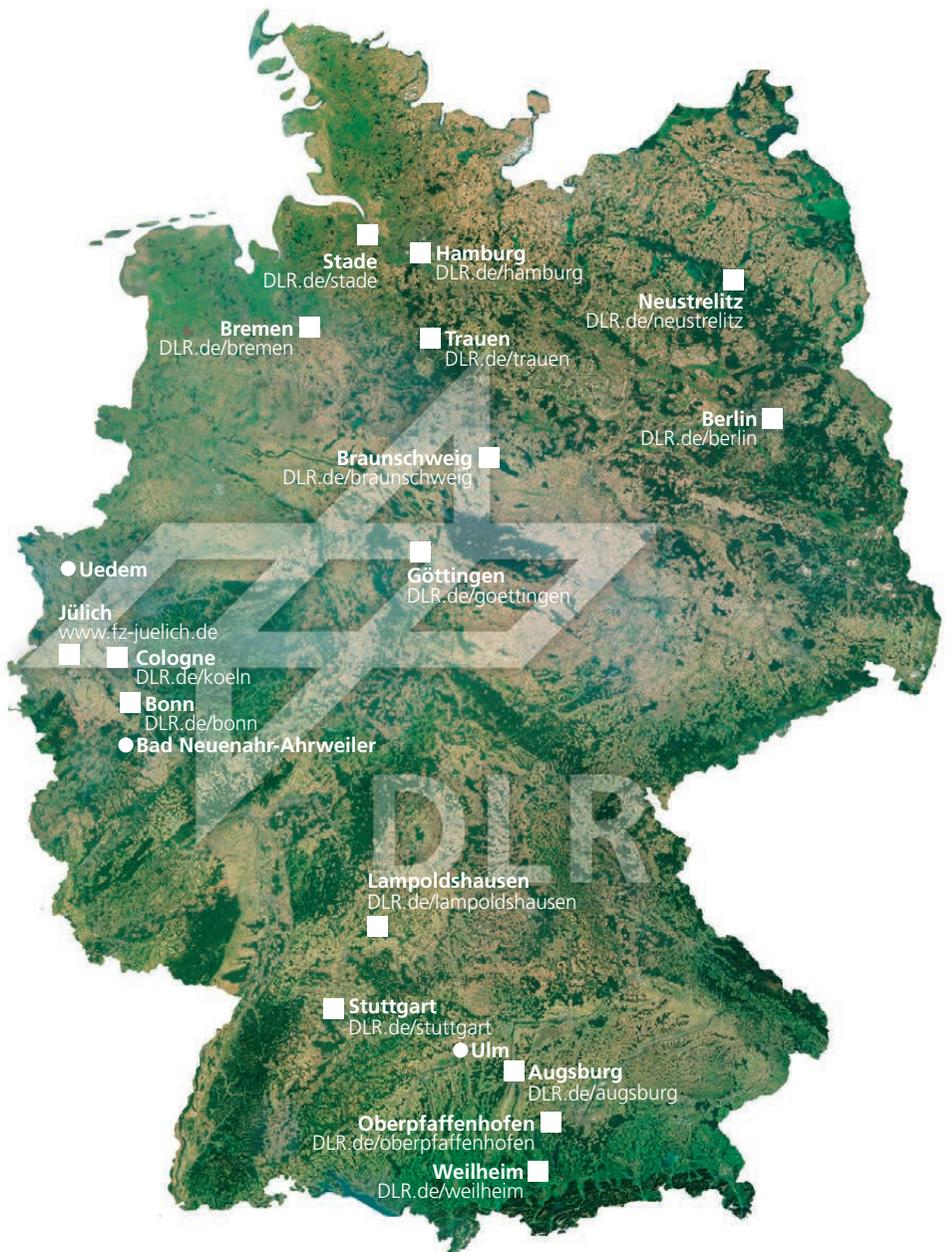
# Some of DLR's Infrastructures

## Braunschweig



### MoSAIC Driving Simulator

Communication technologies can be used to acquire additional information for driver assistance and automation. Vehicles can communicate with each other and with the transport infrastructure – examples include cooperative lane change assistants, green wave assistants or intelligent traffic cones. The MoSAIC laboratory with its three coupled driving simulators is used to examine interactions between drivers and test cooperative systems, focusing on how well drivers accept assistance systems and how effective they find them as well as on the effects of their use on other road users. Systems tested in the simulators can then prove their practical worth in real traffic on the AIM reference route.



## Braunschweig



### AVES (Air Vehicle Simulator)

AVES (Air Vehicle Simulator) consists of two high-quality systems for highly sophisticated airplane and helicopter simulation. AVES is designed as a modular, flexible platform using the latest technologies for holistic aeronautics research. The cutting-edge test system bridges the gap between numeric aerophysical simulation and experimental flight operations at the Braunschweig research airport. Its main research application is to further examine dynamic interaction between humans and aircraft, in particular for commercial aircraft and helicopters and for new configurations.

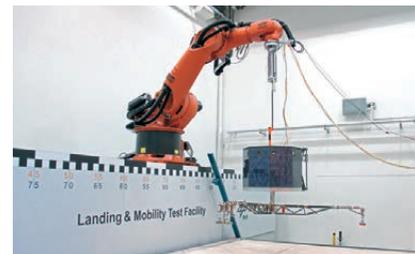
## Braunschweig



### NWB

The NWB is an atmospheric, closed wind tunnel for testing at low speeds. It was thoroughly renovated between 2009 and 2010 and is now equipped with the latest technology to deliver outstanding results in aeroacoustics while also maintaining its highly valued aerodynamic qualities.

