Annual Report

Research Report and Economic Development

2012/2013

DLR

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The male and female terms used in the texts should be considered to refer to all genders.

Research Report and Economic Development 2012/2013

Deutsches Zentrum für
Luft- und Raumfahrt e.V.
German Aerospace Center (DLR)

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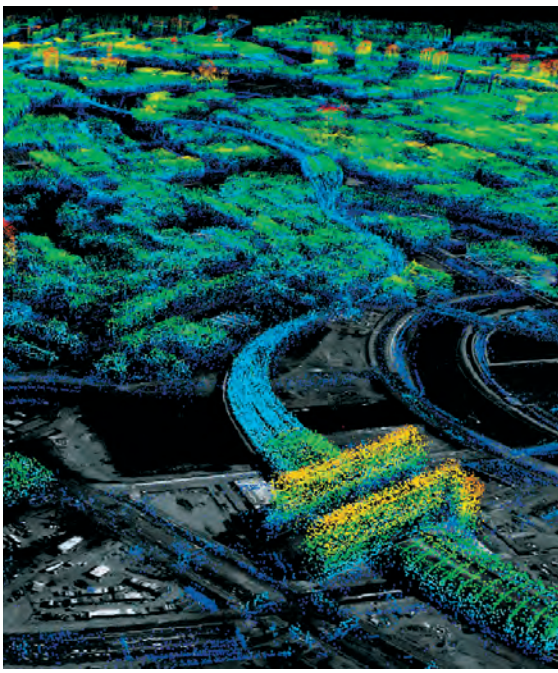


Dear Reader,

I am frequently asked what I see as my personal highlight at DLR, which project I am particularly fond of, which topic I consider particularly important. As understandable as the question may be, it is clear that I will never be able to give a simple answer. What father, if asked which was his favourite child, would name only one of his offspring?

My responsibility as Chairman of the Executive Board demands that I attend to all areas of DLR, i.e. to each of its key research areas Aeronautics, Space, Energy, Transport and Defence and Security, to all its organisational units in research and administration, and to all its sites in equal measure – that is, that I give the expression ONE_DLR a personal dimension. It is with this understanding that I embark on my annual tour of our sites, where I aim to offer as many employees as possible from all areas of DLR the opportunity to address their individual concerns in direct personal contact with me. At the same time I take advantage of the occasion to report on current developments.

Moreover, the assessments of the Helmholtz Association research field "Aeronautics, Space and Transport", for which I am responsible in my dual functions as Chairman of the Executive Board of DLR and Vice President of the Helmholtz Association, were conducted in early 2013. These assessments all presented outstanding results for DLR's research, and made important recommendations regarding future priorities.
Provided that these recommendations are implemented in terms of research content by DLR and in terms of funding by the government, I foresee very positive

advancements for DLR in the coming years. The recommendations of the assessors are on the one hand designed to provide a basis for long-term development with the corresponding funding, but must on the other hand not be misunderstood as utterly immutable stipulations should the circumstances and challenges, for whatever reason, change – as seen, for example, in the energy transition after Fukushima. DLR must be prepared for such eventualities. Instead of extolling rigid notions of the future, we must consider a range of scenarios in order to ensure that our work remains successful, stable and sustainable.

In this regard, the present Research Report is a quantitative and qualitative account to those within and those outside the organisation, designed to convey our path and our results in the last twelve months. It is therefore aimed both at shareholders, to be understood as decision-makers in terms of funding, and at interested stakeholders such as our society and industry.

I hope that this Research Report will provide all readers with precisely the information they expect...

Yours sincerely,

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

RESEARCH REPORT

Aeronautics

As a large-scale research institution, DLR of course also has a correspondingly large number of research infrastructures. Two new major infrastructures were completed in the early summer of 2013: the Augsburg site of the Center for Lightweight Production Technology opened on May 14, 2013; the opening ceremony for the AVES simulator centre took place at the Braunschweig Research Airport on June 5, 2013.

The Center for Lightweight Production Technology (Zentrum für Leichtbauproduktionstechnologie, ZLP) is a DLR national research institution with two sites, Augsburg and Stade; both focus on the automated production of components from carbon-fibre reinforced plastics (CFRP), with the research priorities at each site technologically complementing the other. A cooperation between four DLR institutes enables DLR to replicate the entire fibre composite process chain here – from materials to automated production.

The AVES (Air VEhicle Simulator) simulator centre is an outstanding USP for the Braunschweig Research Airport. As a national centre for flight simulation, the new facility will offer opportunities for flight research at highest standards and is expected to attain a high profile throughout Europe and beyond. AVES forms the scientific bridge between DLR's internationally leading capabilities in flight physics simulations and the research aircraft at the Braunschweig site.

AVES

High-performance simulator centre at the Braunschweig Research Airport

In a joint initiative between DLR and TU Braunschweig, a high-performance flight simulation centre has been established at the Braunschweig Research Airport. Following a three-year construction period, the opening ceremony took place on June 5, 2013. The investment costs totalled approximately ten million euros, including the new building.

With this research facility, which is unique in Europe and known as AVES (Air VEhicle Simulator), DLR now has a motion and a fixed-base simulator, both state-of-the-art. The facility's outstanding feature is its modularity: the two high-quality cockpits for the Airbus A320 and the Eurocopter EC135 can be operated either on the motion platform or in the fixed-base simulator, as required. Switching cockpits takes approximately four hours.

The two display systems feature cutting-edge technology and are each equipped with fifteen high-quality LED projectors providing a field of vision of 240 degrees horizontally and 90 degrees vertically. The motion platform was designed as an electromechanical system for a payload of approx. 14 tonnes and conveys impressions of motion to the pilots in all six degrees of freedom. The entire simulator software is being developed by DLR with the assistance of TU Braunschweig, offering maximum flexibility for special research requirements and for continuous further development of this simulator facility, which is extremely valuable for flight research.

AVES is now available for flight research centred mainly on dynamic interactions between pilot and aircraft. Ongoing research is focused on further improving training for commercial aircraft and helicopter pilots and on the situation awareness of the cockpit crew in highly automated aircraft; the facility is however also designed to test and evaluate possibilities of new aircraft configurations regarding their flyability. AVES thus forms the scientific bridge between DLR's internationally leading capabilities in flight physics simulations and the research aircraft at the Braunschweig site.

› http://bit.ly/17dfioh

AVES simulator building

CFRP Laminar Upper Wing Shell

Highly integrated construction methods to maintain strict geometric tolerances

The development of future commercial aircraft focuses on technologies to reduce fuel consumption. Due to their outstanding specific characteristics, carbon-fibre reinforced plastics (CFRP) are to be used to keep wing weight as low as possible. Aerodynamic drag can be significantly reduced by keeping the boundary layer on the upper side of the wing laminar.

Laminar upper wing shell

In order to achieve natural laminarity it is necessary that profile geometries adhere to strict geometric tolerances, as even minute ridges, cracks or ripples in the profile contour or protruding rivet heads may cause a premature transition from laminar to turbulent flow. To this end, a wing shell design featuring integrated stringers and rib connectors and suitable for fibre-composite construction has been developed in cooperation with the industrial partners Airbus, PAG, CTC and GOM.

This highly integrated upper wing shell design, which requires not a single rivet on the outside, was developed in close cooperation with Airbus. A coupled design process takes manufacturing-related deviations and local deformations under aerodynamic loads into account. The manufacturing concept was developed in cooperation with PAG and is based on hollow aluminium cores that form the stiffening members on the inside of the wing, while the external profile contour is created with a high-precision external tool. A co-curing process then hardens the wing skin together with the stiffening members manufactured concurrently.

The concept was tested by constructing eight 1.0 m x 0.6 m test components and measured by an optical 3-D method in cooperation with our partner GOM. In the next step, a 2.3 m x 1.5 m external wing shell was manufactured. The functional prototypes created in this process demonstrated that it is possible to achieve the excellent geometric precision which enables laminar flow, and thus environmentally friendly flying, in a manner that is transferable to series production.

Microphone array and individual microphones for measuring engine flow

SAMURAI

Examining engine acoustics in an ATRA ground test

A ground test to acoustically measure jet engine flow was successfully conducted with the Airbus A320 ATRA on May 2, 2013, at Cochstedt Airport. The two participating DLR Institutes of Propulsion Technology and of Aerodynamics and Flow Technology took measurements at various engine operating points using single microphones and a microphone array, and are currently evaluating them further. At the same time, the nacelle movement of the ATRA in the various operating states was recorded in photographs and on video using markers.

A total of 20 single microphones were used to quantify jet noise in the far sound field. They were set up in two lines parallel to the longitudinal engine axis at lateral offsets of 25 metres and 50 metres. The ten microphones on each measuring line covered an angle of radiation from 15 degrees to 100 degrees. Initial evaluations proved that jet noise is dependent on the eighth power of the jet speed.

Complementary measurements were carried out using a 43-metre linear microphone array with 248 microphones at a lateral distance of 10 metres from the engine axis, providing detailed coverage of an angle from 35 degrees to 135 degrees relative to the engine outflow. The preliminary evaluation of these measurements has shown that at higher rotation speeds, the circular saw sounds dominate in a forward direction while to the side only a few sounds occur beyond the blade sequence frequency. The blade sequence frequency itself is however very loud and clearly detectable. In the low frequency range, no significant directional pattern is expected. Towards the rear there are very few sounds; the blade

sequence sound appears not to be audible over the more intense bypass and jet noises. Evaluations are currently underway to identify the individual sound sources in order to quantify the contributions of these sources at the fan and the jet stream to the far sound field.

The field study performed at Cochstedt Airport purely to determine the acoustic characteristics of the engine flow represents the first part of two ground experiments conducted by ATRA within the DLR project SAMURAI. A further ground experiment performed in late September 2013 at Lufthansa Technik in Hamburg is using four other optical and imaging measuring processes in addition to the acoustics array: the experiment determines velocity fields in the jet engine stream and air intake with the PIV technique, density gradients in the jet engine stream via the BOS procedure, nacelle movements with the MODE technique and fan blade deformations volumetrically and across surfaces via the PROPAC technique.

Ground Vibration Test

Milestone for approval of the Airbus A350 XWB

Due to their extremely lightweight construction, modern aircraft are susceptible to vibrations which occur whenever the structure is subject to dynamic stress (wind gusts, flight manoeuvres, landing shock). The DLR Institute of Aeroelasticity is a global leader in the field of ground vibration tests, which represent a major milestone on the path towards approval for new aircraft types. Such experiments serve to determine the vibration characteristics of aircraft in order to validate the numeric model.

Ground vibration test with Airbus A350 XWB

Using the validated numeric model, flutter analyses examine whether interaction with the surrounding flow field can excite vibrations during aircraft operation. For aircraft to gain approval, experiments must also demonstrate that the required levels of safety exist throughout the flying envelope, i.e. that vibrations are always attenuated.

The client set very high requirements for the ground vibration experiment on the Airbus A350 XWB. Never before had an aircraft of this size been tested in just 13 days – including setting up and dismantling the experiment. The experiment was therefore carried out in a cooperation between DLR and ONERA using optimised test methods and procedures developed at DLR with funding from the LuFo IV joint research project FTEG.

Vibrations were excited at 25 specific points of the aircraft, while 530 acceleration sensors installed throughout the aircraft measured the aircraft's response to these vibrations. By means of the measured vibration data, the required modal characteristics of the aircraft were identified using experimental modal analysis. Database software developed by DLR for archiving and analysing experiment data allowed the client Airbus to stay apprised of the current state of data capture and data analysis at all times.

Opening of ZLP Augsburg

The ground vibration test on the A350 XWB set a new standard that underlines the technological leadership of DLR and ONERA. The successful and timely conclusion of the campaign was an excellent recommendation for the upcoming tests on the Airbus A320 NEO.

ZLP Augsburg

Opening of the Center for Lightweight Production Technology

On May 14, 2013, DLR opened its Augsburg site with the new research facility "Center for Lightweight Production Technology" (Zentrum für Leichtbauproduktionstechnologie, ZLP).

It was inaugurated under the patronage of Martin Zeil, Deputy Prime Minister of Bavaria and Bavarian State Minister of Economic Affairs, Infrastructure, Transport and Technology, together with Prof. Dr Johann-Dietrich Wörner, Chairman of the Executive Board of DLR, Dr Kurt Gribl, Lord Mayor of Augsburg, and Prof. Dr Heinz Voggenreiter, Director of the DLR Institutes of Structures and Design and of Materials Research.

The aim of the ZLP in Augsburg is to for the first time demonstrate an automated production process for CFRP components. The use of robots can reduce production costs and increase productivity and quality, allowing a technological advantage to be achieved that will secure the international competitiveness of German industry and and help gain a larger share of the European market.

The new research platform is the only one of its kind in Europe and was devel-

oped in cooperation with KUKA Systems and with support from industry partners. At its core is a "multifunctional robot cell" equipped with five robot arms; at an overall size of approximately 30 metres in length, 15 metres in width and 7 metres in height, it serves to examine a range of production processes and validate their automatability at an industrial scale. Further research facilities for manufacturing CFRP components round off the portfolio in Augsburg.

Four DLR institutes collaborate at ZLP: the Institute of Structures and Design from Stuttgart, the Institute of Composite Structures and Adaptive Systems from Braunschweig, and the Institutes of Robotics and Mechatronics and of System Dynamics and Control from Oberpfaffenhofen. Their cooperation allows DLR to model the entire CFRP engineering process chain from basic materials to automated production.

NICETRIP

Wind tunnel experiment with a tilt-rotor aircraft

Traditional helicopters have limited maximum speeds and reach travel velocities of less than 310 km/h. Tilt-rotor aircraft represent a way of pushing this speed limit to over 600 km/h. The advantage of such a high travel velocity for a rotary wing aircraft is however offset not only by poor hover characteristics, but also by several other disadvantages exhibited by the current V22 tilt rotor aircraft due to its relatively large rotors:

Its efficiency in fixed-wing mode at high flight speeds with forward-tilted rotors would be significantly greater if the rotors were smaller. This would also noticeably reduce a number of aeroelasticity issues. Moreover, large rotors mean that if all engines fail, the aircraft has to be landed in autorotation, which while possible with a tilt rotor represents a highly sophisticated manoeuvre.

The ERICA concept was developed in response to these issues. It is based on rotors the diameter of which permits take-off and landing manoeuvres in fixed-wing mode with forward-tilted rotors. In order to nonetheless achieve acceptable hover performance, parts of the wing can be tilted. Various EU projects were carried out with numerous partners to examine such a configuration. The results of these projects are summarised in the NICETRIP project (Novel Innovative Competitive Effective Tilt Rotor Integrated Project).

Wind tunnel experiments performed in the DNW LLF and ONERA S1 tunnels using a complete model were designed to deliver significant insights into the practicability of this concept. After completion of the model was delayed several times due to technical difficulties, the long-awaited measurements at DNW LFF were finally conducted in summer 2013, so a huge volume of reference data is now available. The tests focused mainly on the transitions from hover to forward flight and back, and on low-speed flight. The measurements for travel and maximum velocity are to take place in the ONERA S1 tunnel in late 2013.

BOS Technology

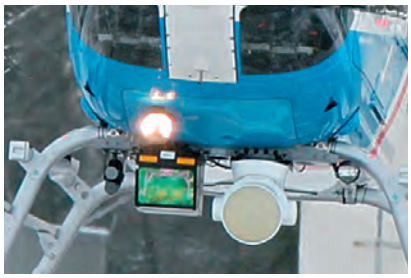
Helicopter flight experiments in the Alps

The flow field around a helicopter is dominated by the vortices generated at the rotor tips of the main and rear rotors, among other places. Knowing the precise vortex paths is a major requirement in order to understand many vibration, oscillation and noise phenomena. Highly sophisticated experimentation techniques for wind tunnels were developed to this end, which however are generally not applicable to free-flying helicopters for a number of reasons.

NICETRIP wind tunnel model in the 9.5 metre x 9.5 metre measuring section of DNW LLF

Main rotor vortices on a Eurocopter Cougar helicopter in low-velocity forward flight

ACT/FHS with integrated sensors



Integrated sensor package

The enhanced reference-free BOS (background oriented schlieren) technique makes it possible for the first time to measure the vortex paths of a real helicopter in free forward and manoeuvre flight outside the ground effect. The measuring principle is based on two minutely time-shifted photographs taken by parallel cameras, where the natural structures of the background serve as reference samples. Reduced density in the helicopter's blade vortices results in localised optical shifting of the image in one of the cameras. This shifting can be evaluated with the help of cross-correlation methods and allows vortex paths to be determined in two dimensions.

In flight experiments, measurements were performed on various manoeuvres (transition from hover to forward flight and back, accelerated flight, interception etc.), enabling unique insights into the flow topology. In addition to instability effects in connection with vortex decay, the experiments measured the convection of the jet engine streams, the interaction of the blade vortices with the fuselage and other non-stationary changes in the vortex system.

ALLFlight

ACT/FHS flights with complete sensor package

Helicopter rescue operations are also dangerous for the pilots themselves: fog, swirled-up sand or snow may limit visibility almost entirely, creating increased risks during landing. Moreover, rescue operations frequently take place in uneven and unfamiliar terrain – as opposed to commercial airline pilots, helicopter rescue pilots are frequently faced with unprepared landing places. The aims of the ALLFlight (Assisted Low Level Flight and Landing on Unprepared Landing Sites) project are to develop a system that creates an always up-to-date digital 3-D local map for the cockpit and to assist pilots in difficult situations – up to and including fully automated landing.

The local map is created based on an integrated sensor solution. To this end, further major components for exploring the environment, including obstacles, terrain etc., were added to the existing ACT/FHS sensor package, which is designed to record the helicopter's flight dynamic states. A ladar sensor, a radar sensor, an infrared and a TV camera were integrated into the ACT/FHS. In addition, a special computer was integrated and approved with which data can be recorded in flight, merged online and displayed to the pilot.

The first flight experiments with the complete sensor package were performed in December 2012. In addition to acquiring sensor data, initial overland flights and landing approaches were also carried out with the help of the helmet-mounted display system integrated into the ACT/FHS. To support pilots during landing, particularly under adverse weather conditions, landing approaches were tested by several flight test pilots, to whom both two-dimensional symbols and 3-D waypoints were displayed in a manner that conformed to the exterior view.

In a following step, the results of the data merge are now to be processed together with the detected objects and displayed on the monochrome helmet display in such a way that the pilot is enabled to easily interpret the current situation, thus reducing the pilot's workload.

HBK 1
Engine Test Rig

Optimised production of a flame tube for the measuring section

Lean burn chambers enable a quantum leap in reducing nitrogen oxides emitted by aircraft engines. They however require the fuel-air mixture to be diluted before the flame. To achieve this, as opposed to conventional combustion chambers, up to two thirds of the combustion chamber air are routed through the burner, which is equipped with swirlers to stabilise the flame. This results in significant residual swirl at the turbine inlet, which has to be taken into account when designing the turbine. In addition, the temperature profile at the combustion chamber outlet differs from that seen in the conventional design. Recording the flow at the combustion chamber outlet as precisely as possible is therefore of great interest in order to facilitate optimal interaction between the engine components.

Previous measuring techniques were based on cooled suction probes, which achieved only limited local resolution due to their cooling jackets. This issue is the focus of a collaboration between Rolls-Royce Germany and DLR to optically measure the combustion chamber outlet of an annular combustion chamber which is to be operated in the HBK 5 test rig currently under construction.

To test this measuring technique and derive initial conclusions on the outflow of an individual sector, a combustion chamber sector with visual access to the outlet is to be examined at the HBK 1 test rig. The required flame tube was recently completed by the DLR Technology Systems House. In cooperation with the DLR Institute of Propulsion Technology, the Technology Systems House succeeded in designing the highly complex component, which is characterised by an extremely high number of precisely formed effusion cooling holes, in such a way that it became possible to manufacture it in one piece at the Direct Laser Deposition Facility of the DLR site in Cologne. Compared to traditional manufacturing methods, this technique enables significant time and cost savings for the work piece.

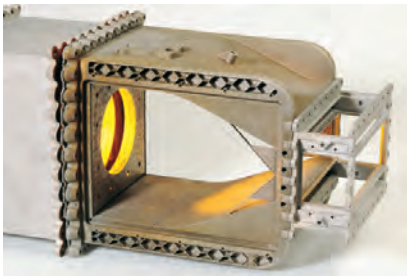
UHBR Fan

Combinative measuring of the non-stationary flow field

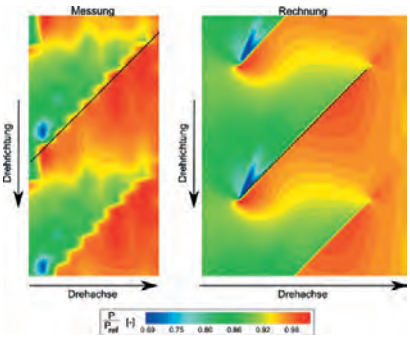
The DLR UBHR rig is representative of the slowly turning fan of a high-bypass engine with a bypass ratio of approximately 12. While the design phase and initial experiments focused on operating behaviour and on the performance map, developing the next generation of fan stages will require more extensive examination and comprehension of the time-dependent flow processes, which will have to be considered in future designs in order to develop highly efficient fans with low noise emissions.

To this end we conducted extensive measurements using state-of-the-art measuring techniques such as Particle Image Velocimetry (PIV), heat wires, traversable combination probes and non-stationary pressure sensors in the casing above the rotor. The result was a flow pattern reconstructed from the precisely timed static pressure measurements, which showed the suction-side expansion area, the subsequent compression shock and the location of the tip gap vortex. Numerical data confirm this flow pattern.

With this knowledge, new ideas for reducing noise and their experimental examination will become a key focus of our future work: it is expected that air injection near the rear edge of the rotor will actively affect and reduce noise emissions. Initial promising preliminary experiments have already taken place in this respect.



Above: Plenum, flame tube and window casing at the combustion chamber outlet from left to right
Below: Enlarged section of the hot side of the flame tube with effusion cooling holes



Reconstruction of the static pressure field above the DLR UHBR rotor from precisely timed measurements (left) and comparison with the simulator results under partial load (right)

Synthetic Fuels

Characterising combustion properties

Synthetic fuels represent aviation's first chance of improved properties compared to traditional kerosene. Examples of such properties include greater specific energy content, which determines the maximum possible payload and reach, and better emission performance thanks to lower pollutant levels. In order to optimally utilise synthetic fuels it is however indispensable to comprehensively characterise their combustion properties.

The DLR Institute of Combustion Technology has therefore begun to examine the chemical components of synthetic kerosenes – individual molecule families – in detail. To this end, a measurement campaign on the combustion of relevant individual substances was conducted in cooperation with the University of Bielefeld. To implement the new requirements of synthetic kerosenes, an optimised measuring concept for flame analysis of minute amounts of poorly vaporisable hydrocarbons was established based on mass spectrometric methods of analysis. The results indicate that it is necessary to develop detailed chemical models for synthetic fuels and their components. Reaction kinetic models of this kind are required to numerically simulate chemical reactions in the turbine combustion chamber.

The core of the modelling process now underway is to establish how synthetic fuels can systematically be compounded from chemical components with specific properties. As there is a large number of possible components, rule-based generation of partial models is a promising approach; this work has begun as part of a cooperation with the Massachusetts Institute of Technology (Cambridge, USA) and is embedded into a current PhD thesis.

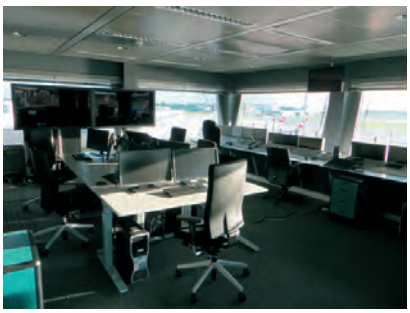
Developing models for synthetic kerosenes requires an understanding of the thermodynamic properties of the potential components of alternative fuels. This will be achieved through a combination of experiments (Synchrotron, Paul Scherrer Institute, Villigen, Switzerland) and quantum mechanical computations (DLR Institute of Combustion Technology).

Airport2030

Solutions for the airport of the future

At many airports, the limiting factors for air traffic are capacity and environmental regulations. In addition, airport processes account for a significant proportion of journey time in air transport. The project network Airport2030, funded by the Leading-Edge Cluster Initiative of the Federal Ministry of Education and Research, therefore collaborated with industrial and university partners to examine selected new airport technologies.

The Airport Research and Innovation Facility at Hamburg Airport is operated by DLR in cooperation with the German air traffic control organisation Deutsche Flugsicherung and Hamburg Airport. In the course of Airport2030, the DLR Institute of Flight Guidance completed a significant extension: in a room used jointly by the partners, the institute has established an airport control centre that enables research and development for the key research area Total Airport Management – even linked directly to live operations at Hamburg Airport.



DLR research control centre at Hamburg Airport

Using the blended wing body, an aeroplane where fuselage and wings are integrated, as an example, the DLR Institute of Air Transportation Systems examined the airport compatibility of new aircraft configurations in terms of take-off, landing, taxiing, parking and ground services. The current infrastructure is also suitable for this new aircraft configuration, but the project identified necessary changes in baggage handling, refuelling, de-icing and engine checks due to the higher wing position.

In the Green Airport project, DLR developed models for the environmental effects of operative decisions. In coopera-

tion with the 'Environment' administrative department of Hamburg Airport, the project describes measures through which the environmental impact of airport operations can be reduced in various situations. This work is intended to result in planning systems that apprise operators immediately of the environmental effects of their decisions.

LDACS-NAV

Navigating with communication signals

Aircraft positioning will in future be based on satellite navigation. To ensure that a safety net is available in the event of failure, suggestions for what is known as APNT (Alternative Positioning, Navigation and Timing) systems are currently being developed. A promising approach for APNT is to implement positioning by means of the future aeronautical communications system LDACS1 (L-band Digital Aeronautical Communications System, Type 1). A major advantage of this method compared to other suggestions is its use of the aeronautical communications infrastructure for navigation.

The DLR Institute of Communications and Navigation has initiated the DLR-internal project LDACS-NAV (LDACS Navigation) to verify its suitability. The aim of the project is to demonstrate through flight experiments that LDACS1 enables positioning that meets the requirements of APNT, which in addition to accuracy also relate to availability, continuity and integrity.

Flight paths (blue) and positions of LDACS1 ground stations (red)

The flight measurement campaign was carried out in late 2012 in Oberpfaffenhofen using four LDACS1 ground stations and the DLR research aircraft Falcon. Even without post-processing, evaluations of the pseudo-distance measurements between the aircraft and the LDACS1 ground stations in many cases already indicate an accuracy to within 10 metres.

In the few cases of strong interference caused by multipath scattering, the achievable accuracy is lower, but can be improved significantly through appropriate post-processing (multipath suppression). It therefore seems possible to achieve a positioning accuracy that meets the requirements for APNT.

To ensure the integrity of this positioning, a threat analysis was initiated that considers and evaluates all possible sources of error, such as synchronisation errors, multipath errors and tropospheric scattering errors. DLR is currently developing corresponding error models and protection level concepts based on the results, which will ultimately ensure the integrity of the positioning solution.

Why is DLR committed to Clean Sky?

Clean Sky

Reducing noise and emissions is one of the greatest challenges in aeronautics. In cooperation with large-scale research institutions, universities and small and medium-sized businesses, the European aviation industry is therefore conducting research into environmentally friendly aircraft in the Joint Technology Initiative "Clean Sky". As Europe's biggest large-scale aeronautics research institution, DLR is of course participating in "Clean Sky", and is moreover a founding member and directly involved in planning its successor initiative "Clean Sky 2".

Wake Vortices

Increasing safety during landing approaches

Planes most frequently fly into wake vortices during their final approach directly before landing, as at that point the wake vortices no longer sink below the flight corridor but may on the contrary even rise again due to their interaction with the ground. In addition, at lower flight altitudes pilots' options to compensate for critical rolling moments are limited.

Patented plate lines along runways are designed to significantly accelerate the decay of wake vortices and thus increase the safety of the final landing approach. Smaller vortices form around the plates which due to velocity induction actively approach the actual wake vortices and force their decay.

Once this method had been shown to be effective in the Göttingen Water Towing Tank and a numeric flow simulation (LES), the WakeOP field experiment was conducted at the special airport in Oberpfaffenhofen on April 29 and 30, 2013, to demonstrate the functionality of the plate lines. The HALO research aircraft repeatedly circled the airfield at low altitude above the plate line while the behaviour of the vortices was measured via LIDAR and made visible with smoke. Initial evaluations of the LIDAR measurements confirmed that wake vortex decay was indeed accelerated at all relevant vortex ages. Discussions are currently underway with the German air traffic control organisation DFS, which would like to test the plate patent at Munich Airport in the near future.

Sleep experiments in the crew rest compartment

Sleep in the Crew Rest Compartment

Crew potentially at risk of oxygen deficiency

With the growing number and length of long-haul flights, rest and recovery options for the crew aboard aircraft are becoming increasingly important. This is especially the case when two cockpit and cabin crews are working and resting alternately. Although there has so far been no research into whether restful sleep is possible on board, it is scheduled and taken for granted. The environmental influences that affect human beings during a flight at cruising altitude, such as reduced pressure and the resulting lower oxygen partial pressure in the lungs, interior aircraft noise or the small size of crew rest compartments however make the restfulness of sleep under these circumstances questionable.

In order to examine this issue, the STELLA project recreated the above-described environmental conditions in a crew rest compartment in the DLR pressure chamber TITAN. The experiment showed that sleep duration and depth – important for recuperation – were reduced in the test subjects compared to sleep under normal environmental conditions.

Moreover, oxygen saturation sank significantly, even to below the hypoxia threshold (level at which there is a risk of oxygen deficiency). Disrupted sleep and reduced oxygen saturation were due mainly to the reduced oxygen supply, not to reduced pressure, interior aircraft noise or the confined space. Accordingly, sleep disruption and oxygen desaturation could be counteracted by increasing oxygen levels in the cabin air. Increasing oxygen supply for the crew while they sleep would therefore represent an effective way of ensuring restful sleep on board aircraft.

Outlook

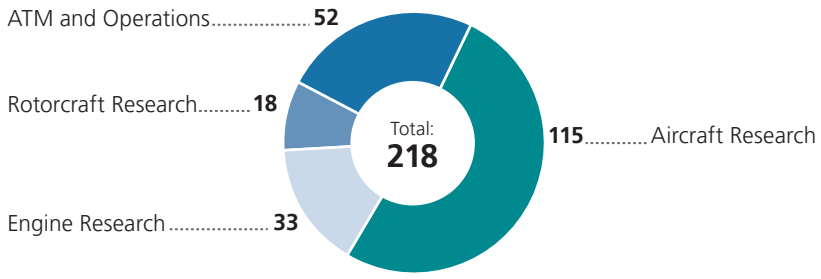
The new European Framework Programme "Horizon 2020" launches on January 1, 2014, replacing the current 7th EU Framework Programme. "Horizon 2020" is scheduled to run for seven years and will again include a higher budget for aeronautics research. As previously in the 7th Framework Programme, the three main elements of aeronautics research are Collaborative Research, that is, small and medium-sized research projects with partners from various European countries, and the successor projects to the two large European research initiatives "Clean Sky" and "SESAR".

While Collaborative Research has so far been DLR's main pillar in European aeronautics research, in future the German Aerospace Center intends to invest a larger proportion of its aeronautics budget in the larger research initiatives, in particular "Clean Sky 2". DLR has accordingly positioned itself early on as one of 14 founding members of "Clean Sky 2", and as the only large-scale aeronautics research institution also represents the interests of the other European research institutions. It is thus excellently placed for participation in "Horizon 2020".

Aeronautics: Revenues in millions of euros	2012 Actual	2013 Planned	2014 Planned
Institutional funding	135	140	148
Third-party funding	85	78	69
Total revenues	**220**	**218**	**217**

Expected revenue for the year 2013

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 covers Germany's participation in the programmes of the European Space Agency (ESA), 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 prominently in national and international space missions and research projects in cooperation with partners. The following examples provide a brief overview of the results and events of the past year. Due to DLR's dual function as both a space agency and a research institution, the items are divided into the following sections:

- **Highlights/Projects from the Space Administration**
- **Joint projects from the Space Administration and DLR's Space Research and Technology division**
- **Projects from DLR's Space Research and Technology division**

Highlights/Projects from the Space Administration

ESA Ministerial Council

Success for German space exploration

On November 20 and 21, 2012, delegates of the 20 ESA member states and delegates from Canada met at the Mostra d'Oltremare congress centre in Naples, Italy, and agreed programmes for approximately 10.1bn euros. At approximately 2.6bn euros, Germany's share of these programmes is the largest, followed by France with 2.3bn euros. Alongside the science programme with approx. 2.5bn euros, the largest programme areas are Earth observation with approx. 1.9bn euros, operation of the International Space Station with 1.1bn euros and the further development of the Ariane rocket with approx. 700m euros. Mr Hintze, Parliamentary State Secretary at the Federal Ministry of Economics and Technology, led the negotiations for the German Federal Government, assisted by the German delegation to the ESA Council – Prof. Dr Wörner, Dr Gruppe and Dr Densing in particular.

MetOp-B

A meteorological 3-D image of Earth

The European weather satellite "MetOp-B" was launched on September 17, 2012, from Baikonur (Kazakhstan). MetOp-A, -B and -C are three identical satellites whose twelve instruments provide meteorological data to create a three-dimensional meteorological image of Earth and improve weather predictions.

The satellite launched by the European Space Agency ESA is the second satellite in the MetOp programme run by EUMETSAT, the European organisation for the use of meteorological satellites. DLR is responsible for technical monitoring of the MetOp programme. Via the DLR Space Administration, Germany has a share of approximately 30 percent in the MetOp mission; funding was provided by the Federal Ministry of Transport. The satellite bus and an important instrument also come from Germany, and were built by EADS Astrium in Friedrichshafen.

Galileo

Two further satellites launched

On October 12, 2012, a Soyuz ST-B carrier with two further satellites for the European navigation system Galileo on board took off from Kourou spaceport in French Guiana. All stages of the Soyuz operated as planned. Three hours and 45 minutes after launch, the Fregat-MT upper stage released the Galileo satellites at an altitude of approximately 23,200 kilometres.

With the four operational Galileo satellites in space, it is now for the first time possible to determine positions using a Galileo receiver; however, the European navigation system will not be complete until a total of 30 satellites are orbiting the Earth on three paths. The atomic clocks on board the satellites, which provide the transmission time of the signals with an accuracy of a billionth of a second, are so precise that they will diverge no more than one second in a million years.

BEXUS 14 and 15

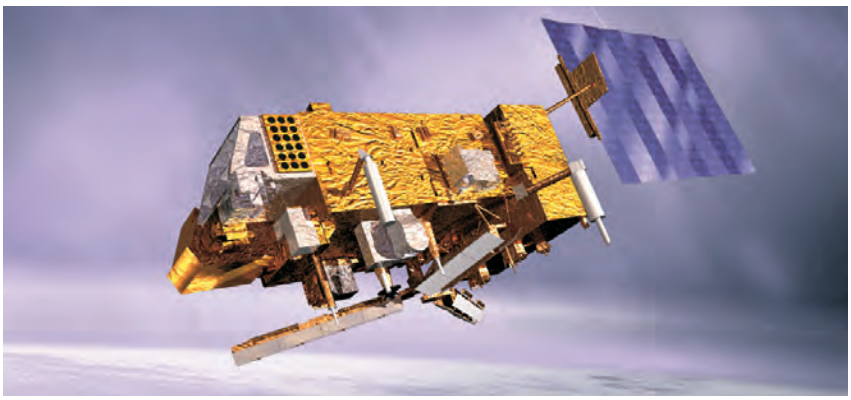
Student balloons successfully launched

On September 25, 2012, the BEXUS 15 research balloon took off from the Swedish space centre Esrange for a several-hour flight into the stratosphere. A day earlier, its sister balloon BEXUS 14 had also launched successfully. On board the two joint missions of DLR and the Swedish space agency SNSB were six scientific experiments designed and constructed by student groups from Germany, Hungary and Italy, and by a French-Japanese team.

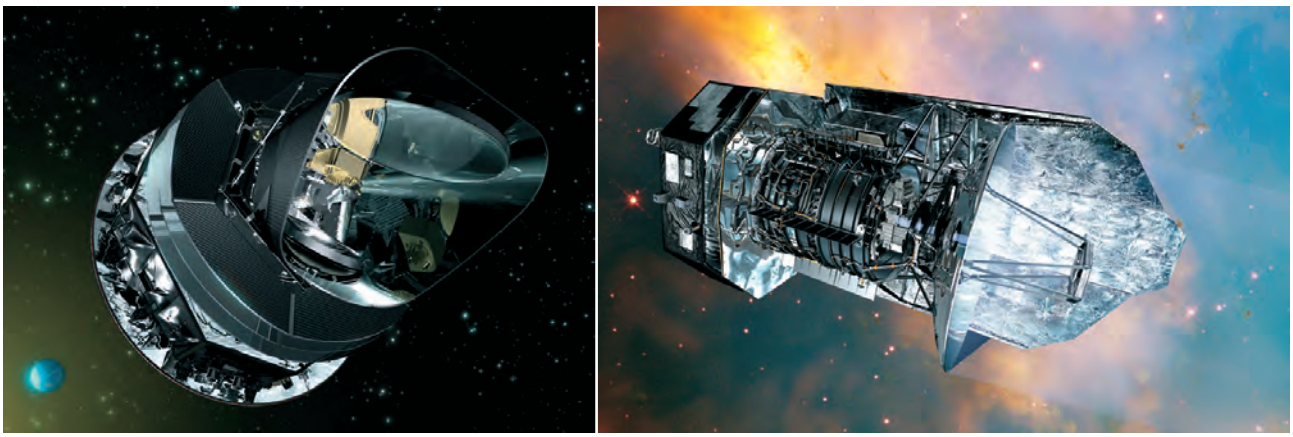
Planck and Herschel

Planck's new image of the universe; Herschel telescope concludes mission

Europe's first mission to explore the cosmic microwave background (CMB) began on May 14, 2009, when the space telescope named after German physicist Max Planck launched together with its sister probe Herschel, named for the German-British physicist William Herschel. The first complete map of this background radiation is now available at a previously unseen quality. On behalf of DLR, German researchers are also participating in the project. The minimal temperature variations in the CMB map provided by Planck highlight minute



MetOp-B, which replaces its predecessor launched in 2006



Artist's renderings of the Planck space telescope and the Herschel infrared telescope, now retired

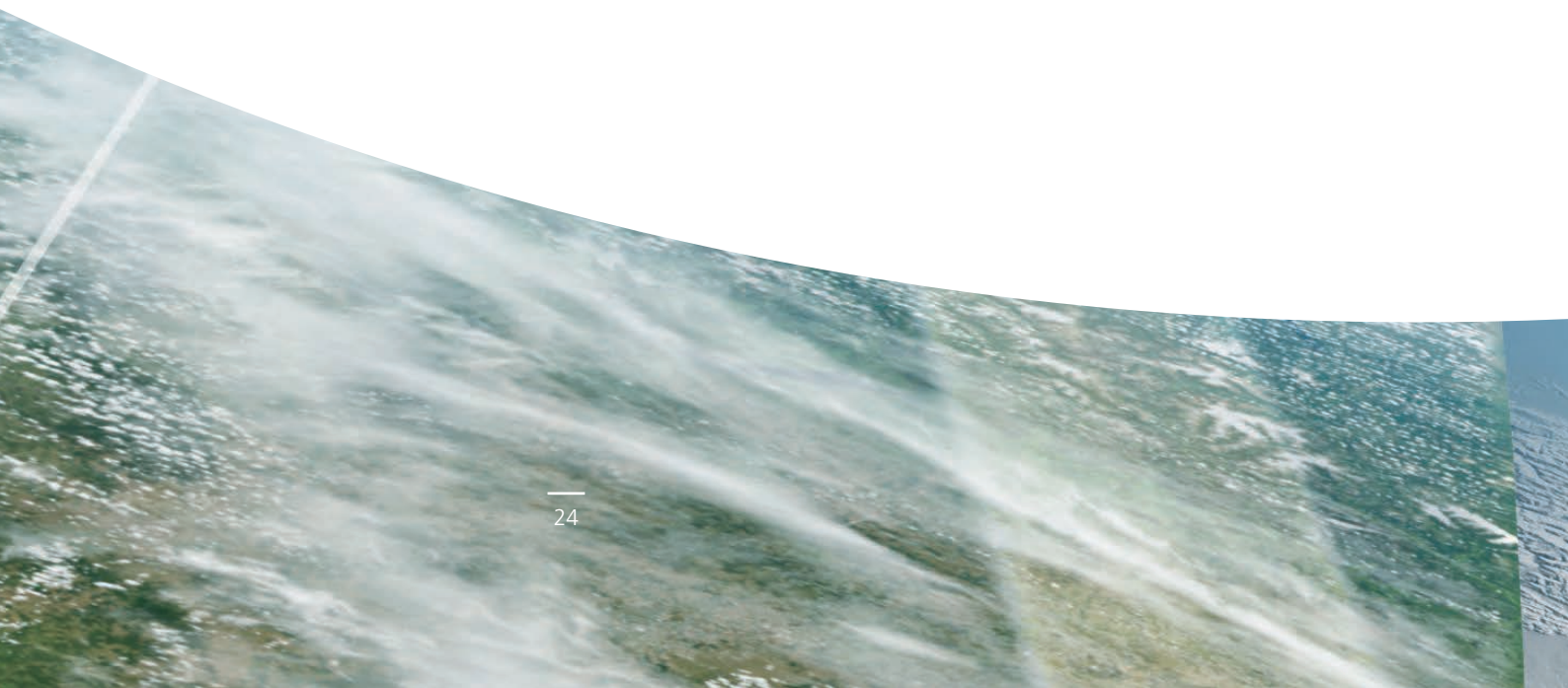
differences in density distribution in the early universe; relic radiation from the Big Bang has been measured more accurately than ever before. The tiny temperature variations in the microwave background are particularly interesting in order to derive conclusions as to precisely how the universe came into being and how energy and density have spread in space.

The helium fuel reserves of the European space telescope Herschel ran out in early 2013 as planned. The infrared telescope, which is 7.5 metres high and weighs 3.4 tonnes, was in space for over three years in order to observe phenomena such as the birth of new stars. DLR financed the construction of two of Herschel's three instruments with funds provided by the Federal Ministry of Economics and Technology (BMWi). With its PACS, HIFI and SPIRE instruments, the telescope with its 3.5-metre reflector could penetrate dust and gas clouds at various wavelengths, allowing researchers to see through apparently impermeable nebulae and discover complicated structures that optical telescopes cannot see in this way. The so far largest telescope ever to fly in space was instead able to detect heat from stars, galaxies and nebulae, and could register even extremely weak thermal radiation. But Herschel was also used to observe planets, asteroids and comets in our solar system.

SOLAR

ISS flight manoeuvre for solar observation

The SOLAR instrument is affixed to the outside of the International Space Station ISS. For almost five years, its two devices SOLSPEC and SolACES have been measuring solar radiation at various wavelengths in order to examine for example its effects on Earth's climate. While the space station is on its usual orbit, observation periods are however limited to ten to twelve days; SOLAR is unable to measure for approximately half the time because the space station blocks the instrument's view of the sun.



On December 1, 2012, the station's flight path was therefore for the first time altered to facilitate a scientific experiment. Such manoeuvres had previously only been performed e.g. to allow space shuttles to dock. For two weeks, ISS orbited the Earth rotated by seven degrees, making it possible to scientifically analyse an entire rotation of the sun around its own axis using SOLAR.

Space Administration: Funding budget in million euros	2012 Actual	2013 Planned	2014 Planned
National programme (incl. share of management of BMWi contract)	212	274	277
ESA (total incl. BMVBS et al.)	760	777	772

Sterex

Video shows space transport vehicle ATV-4 in space

When the fourth ESA space freighter ATV "Albert Einstein" launched on June 5, 2013, at 11:52 p.m. Central European Summer Time (CEST), it had a very special passenger on board: the Sterex experiment funded by the DLR Space Administration and the European Space Agency ESA. At the heart of this four-camera system is a stereoscopic assembly of two cameras, which recorded the separation of ATV-4 in 3-D for the first time from on board Ariane 5. The images show the dynamic processes leading up to the separation of the ATV from Ariane from a new perspective, and will help researchers better understand and analyse these processes. These are the first video images of an Ariane launch to be recorded from on board the rocket itself since 2006. For videos, please visit:
› http://bit.ly/1fE4BNb

E-Nose

Measuring device detects microbial contamination on the space station

The E-Nose measuring device was taken into operation on the ISS on February 28, 2013. It is designed to detect traces of microbial contamination by fungi, bacteria and spores on the space station. The E-Nose project was implemented by DLR's Product Assurance department (see p. 71).

Microbial contamination is a major threat to the health of astronauts on the ISS. Visible fungal growth occurs for example on cable strands, on parts of air conditioning devices and in systems for water reclamation; the Moscow Institute for Biomedical Problems has so far identified up to 300 different organisms. However, this previously required a fairly complex and time-consuming process: the samples had to be transferred to Earth and analysed there. The E-Nose now allows the astronauts themselves to measure microbial load at various points of the ISS. The super-sensitive nose electronically detects microbial load on the space station using a gas sensor system.

Before its deployment in space, the E-Nose was tested in the Russian isolation experiment Mars500, among other places. Having proved its fitness for purpose on Earth there, the electronic nose took off for the space station on a Russian Soyuz rocket on December 19, 2012.

Joint projects from the Space Administration and DLR's Space Research and Technology division

RAD on "Curiosity"

Measuring radiation on the way to and on Mars

During a flight to Mars as part of the "Mars Science Laboratory" (MSL) mission, the Radiation Assessment Detector (RAD) successfully measured radiation in space.

Valuable datasets were for the first time collected in interplanetary space between Earth and Mars which provide information on the radiation field in the solar system. Among other things, the device measured five solar storms – a happy coincidence for the researchers, as this meant they were already able to gain a wide range of valuable data on the effects of solar storms on radiation exposure during the flight. The data will form the basis for calculations on how, for example, Mars astronauts will have to be protected from radiation.

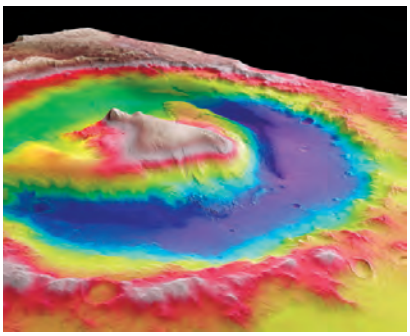


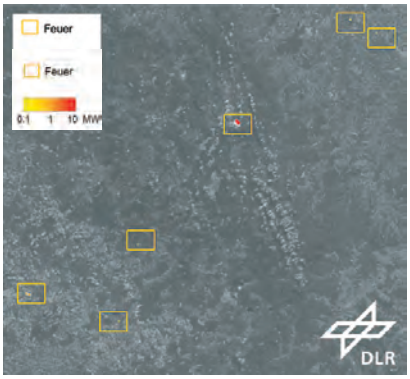
Image of the Gale Crater

In the further course of the MSL mission, RAD will for the first time perform measurements on the surface of Mars itself. Over a period of two years, data will be gathered in order to correct and refine the previously calculated models. As Mars has no magnetic field and is protected only by a very thin atmosphere, researchers expect that the number and energies of particles will behave very differently than they do for example on Earth. The collected data will also be used to help better plan future long-term missions for astronauts. To what level of radiation will the crew of a spaceship be exposed on a flight to Mars? What measures are required to keep this dose of radiation as low as possible? These are questions the researchers hope to answer with the help of the newly gathered data.