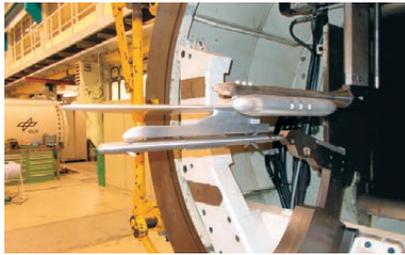
## Bremen



### LAMA

The Landing and Mobility Test Facility enables globally unique experiments to examine the touchdown dynamics of planetary landers. Alongside simple drop tests, reduced gravity can be simulated by offloading the weight of the test object in order to test interactions between landing probes and the ground under those conditions. Numeric tools for computer-assisted simulation of touchdown processes complement these experimental options. LAMA's experimental and numeric tools were used to help select the touchdown site for the comet lander Philae: test and simulation data were analysed to determine the safe operational limits for the landing process and the results made available to Mission Operations to evaluate possible landing sites.

## Cologne



### Trisonic Test Section Cologne (TMK)

The high requirements of modern guided defence missiles demand a precise understanding of their aerodynamic behaviour across a wide range of flight operations. With its simulation range from subsonic to transonic to high supersonic speeds, the Trisonic Test Section of DLR in Cologne (TMK) is the perfect facility to gain this information. The long test periods of up to 90 seconds make it possible both to aerodynamically examine complete configurations and to measure and qualify vital components such as air inlets on ramjet engines. Even complex processes such as missile separation from carrier aircraft can be examined realistically.

## Lampoldshausen



### P5 Engine Test Rig

The P5 test rig is used to test the Ariane-5 engine Vulcain. Its construction enables testing under realistic conditions: the upper part of the test rig contains a tank with 200 m<sup>3</sup> of liquid oxygen, the same as that in the carrier rocket. The 600 m<sup>3</sup> hydrogen tank is situated directly next to the test rig. For the tests, the liquid propellants are transported to the engine's turbo pumps via vacuum-insulated pipelines that have to be cooled down to around minus 270°C in order to function correctly. Later, during the simulated launch, the combustion chamber heats up to 3000°C; the engine must be able to withstand these enormous temperature differences.

## Oberpfaffenhofen



### The measuring facility: Compact Test Range

The Compact Test Range serves to develop and characterise antennas and to determine the radar backscatter characteristics of test objects. It is operated in a shielded room lined with microwave absorbers under constant ambient conditions and features a usable frequency range of between 300 MHz and 100 GHz for objects up to 3.8 metres in diameter. Alongside measuring standard antenna parameters (gain, directivity and polarisation), new methods for analysing antenna characteristics can be applied; for example, the fields in immediate proximity to the antenna can be calculated holographically from the measured far field data to identify interference effects of the antenna support structure on the antenna radiation pattern.

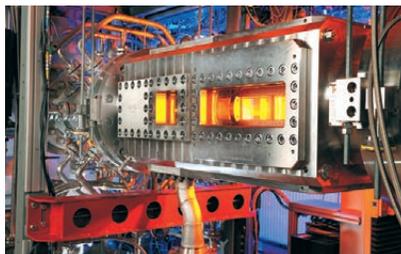
## Stuttgart



### CellFlux

Affordable and flexibly adjustable thermal energy stores contribute significantly to improving efficiency in the process industry and increasing flexibility in power plants. For example, low-cost natural stones can be used to store thermal energy. These stores can be coupled with almost any thermal process by means of a heat exchanger and a circumferential hot air flow. The volume of the storage medium, the size of the heat exchanger and the type of storage material make the capacity, performance and maximum operating temperature of the store independent of each other, allowing them to be optimally tailored to the respective process. Depending on how it is operated, the pilot store developed in Stuttgart has a capacity of up to 2000 kWh at a maximum operating temperature of 400°C.

## Stuttgart



### High-pressure Combustion Chamber Test Rig (HBK-S)

Stationary gas turbines will continue to play an important role in maintaining our energy supply in the future. They must offer high fuel and load flexibility in order to compensate for the heavily fluctuating input from renewable energies. Developing and advancing corresponding burners and burner systems is crucial in this respect, and examining the combustion characteristics of a range of different fuels and burners/combustion chambers by means of state-of-the-art optical measuring methods at HBK-S is a major factor in this work. Thanks to the available outstanding test rig infrastructure these examinations can be conducted under gas turbine relevant operating conditions (pressure, temperature, speed).

## Stuttgart



### Dynamic Component Test and Crash Facility

DLR develops innovative vehicle concepts and technologies for lighter and safer vehicle chassis and structures. A dedicated test rig is used to test concepts, components, assemblies and material combinations for which no sufficiently validated calculation methods for crash events exist. The aim is to use the measured results to further enhance existing simulation methods and tools in order to reduce the number of complete vehicle crash tests. Thanks to the flexible design of the dynamic component test facility, crash tests can be adapted precisely to DLR and customer requirements.

# Commendations and Awards

DLR awards various prizes and honours to support and motivate its employees, including the Science Prize, the Senior Scientist award and also research stays. The assistance of DLR's funding institutions and other external organisations allows DLR to offer a broad and interesting range of awards and prizes. Below is an excerpt from 2013.



Otto Lilienthal Research Semester 2013/Prof. Dr Claus Wagner

## Internal Commendations

### DLR Science Prize

- Florian Dahlkötter
- Dr Andreas Minikin
- Dr Andreas Petzold \*
- Dr Oliver Reitebuch
- Dr Daniel Sauer
- Dr Rainer Schnell  
at the Institute of Propulsion  
Technology
- Andreas Veira \*\*  
at the Institute of Atmospheric Physics
- Dr Melanie Voges
- Prof. Dr Bernadett Weinzierl

\* now at the Jülich Research Centre,  
Jülich

\*\* now at the Max Planck Institute for  
Meteorology, Hamburg

### DLR Senior Scientists

- Dr Oliver Reitebuch,  
Institute of Atmospheric Physics
- Dr Patrick Robertson,  
Institute of Communications and  
Navigation
- Dr Joachim Winter,  
Institute of Vehicle Concepts

### DLR Quality Prize 2013

- Jan Sascha Below,  
Technical Infrastructure
- Stephan Lehner,  
Institute of Air Transportation Systems

## Awards presented by the Society of Friends of DLR (SoF)

The SoF presented its awards on October 22, 2013, during a scientific colloquium held at the DLR site in Cologne as a joint event between DLR and the SoF. Guests included members and sponsoring members of the SoF, institute directors, managers and researchers from the local institutes. The event offered current and previous award winners and senior scientists the opportunity to present their work and the results of their research stays abroad.

### Otto Lilienthal Research Semester

- Prof. Dr Claus Wagner, Institute of Aerodynamics and Flow Technology, for his role in researching mixed and thermal turbulent convection in aircraft cabins and rail vehicles and his work as head of the Fluid Systems department, coordinator and head of various LuFo joint projects and the DLR project ECCO

### Fritz Rudolf Prize

Organisational team

- Dr Kathrin Specht, Silke Hüttemann, Manuela Günther, Dr Gerd Kraft,

Space Administration/ESA Affairs, Bonn-Oberkassel, in recognition of their services in administration, planning or project management for the coordination and organisation of the ESA Council of Ministers in Naples in 2012

### Innovation Prize

The project team

- Dr Peter Haschberger, Martin Israel, Thomas Schwarzmaier, Dr Volker Tank, Andreas Wenisch, Tilman Wimmer, Jürgen Wörishofer,

Institute of Remote Sensing Technology, Oberpfaffenhofen,

- Stefan Keim,

German Remote Sensing Data Center, Oberpfaffenhofen,

- Claudia Pápa,

Technology Marketing, Cologne, for the project "Flying Wildlife Finder". The device has meanwhile been licensed to ISA Industrieelektronik GmbH in Weiden and following a promising test phase is now being developed to market readiness.

### Chairman's Prize

- Stefan Erl (youngest person to register a patent)

Institute of Communications and Navigation, Oberpfaffenhofen, for "Method for synchronizing data stored in databases of distributed database systems"

### DLR\_School\_Lab

The DLR\_School\_Lab Prize 2013 was announced and evaluated by the DLR\_School\_Lab TU Dortmund; its topic was "Searching for samples on Mars/ Mars Rover". The prize went to:

- Niklas Canisius, Johannes Frielingsdorf, Kai Schilke and Jan Schwenzfeier,

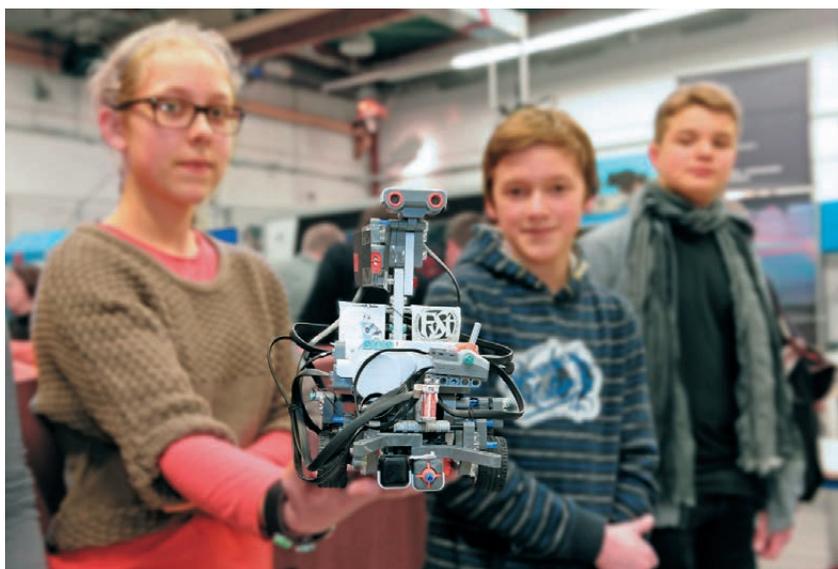
Gymnasium Grotenbach-Gummersbach, 1st Prize

- Sarah Pressner, Torben Hebel, Felix Roll, Malte Kern, Tim Stürmann and Georg Berger,