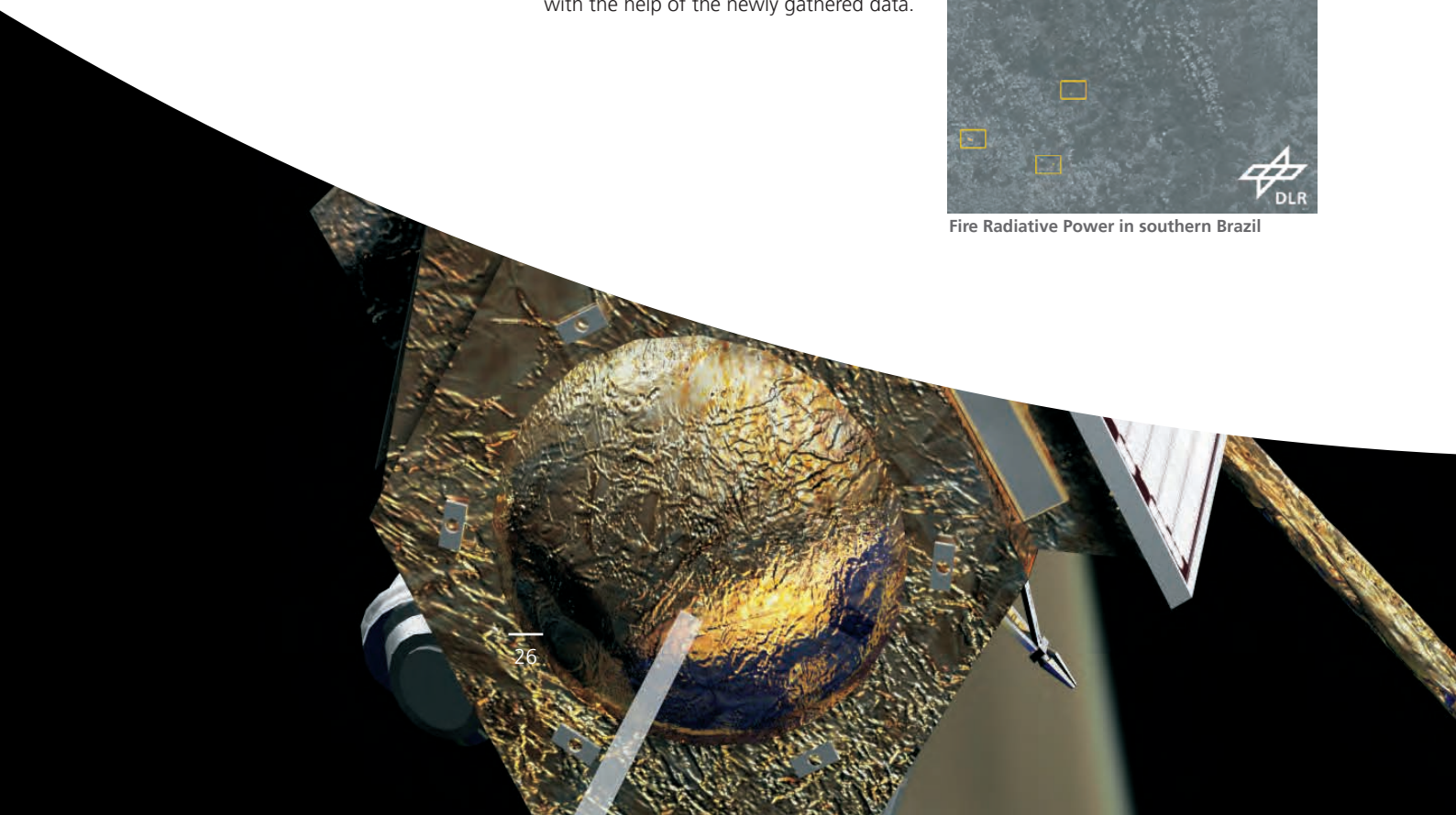
TET-1 Launch

FireBIRD mission begins

On July 22, 2012, the first German microsatellite in the "On-Orbit Verification" (OOV) programme took off from the spaceport in Baikonur (Kazakhstan) on board a Russian Soyuz rocket: TET-1 is a technology test carrier with eleven experiments on board which will have to prove their effectiveness under real space conditions for one year. Components for satellites, the International Space Station ISS and other systems have to withstand the effects of, for example, major temperature fluctuations, zero gravity and space radiation, and continue to operate reliably. The OOV programme is the first time that DLR has tested space technologies directly in space. One of the experiments is an IR camera developed by the Institute of Optical Sensor Systems, which can detect high-temperature areas such as forest fires. With this technology DLR is contributing to early fire detection from space, and will revolutionise worldwide near real-time early fire warnings.



Fire Radiative Power in southern Brazil



Maps to assist emergency responders in disaster areas

DLR takes chair of international charter

DLR Provides Unbureaucratic Assistance in Global Disasters

On April 16, 2013, DLR assumed the chair of the "International Charter Space and Major Disasters" for six months. 15 space agencies have come together under this charter to provide unbureaucratic assistance; DLR has been a member since October 2010.

One element of the chairmanship was to prepare the four-day conference held at the beginning of the German charter chairmanship from April 16 to 19, 2013, in Berlin. The aim of this meeting was to further develop the charter's activities. The charter was activated 40 times in 2012, and ten times so far this year (as of June 24, 2013).

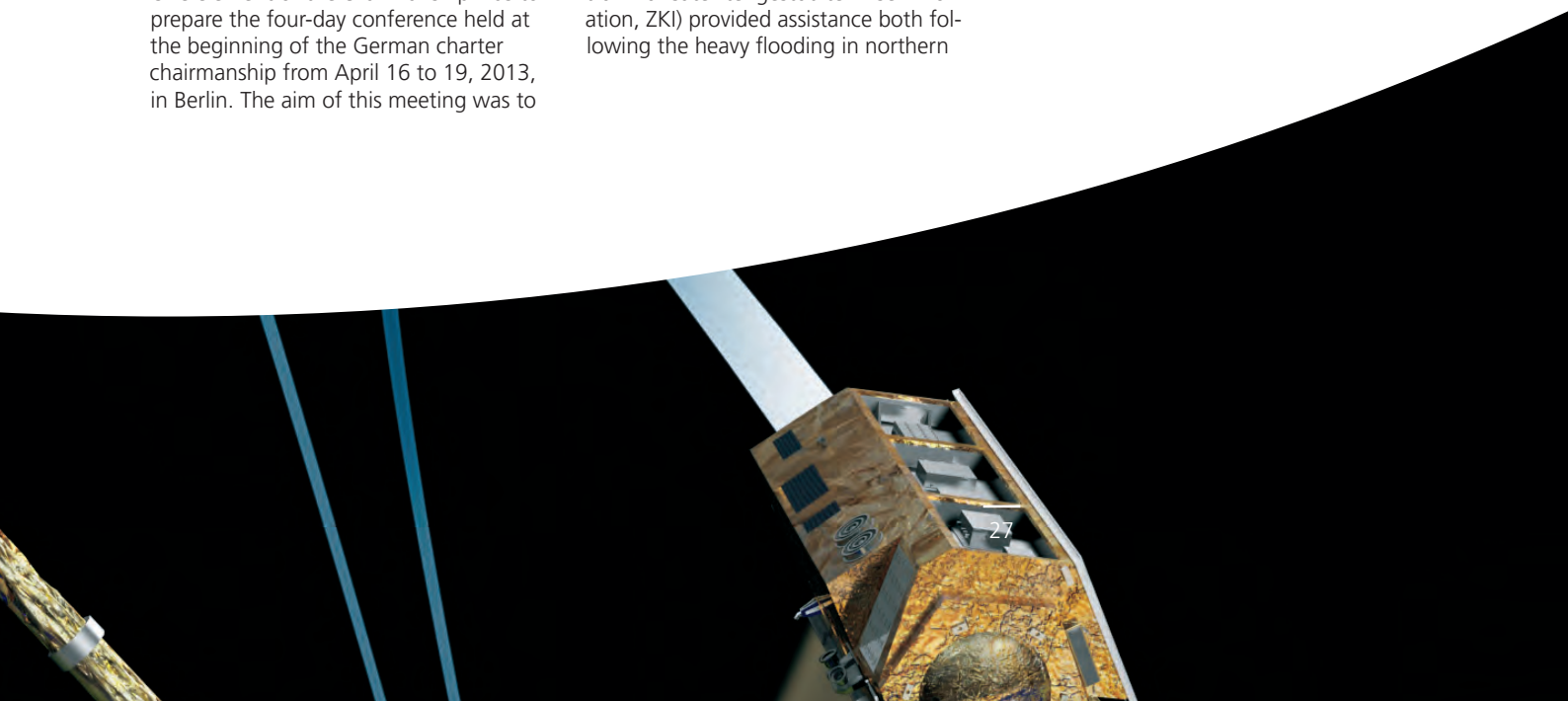
In June 2013, DLR aided emergency management organisations on no less than two separate occasions by providing images of flooded areas from its radar satellite TerraSAR-X: the DLR Center for Satellite Based Crisis Information (Zentrum für satellitengestützte Kriseninformation, ZKI) provided assistance both following the heavy flooding in northern India and Nepal and after the floods in Germany. By re-commanding its satellites, DLR was able to make satellite data available extremely quickly and free of charge in order to support local rescue teams with information on the current situation on the ground. The satellite data are combined with additional information to indicate rescue routes, damage, persons in danger and much more.

REXUS 11 Launched

Experiments to improve zero-gravity research on high-altitude rockets

On November 16, 2012, the DLR student research rocket REXUS 11 took off from the Esrange space centre near Kiruna in northern Sweden. Along with a second German experiment by students of TU Dresden, experiments designed by teams from Ireland, Sweden and Switzerland were on board.

REXUS 11 reached an altitude of approximately 79 kilometres on its flight; zero gravity was achieved for approximately two minutes. After the rocket had landed by parachute, its payload was retrieved by a helicopter team and brought back to the rocket base, where the students were able to begin evaluating their data.



REXUS 13 and 14 – experiments on space debris and radiation

REXUS 11 launches

Dual Campaign with Student Experiments

A further lift-off from the Esrange space station took place on May 9, 2013, when the research rocket REXUS 13 launched with four student experiments on board. Its sister rocket REXUS 14 had taken off two days earlier. The dual campaign, in which approximately 50 students from Germany, Sweden, Great Britain, Switzerland and Hungary took part with experiments they had designed and constructed themselves, is part of the REXUS/BEXUS student programme of DLR and the Swedish space agency SNSB. The main themes included experiments on space weather, concepts for disposing of space debris, testing of a platform comprising frequently required experimental functions, and possibilities for performing repairs (soldering) under zero-gravity.

What is REXUS/BEXUS?

REXUS/BEXUS (Raketen- und Ballon-Experimente für Universitäts-Studenten, Rocket and Balloon Experiments for University Students) is a joint programme of the German Aerospace Center (DLR) and the Swedish National Space Agency (SNSB). German and Swedish students are therefore each permitted to take up half the rocket and balloon payloads. The SNSB has additionally opened its share up to students from other member states of the European Space Agency (ESA). Suitable payloads are for example topics from atmospheric physics, balloon and space technology, radiation physics or biology, low-gravity research, remote sensing or communications. The competitions are held at regular intervals.

› www.rexusbexus.net

TEXUS 50

Anniversary of Germany's research rocket programme

35 years after the first TEXUS mission in December 1977, the 50th TEXUS rocket successfully launched into space from the Esrange space centre near Kiruna in northern Sweden on April 12, 2013 at 6:25 a.m. Central European Summer Time, making history in the process: the TEXUS programme is the world's longest-running rocket programme for zero-gravity research.

The flight lasted 15 minutes; zero gravity was achieved for six minutes and twenty seconds. A parachute brought the scientific payloads back to Earth after the flight.

The DLR research rocket carried four German biology and materials science experiments up to an altitude of 261 kilometres. The VSB-30 rocket was only accelerated directly after launch and then flew on without further propulsion.

TEXUS 50 launches

Projects from DLR's Space Research and Technology division

Dawn Space Probe

Mission more than met expectations

The first image of the asteroid Vesta was taken by Dawn from a distance of 975,000 kilometres. The probe has meanwhile enabled scientists to observe Vesta from a distance of just 175 kilometres, resulting in initial astonishing findings. For example, the asteroid consists of a core, mantle and crust, similar to a planet. But its structure is destroyed by two enormous, overlapping meteor strike craters on its south pole and by deep gorges around its equator. The ejected masses are between one and two billion years old, and thus very young in terms of planetary geology. The more than 28,000 images of Vesta recorded by the on-board camera during the mission show dark material around and in the numerous craters. Where this dark material comes from and which processes took place on the asteroid in the past are questions that will be occupying researchers in the coming years, as will the large amount of hydrogen protons discovered. Even bearing in mind that Vesta is smaller than a planet, the geologists and physicists at DLR and the Max Planck Society succeeded in measuring the asteroid in record time. The probe left Vesta's orbit in early September 2012 and is now flying on to the dwarf planet Ceres (see issue 2011/2012).

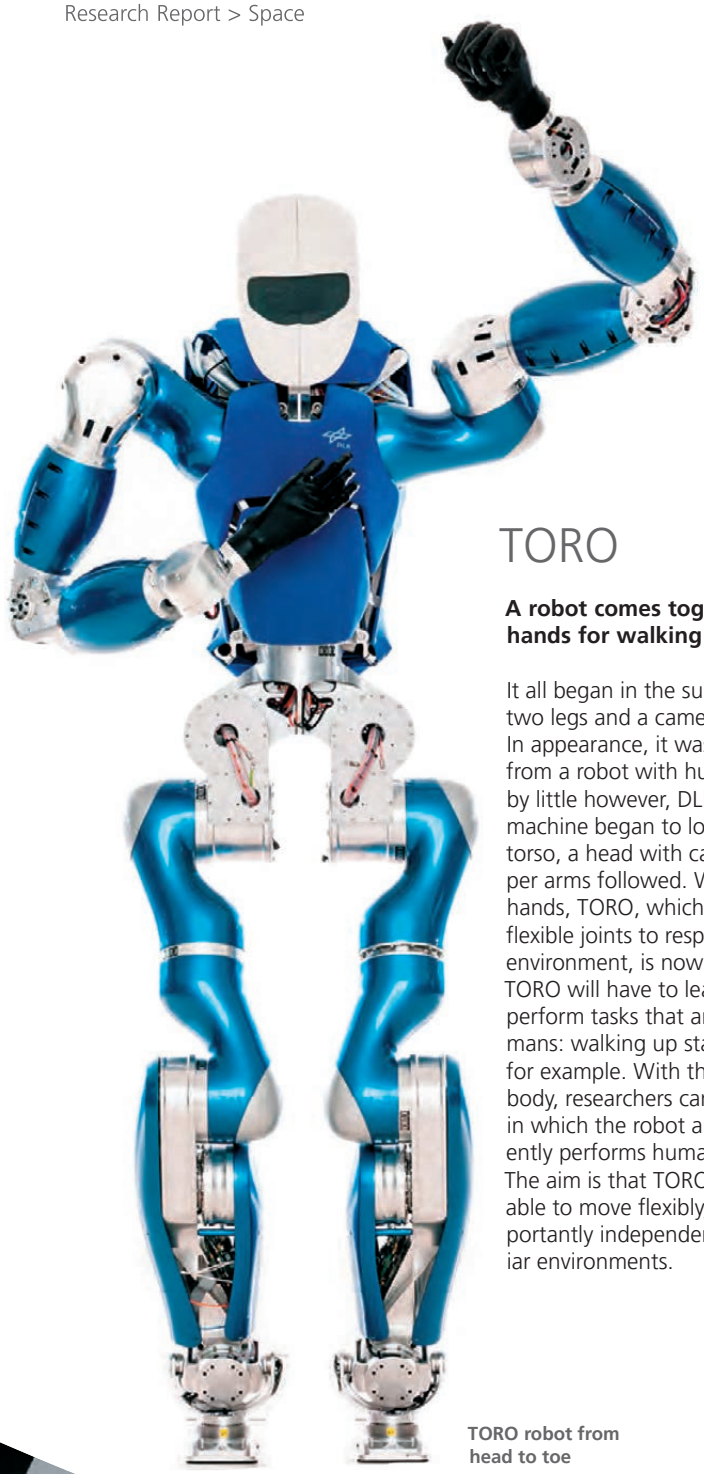
Sentinel-1 and -3 Data Centre

European data centre for GMES Sentinel satellites at DLR

The competencies existing within DLR in Earth observation and data processing are the key to the successful establishment of the European data centre. The ground segment for GMES (Global Monitoring for Environment and Security) for the Sentinel-1 and Sentinel-3 satellites was therefore opened in Oberpfaffenhofen in July 2012. The unique combination of research and engineering services means that DLR's German Remote Sensing Data Center (Deutsches Fernerkundungsdatenzentrum, DFD) is ideal for designing and operating complex systems for receiving, processing and archiving Earth observation data.

Images from the Sentinel-1 radar satellite and data from the Ocean and Land Color Imager (OLCI) of the Sentinel-3 satellites are processed into information products, distributed to users and stored for the long term. The new GMES data centre is largely based on existing infrastructure; its computer infrastructure and the national data archive were expanded to be able to process the annual data volumes of more than two petabytes. The datasets gathered over several decades provide researchers with fundamental information for understanding the dynamics of the geosphere, and give answers to urgent global questions.

A satellite in space, here Sentinel 1, and its terrestrial counterpart for data processing, here the Earth Observation Centre (EOC) at the DLR site in Oberpfaffenhofen



TORO robot from head to toe

TORO

A robot comes together: arms and hands for walking machine

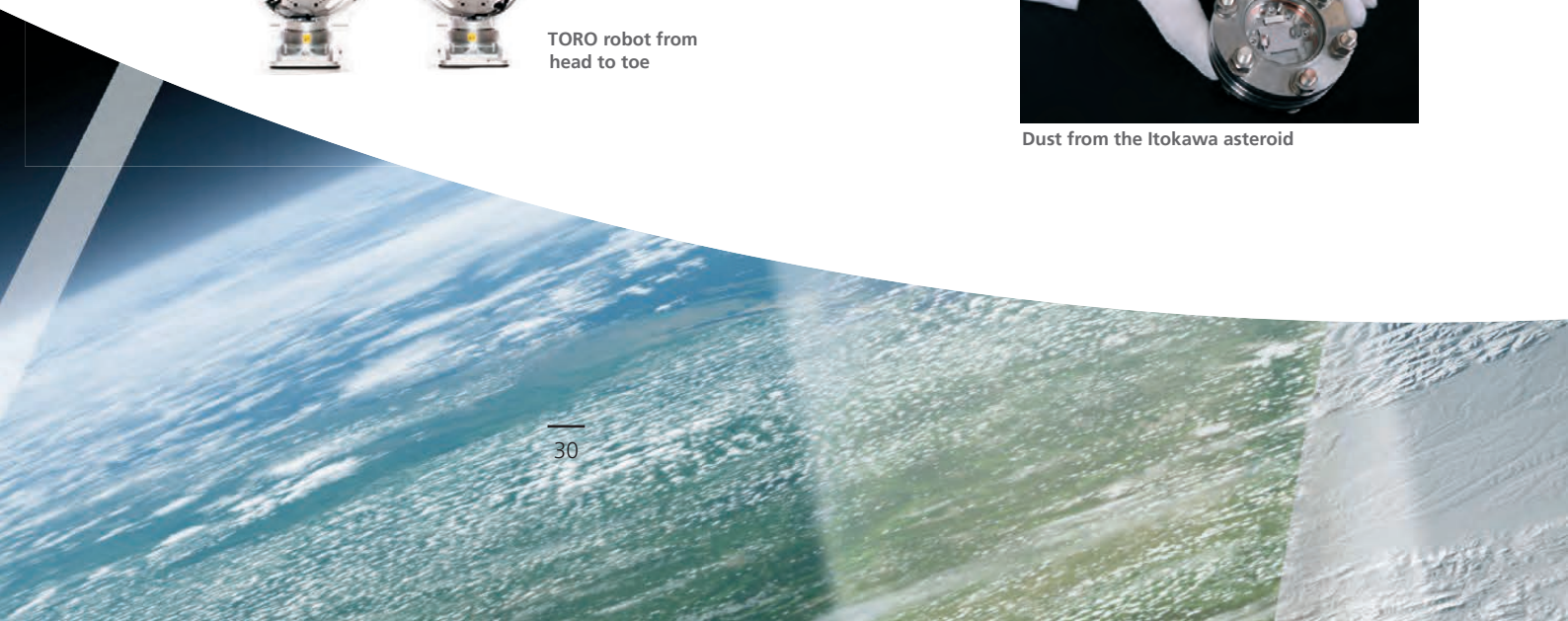
It all began in the summer of 2009 with two legs and a camera mounted on top. In appearance, it was still a long way from a robot with human features. Little by little however, DLR's TORO walking machine began to look more human: a torso, a head with camera eyes and upper arms followed. With forearms and hands, TORO, which uses sensors and flexible joints to respond sensitively to its environment, is now complete. Next, TORO will have to learn in small steps to perform tasks that are simple for humans: walking up stairs or opening doors for example. With the completed robot body, researchers can now test processes in which the robot anticipatorily and fluently performs human motion sequences. The aim is that TORO will someday be able to move flexibly, safely and most importantly independently in new, unfamiliar environments.

Asteroid Dust from Space

DLR examines entirely untouched extraterrestrial material

For the first time ever, researchers had the opportunity to examine dust collected by a probe from an asteroid in space and brought back to Earth. Scientists at the Institute of Planetary Research are part of one of eleven teams around the world who are permitted to work scientifically with the extraterrestrial asteroid particles from the Japanese Hayabusa mission. Along with the moon rocks from the Apollo and Luna missions, these samples are the only material that has ever been collected directly from a body in the solar system and returned to Earth. This is the first time that the provenance of asteroid material has been known and unaltered by its entry into the Earth's atmosphere. The particles come from the Itokawa asteroid, from which the Japanese probe took a sample in 2005. Scientists determined the mineralogical composition of the asteroid matter in the laboratory of the DLR Institute of Planetary Research. As Itokawa is an original asteroid and thus up to four and a half billion years old, the results may provide information about the formation of the solar system.

Dust from the Itokawa asteroid



TOGS

Rapid information from lasers

The mobile ground station TOGS (Transportable Optical Ground Station) was taken into operation in November 2012 in Oberpfaffenhofen. The core of the facility is a telescope for data reception, which is optimised for linking to satellites and aircraft. Infrared lasers can easily transmit very high data rates across large distances. In addition to receiving satellite data, the ground station can also be used to exchange data with aircraft. Satellites can benefit from the optical technology: it keeps down the weight and power consumption of the communications transmitter on board while offering a data transmission capacity that is significantly higher compared to the methods currently in use. In TOGS, DLR has developed a system that can receive high-resolution aerial images via laser directly on the ground and make them available there in real time. A specific application is for example in the event of disasters: images can be transmitted directly to the area where search and rescue teams are deployed and used to coordinate their efforts.

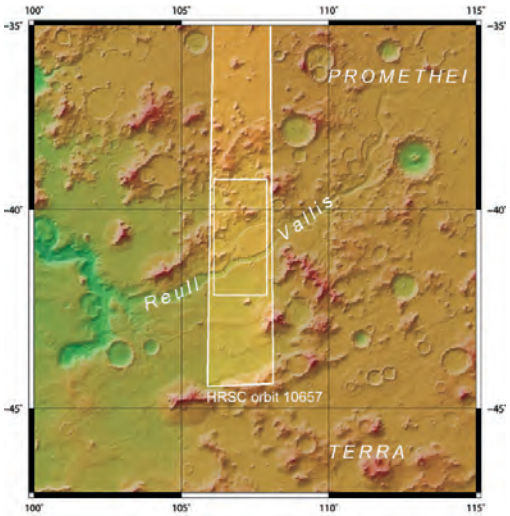
The Transportable Optical Ground Station

Aircraft positioning over Great Britain

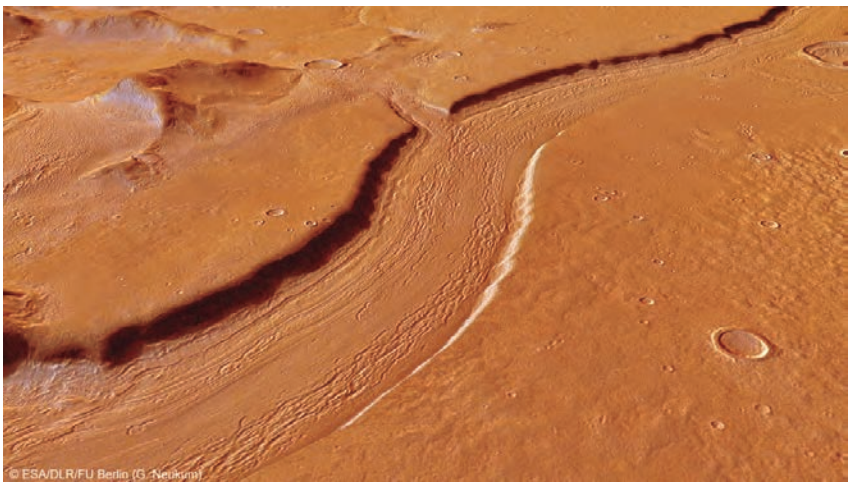
ADS-B over Satellite

First aircraft positioning from space

With the receiver for ADS-B (Automatic Dependance Surveillance – Broadcast) signals developed in DLR, researchers have for the first time succeeded in receiving aircraft signals via satellite. Continuous radar-based monitoring of air traffic is currently impossible in oceanic airspaces and over regions with limited air traffic control infrastructures. The option of positioning from space will close this gap in the future. Satellite reception now makes it possible to receive aircraft signals, which include e.g. information on speed and position as well as the aircraft's identification code, outside monitored areas. This will enable air traffic controllers to detect the precise position and speed of aircraft and respond accordingly if necessary. The system can be used to optimally plan flight routes and thus contributes to reducing fuel consumption, which ultimately leads to less environmental pollution and lower costs for airlines. A further important aspect is the possibility of initiating immediate search and rescue activities in the event of an emergency. As the position of the aircraft is known to ground control at the time of the accident, extensive and time-consuming search efforts over oceanic areas and other places not well covered by radar are rendered unnecessary.



Topographic map of Reull Vallis



Debris and rubble in Reull Vallis

MarsExpress

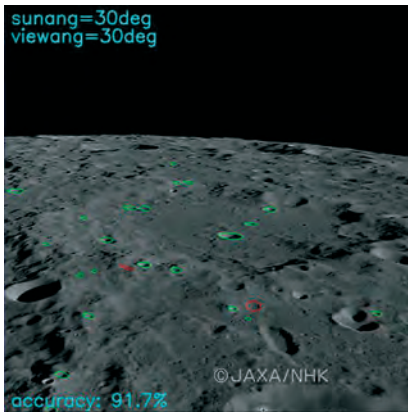
HRSC has been photographing the surface of Mars for ten years

The MarsExpress probe has now been orbiting the red planet for a decade, and is still delivering important insights into its geological history. The high-performance camera HRSC (High Resolution Stereo Camera), which was developed in DLR and built in cooperation with German industry, contributes significantly to this success. The HRSC photographs Mars globally at high resolution, in colour and in 3-D. Over half the planet has already been recorded at a resolution of ten to twenty metres per pixel. The aim is to create a global topographic map of Mars; to date, more than two thirds of the planet's surface have been covered. The images from the camera provide a valuable basis for current and future Mars research.

ATON

Safe landing for exploration missions

Future lander missions will be equipped with complex navigation systems. To enable autonomous, precise and safe landings during exploration missions, DLR has developed a demonstration hardware version of an optical navigation system for precise landing on the Moon. An important component of this system are imaging optical systems, as they can perform measurements independently of Earth, i.e. autonomously and with no latency. By integrating them into the navigation system, the sensor data can be used to autonomously and absolutely determine the position and state of the lander in a local coordinate system for the target object. This ability is a necessity for performing precise landings. The sensor data can also be used to select a safe landing site. This successful demonstration is a prerequisite for designing a potentially space-capable flight model, which is currently being developed in the follow-up project ATON2.

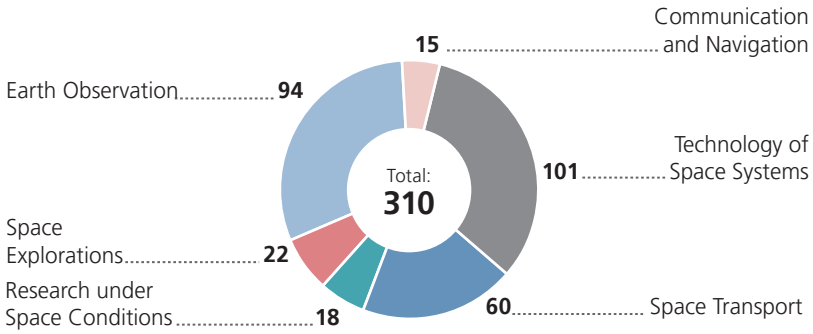


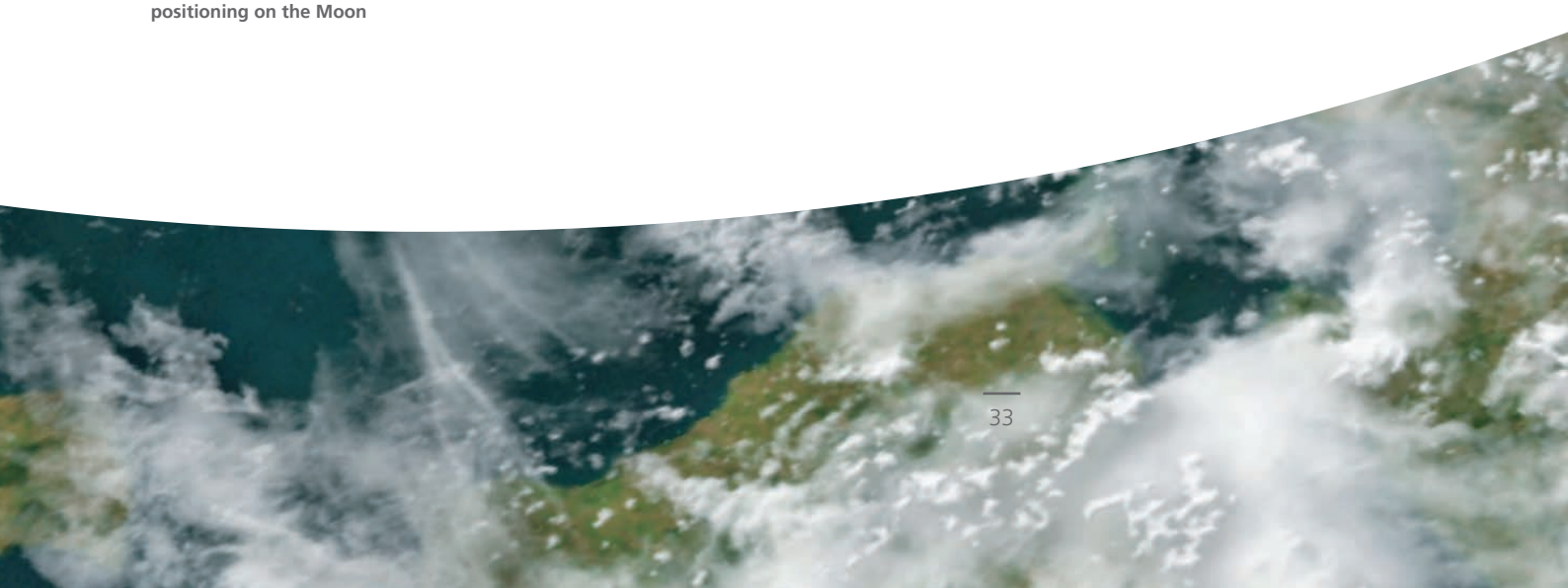
Example of autonomous crater detection for positioning on the Moon

Space R&T: Revenues in millions of euros	2012 Actual	2013 Planned	2014 Planned
Institutional funding	168	174	182
Third-party funding	141	136	138
Total revenues	**309**	**310**	**320**

Expected revenues for the year 2013

All figures in million euros





Transport

For Germany with its export-driven economy and central transit location in the heart of Europe, transport is an essential sector. 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. Our 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; it uses transport-specific expertise to systematically tap into DLR-internal know-how from the fields of aeronautics, space and energy for transport applications, focusing on the 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. DLR contributes 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 follow new paths in researching transport system interactions. As a service for the national and European community, DLR additionally runs the Clearing House for Transport Data. Cooperation between 25 institutes and a free flow of information enables DLR to systemically study highly complex interdisciplinary themes; in this context, research on electromobility and mobility in the cities of tomorrow is of particular importance to DLR.

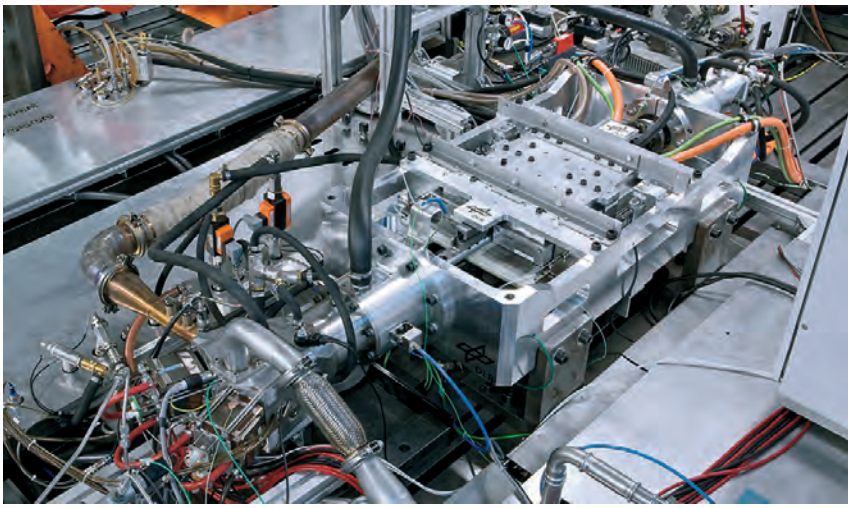
The work never loses sight of the overarching goal of DLR transport research, which is to maintain a transport system that is powerful, reliable, secure and at the same time both economically and ecologically sustainable. This is reflected in the wide range of results DLR has achieved; the following pages describe several examples from the 2012-2013 period.

Free-piston Linear Generator

Innovative range extender for electric cars presented

DLR has been working for some years on developing a fundamentally new engine concept – the free-piston linear generator (Freikolben-Lineargenerator, FKLG). The FKLG resembles a combustion engine that generates electricity in order to power an electric car across greater distances than a battery alone would allow. However, rather than transforming the linear movement of the pistons into rotational movements of the crankshaft, it generates electricity directly. In the combustion chamber, a fuel-air mixture is ignited; the pistons are then decelerated by gas springs and pushed back. In contrast to conventional propulsion technologies, the free-piston linear generator allows compression ratio and cubic capacity to be flexibly adjusted, enabling the use of different fuels – from gasoline, diesel or natural gas to ethanol or hydrogen. Thanks to its variable properties, the DLR range extender can always be adjusted to permit an optimal operating strategy.

The principle of this engine has been known for some time, but no one had previously been able to demonstrate that the technology actually works. DLR succeeded in doing so on a test rig developed specifically for this purpose. A system consisting of a combustion section, the linear generator and an innovative gas spring was successfully taken into operation. The challenge was to develop an especially powerful mechanism with a highly dynamic control system responsible for managing the complex interaction between the individual components. For example, the control system regulates the movement of the piston accurately to within one tenth of a millimetre. At the same time, it detects and compensates for fluctuations in the combustion process.



Free-piston linear generator successfully tested

In cooperation with industry, DLR intends to develop the FKLG technology further and construct a prototype that will be barely larger than a shoebox, run very quietly and generate very few vibrations.

Powerful Powder

New thermoelectric materials reduce fuel consumption

Vehicle manufacturers around the world are working on fuel-saving vehicles. Alongside reducing weight, other methods currently being pursued include greater vehicle electrification, fuel-saving engines or the use of exhaust heat from combustion engines. DLR is conducting research into thermoelectric generators (TEG) that can transform heat that would otherwise be lost through the exhaust system into electrical energy. This can significantly improve the energy balance of modern vehicles. DLR is working with partners from the automotive industry and its component suppliers to make thermoelectric generators suitable for serial implementation in motor vehicles. The aim is to develop highly efficient thermoelectric materials and thermoelectric generators for use at temperatures of up to 400 degrees Celsius. At present, prototypes and demonstrators use lead telluride, as it is the currently most widely available and technologically mature high-temperature material.

For wider use, more environmentally friendly, lead-free functional materials will have to be found. Research is therefore focusing increasingly on a TEG module technology based on materials in the skutterudite class. DLR is examining and optimising these materials with regard to their electric and mechanical properties in order to increase material efficiency and toughen the modules for continuous use.

Thermoelectric generator module: transforms excess heat into electric power

Particular emphasis is being placed on raw materials that are produced at sufficient throughput levels and can be fed into corresponding development and manufacturing steps, as low material throughput has so far presented a practical obstacle to the industrial use of thermoelectric systems. A promising technique consists of atomising the melted thermoelectric material. This procedure is already industrially possible for many materials. After synthesising lead telluride and successfully atomising doped lead telluride into powder at the DLR experimental plant, the challenge for the researchers now consists in establishing the ability to atomise skutterudite material at good quality. In further steps, they will optimise this process in terms of material quality in order to create the basis for industrial manufacture of large quantities of thermoelectric powder. The achieved progress indicates that DLR will make a significant contribution to establishing thermoelectric systems and thus more efficient vehicles. We are currently working to transfer this technology to industry with the specific aim of setting up a pilot plant.

Attendees of the final FAIR project presentation

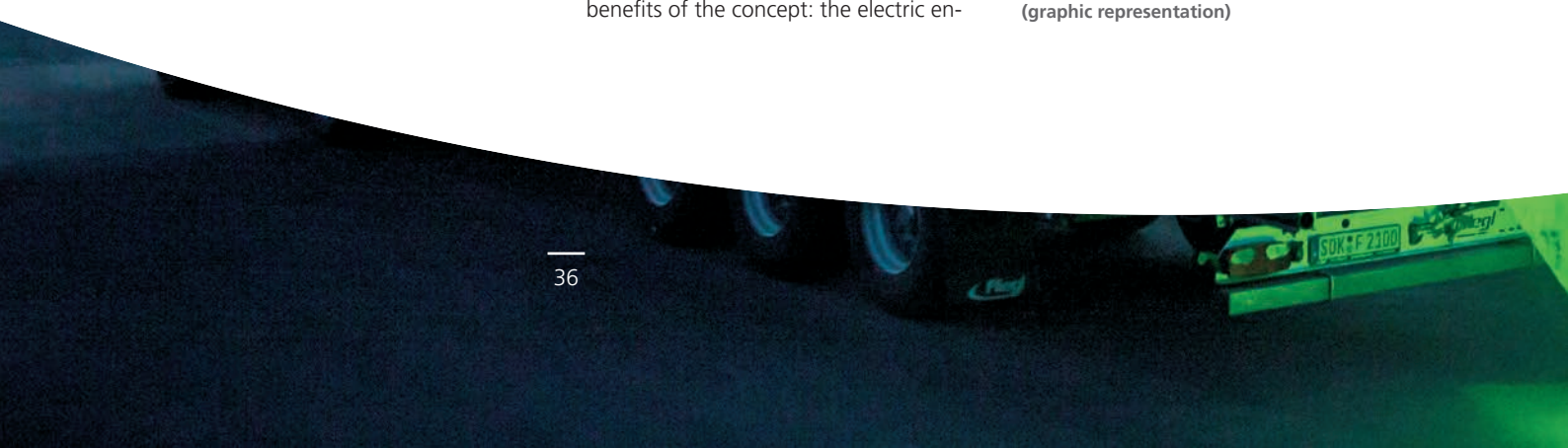
Electromobility

FAIR research project shifts engine to the wheel

To date, electric vehicles have typically been developed according to the principle of "conversion" design, i.e. as a variant of the standard model designed to use a combustion engine. But how could the most be made of the advantages of an electrically powered car if this compromise were not necessary? This was the question at the heart of the FAIR ("Fahrwerk/Antrieb-Integration ins Rad", Chassis/engine integration into the wheel) research project. Carried out in cooperation with BMW Group Research and Technology and Schaeffler, the project aimed to systematically examine what is known as in-wheel variants, where chassis and engine components are integrated into the wheel. The most promising concept was selected and its functionality demonstrated by developing a prototypical mechatronic axle.

DLR developed methods and calculation tools to evaluate and optimise dynamic performance, while Schaeffler manufactured two in-wheel modules and BMW created a demonstrator with the mechatronic axle which illustrates the major benefits of the concept: the electric engine sits on the rear axle; it is also able to brake and fully reclaim the energy thus generated, making the mechanical friction brake at the rear of the vehicle unnecessary. The battery is installed under the boot between the powered rear axle wheels. This compact design is advantageous because it helps create a low centre of gravity in the vehicle and increases the crash safety of the high-voltage battery. In addition, it causes no restrictions regarding seating. A new type of gear box combines the vehicle's elementary chassis functions of propulsion, wheel guidance and suspension and makes it possible to attach electric motors to the chassis without the traditional bulky drive shafts, ensuring that despite high drive capacity the weight of a complete rear wheel was not increased compared to the corresponding standard car.

Optimised battery arrangement (graphic representation)



Too Tired to do the Job?

A short DLR test can find out

Errors due to tiredness are one of the major causes of road accidents, accounting for approximately one quarter of all fatal accidents on German motorways. Even in the highly automated world of aviation, fatigue is responsible for 15-30 percent of accidents resulting from human error. DLR has examined this issue in its recently completed "FIT" project (validation of a fitness for duty test to increase safety in aviation and road traffic) and developed a test designed specifically to detect reduced performance caused by tiredness. It is performed on a portable hand-held computer and can validly determine mental acuity in just three minutes. The short duration of the test means it can be used in a wide range of situations, for example during working hours in especially time-sensitive jobs in aviation or professional haulage; the small amount of time required also increases acceptance for conducting the test.

Preparations during FIT testing

Development of the test was based on longer psychomotor attention tests which are already well validated for detecting loss of acuity through lack of sleep. To evaluate whether such tests could really be compressed into just three minutes, DLR conducted a study in which the duration and quality of test subjects' sleep was intentionally reduced in a sleep laboratory in order to induce varying performance levels and degrees of fatigue. The test was then evaluated for reliability in a number of different test procedures and validated. The comparison tests comprised a parallel test version requiring ten minutes and application-related tests that reflected the range of tasks required of operators in aviation and transport.

ROboMObil

Wheel robot wins eCarTec Award

The ROboMObil developed by DLR enables autonomous driving with previously unknown manoeuvrability. The vehicle is based on the wheel robot concept: engine, steering, suspension and brakes are integrated into each of the four wheels. The wheel robots are coordinated with the help of an intelligent central control system. The ROboMObil is omnidirectionally manoeuvrable, meaning that it can travel diagonally or sideways in a "crab walk" or "dog walk" or turn in place thanks to single-wheel steering. The benefits of this enhanced manoeuvrability become apparent particularly in large cities and in the logistics sector.

ROboMObil

The movement desired by the driver can be transmitted to the vehicle either via a sidestick in the cockpit or by remote control. Eight stereo camera pairs create a three-dimensional 360-degree field of view around the vehicle; powerful image processing algorithms generate a dynamic representation of the surrounding area. The ROboMObil is used as a test vehicle for control and estimation algorithms in energy management and vehicle dynamics. The two-seater concept derived from planetary rover technologies and robotics won the Bavarian State Award for Electric Mobility at the electric mobility trade fair eCarTec in October 2012.

Valet Parking

An end to the stressful search for a parking space

It's currently one of the hottest topics at vehicle trade fairs around the world: "Valet Parking" is designed to enable drivers to avoid the cumbersome search for a parking space altogether – thanks to smartphones and highly sophisticated technology. The future of parking might look like this: a traveller drives her car to the central station, leaves it near the entrance and goes to catch her train. Meanwhile, the car automatically drives itself to a free parking space and independently parks there. The traveller doesn't have to do a thing, and can start her train trip without delay. To return home from the station, she calls her car to the entrance by smartphone, gets in and drives off.

DLR has successfully demonstrated that this vision of the future is already possible with today's technology: the test vehicle FASCar I is equipped with the corresponding sensors, a special steering system and powerful computing hardware that allow the vehicle to travel autonomously – without a driver at the wheel. For the test, a high-resolution camera installed on a parking lot recorded free parking spaces. In connection with a parking space management system, the vehicle was assigned a suitable parking space by radio. The driver pressed a button on the smartphone to confirm the system's suggestion, and the car then drove itself automatically to the assigned space. The smartphone was also used to transmit the precise parking position of the vehicle and a request to make it available at a defined handover point. In addition to the convenience aspects it offers users, Valet Parking also helps better manage the general parking space by for example preventing vehicles from taking up multiple spaces due to crooked parking.

The parking symbol on the vehicle display indicates a free parking space

The driver can send the car to the free parking space via smartphone

Across the City with Less Stress

DLR conducts research into intelligent intersection

Intersections are bottlenecks in transport systems. Their capacity is limited and unexpected disruptions frequently occur, for example due to queues forming or emergency vehicles entering. To improve traffic flow, intersections are to be enabled to communicate with vehicles in the future. In cooperation with 30 partners, DLR is conducting the joint project UR:BAN (Urbaner Raum: Benutzergerechte Assistenzsysteme und Netzmanagement – Urban Space: User-friendly Assistance Systems and Network Management), which is funded by the Federal Ministry of Economics until 2016, to examine the options for implementing such a system.

The "smart intersection" will address the above-mentioned efficiency issues by "speaking" with cars by means of functionalities in traffic lights and through vehicle-side assistants. This could lead to a sort of "intersection pilot" which would for example provide information on how a car should ideally enter the intersection, which driving strategy is best employed for long red-light phases, and whether the vehicle should enter a busy intersection at all. Such a pilot would promote driving behaviour that is better adapted to the current traffic situation and the particularities of traffic control systems, reduces emissions and increases both road safety for everyone involved and the capacity of the transport network. In addition to inter-vehicle interaction and traffic simulations, the UR:BAN project is examining the three subject areas cognitive assistance, networked transport systems and humans in traffic.