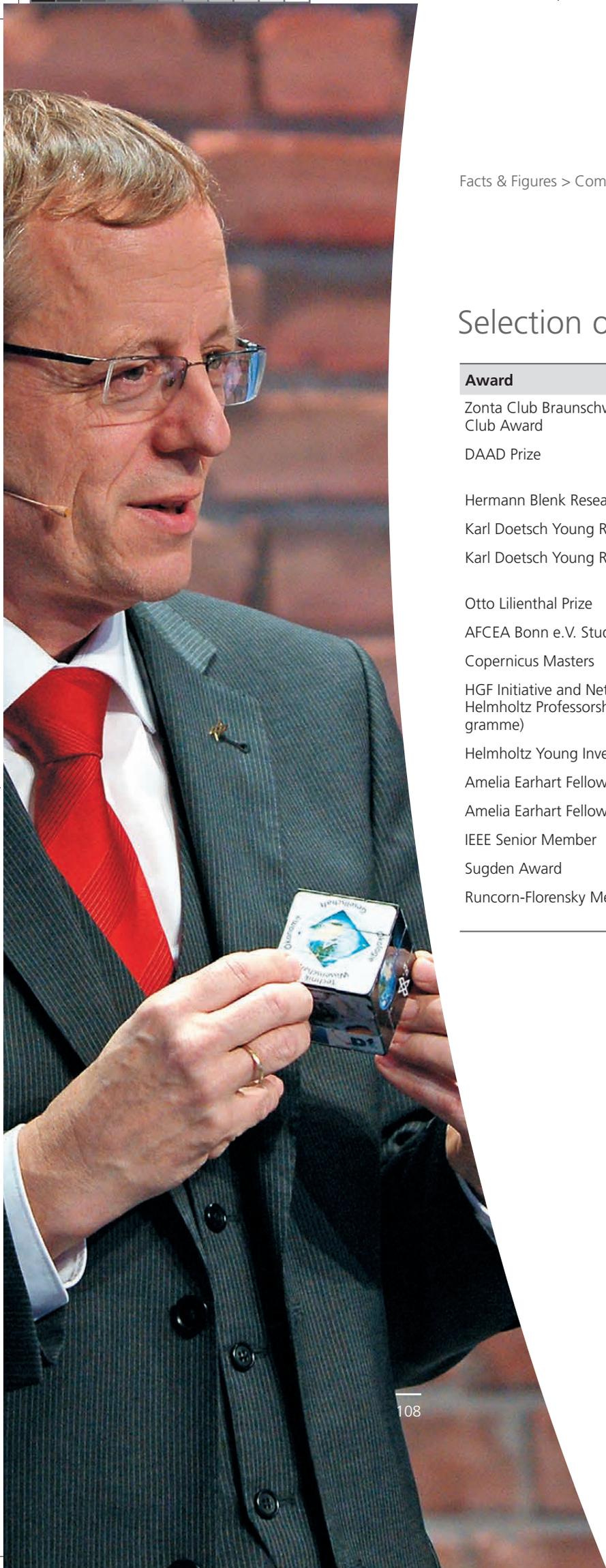
EpTa Group (Energy Project for Talented Pupils) of the Freiherr-vom-Stein Gymnasium, Leverkusen, 2nd Prize

- Melina Lawida, Josephine Pröls, Anne von Landenberg, Sara Weltner and Jeannine Wochnik,

Astronomy Club at the Martinus-Gymnasium, Linz, 3rd Prize



DLR\_School\_Lab Prize 2013



## Selection of External Awards in 2013

Award	Prize winner
Zonta Club Braunschweig Amelia Earhart Club Award	Bettina Birkmeier
DAAD Prize	Zhenwei Miao (TU-BS/DLR)
Hermann Blenk Research Award 2013	Dr Jochen Wild
Karl Doetsch Young Researcher Award	Falk Sachs
Karl Doetsch Young Researcher Award	Yannick Lammen (Master thesis TU-BS/DLR)
Otto Lilienthal Prize	Prof. Dr Ulrich Wagner
AFCEA Bonn e.V. Study Award 2013	Milberg, J. (Master thesis)
Copernicus Masters	Dr Runge, Hartmut
HGF Initiative and Networking Fund Helmholtz Professorships (W2/W3-Programme)	Prof. Dr Christiane Voigt
Helmholtz Young Investigators Group	Dr Hella Garny
Amelia Earhart Fellowship	Bianca I. Gursky
Amelia Earhart Fellowship	Katharina Heimerl
IEEE Senior Member	Dr Prats, Pau
Sugden Award	Dr Elke Goos
Runcorn-Florensky Medal of the EGU	Prof. Dr Tilman Spohn

# Affiliates and Joint Ventures

DLR holds shares in other notable companies and company start-ups that represent added value for DLR's work in the context of its research and its strategic alignment, thereby achieving the best possible utilisation of a wide range of synergy effects for scientific contributions to meeting societal challenges. Management and controlling of these shares is handled by a staff department which additionally oversees DLR's memberships, institutional cooperations and networks particularly with regard to administrative and legal matters. This staff department operates as a central point of contact in all matters relating to DLR's participations and memberships, from initiation through administration to processing.

@ <http://s.DLR.de/19nb>

**DLR Joint Ventures Gesellschaft mit beschränkter Haftung (DLR Joint Ventures Limited Liability Company),** Bonn  
100 percent

**DLR Gesellschaft für Raumfahrtanwendungen (GfR) mbH (DLR Institute of Space Applications),** Weßling  
100 percent

@ [www.DLR.de/gfr](http://www.DLR.de/gfr)

**German-Dutch Wind Tunnels (DNW) Foundation,** Noordoostpolder/Netherlands  
50 percent  
@ [www.dnw.aero](http://www.dnw.aero)

**European Transonic Windtunnel GmbH (ETW) (European Transonic Wind Tunnels),** Cologne  
31 percent  
@ [www.etw.de](http://www.etw.de)

**TeleOp Gesellschaft mit beschränkter Haftung (TeleOp Limited Liability Company),** Weßling  
25 percent  
@ [www.teleop.de](http://www.teleop.de)

**Anwendungszentrum GmbH (Application Center) Oberpfaffenhofen,** Gilching  
25 percent  
@ [www.anwendungszentrum.de](http://www.anwendungszentrum.de)

**Europäische Akademie zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen Bad Neuenahr-Ahrweiler GmbH (European Academy of Technology Assessment in Germany),** Bad Neuenahr-Ahrweiler  
25 percent  
@ [www.ea-aw.de](http://www.ea-aw.de)

**WPX Faserkeramik GmbH (WPX Fibre Ceramics),** Cologne  
10 percent  
@ [www.whipox.com](http://www.whipox.com)

**Zentrum für Angewandte Luftfahrtforschung GmbH (ZAL Center of Applied Aeronautical Research),** Hamburg  
10 percent  
@ [www.zal.aero](http://www.zal.aero)

**Innovationszentrum für Mobilität und gesellschaftlichen Wandel (InnoZ) GmbH (Innovation Centre for Mobility and Societal Change),** Berlin  
6.5 percent  
@ [www.innoz.de](http://www.innoz.de)

**ZTG Zentrum für Telematik im Gesundheitswesen GmbH (Competence Centre for Healthcare Telematics),** Bochum  
6 percent  
@ [www.ztg-nrw.de](http://www.ztg-nrw.de)

**DUALIS MedTech GmbH,** Weßling  
4.9 percent  
@ [www.dualis-medtech.de](http://www.dualis-medtech.de)



# Members and Committees

**As of June 30, 2014, DLR had 41 sponsoring members in addition to honorary members, scientific members and ex officio members.**

## Ex Officio Members

- Prof. Dr Manfred Aigner, Stuttgart
- Prof. Dr Marion Bartsch, Cologne
- Prof. Dr Christa Baumstark-Khan, Cologne
- Uwe Baust, Düsseldorf
- Jürgen Bretkopf, Munich
- Bernhard Conrad, Hamburg
- Prof. Dr Hansjörg Dittus, Cologne
- Marco R. Fuchs, Bremen
- Prof. Dr Michael Grewing, France
- Dr Gerd Gruppe, Bonn
- Klaus Hamacher, Cologne
- Prof. Rolf Henke, Cologne
- Prof. Dr Gerd Jäger, Essen
- Prof. Dr Uwe Klingauf, Darmstadt
- Axel Krein, France
- Dr Reinhold Lutz, North America
- Dr Rainer Martens, Munich
- Prof. Dr Liqiu Meng, Munich
- Prof. Dr Reimund Neugebauer, Munich
- Prof. Dr Christiane Schullius, Jena
- Prof. Dr Stephan Staudacher, Stuttgart
- Prof. Dr Martin Stratmann, München
- Prof. Dr Peter Strohschneider, Bonn

- Dr Hanna von Hoerner, Schwetzingen
- Prof. Dr Ulrich Wagner, Cologne
- Dr Gerardo Walle, Überlingen
- Prof. Dr Johann-Dietrich Wörner, Cologne
- Prof. Dr Gunter Zimmermeyer, Berlin

## Sponsoring Members

**(Public entities that regularly give at least 50,000 euros annually)**

- Federal Republic of Germany, represented by the Federal Minister of Economic Affairs and Energy, Berlin
- State of Baden-Württemberg, represented by the Baden-Württemberg Minister of Finance and Economics, Stuttgart
- The Free State of Bavaria, represented by the Bavarian State Minister of Economic Affairs, Media, Energy and Technology, Munich
- State of Berlin, represented by the Senator for Education, Science and Research for the State of Berlin, Berlin
- State of Bremen, represented by the Senator for Education and Science, Bremen
- State of Lower Saxony, represented by the Lower Saxony Minister for Science and Culture, Hanover
- State of North Rhine-Westphalia, represented by the Minister for Innovation, Science and Research for the State of North Rhine-Westphalia, Düsseldorf



**(Natural persons, legal persons, societies and associations with no legal capacity)**

- Aerodata AG, Braunschweig
- AIR LIQUIDE Deutschland GmbH, Düsseldorf
- ALSTOM Power GmbH, Mannheim
- AOPA-Germany, Verband der Allgemeinen Luftfahrt e. V. (Aircraft Owners and Pilots Association), Egelsbach
- Arbeitsgemeinschaft Deutscher Verkehrsflughäfen (German Airports Association), Berlin
- Robert Bosch GmbH, Berlin
- BP Europa SE, Hamburg
- Bundesverband der Deutschen Luft- und Raumfahrtindustrie e. V. (BDLI, German Aerospace Industries Association), Berlin
- CAM Systems GmbH, Munich
- Carl-Cranz-Gesellschaft e. V., Weßling/Obb.
- Commerzbank AG, Großkundencenter Region West, Düsseldorf
- Deutsche Gesellschaft für Luft- und Raumfahrt – Lilienthal Oberth e. V. (DGLR, German Society for Aeronautics and Astronautics), Bonn
- Deutsche Gesellschaft für Ortung und Navigation e. V. (DGON, German Institute of Navigation), Bonn
- DFS Deutsche Flugsicherung GmbH, Langen
- Diehl Aerospace GmbH, Überlingen
- Diehl Defence Holding GmbH, Überlingen
- Dornier GmbH, Friedrichshafen
- EADS Deutschland GmbH, Munich
- ESG Elektroniksystem- und Logistik GmbH, Fürstfeldbruck
- Fraport AG, Frankfurt/Main
- GAF AG, Munich
- Gemeinde Weßling (local authority), Weßling/Obb.
- HDI-Gerling Industrie Versicherungs AG, Hanover
- Industrieanlagen-Betriebsgesellschaft mbH (IABG), Ottobrunn
- Kayser-Threde GmbH, Munich
- KUKA Laboratories GmbH, Augsburg
- LIEBHERR-AEROSPACE LINDENBERG GmbH, Lindenberg
- Lufthansa Technik AG, Hamburg
- MST Aerospace GmbH, Cologne
- MT Aerospace AG, Augsburg
- MTU Aero Engines GmbH, Munich
- Nord-Micro Elektronik AG & Co. OHG, Frankfurt/Main
- OHB-System AG, Raumfahrt- und Umwelt-Technik, Bremen
- RheinEnergie AG, Cologne
- Rheinmetall Defence Electronics GmbH, Bremen
- Rolls-Royce Deutschland Ltd. & Co. KG, Blankenfelde-Mahlow
- RUAG Aerospace Deutschland GmbH, Weßling
- Siemens AG, Munich
- Snecma Groupe SAFRAN, France
- City of Braunschweig, Braunschweig
- Tesat-Spacecom GmbH & Co. KG, Backnang
- Volkswagen AG, Wolfsburg
- ZF Luftfahrttechnik GmbH, Calden