UR:BAN project

Next Generation Train

Scale model at the InnoTrans trade fair

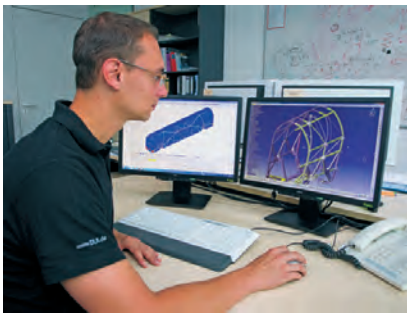
In September 2012, DLR Rail Transport Research presented itself at InnoTrans, the leading international trade fair for rail technology, at the Messe Berlin exhibition centre. The researchers took the trade fair's motto "The future of mobility" literally: as the centrepiece of its booth, DLR exhibited a scale model of the intermediate carriage of a Next Generation Train (NGT) measuring five metres in height and twelve metres in length. Accessible on two decks, it acquainted visitors with the modular lightweight construction concept and the innovative chassis developed by the DLR research project. Steel, aluminium and fibre-reinforced plastics dominate its external appearance. At its core is a framework structure with load-bearing double-shell breast boards in multi-material lightweight construction. These boards structure the carriage body into its various sections through ribs at defined points, creating an entry module, a running gear module and a passenger module. The technical basis for the full-scale implementation of the research laboratory was developed on the computer. The topology was optimised for the entire static load of the carriage body and is designed to enable economic "distribution" of materials under certain general conditions while at the same time meeting safety requirements for high-speed trains. DLR researchers calculated which loads exist at which points of the carriage body, and then determined which materials would best be used for which area. Aspects relating to ease of maintenance and repair were also taken into consideration.

Why synergies for the NGT?

"Vehicle concept, lightweight construction and running gear should not be considered separately from each other. Only by optimally coordinating all sections can we achieve our aim: to transport more passengers more quickly, more energy-efficiently and more affordably while maintaining the same level of safety."

Dr-Ing. Joachim Winter
Project manager Next Generation Train (NGT)
Institute of Vehicle Concepts

The passenger module is in the middle of the carriage. Due to its planar structure and the distribution of loads through the ribs it is particularly predestined for intensive use of fibre-reinforced plastics in construction, which can save up to 30 percent in weight compared to metal constructions. The carriage body is built like a honeycomb tube and also includes a model of the NGT's single wheel single running gear. It features a mechatronic single wheel single running gear with a wheel-based electric motor and a regenerative brake. The mechanical and electrical track guiding system provides an increase in safety and comfort which manifests itself for example in lower wear and tear on the wheelset and the rails and in quieter running of the wheels on the track. Vehicle concept, lightweight construction and running gear are considered as a unit in order to ensure optimal coordination of all sections. This is necessary to achieve the aim of the NGT to transport more passengers more quickly, more energy-efficiently and more affordably while maintaining the same level of safety. The carriage body exhibited at InnoTrans has since been used as a research laboratory to examine issues relating to e.g. air conditioning and passenger comfort.



Construction of the NGT running gear module

Working Together to Improve Punctuality

Intelligent algorithms for railway points diagnostics in use at Deutsche Bahn

Delays in rail travel are still among the greatest annoyances for passengers. Technical failures are the most frequent cause of late trains and a relevant cost driver in railway operations. Since 2009, DLR has therefore been examining the question of how the state of technical equipment can be precisely diagnosed and prognosticated. For railway points, an answer to this question was found when researchers succeeded in quantifying factors that influence points condition. Based on existing monitoring systems for railway points, characteristic patterns were identified that permit automated remote diagnosis of faults. Deutsche Bahn as an infrastructure operator has commissioned DLR to conduct further research and validation. Over a period of 14 months, DLR will be further developing algorithms to process monitoring data. The technology is intended for use throughout the network of Deutsche Bahn.

The focus is on railway points because they are not only essential to flexible operations, but as complex infrastructure elements also prone to failure. In combination, these two aspects mean points become a critical factor. A points failure will generally make more than one strand of rail inaccessible. In addition, the repair process is time- and cost-intensive because it requires travelling to the site, determining the source of the error, travelling to fetch spare parts or tools, travelling back to the site, repair, and a return journey. Precise remote diagnosis results in lower repair costs and shorter outages, which means that travellers can continue on their journey more quickly. DLR is currently working on a reliable status prognosis that would enable timely intervention before a failure occurs. If it could prevent just five percent of delays resulting from points failures, delays would be reduced by approximately 153,140 minutes or about 106 days a year.

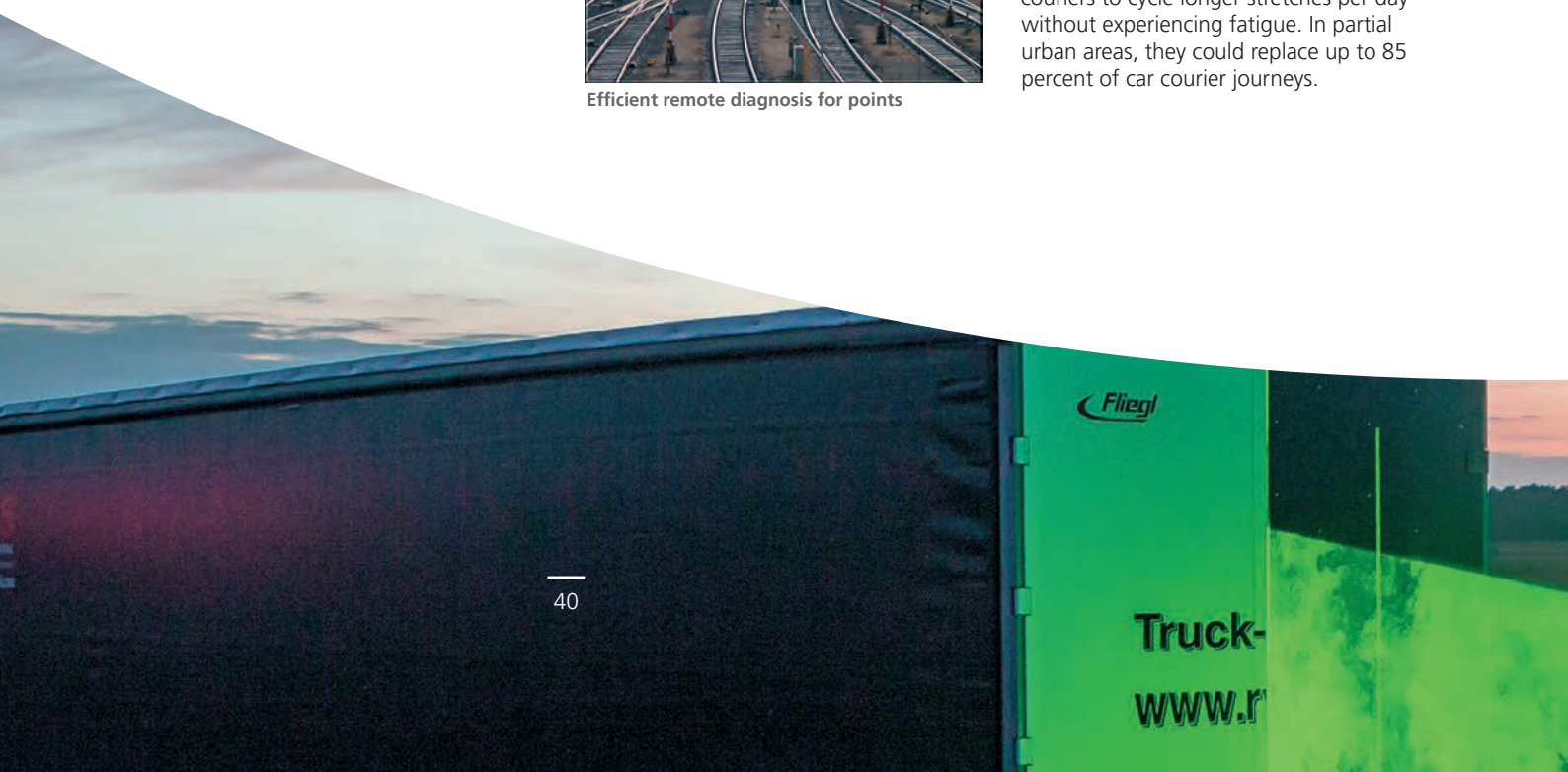
Efficient remote diagnosis for points

Climate-friendly Urban Logistics

Electric cargo bikes as an alternative for courier companies

As part of the national climate protection initiative, DLR is examining how electric cargo bikes can be integrated into everyday urban couriering. 40 electrically powered cargo bikes are currently rolling through the streets of Berlin, Hamburg, Munich, Düsseldorf, Leipzig, Bremen, Nuremberg and Mainz under the motto "I replace a car", taking the place of traditional transport vehicles powered by combustion engines in urban commercial transport. The project focuses on the point at which deliveries by normal bicycle are no longer feasible due to the size or weight of the shipment but it is preferable to avoid the use of cars in order to reduce traffic congestion and CO_2 emissions in large cities. With an electric range of up to 90 kilometres, the electric cargo bikes can carry a payload of 100 kilograms, sufficient for urgent documents, medical samples, spare parts and the like. They also save couriers the cumbersome and often time-consuming search for a parking space.

The advantage of electric cargo bikes over their unmotorised counterparts is obvious: they permit shorter delivery times while at the same time enabling couriers to cycle longer stretches per day without experiencing fatigue. In partial urban areas, they could replace up to 85 percent of car courier journeys.



Climate Protection in Transport

Research project reveals potential until 2030

The project, which is funded by the Federal Ministry of the Environment, thus identifies an innovative way to reduce emissions in urban traffic that are hazardous to health and the environment. The project has met with interest from both vehicle and bicycle couriers: the performance of the electric cargo bikes and potential savings of up to 98 percent of fuel costs make switching to electric cargo bikes a worthwhile alternative for vehicle couriers, while the electric motor would enable current bicycle couriers to compete directly in the market for vehicle courier jobs. Until mid-2014, DLR transport researchers will continue to examine how electric cargo bikes can best contribute to reducing motorised transport in urban areas and thus to achieving environmental and climate goals by posing a whole range of different research questions: Which drivers and obstacles affect switching to electric cargo bikes? How do customers accept being served by electric cargo bikes? Which infrastructures would be necessary in order to reorganise inner-urban deliveries? How can electric cargo bikes be integrated into existing vehicle fleets?

Courier on an electric cargo bike in the city centre

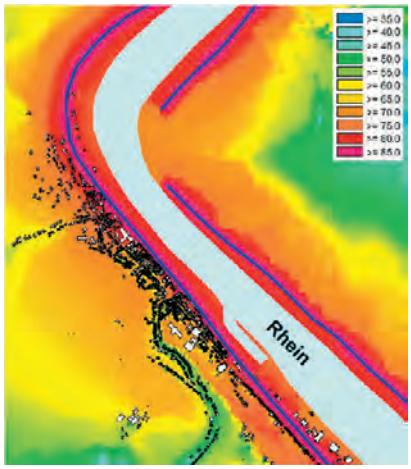
By 2030, the transport sector can cut its greenhouse gas emissions by 37 percent compared to 2005, corresponding to approximately 84 million tonnes of greenhouse gas equivalents. This is the conclusion reached by the Renewbility II research project conducted by DLR in cooperation with the Öko-Institut and the Fraunhofer Institute for Systems and Innovation Research. This level of reduction will however only be achieved if all the measures contained in the corresponding climate scenario are implemented. The most important climate preservation measures include the use of more efficient vehicles, a shift to more energy-efficient methods of transport, optimised transport chains and the use of alternative fuels.

The scenario analyses however also indicate significant differences in the climate protection potential of passenger and freight traffic: in passenger transport, greenhouse gas emissions can be almost halved by 2030; by contrast, freight traffic can only achieve a reduction of just under 17 percent over the same period. Although the specific emissions per transported tonne can be reduced by more than half, this effect is overcompensated by the overall growth in freight traffic. The Renewbility II project, which was funded by the Federal Environment Agency and the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, is an extension of the joint project "RENEWBILITY – Material Flow Analysis of Sustainable Mobility in the Context of Renewable Energies until 2030", based on which an integrative analytical toolset was developed between 2010 and 2012 to map the measures and effects of a future sustainable transport policy and quantify the possible climate protection contribution by the transport sector based on various developments. Representatives of the automotive, railway, energy and logistics industries and of environmental and consumer protection agencies were involved in the process of expanding the models and designing scenarios.

Renewbility II research project

Focus on Traffic Noise

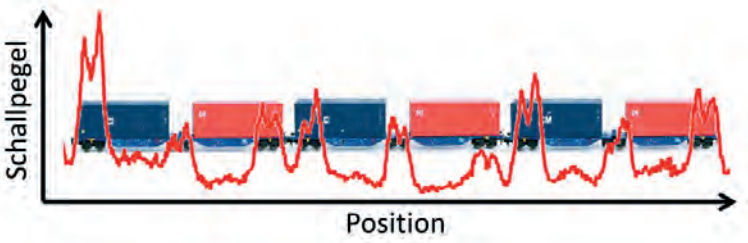
Field study in the Middle Rhine Valley



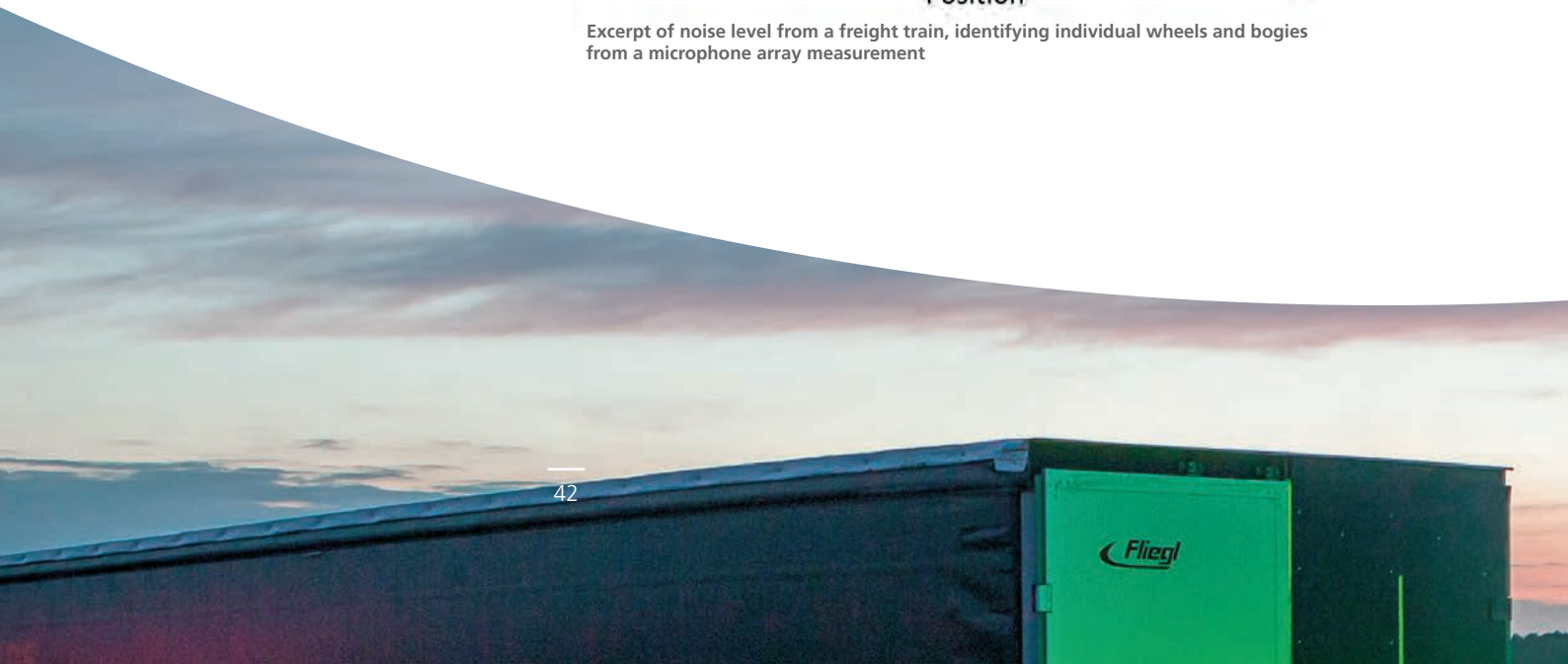
Noise pollution (LDEN) from rail traffic in the Middle Rhine Valley near Oberwesel.

Traffic noise, considered from source through propagation to its effects on humans: in the DLR project Transport Development and Environment, researchers from several DLR institutes examined this complete chain of effects in a field study conducted in the Middle Rhine Valley, where a conflict exists between the valley's role as a main artery for road, rail and inland waterway transportation, its desired attractiveness to tourists and the local population's quality of life. The study, conducted with innovative methods, focused on the noise caused by the numerous freight trains that travel through the Middle Rhine Valley near Oberwesel on both sides of the Rhine.

The sound emissions of these trains were recorded with an array consisting of 19 individual microphones. A delay-and-sum beamforming algorithm enabled researchers to derive focused noise level timelines and the acoustics of individual axles of passing trains. Additional microphones were used to measure sound immission at selected points in the valley, within the town and above the valley. Meteorological parameters were also recorded. With a numerical model, researchers were able to determine the effects of topography and localised meteorological conditions on sound propagation. Finally, the project examined the effects of the noise on residents. A newly developed, cost-efficient EEG, EKG and actometry recording system was trialled on ten test subjects in the town while they slept in order to identify wake-up reactions due to the noise of passing trains. In addition, a survey recorded the extent to which the test subjects felt disturbed by train noises. The long-term irritation experienced by the population due to different sources of noise was determined using a questionnaire survey conducted throughout the town. The measurements, simulations and survey results confirmed a high level of noise pollution in the narrow valley and its surrounding areas. The researchers were able to holistically examine and understand the entire noise process chain using scientific methods. The methodology tested in Oberwesel will contribute to optimising noise abatement measures and assessing transport development scenarios with regard to their noise effects.



Excerpt of noise level from a freight train, identifying individual wheels and bogies from a microphone array measurement



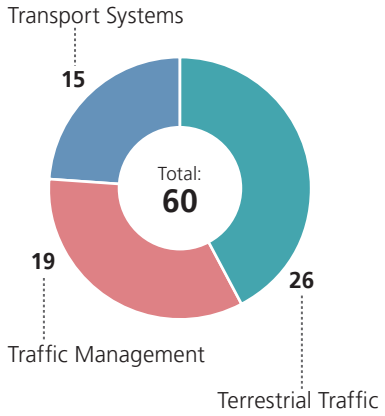
Outlook

The debate regarding alternative engine designs has been accelerated by a major increase in transport volumes on the one hand and more effective climate protection and better resource conservation on the other hand. In this context, significant hopes have for several years rested on electric mobility. However, DLR researchers believe that the customary focus on vehicles and a number of vehicle components is insufficient. Rather, it is necessary to cover the entire relevant spectrum, from the vehicle itself through its integration into the transport and energy system to systems analysis. To this end, DLR is bringing the corresponding research work in its three research areas together in a cross-disciplinary cluster. In addition, DLR is contributing its competencies in this field to the Helmholtz Cross-programme Activity Electromobility, which is coordinated by DLR together with the Karlsruhe Institute of Technology (KIT).

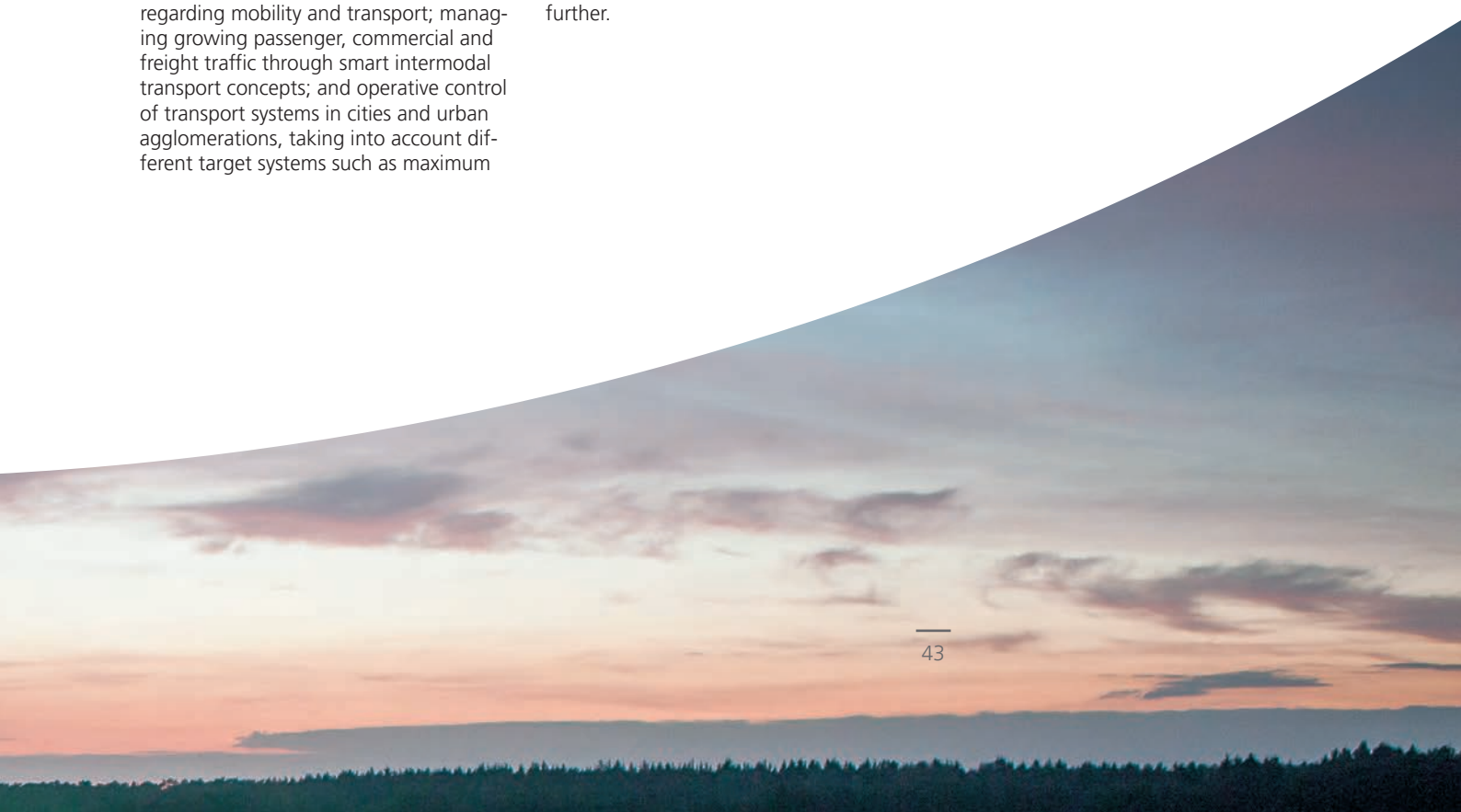
Urban areas form the living environments of most people in Europe today, yet many questions on urban mobility remain unanswered. DLR's transport researchers are working to provide convincing solutions, focusing mainly on three aspects: demographic change and the resulting changes to demands and requirements regarding mobility and transport; managing growing passenger, commercial and freight traffic through smart intermodal transport concepts; and operative control of transport systems in cities and urban agglomerations, taking into account different target systems such as maximum efficiency or minimal noise pollution. DLR believes that transport development and management options along with their effects on the environment, business and society can only be effectively examined through an integral approach. Here too the institutes are combining their competencies and making extensive use of synergies. The Transport programme recently expanded its portfolio by taking up work on noise generated by road traffic and its effects on humans. In this respect, DLR is building on its many years of expertise on the generation, propagation, measuring and effects of noise from rail and air traffic. In the long run, this will lead to an end-to-end methodology for the three above-mentioned modes of transport along the entire chain of effects. In addition, operational aspects will be added to the current research, which is aimed at prognoses and scenarios. DLR's competencies in transport economy are also being expanded further.