## Honorary Members

- The Honorable Daniel Saul Goldin, Washington
- Prof. Dr Walter Kröll, Marburg
- Prof. Dr Reimar Lüst, Hamburg
- Jean Sollier, Rueil-Malmaison, France
- Prof. Gerhard Zeidler, Stuttgart

## Scientific Members

- Prof. Dr Philipp Hartl, Munich
- Prof. Dr Hans Hornung, Pasadena, California, USA
- Prof. Dr Joachim E. Trümper, Garching



## Members of the Executive Board

### As of June 30, 2014

- Prof. Dr Hansjörg Dittus
- Dr Gerd Gruppe
- Klaus Hamacher (Vice Chairman)
- Prof. Rolf Henke
- Prof. Dr Ulrich Wagner
- Prof. Dr Johann-Dietrich Wörner (Chairman)

## Senate

### As of June 30, 2014, the following persons were members of the Senate:

#### From the scientific sector

- Prof. Dr Manfred Aigner
- Prof. Dr Marion Bartsch
- Prof. Dr Christa Baumstark-Khan
- Prof. Dr Michael Grewing
- Prof. Dr Uwe Klingauf (Vice Chairman)
- Prof. Dr Liqiu Meng
- Prof. Dr Reimund Neugebauer, ex officio
- Prof. Dr Christiane Schmallius
- Prof. Dr Stephan Staudacher
- Prof. Dr Martin Stratmann, ex officio
- Prof. Dr Peter Strohschneider, ex officio

#### From the business and industrial sector

- Uwe Baust
- Jürgen Breitkopf
- Bernhard Conrad
- Marco R. Fuchs (Vice Chairman)
- Prof. Dr Gerd Jäger
- Axel Krein
- Dr Reinhold Lutz
- Dr Rainer Martens
- Dr Hanna von Hoerner
- Dr Gerardo Walle
- Prof. Dr Gunter Zimmermeyer

#### From the state sector

- State Secretary Mr Guido Beermann
- Brigadier Dr Thomas Czirwitzky
- Under Secretary Rüdiger Eichel
- Under Secretary Dr Thomas Gerhardt
- State Secretary Stefan Kapferer (Chairman)
- Counsellor of State Gerd-Rüdiger Kück
- Under Secretary Günther Leßnerkraus
- Under Secretary Dr Ronald Mertz
- Under Secretary Gerold Reichle
- Ulrich Schüller

#### (without voting rights in 2014)

- Under Secretary Dr Beate Wieland

## Senate Committee

As of June 30, 2014, the senate committee comprised six members from the scientific sector, six members from the business and industrial sector and six members from the state sector.

#### From the scientific sector

- Dr Joachim Götz
- Prof. Dr Angelika Heinzl
- Prof. Dr Rolf Radespiel
- Prof. Dr Christiane Schmallius (Chairwoman)
- Prof. Dr Heinz Voggenreiter
- Prof. Dr Gebhard Wulfhorst

#### From the business and industrial sector

- Eva-Maria Aicher
- Christian Below
- Prof. Dr Jürgen Lehold
- Dr Artur Redeker
- Dr Helmut Richter
- Berry Smutny (Vice Chairman)

#### From the state sector (entitled to vote in 2014)

- Under Secretary Helge Engelhard
- Under Secretary Bernd Hoepner
- Under Secretary Dietmar Schneyer
- Under Secretary Dr Ulrich Steger
- Under Secretary Norbert Michael Weber



**(without voting rights in 2014)**

- Dr Marcus Beiner
- Dr Walter Dörhage
- Senate Counsellor Bernd Lietzau
- Chief Under Secretary Dr Peter Mendler
- Under Secretary Dr Dietrich Nelle
- Under Secretary Karl Trauernicht

- USec Dr Ewold Seeba,  
Federal Ministry for the Environment,  
Nature Conservation and Nuclear  
Safety
- USec Norbert Weber,  
Federal Ministry of Defence
- Assistant Director Frank Wetzel,  
Industrial Policy, Federal Chancellery

- Prof. Dr Felix Huber,  
Institute of Space Operations and  
Astronaut Training
- Prof. Dr Dirk Kügler,  
Institute of Flight Guidance
- Prof. Dr Karsten Lemmer,  
Institute of Transportation Systems
- Firas Lethaus,  
Institute of Transportation Systems
- Prof. Dr Stefan Levedag,  
Institute of Flight Systems
- Dr Simon Plass,  
Institute of Communications and  
Navigation
- Prof. Dr Johannes Reichmuth,  
Institute of Air Transport and Airport  
Research
- Dr Jan Hendrik Starcke,  
Institute of Combustion Engineering

## Space Committee

**As of September 2014**

- USec Dr Sven Halldorn,  
Federal Ministry of Economics  
and Energy
- USec Hans-Borchard Kahmann  
(Deputy),  
Federal Ministry of Finance
- USec Dr Werner Kloos,  
Federal Ministry of Food, Agriculture  
and Consumer Protection
- USec Beate Lohmann,  
Federal Ministry of the Interior
- USec Dr Dietrich Nelle,  
Federal Ministry of Education  
and Research
- USec Gerold Reichle,  
Federal Ministry of Transport, Building  
and Urban Development
- VLR I Stephan Röken,  
Federal Foreign Office