Transport: Revenues in millions of euros	2012 Actual	2013 Planned	2014 Planned
Institutional funding	39	42	43
Third-party funding	19	18	19
Total revenues	**58**	**60**	**62**

Expected revenues for the year 2013



All figures in million euros



Energy

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 makes a wide range of contributions in the form of technical developments while also providing orientational knowledge in the form of surveys. 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 these institutes permit complex issues to be examined in a multi-disciplinary fashion and offer the benefits of a wide range of synergies. DLR researchers are currently preparing for the evaluation of the Helmholtz Association's Energy research field, which is due to take place in early 2014.

Centrifugal receiver being tested in the High Flux Solar Simulator

Test facility for thermochemical storage

Hot Particles from the Sun

Solar particle receiver reaches 900 degrees Celsius

A major objective in developing solar thermal power plants is to achieve higher receiver temperatures by using storage-capable heat transfer media. A promising option are directly absorbent receiver systems with particles, where small ceramic particles measuring approx. 1 mm in diameter are heated to high temperatures directly by concentrated solar radiation. This receiver type allows the over temperatures that would otherwise occur in the receiver components to be reduced, increasing its effectiveness. The concept moreover promises cost reductions, as it requires the use of fewer expensive high temperature materials.

In order to maintain a constant outlet temperature under varying load conditions, the mass flow has to be adjusted appropriately as required. The difficulty lies in generating a stable and dense particle film under heavily varying mass flows. The innovative centrifugal receiver concept uses the controlled rotation of a cylinder-shaped cavity receiver to ensure that a particle film that remains optically dense under all operating conditions flows off the interior wall. The concentrated solar radiation hitting the film heats the particles as they pass through.

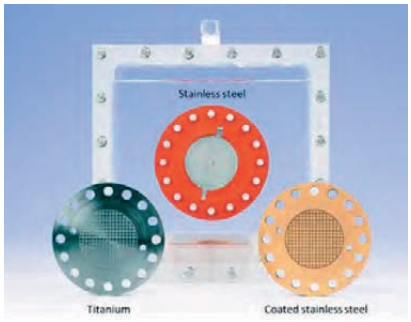
Following preliminary examinations, an initial prototype of a centrifugal receiver for a power range of up to 10 kilowatts was developed and constructed. In a test campaign at the DLR High Flux Solar Simulator in Cologne, particle temperatures of over 900 degrees Celsius were achieved. The test also confirmed that the particle film can be regulated easily and reliably. The test results will now serve as the basis for the intended scaling of the receiver to several hundred kilowatts.

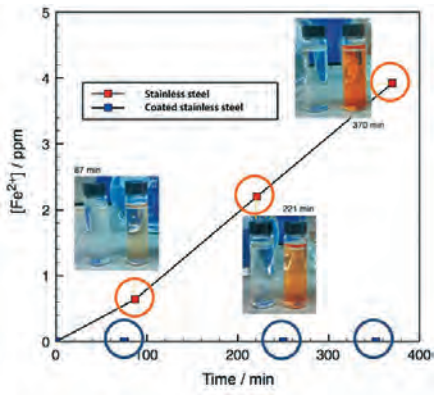
The Lime Trick

Lime stores heat in chemical form at 500 degrees Celsius

Energy stores play a key role in our future energy supply. In industry, stores can absorb process heat so that the resulting thermal energy can be re-used when required. Reversible chemical reactions allow large amounts of heat to be stored in small volumes. If the storage material is also affordable, high-density, high-capacity stores can be implemented at comparatively low cost. The decomposition of slaked lime (calcium hydroxide) into quicklime (calcium oxide) and steam represents such a reaction for thermochemical heat storage in the temperature range between 400 and 600 degrees Celsius. Development of stores of this kind is however in the very early stages.

At the CeraStorE center of excellence in Cologne, a new, flexible test infrastructure with a power range of up to ten kilowatts was designed and installed in order to examine various reaction systems up to 1000 degrees Celsius. Funded by the Federal Ministry of Economics and Technology, the CWS project implemented a heat store for calcium hydroxide with a storage capacity of 10 kWh. It requires approximately 22 kilograms of storage material. With this store, which was based on the concept of a plate heat exchanger, thermochemical heat storage under near-realistic conditions of between 420 and 550 degrees Celsius was successfully demonstrated for the first time. Stores of this kind could be used in solar thermal power plants or for high-temperature processes in industry.





Bipolar plates of a PEM electrolyser made of coated stainless steel instead of titanium (top) and analysis of Fe2+ ions dislodged by corrosion from coated and uncoated bipolar plates over time (bottom)

Full Protection for Electrolysers

Affordable corrosion-resistant bipolar plates for PEM electrolysers

Hydrogen will be an important chemical storage medium for renewable energies in the future. Electrolysers with polymer electrolyte membranes (PEM) can play an important role in gaining hydrogen from excess electricity which offers high power density and gas quality as well as excellent dynamic operating properties. The main components of this electrochemical reactor are bipolar plates with gas diffusion layers, known as interconnects.

These elements were previously manufactured mainly from titanium, as titanium has high electric potential and excellent corrosion resistance in acidic media. However, passively forming titanium dioxide causes increased ohmic resistance and results in limited durability of the electrolyser. In addition, titanium and its mechanical processing are complex and cost-intensive. Stainless steel is significantly more affordable; however, it corrodes when used in PEM electrolysers, poisoning the electrolyser's membrane-electrode unit with discharged ions in the process.

DLR has therefore developed widely acclaimed stainless steel bipolar plates for PEM electrolysers that are covered in a conductive, corrosion-resistant protective layer for acidic environments. Under near-realistic operating conditions, these plates show similar or better properties than titanium-based versions. In addition to protecting against corrosion, they also permit significantly lower material and manufacturing costs compared to titanium interconnects because they can be easily and widely manufactured on an industrial scale.

Steam in Tubes

Solar direct steam generation

In solar direct steam generation, steam is generated directly in the receiver tubes of parabolic trough collectors; this steam can then be used to drive a turbine to generate electricity or for other processes. A first power plant using this technology was constructed with the help of DLR and has been in commercial operation in Thailand since last year.

The plant's design calls for a split solar field, analogous to a traditional forced-circulation boiler:
one part is used to evaporate the water, the other to overheat the generated steam to the required final temperature. A separation tank located between the two separates the excess water from the vaporiser from the saturated steam. This design is very robust with respect to fluctuations in solar radiation and was therefore favoured.

Current research is concentrating on enhancing it and on further reducing the cost of direct steam generation. Similarly to a traditional once-through boiler, DLR

Direct steam generation in parabolic troughs at Plataforma Solar in Spain

aims to develop and demonstrate what is known as the once-through concept. In this design, the solar field is no longer split; instead, the water is pre-heated in a collector loop, vaporised and overheated.

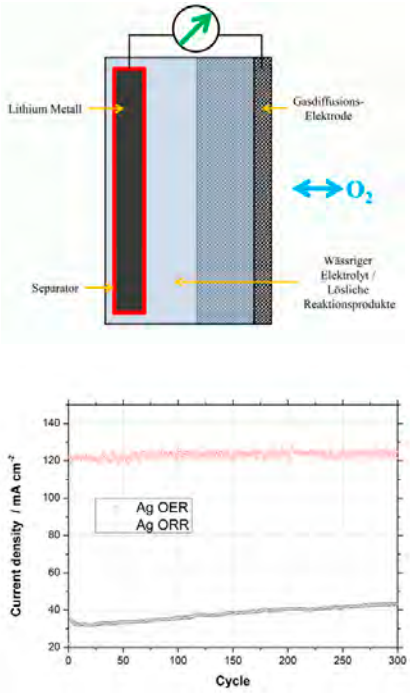
To this end, a parabolic trough loop on the Plataforma Solar de Almería was extended to a length of 1000 metres, and a large-scale DLR investment enabled the installation of measuring instruments to analyse the new concept. In addition, the new system permits promising long-term steam parameters of 500 degrees Celsius and 120 bar at the outlet.

The test loop was taken into operation this year, and initial experiments have been conducted. The current goal is to develop directly commercially viable control concepts for large-scale solar power plants. The main challenges are the high delays between loop entry and outlet, and the low "observability" of the water-steam mixture in the vaporisation area. In the long term, model prognoses of direct radiation are to be included for further improvement.

An Airy Prospect

New batteries enable capacities that almost rival gasoline

Lithium-air batteries are among the promising new battery designs. Featuring capacities five to ten times higher than today's lithium-ion batteries, they could enable significant ranges for battery-driven vehicles. Lithium-air batteries are metal-air batteries and have a metallic anode (lithium) and a gas diffusion electrode as a cathode. Oxygen as a reactant can be taken from the surrounding air directly at the cathode and therefore does not have to be stored in this open battery system. As part of a project titled "Strom aus Luft und Li" (Electricity from air and Li), DLR is developing cathodes for such future lithium-air batteries and working on cell concepts that use a watery electrolyte solution (see illustration). The technical challenges in implementing electrodes of this kind are to significantly reduce electrode losses – known as overvoltages – when charging and discharging, and to improve the long-term stability of these electrodes. This requires catalysts that have a high reactivity both



Schematic of the aqueous lithium-air cell (top) and cycle stability of the new electrodes for oxygen reduction (ORR) and oxygen generation (OER) (bottom)

Prof. Dr Manfred Aigner explains the principle of the FLOX® burner to Baden-Württemberg's Minister of Science Theresia Bauer and Prof. Dr-Ing. Ulrich Wagner, member of the DLR Executive Board

for reducing oxygen (reaction equation from left to right) and for generating oxygen (reaction equation from right to left). So far, promising catalysts have been synthesised through plasma injections, and electrodes have been manufactured in various production processes. Recently, the use of an Ag composite catalyst has significantly reduced the occurring voltage losses (overvoltages) for both reactions, and excellent cycleability was noted for well over 100 cycles, achieving a significant milestone in the project towards technically implementing lithium-air batteries.

Closing Symposium

Power plants of the 21st century (KW21)

On September 24 and 25, 2012, the German research initiative KW21 presented its solution approaches on the energy transition in Stuttgart. KW21 was dedicated to developing low-emission and highly efficient power plants that reliably and affordably generate power from various fossil and renewable resources. In all, over 25m euros were invested in the research association; half of this sum was provided by the states of Baden-Württemberg and Bavaria, and half by industry. The aims of KW21 were to make power plant technology more economic and more sustainable, and to prepare power plants for the challenges of the energy transition. Representatives from politics, business and academia praised the successful cooperation between research institutions and the power plant industry.

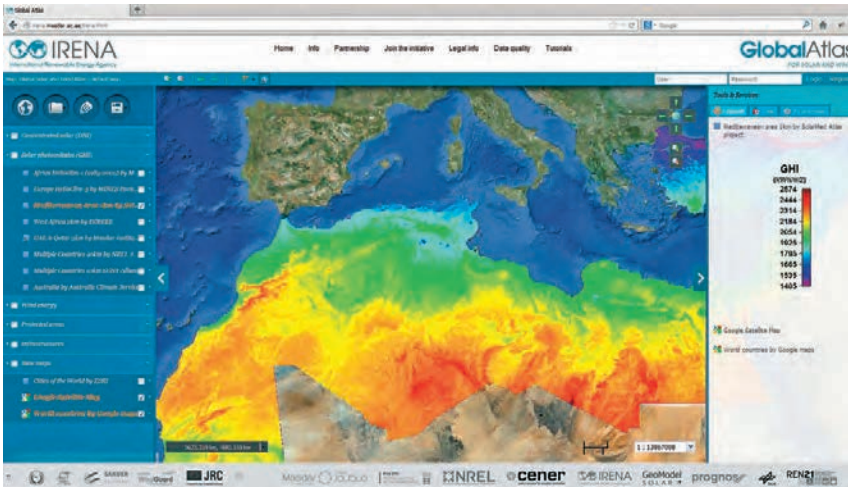
Why does DLR conduct energy research?

A vast amount of research is required to make our energy supply permanently environmentally friendly and secure while keeping it as affordable as possible. For over 100 years, we have been using mainly fossil fuels such as coal, oil and natural gas, and have barely concerned ourselves with technologies for using solar, wind or bio energy. DLR decided early on to apply its skills and expertise from aeronautics and space exploration to energy research. Aircraft engines and power plants benefit when gas turbines are optimised; the aerodynamics of helicopter rotors are useful in designing wind power rotors, and fuel cells can supply electricity for a space shuttle or for a block of flats. Energy research has been a firm component of DLR research since 1976 and contributes to a societal benefit. It is precisely the range and diversity of its abilities that enables DLR to conduct highly successful energy research and create synergies with its other research programmes. Despite its small energy budget, DLR is therefore a highly productive and internationally recognised energy research centre.

Global Atlas of Solar and Wind Energy

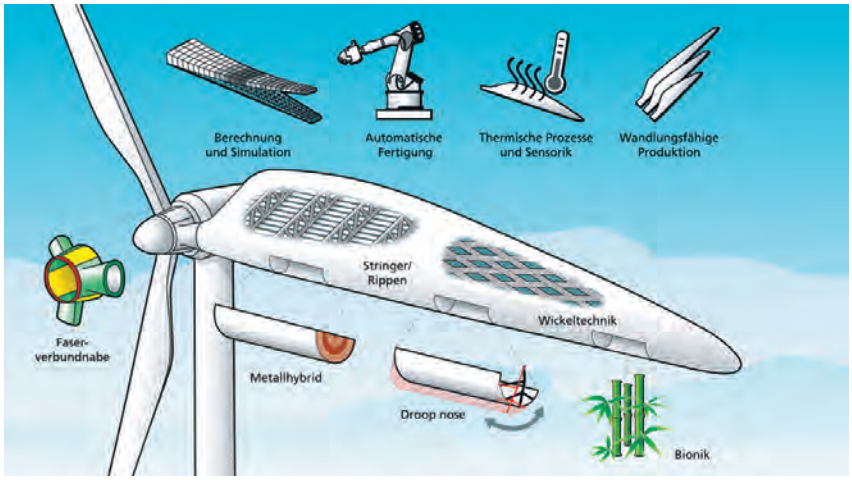
DLR coordinates development of online platform

The International Renewable Energy Agency (IRENA) has published the world's first global atlas of renewable resources at its Council Meeting in Abu Dhabi. The atlas uses databases and maps and is freely accessible on the Internet. With its knowledge of energy systems modelling, remote sensing and geodata processing, DLR has contributed significantly to developing this resource. The global atlas is the so far largest initiative to help countries and businesses determine the potential of renewable energy sources around the world, combining data and maps from leading technical institutions and private companies. Data on solar and wind energy are currently available; information on other resources is to follow in 2013 and 2014. The open and flexible Internet portal was developed under the leadership of the Systems Analysis and Technology Assessment department of the DLR Institute of Technical Thermodynamics. With its knowledge in energy systems modelling, remote sensing and geodata processing, the institute was ideally placed to support the international team of researchers from globally leading institutions. The institutions involved in developing the portal were the National Renewable Energy Lab (USA), Mines-ParisTech (France) and the Masdar Institute (United Arab Emirates). The Internet-based platform is designed to raise awareness of global renewable resources and help countries that want to invest in expanding them.



IRENA global atlas

› www.irena.org/GlobalAtlas



Structure of the planned DLR wind energy research platform

Wind energy research

First large-scale DLR Projects

In the autumn of 2012, a cross-institutional collaboration launched the first large-scale projects for the "Rotor of the Future" at DLR. The project to create a DLR wind energy research platform is supported by the federal state of Lower Saxony and has received 9.8m euros in funding. In a further project that was also launched in late 2012, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety is funding the Wind Energy Research Alliance with a total of 12.6m euros. With a share of 5.2m euros, DLR as a coordinator is conducting research into the development of intelligent rotor blades in Göttingen and Braunschweig. The Wind Energy Research Alliance was founded in January 2013 as a cooperation between DLR, the Fraunhofer IWES and the ForWind Center for Wind Energy Research of the universities of Hanover, Oldenburg and Bremen.

Outlook

The demand for systems analyses to provide policy advice and their practical relevance have increased significantly due to the energy transition. Accordingly, DLR's competencies are highly sought after and largely financed through third-party funding, making it necessary to further increase operational funding in order to expand leeway and enable methodological progress.

DLR's research in the field of high-temperature heat stores, batteries and chemical storage including electrolysis is being expanded further. The work on batteries is taking place in close collaboration with partners at the Helmholtz Institute Ulm. In the field of chemical storage, work on load-flexible electrolysis and on synthetic hydrocarbons for use as fuels is being intensified.

The current results relating to the optimisation of gas and steam turbines show that there is still room to improve the efficiency of electricity generation while also increasing flexibility – both at large-scale power plants and in decentralised facilities. In this area, experimental and numerical work complement each other extremely well. The use of alternative fuels is also being further researched and prepared. Research into fuel cell systems aims to further improve their reliability

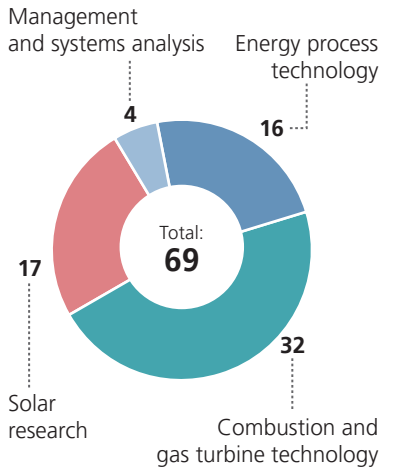
and durability for use in energy supply. The achieved durabilities should facilitate the implementation of pilot plants in the coming years.

The specific advantage of solar thermal power plants lies in the use of affordable heat stores that enable reliable power generation at industrial scales even in periods with no sunshine. Cost reductions in photovoltaics have currently increased the pressure to more quickly implement innovative techniques arising from DLR research in solar thermal power plants. Based on work undertaken with operational funding, DLR wind energy research was able to submit a number of ambitious funding proposals with which it aims to deliver relevant contributions to efficient rotors – in terms of aerodynamics, aeroacoustics and design – in the short to medium term.

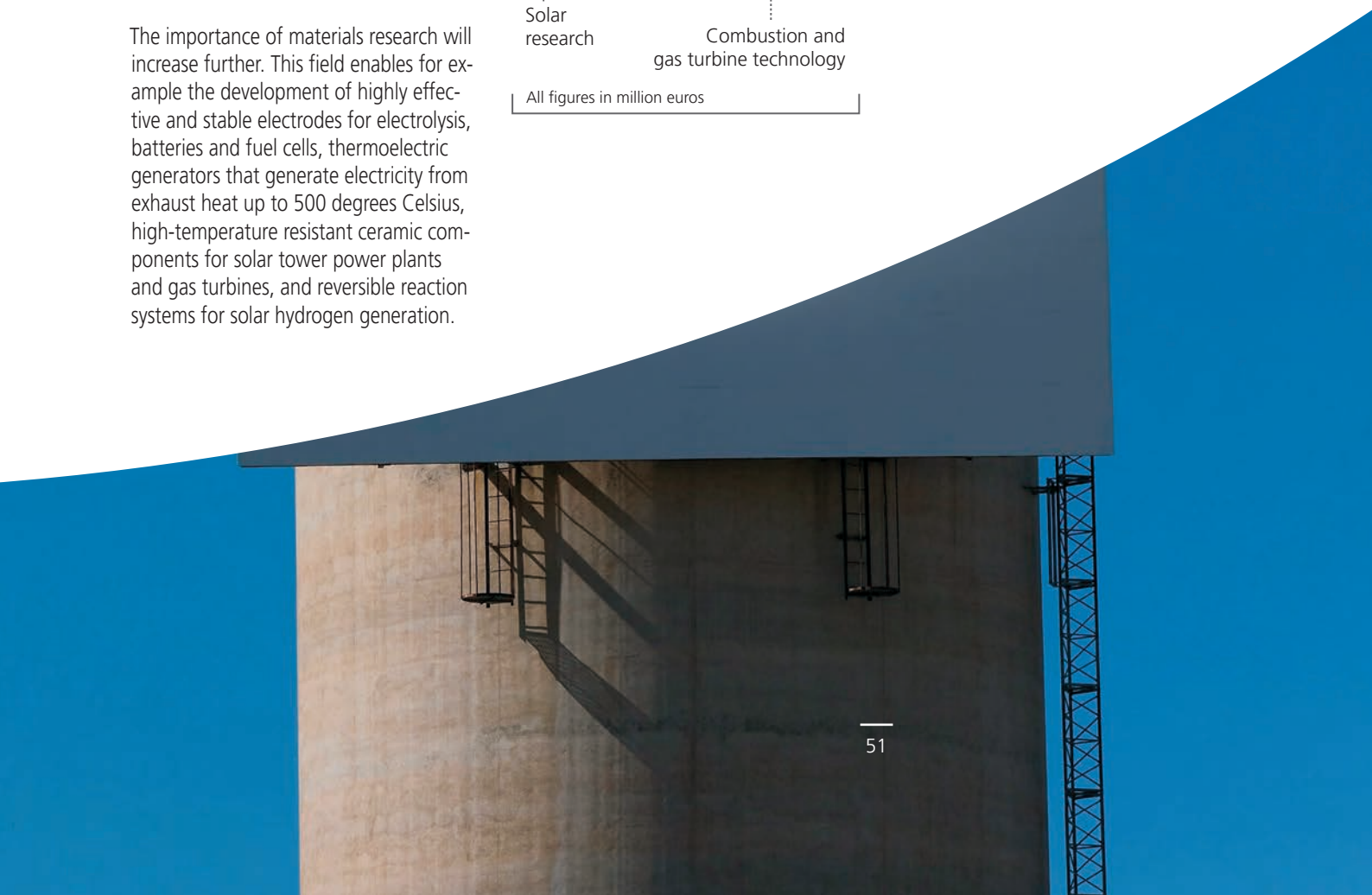
The importance of materials research will increase further. This field enables for example the development of highly effective and stable electrodes for electrolysis, batteries and fuel cells, thermoelectric generators that generate electricity from exhaust heat up to 500 degrees Celsius, high-temperature resistant ceramic components for solar tower power plants and gas turbines, and reversible reaction systems for solar hydrogen generation.