## Scientific and Technical Council

**Members of the STC  
as of June 30, 2014**

- Prof. Dr Alin Albu-Schäffer,  
Institute of Robotics and Mechatronics
- Niko Bier,  
Institute of Aerodynamics and Flow  
Technology
- Dr Martin Bruse,  
German-Dutch Wind Tunnels
- Dr Thomas Holzer-Popp,  
German Remote Sensing  
Data Center



# Overview of Operating Figures

<b>Third-party Funding</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Total revenue from third-party funding	436m euros	419m euros	449m euros
Proportion of overall revenue from third-party sources	55 %	53 %	53 %
Earnings trend in revenue from R&T activities in Germany	-5 %	-2 %	6 %
Percentage of earnings from foreign clients (profit volume)	21 %	21 %	21 %
Revenue from EU funding	26.1m euros	26.8m euros	30.1m euros
Success rate of EU applications (accepted/submitted)	31 %	30 %	36 %
Coordinator quota on approved EU projects	18 %	16 %	28 %

<b>Research-related Results</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Publications in peer-reviewed journals	721	656	781
Peer-reviewed publications in proceedings, books, etc.	491	647	1012
Talks given at scientific conferences, workshops, lectures*	0.58	0.56	0.51
Appointments to universities	17	15	29
Lectureships	295	289	304
Diplom theses	542	438	385
PhD theses	105	109	135
Habilitations	6	3	1

\* per member of scientific staff employed by the institutes and facilities

<b>Technology Marketing</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Investments in technology transfer projects	4.5m euros	4.5m euros	4.5m euros
New in-house technology transfer projects	17	10	18
Revenues from licenses	4.5m euros	5.1m euros	11.3m euros
Start-up companies	2	3	2

<b>Management Instruments</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Total project work	74.8 %	77.0 %	77.2 %

<b>Quality and Product Assurance</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Existing certifications	30	29	29
Number of DLR auditors	11	14	23
Audits performed	45 %	72 %	82 %
Supporting projects of Space Administration	26	33	38

<b>National and European Networks</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
DFG participations	32	35	33
Sponsorship agreements	33	38	41

<b>International Cooperation</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
International visiting scientists*	2.4 %	2.9 %	2.5 %

\*Percentage of scientific staff in institutes and facilities (stays > one month)

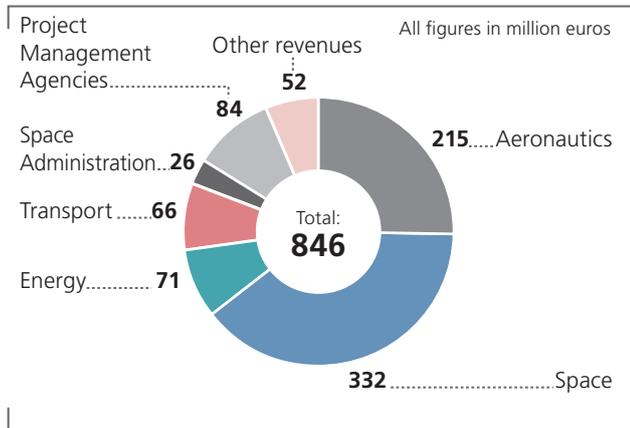
<b>Employees</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Employees	7046	7385	7730
Scientific staff (total)	4080	4273	4473
Scientific staff employed by institutes and facilities	3569	3744	3913
Permanent/fixed-term contracts	3534/3512	3707/3678	3932/3798
Proportion of women			
- in total	31 %	30 %	30 %
- in management positions	13 %	16 %	17 %
- scientific staff	18 %	17 %	17 %

<b>Education and Outreach</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Junior researchers	51	47	45
Doctoral candidates (internal/external)	879	947	1005
Trainees	244	253	268

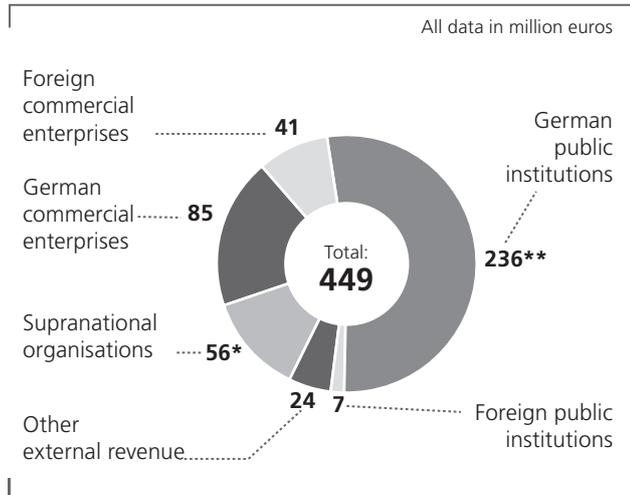
<b>HR Development and Mobility</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>
Training days per employee	2.0	1.9	1.9
Mentoring pairs	10	11	11
Postings abroad (months)	518	449	499