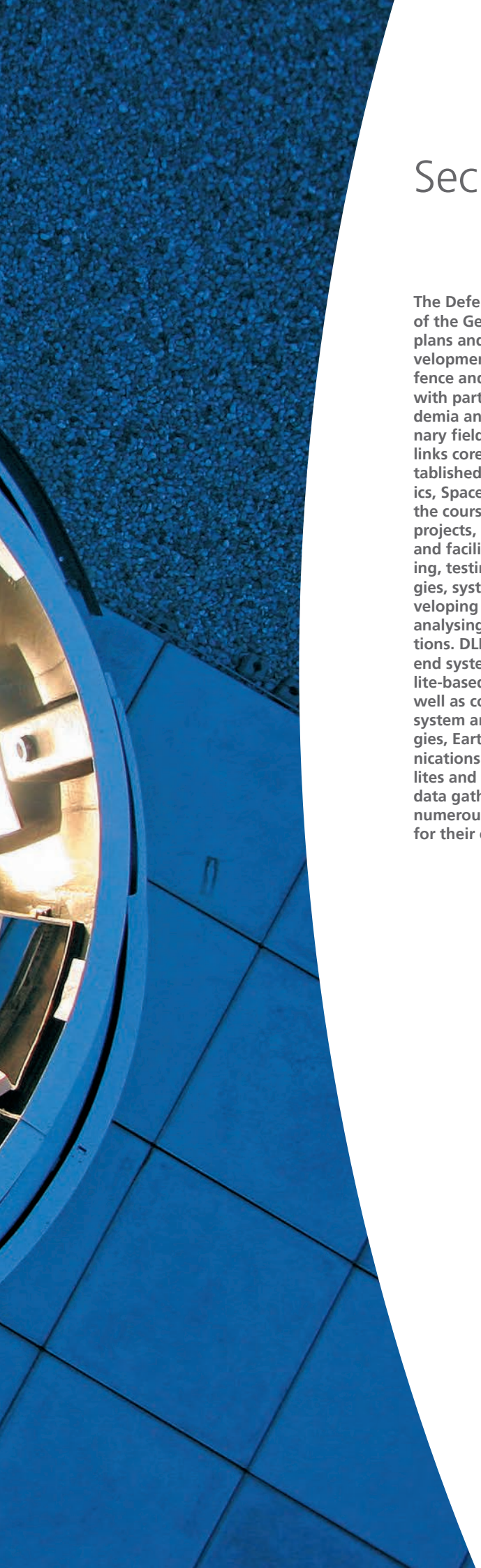
Energy: Revenues in millions of euros	2012 Actual	2013 Planned	2014 Planned
Institutional funding	25	26	29
Third-party funding	40	43	46
Total revenues	**65**	**69**	**75**

Expected revenues for the year 2013



All figures in million euros





Security

The Defence and Security programme of the German Aerospace Center 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 additionally 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 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 following results are examples from the interdisciplinary Defence and Security programme that were achieved in the previous year.

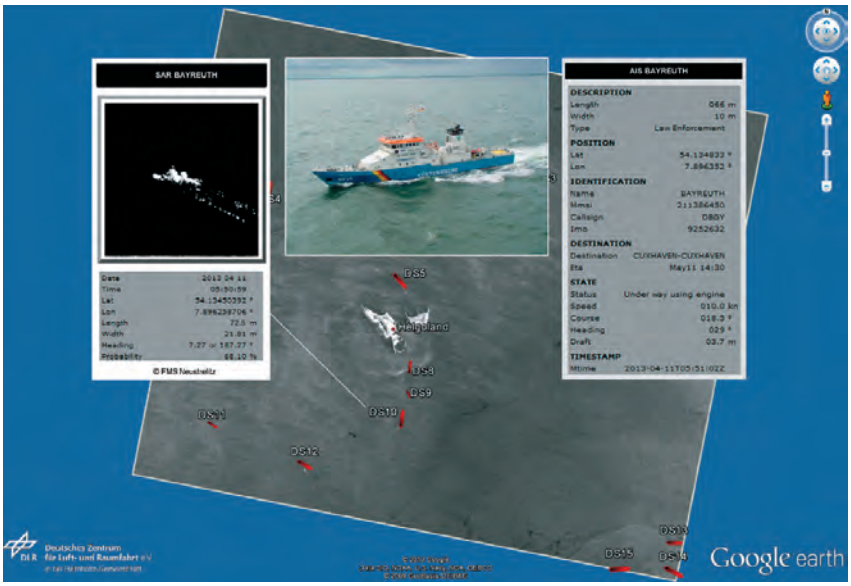
Maritime Security

From space to the ground and towards the sea

The German Aerospace Center develops satellite-based and airborne systems that enable public authorities such as the federal maritime police force Bundespolizei See to expand their existing technologies, allowing them to, for example, better and more quickly identify illegal activities at sea or in coastal areas, or to warn ships of heavy seas.

A key technology here is Synthetic Aperture Radar (SAR), which is used by the German satellite missions TerraSAR-X and TanDEM-X. The SAR satellites can take high-resolution images (up to one metre) of the Earth's surface at any time of the day or night and regardless of weather conditions. These allow the detection of even very small objects, such as containers drifting on the seas, but also smuggling boats or pirate motherships.

The data are transmitted in near real time (< 30 minutes), so objects can be identified and classified and behaviours analysed within the time frames required by public authority users. SAR enables public authorities to respond more quickly to maritime disasters and more effectively counteract illegal activities at sea. The data streams come together in the ground station at the German Remote Sensing Data Center in Mecklenburg-Vorpommern. A state-of-the-art real-time data centre is currently being set up in Neustrelitz which will further improve early detection of possible threats. At under ten minutes, the transmission and availability of the data will be significantly faster in future.



Google Earth view of the TerraSAR-X stripmap mode satellite image with overlaid detected ships (red) and correlated AIS using the BP 25 "Bayreuth" (DS10) of the federal police force as an example. Satellite image analysis and merging with AIS data: Research Centres for Marine Safety (Forschungsstellen für maritime Sicherheit, FMS) Neustrelitz and Bremen.

In the course of an exercise with the Bundespolizei See in April 2013, DLR demonstrated the effectiveness of its technologies in an operation off Helgoland. In various manoeuvres, which also involved dinghies, patrol boats and police boats, DLR researchers proved the detectability of smaller boats and larger ships under operational conditions. The collected radar data from satellites and the recorded in-situ data were subsequently analysed, evaluated against typical threats and successfully utilised.

From research to standard operation

Satellite data for disaster management

The Center for Satellite Based Crisis Information (ZKI, see p. 103) has been fully operational since January 2013. The remit of this service facility, which was established in 2004, includes providing highly topical satellite maps in the event of natural and environmental disasters, to assist humanitarian aid campaigns and for civil defence around the world. On January 22, 2013, the German Aerospace Center (DLR) and the Federal Ministry of the Interior (BMI) officially launched the cooperation for regular operation of the ZKI.

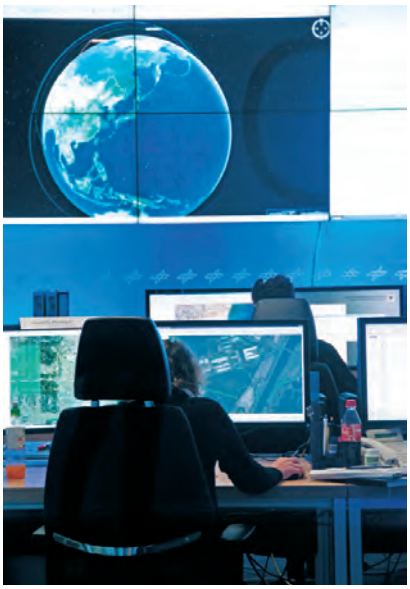
"Civil Earth observation satellites such as our radar satellites TerraSAR-X and TanDEM-X continuously deliver data at a quality that enables entirely new applications. They allow us to map oil slicks on the sea, flooded areas, landslides and building damage from space. The ZKI makes these capabilities available to institutions such as the Federal Office of Civil Protection and Disaster Assistance, the Technisches Hilfswerk and the German Red Cross," explains Prof. Dr Wörner, Chairman of the Executive Board of DLR.

Particularly in the fields of civil defence and emergency management, the ZKI thus provides a long-term response to the increasing demand for current geo information in public administration. The satellite image maps created in the course of its work are made freely available to the public.

"Satellite-based maps can highlight sources of risk, simplify logistical planning and thus enable aid workers to respond more quickly. Precise planning is vital to assisting the affected population, as in the event of a disaster time is the most valuable asset we have. By cooperating with the ZKI we hope to gain time for our emergency responders and support modern and efficient operations planning", says Cornelia Rogall-Grothe, State Secretary at the Federal Ministry of the Interior.

The ZKI has already implemented the first request received under the cooperation agreement: over 40,000 refugees have already arrived at the Al Zaatari refugee camp in Jordan as a result of the ongoing conflict in Syria, and that number is growing every day. In early January, heavy rainfalls caused flooding and destruction in the camp. On behalf of the Technisches Hilfswerk, the ZKI immediately created damage analyses and satellite maps to aid precise assessment of the situation and facilitate optimal coordination of the emergency services.

Employees are on duty around the clock at ZKI to acquire, process and analyse satellite data – not only to support emergency management following civil crises, but also to prepare and follow up on crisis events and to assist public authorities in their administrative tasks, for example in the preparation of large-scale events. In addition, the ZKI offers training and develops remote sensing based services tailored to the needs of users. Clients included in the current framework contract are national political decision-makers, emergency operations centres and aid organisations. The cooperation is also open to participation from other organisations: the first institution to join has been the German Red Cross.



View into the Center for Satellite Based Crisis Information (ZKI)

Cryptography of the Future

DLR technology enables quantum key transmission from air to ground

A successful experiment conducted by the German Aerospace Center (DLR) in cooperation with Ludwig-Maximilians-Universität (LMU) Munich has opened up new possibilities in cryptography. For the first time anywhere in the world, the researchers succeeded in transmitting what is known as a "quantum key" from a rapidly moving object. The quantum data were sent from an aeroplane to a ground station by a laser beam.

Key exchange based on quantum mechanics is considered absolutely secure and impossible to intercept. The encryption method uses quantum mechanical states of individual particles of light. Any interception attempt will disturb the behaviour of the particles and is therefore immediately obvious. However, quantum cryptography is not yet widely used – the data are generally transmitted via fibre-optic cables, which means they can only cover limited distances. The present flight experiment has now shown that the encryption technology can also be used for rapidly moving objects, and integrated into existing optical communication systems. In future, quantum data could also be transmitted worldwide via satellites.

The experiment on quantum key transmission took place in Oberpfaffenhofen using the optical ground station of the DLR Institute of Communications and Navigation and the DLR research aircraft Do 228-212. DLR was therefore also responsible for flight certification and for planning the campaign. For the experiment, a laser system combining a transmitter for data communication with a second transmitter for quantum cryptography was installed on the plane.

The external attachment of the laser terminal is affixed to the fuselage of the DLR research aircraft DO 228-212

The laser light sent from the aircraft was received by the ground station, recorded with specially designed measuring devices and analysed. The detailed results have now been published in the journal "Nature Photonics". The communication laser developed by DLR has already proven itself in previous projects. It consists of two units: on the outside, mounted on the fuselage of the Dornier DO 228-212, is the coarse alignment unit. Its rotating mirror lens is protected by a small glass dome. This unit is complemented by a fine alignment unit in the interior of the plane. Sophisticated sensor technology and very fast-moving mirrors compensate for aircraft vibrations in a frequency range of up to 100 Hertz; this compensation is crucial in order to align the laser beam with sufficient accuracy. In addition, the transmitter is also used for optical tracking, i.e. to automatically track the aircraft. In the experiment on quantum key transmission, the communication laser was also used to transmit a reference signal that enabled synchronisation between the aircraft and the ground station.

The quantum cryptography laser was developed specifically for this experiment by a working group led by LMU physicist Professor Harald Weinfurter. The system is able to generate extremely weak laser pulses and thereby take advantage of the quantum properties of individual light particles, which is a prerequisite to applying this secure encryption technology. For the experiment, the researchers successfully integrated the laser source into the DLR laser system; particular specifications were not required.

Secure key exchanges – today from air to ground, tomorrow from space into the entire world. The current results open up new possibilities in quantum cryptography, as the conditions of the flight experiment and the angular velocity of the aircraft were comparable to communication via satellite. The researchers will be integrating the newly gained insights into new research projects and further developments.

Outlook

In civil defence research, DLR will begin work on the EU project "Driving Innovation in Crisis Management for European Resilience" (DRIVER), which it won in the summer of 2013, in early 2014. The project within the European Security Research Programme is a "demonstration programme for crisis management" involving a total of 40 European partners with a research budget of approximately 46 million euros, of which DLR will receive approximately 2.9 million euros to be distributed among four DLR institutes. Partners include the Fraunhofer-Gesellschaft (Fraunhofer IAO/Stuttgart, Fraunhofer INT/Euskirchen), the International Red Cross and the Technisches Hilfswerk (THW).

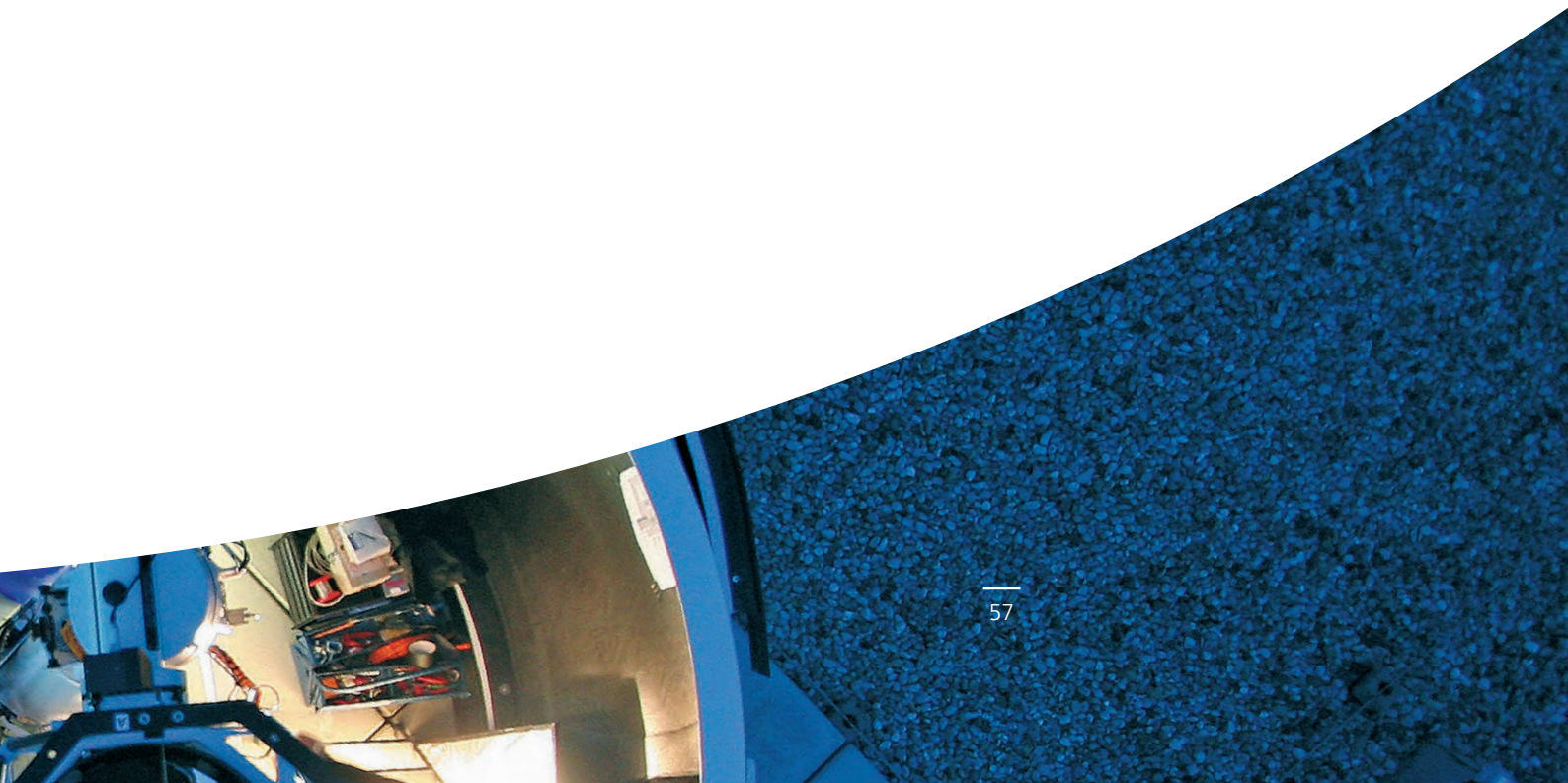
In maritime security, the projects of the research association on maritime operating security that were begun in October 2012 will be expanded further. Of major significance here will be the development of methods and systems to improve maritime navigation and communication. On the joint project "Echtzeitdienste für die Maritime Sicherheit – Security" (Real-time services for maritime security, EMSec) led by DLR, work will focus more strongly on researching and introducing 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.

Why is maritime security important?

In 2012, almost 25 percent of all goods required in Germany arrived directly by sea and thus through the German sea ports on the North Sea and the Baltic; the proportion of long-distance cargo transported by sea amounted to no less than 95 percent. Maritime foreign trade thus accounted for goods weighing a total of 249.5 million tonnes with a total value of approximately 437 billion euros. These figures show how dependent Germany as a strongly export-oriented country with few natural resources is on a well-functioning, efficient and secure maritime sector to maintain its international competitiveness.

Special forces in an operation against piracy

Reliable and undisrupted navigation and communication, improved maritime weather and ice forecasts or an innovative airborne and satellite-based monitoring system that aids emergency responders in the event of an accident or disaster, reducing risks to persons and the environment, contribute decisively to achieving this goal. DLR is therefore increasing its existing research activities in the field of maritime security so it can continue to offer solutions for the new security challenges in maritime transport in the future.



Project Management Agencies

The Project Management Agency in DLR

Whether Federal Government, federal states, industry or foundations, whether institutional or project financing, government or third-party funding, national or EU money – research financing and the ways to acquire funding are almost as varied as Germany's research landscape itself.

An important role in governmental research funding is played by the federal ministries. Among other things, they create funding programmes that are designed to specifically support innovative projects and ideas. A further major source of funding is the European Union with its Framework Programme.

In this kind of research funding, the Project Management Agency in DLR (PT-DLR) acts as a mediator between the Federal Government, industry and research by organising project funding and managing research funds. It supports ministries in shaping funding priorities, informs the scientific community of new funding programmes and advises researchers. It accompanies research projects throughout their funding period and ensures that projects are executed to highest standards and adhere to applicable legal requirements. The Project Management Agency reports regularly to the ministries on a project's progress and on whether the results will be appropriately utilised after the end of the funding period, i.e. whether it will give rise to new products, services or educational structures.

Projects and funds managed in 2012	Number of projects	in millions of euros
Health research	2,270	287
Information technology	1,821	224
Environment, culture, sustainability	1,522	209
Education research, integration, gender research*	1,748	277
European and international cooperation	1,379	43
Innovative capacity and research transfer	743	56
Technical innovation in business	745	69
Years of Science	22	6
Total	**10,250**	**1,172**

* co-financed with ESF (European Social Fund) funds of 53.3m euros in 2011

10,250 projects from all areas of science and research

The Project Management Agency in DLR was able to successfully expand its position as Germany's largest project management agency in the fields of research, development, education, innovation and international cooperation.
It currently manages 10,250 projects and over one billion euros in research funding in the fields of healthcare, innovation, environment, culture, education, key technologies and international cooperation.

The Federal Ministry of Labour and Social Affairs was gained as a new client and commissioned PT-DLR to manage projects on "Inclusion of People with Disabilities". The Austrian Centre for Social Innovation has also for the first time commissioned the Project Management Agency to conduct a feasibility study. The "Environment" department of the Project Management Agency is supporting the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) in its project "Stillegung und Rückbau kerntechnischer Versuchsanlagen" (Shutting down and dismantling nuclear experimental facilities).

The Federal Ministry of Education and Research has again demonstrated its confidence in the Project Management Agency and extended contracts for existing project management, e.g, on "Health Research", on "Empirical Education Research" and on "Global Change" in the field of environmental research. The Federal Ministry of Economics and Technology has extended commissions in the field of "Information and Communication Technologies" and "Electromobility".

Well prepared for the future

Assignments from the European Commission are increasing: in November 2012, PT-DLR won the contract to manage the EURAXESS link networks for European researchers in the USA, Japan, China, India and Singapore and develop a new network in Brazil. The EU Commission cited PT-DLR's "excellent knowledge of the international research landscape and its know-how in establishing research funding programmes in third countries" and its "excellent instruments for quality assurance and quality control" as reasons for choosing the Project Management Agency.

International research collaboration is a feature of almost all areas in which the Project Management Agency in DLR operates, and is also embedded into the department of European and International Cooperation. As a new service, PT-DLR offers further training seminars on international topics such as EU project management, applying for funding, intercultural management and communication.

The Project Management Agency in DLR has further expanded its strengths in the fields of innovation and interdisciplinarity over the past year. For example, it supports the Federal Government not only with traditional project and funding management services, but also by holistically shaping, evaluating and managing innovation processes. With its wide range of subjects, PT-DLR is also well positioned to manage interdisciplinary research projects.

For more information, please see
› http://bit.ly/1bKNOpn

Project Management Agency for Aeronautics Research

The Project Management Agency for Aeronautics Research (PT-LF) supports the Federal Ministry of Economics and Technology (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.

Long-term funding for aeronautics research

With its publication of the Aeronautics Strategy at the beginning of this year, the Federal Government is focusing its activities to create an efficient and environmentally friendly air transport system. 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 civil research funding, the first call for proposals has been issued in the successor programme to LuFo IV, which again provides significant funding for aeronautics research in Germany. Up to 170m euros will be made available for the three funding lines "Ecologically efficient flying", the traditional, cooperative research projects of the "Technology" funding line and the new funding line "Demonstration", which covers projects with a higher degree of technical maturity. The Aeronautics Research Programme thus for the first time spans the entire innovation chain from basic research to the demonstration of fully operational technologies.

The Federal Government is now providing companies, large-scale research institutions and universities conducting aeronautics research with the funding framework to develop urgently required technologies to application-readiness. During the reporting period, the main focus of PT-LF was on supporting ongoing funding projects from LuFo IV and on carrying out the outlines and application phase of all three funding lines in LuFo V-1.

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 aero-

nautics 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 the Federal Ministry of Economics and Technology (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. PT-LF also supports the BMWi in shaping the new EU Framework Programme Horizon 2020 in order to align the goals listed in the aeronautics strategy with the new European funding toolset.

The ERA-NET EU project "AirTN – Air Transport Net" with 28 partners from 18 European countries, which is managed by PT-LF as a coordinator, continues to contribute significantly to coordinating aeronautics research across borders.

For more information, please see
DLR.de/pt-lf/

Project Management Agency for Aeronautics Research: Revenues and funding budget in millions of euros	2012 Actual	2013 Planned	2014 Planned
Revenue			
Third-party funding	3.6	5.9	4.0
Funding budget			
Federal Ministry of Economics and Technology	119.1	147.3	103.5
Ministry of Economics Free State of Bavaria	19.7	12.9	3.9
Ministry of Economics Brandenburg	0.1	0.1	0.0
Hamburg Department of Economics	3.6	4.4	3.0
Ministry of Economics Lower Saxony	20.0	10.0	2.8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ECONOMIC DEVELOPMENT

Results

Third-party Funding

In the reporting year 2011, DLR again saw its third-party funding increase: it rose by a further 35.4m euros to a total of 436.3m euros, reaching a record level and accounting for 55 percent of DLR's overall budget. This excellent result in 2011 was again due mainly to revenues from direct project funding. Project funding from the Federal Government consolidated at the high level seen in the previous year. Revenues from project funding by the federal states increased by almost 50 percent to 46.7m euros in 2011. Of particular note is the level of funding received from the federal state of North Rhine-Westphalia, which has almost tripled in the course of the large-scale projects "AZVT", ":envihab" (see p. 102) and "Start SF", but project funding from Lower Saxony and Bavaria also deserves particular mention, as do the ongoing projects funded through the Economic Stimulus Package II. Its conclusion at the end of 2011 resulted in a further significant increase in revenue.

Funding from the Federal Ministry of Education and Research (BMBF) has declined due to a number of activities coming to a close; these have been replaced with newly approved projects which however have not yet affected revenues. Revenue from project funding provided by the Federal Ministry of Economics and Technology (BMWi) has also fallen.