# Use of Funds

## Overall Revenue 2013



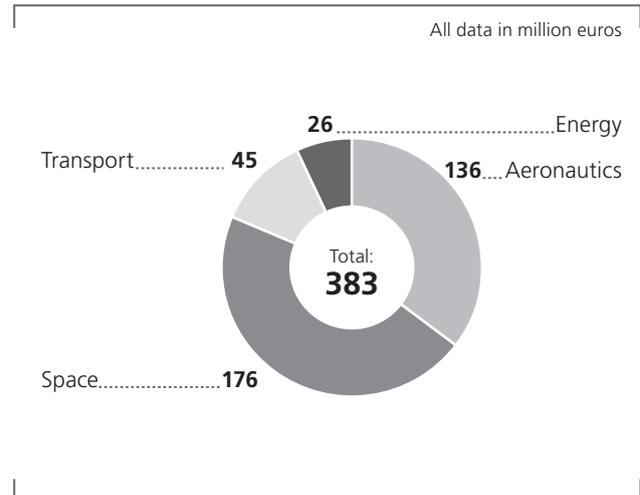
## Third-party Funding Related to Origin 2013



\* including: ESA 25, EU 30, other 1

\*\* including: national public institutions 113, project sponsorship 98, other r&B third-party funding 25

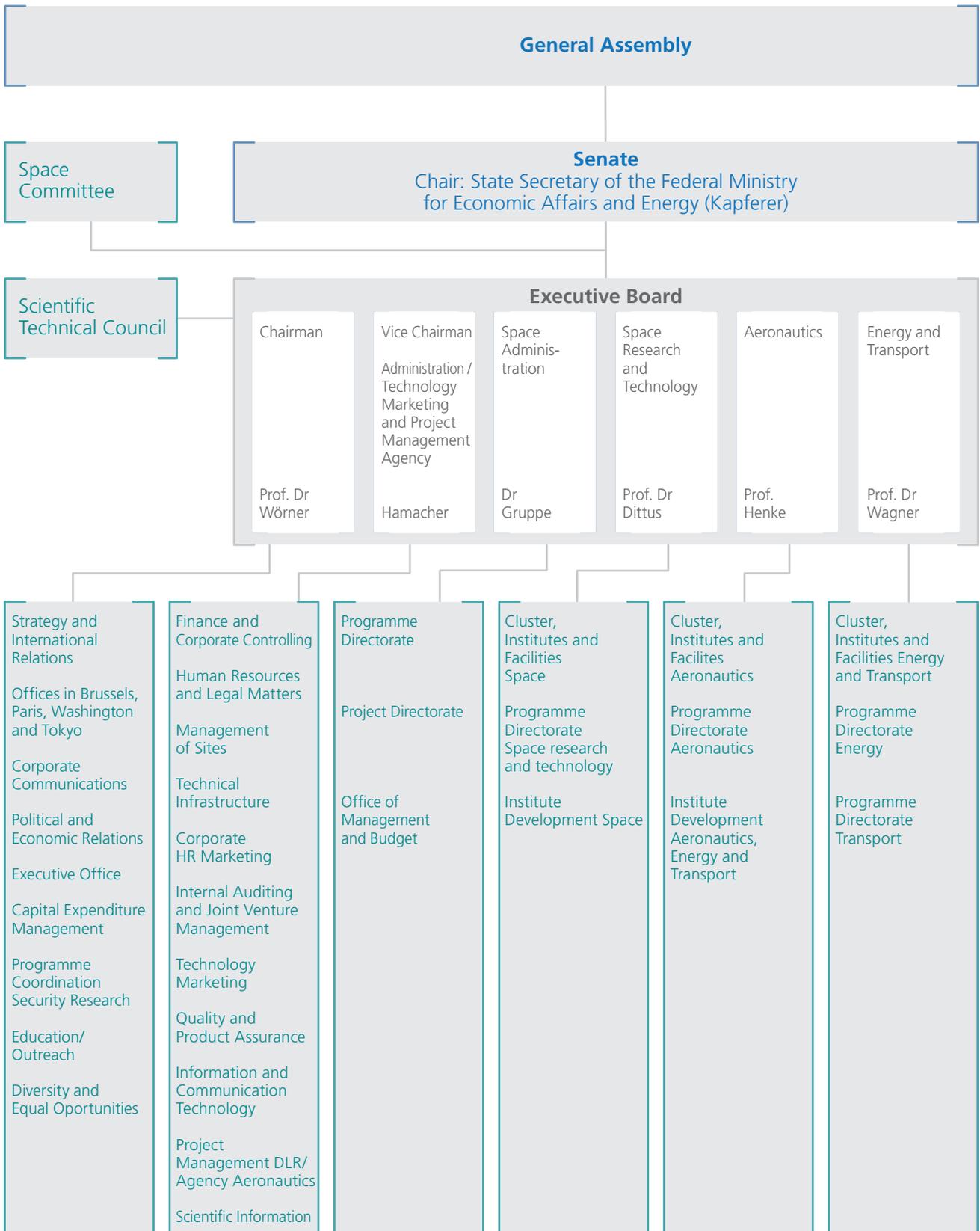
## Institutional Funding 2013\*



\* incl. assigned investments, without HGF funds and ETW



# DLR Bodies



## DLR at a Glance

DLR is the national aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport and security is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for the nation's largest project management agency.

DLR has approximately 8000 employees at 16 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Goettingen, Hamburg, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stade, Stuttgart, Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C.

DLR's mission comprises the exploration of Earth and the Solar System and research for protecting the environment. This includes the development of environment-friendly technologies for energy supply and future mobility, as well as for communications and security. DLR's research portfolio ranges from fundamental research to the development of products for tomorrow. In this way, DLR contributes the scientific and technical expertise that it has acquired to the enhancement of Germany as a location for industry and technology. DLR operates major research facilities for its own projects and as a service for clients and partners. It also fosters the development of the next generation of researchers, provides expert advisory services to government and is a driving force in the regions where its facilities are located.



DLR

**Deutsches Zentrum  
für Luft- und Raumfahrt**  
German Aerospace Center

### **Strategy and International Relations**

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