Income from DFG projects has remained constant, as have other grants. Revenues from projects with German research institutes and higher education institutions on the other hand have increased.

Commissions from the Federal Government and the federal states remained constant, while further increases were seen in project management and the Space Administration.

Third-party funding from German businesses (excluding patents and licenses) fell from 82.7m in 2010 to 79.0m euros in 2011. The proportion of revenues from clients in other countries (profit volume) fell by 3 percent compared to the previous year and came to 21 percent in 2011, although a minimal increase of 0.8m to 29.2m euros (excluding patents and licences) was seen in the "foreign commercial businesses" segment. EADS and its subsidiaries remain the most important of our German and foreign commercial partner companies.

Income from ESA projects fell from 39.8m euros in the previous year to 27.4m euros, due mainly to the conclusion of DLR's participation in the "Galileo Operations" project, which has now been transferred to the DLR subsidiary Gesellschaft für Raumfahrtanwendungen (GfR). As a result, revenue from supranational institutions has also declined overall. An increase in third-party funding was however seen in commissions from foreign government offices.

Revenues from EU projects have again increased by approximately 3.5m euros to 26.1m euros, and thus remain high; the success rate of EU applications in the reporting period of the past three years has however fallen from 36 percent to 31 percent in 2011. At an average of 20 percent, DLR's success rate nonetheless remains well above average. Compared to the previous years, a greater number of applications were submitted in 2011, but relatively fewer were approved. This again indicates that funding volumes in individual projects have increased in recent years. The number of EU coordinator projects has fallen to 18 percent – 4 percent less than the previous year. In absolute numbers however this represents a decline by only three projects.

Third-party Funding	2010	2011	2012
Total revenue from third-party funding	401m euros	436m euros	419m euros
Proportion of overall revenue from third-party sources	54%	55%	53%
Earnings trend in revenue from R&T activities in Germany	-6%	-5%	-2%
Percentage of earnings from foreign clients (profit volume)	24%	21%	21%
Revenue from EU funding	22.6m euros	26.1m euros	26.8m euros
Success rate of EU applications (accepted/submitted)	36%	31%	30%
Coordinator quota on approved EU projects	22%	18%	16%

Research

Alongside the acquired third-party funding, scientific research results made public in print, through talks and lectures are an important criterion of scientific quality. They are of great significance to DLR and their number varies from year to year, attributable mainly to the nature of project work, to staffing fluctuations and to time spent preparing proposals.

During the reporting period, the total number of peer-reviewed publications increased slightly compared to the previous year (see table on p. 66). The number of completed Diplom theses on the other hand has fallen noticeably for the first time in many years, but remains at a high level. The cause of this drop may be a growing number of Bachelor theses, of which 127 were completed in 2012 (no figures were recorded for previous years).

Technology Marketing

The increasing significance of innovation at both national and international levels is undeniable. Calls from policy-makers, society and industry to more effectively transfer new technologies from research to development of products, services and procedures to improve competitiveness and secure jobs have increased further. This is also manifested in DLR's "4*I": invention, innovation, interaction and internationality. DLR has actively committed itself to the challenge of "innovation" and introduced an innovation system in 2012.
Based on this DLR innovation system, DLR Technology Marketing sees itself as a driver and catalyst facilitating the transfer of DLR research results (inventions) into products and technologies on the markets (innovations) and thereby strengthening DLR's innovative performance. Technology Marketing has for e.g. developed and introduced the following processes and tools in order to effectively and transparently implement its core tasks:

- An "ideas portal" implemented throughout DLR
- Promotion of innovation projects such as TransQuer, transfer and demonstration projects
- Strategic innovation partnerships under the trademark "Science2Business"
- Consulting and support for cooperations between DLR institutions and business
- Management of intellectual property rights and licences
- Consulting and support for spinning off companies from DLR
- Business-oriented PR in order to strengthen DLR's profile as a competent technology partner to business

The strategic innovation partnership model (Science2Business) has been expanded to now 22 partnerships, leading to an ever increasing number of market-driven innovation projects. Preparations for further partnerships are underway. The topic "Innovations from DLR" was addressed in four multi-day seminars and two workshops with DLR employees. Demand for further events is growing steadily, and DLR will be expanding them to other DLR sites in the coming year.

To further realise DLR's potential for innovation, the Technology Marketing department organised the DLR IDEA AWARD 2013 – BETTER BUILDINGS, inviting DLR employees to submit ideas for cutting-edge approaches to innovative buildings in order to stimulate new DLR innovation projects. Over 20 ideas were submitted, ten of which are currently being developed further and will be turned into innovation projects if they are considered to offer marketing potential. In September 2013 an award winner will be selected from all submitted ideas.

Research-related results	2010	2011	2012
Publications in peer-reviewed journals	654	721	656
Peer-reviewed publications in proceedings, books, etc.	563	491	647
Talks given at scientific conferences, workshops, lectures*	0.51	0.58	0.56
Appointments to universities	14	17	15
Lectureships	296	295	289
Diploma theses	487	542	438
PhD theses	85	105	109
Habilitations	1	6	3

* per member of scientific staff employed at institutes and facilities

Examples of successful Technology Marketing

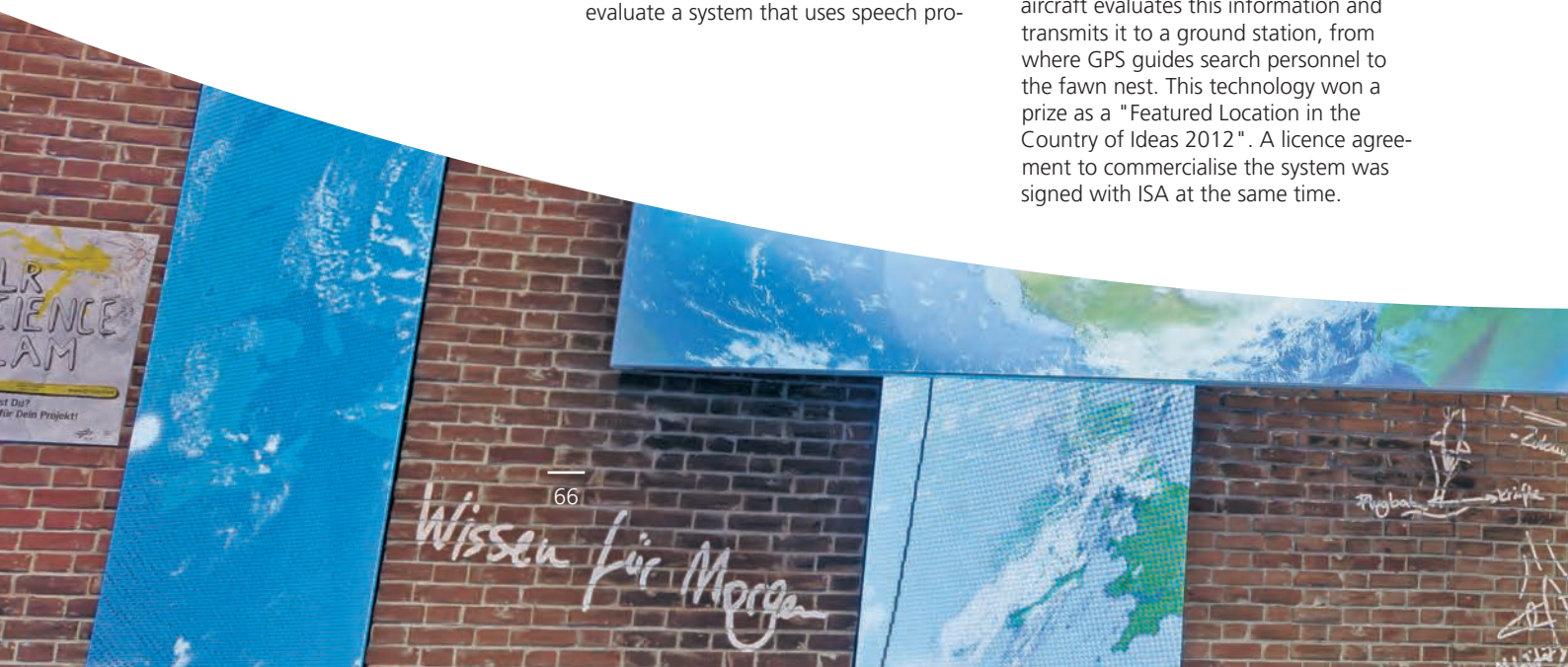
As part of the strategic innovation partnership, the Südzucker food group and the Microwaves and Radar Institute in Oberpfaffenhofen agreed to conduct an innovation project titled "MikroZucker" to develop a new detection process using microwaves. The aim is to significantly increase refining yield in sugar production and thus improve the quality of the sugar product, as sifting processes and permanent magnets are not able to remove all impurities.

The Institute of Vehicle Concepts at the Stuttgart site is using systematically and methodically deployed lightweight construction techniques to develop an innovative design for a high-pressure tank for compressed natural gas (CNG), the "DLR Cellular Tank". In combination with a bonding method suitable for fibre-reinforced plastics, the patented cellular tank design offers new ways of utilising installation space in vehicles at only minimal weight increases. The aim of the project is to develop a complete manufacturing process employing automatable and near-series production processes, and to subsequently validate it through relevant experiments.

In the innovation project "AcListant" ("Active Listening Assistant"), the Institute of Flight Guidance in Braunschweig is cooperating with Saarland University to evaluate a system that uses speech processing to extract information from radio traffic between air traffic controllers and pilots; this information is helpful for improving existing air traffic control systems. The end users will be air traffic controllers who coordinate aircraft during landing, taxiing and take-off. Applications in other fields (e.g. rail transport, shipping, fire services and police) are imaginable.

An example of an immediately economically successful innovation project is "Flatcheck". In this project, the Institute of Aerodynamics and Flow Technology in Göttingen developed a testing system that is able to contactlessly scan large objects with corresponding fields of view at high repeat accuracies and extremely short intervals to measure the smoothness of these objects. Its main application is in measuring and recording large-scale components in the aviation and automotive industries, for which geometric tolerances in the range of hundredths or even thousandths of millimetres are required. The Flatcheck project enabled DLR to acquire six industrial contracts from AIRBUS at a value of 100,000 euros in total over the past two years. As part of a Central Innovation Programme for SMEs (ZIM) project, a cooperation with the company Automation has attracted approximately 120,000 euros in funding for DLR.

In the innovation project "Flying Wildlife Finder", a GPS-controlled flying robot equipped with sensors is sent on reconnaissance flights before fields are mowed. A high-resolution heat imaging camera detects animals in grass due to their higher temperature compared to the surrounding field. A computer on board the aircraft evaluates this information and transmits it to a ground station, from where GPS guides search personnel to the fawn nest. This technology won a prize as a "Featured Location in the Country of Ideas 2012". A licence agreement to commercialise the system was signed with ISA at the same time.



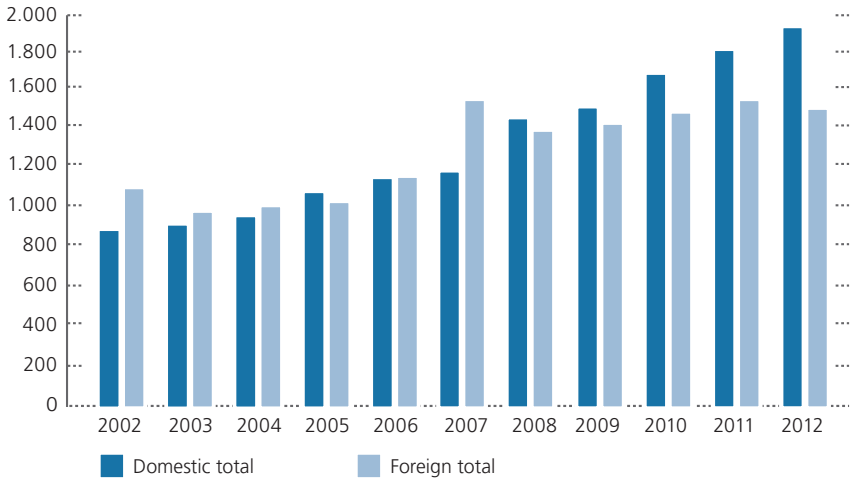
Company Start-ups

DLR's support for company start-ups to accelerate technology transfer in business value creation chains remains highly successful. Funding is now also available for companies whose business is based on DLR technology and which are founded by DLR employees together with external entrepreneurs. The programme is thus better tailored to realistically arising situations in which it is not necessary for company founders to leave DLR altogether if external entrepreneurs – e.g. following a time-limited management phase – take over management while the DLR employees continue to work in research. 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 to achieve technological maturity.

A good example is Aero_DesignWorks in Cologne, which tested the performance of complex software developed by the Institute of Propulsion Technology 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.

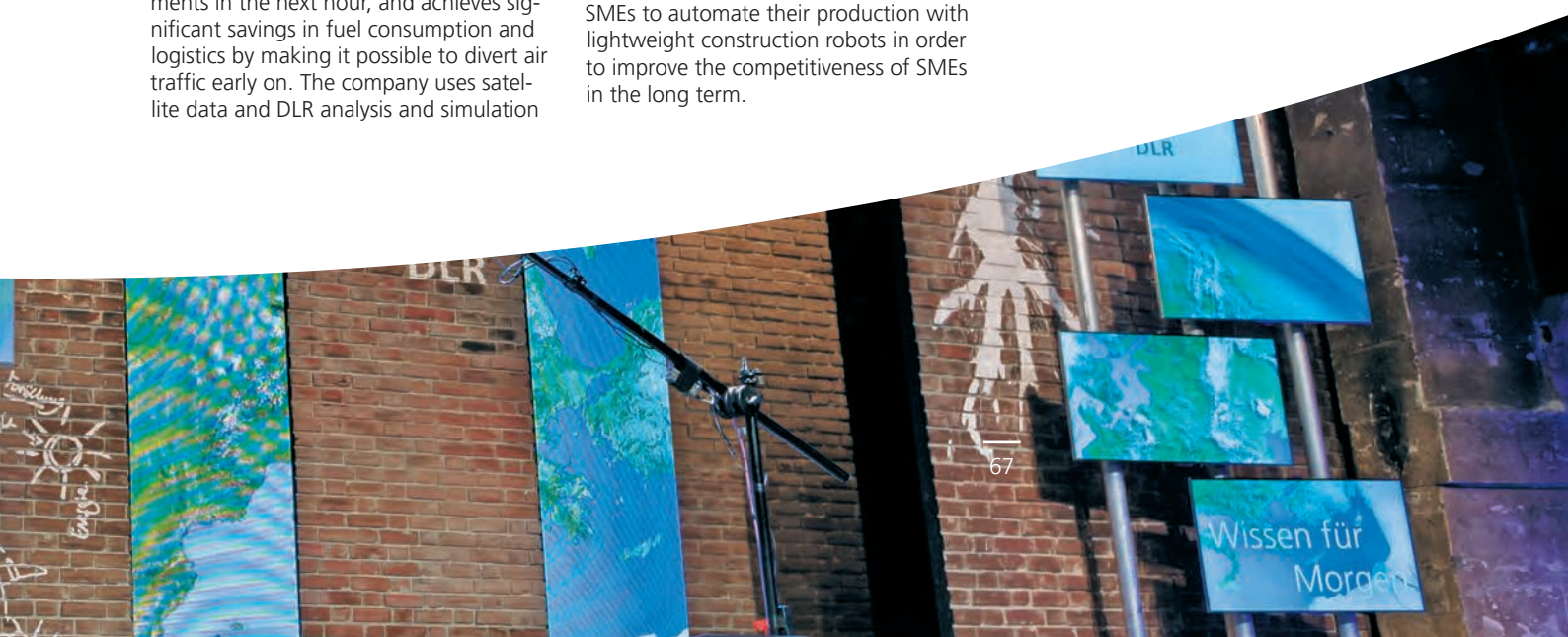
The company WxFusion, a spin-off of the Institute of Atmospheric Physics in Oberpfaffenhofen, provides weather data for pilots, air traffic controllers, airports and airlines on critical weather situations involving electric and other storms which may cause flight irregularities. This reduces the risk posed to aircraft by critical weather situations in very short time frames by predicting weather developments in the next hour, and achieves significant savings in fuel consumption and logistics by making it possible to divert air traffic early on. The company uses satellite data and DLR analysis and simulation programs to provide consistent weather data for all involved parties in the form of images suitable for display in aircraft cockpits and agency consoles, and makes these images available via an Internet portal.

Proprietary rights in Germany and abroad



From the Institute of Robotics and Mechatronics, the company Kastanienbaum produces control software with an entirely new operating philosophy for future lightweight construction robots. 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 the heralded 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 improve the competitiveness of SMEs in the long term.

The WxFusion product in the cockpit



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.

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. DLR's intellectual property rights portfolio now encompasses approximately 3,450 property rights (patent applications and patents in Germany and abroad, including EP and PCT applications) and is thus larger than ever before in the history of DLR. With 296 registrations in 2012, around 13 percent more invention disclosures were submitted than in the previous year.

Why are patents important for DLR?


BUNDESREPUBLIK DEUTSCHLAND

URKUNDE

Patents

All registered patents are viewable by anyone, any time, anywhere around the world via the patent databases at the patent offices, and will remain easy to find there over the coming decades. This preserves the knowledge generated in DLR for future generations of researchers and engineers – with certification from the patent offices that this knowledge was new and innovative at the time of registration and that DLR is the intellectual creator of the respective innovations.

Each accepted patent gives DLR the rights to the protected technology and at the same time the freedom to determine how the technology is used and exploited. This is ultimately the only way to implement one of the core duties defined in the DLR Charter: to create benefit for the general public.

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 2012, ranked 25th with 226 applications (2011: 22nd). The only other research institution on the list is the Fraunhofer Gesellschaft in Munich, ranked 15th. 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 2012.

Licences

In 2012, licensing generated a turnover of approximately 5.2m euros; income from licensing was thus approximately 700,000 euros higher than the previous year, and at its highest level in the history of DLR. This significant income from licensing shows that technologies developed by DLR are in demand and have a high marketing potential.

Structure and Organisation

Technical Infrastructure

Based on the highly successful activities in Construction Management, we are advancing the implementation of an integrated view of sustainability throughout the Technical Infrastructure (TI) organisation. This includes, among other things, resource-preserving use of raw and other materials within TI, but also involves setting standards for implementing sustainability throughout DLR. To this end, TI is for example accompanying a DLR-wide campaign designed to save electricity by changing user behaviour, and supporting the Sustainability steering committee in DLR. Further important key areas of development for TI are energy and knowledge management. To create a holistic energy management system in DLR, a concept for a pilot project is currently being developed as part of a university cooperation. In connection with the DLR-wide EIWis project, TI is establishing an integrated knowledge management system called EIWis@TI designed to meet its specific requirements. The 2012 Fritz Rudorf Prize (see p. 104 ff.) was awarded to the head of the staff department in recognition of her work in consistently aligning the technical service departments to value creation by the institutes and facilities and in developing harmonised processes across all DLR sites and organisations. Within TI, the new Property Management department as a superordinate point of contact for DLR's institutes and facilities is responsible for all facility management issues on the respective sites. Initial results of this change process include the harmonisation of procedures and interfaces, the establishment of a single service number for local issues, the development of a computer-based visitor registration system, and more. In 2013, the department will be focusing on introducing two new cross-site working groups to reshape Area Management and Energy Management in DLR. In Oberpfaffenhofen, Construction Management is currently building a new facility for the Institute of Robotics and Mechatronics, which is to be handed over in mid-2015. The new Augsburg site was inaugurated as planned on May 14, 2013 in the presence of guests from politics and business. On June 28, 2013, a representative building incorporating a museum, rooms for events and meetings and the DLR_School_Lab with the Mittelstufen-Parcours (middle-school course) was inaugurated in the entrance area of the Lampoldshausen site. The building measuring 2,600 m² was presented to the public for the first time on an open day on June 30, 2013, as planned. In Cologne-Porz, the first construction phase of the Energy 2010 project was completed with the construction of the new distribution station. The aim of the project is to ensure that the higher demand

New Augsburg site

Redesigned entrance area of the Lampoldshausen site

Why does Facility Management (FM) in DLR need a change process?

1. Because the more than 80 identified, regularly required FM processes
2. with more than 1,200 associated FM activities
3. are performed by employees at eleven sites with different cultures and structures
4. who as service providers shape direct interfaces to all 32 institutes and facilities of DLR.

As a cooperative service provider and consultant in DLR, Facility Management is responsible for carrying out all real-estate-related tasks and services as well as performing object-specific services. In order to achieve the goal of solution-oriented, reliable support for the core processes of DLR, its procedures and interfaces must be standardised and designed to conserve resources for customers. The FM change process is working to achieve this, and on continuously enhancing a customer-oriented range of FM services.

Quality management	2010	2011	2012
Existing certifications	30	30	29
Number of accreditations	11	11	10
Number of DLR auditors	11	11	14
Audits performed	49%	45%	72%
Space Administration supporting projects	23	26	33

for energy resulting from extensions and expansions to individual research facilities can be met. Since the beginning of the year, DLR internal planning has included basic funding for the Technology Systems House to introduce new technologies and drive their further development to serve the purposes of the DLR institutes. This basic funding is currently being used to implement efficient and systematic further development of the lasercusing and compound fibre technologies in view of future projects with DLR partners. The commitment by the Technology Systems House to increasingly involve itself in third-party funded projects is yielding initial positive results which are currently being implemented.

Quality Management, Product Assurance, Standards

Quality Management

Ensuring quality in science and research is an important corporate goal of DLR, which we are working to achieve with the help of a quality management system – a method that is currently still unusual in research institutions. Our company-wide quality management system is a unique feature within the Helmholtz Association.

DLR's intentions in implementing it are to continuously enhance our competitiveness and customer retention, to further stabilise our legal position, and to increase our efficiency by standardising our operating and management processes. The international quality standard for management systems, DIN EN ISO 9001, was specified as the minimum standard, and all institutes and facilities across the board are expected to qualify for certification soon. By the end of the reporting period, 25 facilities had established quality management systems, while a further 25 are currently in the process of setting them up.

Certificates resulting from management systems are the result of audits 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 and also has sector-specific certificates (VDA 6.2, ISO 13485, OSHAS 18001, ISO 14001, DIN ISO 27001) in some partial systems.

DLR has accredited laboratories at its Simulation and Software Technology facilities and holds approvals from the Federal Aviation Office.

A further significant factor is that certifications and accreditations are becoming increasingly important in successfully acquiring third-party funding.

In 2012, DLR met 72 percent of its audit plan; in 2013, it had already met 40 percent of its audit plan during the first half of the year. DLR currently employs a total of 18 auditors; a further 39 are now in training in order to expand the basis for performing internal audits by increasing the number of qualified personnel.

All institutes and facilities have a quality representative or named contact in the Working Group of Quality Representatives (AKQ). During the reporting period, DLR continued to modernise its existing quality management system. The plan to systematically organise DLR's management processes has stalled, but remains in development.

DLR is a member of the European Foundation for Quality Management (EFQM). Several aspects of this "Business Excellence" are consistently implemented at seven DLR facilities in order to further improve existing systems. DLR provided two assessors to the European Business Excellence Award last year. The courses offered in this area by the DLR internal training programme proved popular with employees over the past year, and DLR now has a sufficient number of employees qualified to support the self-assessments of its institutes and facilities.

Product Assurance

Product assurance ensures success. In space exploration, its purpose is to assure all technology-related activities throughout the manufacturing process of a product, as well as the associated services from initial conceptual design to its ultimate disposition after decommissioning (space debris). In the role of a client, product assurance represents technical controlling as a complementary function to commercial controlling. The shared aim of these controlling functions is comprehensive risk limitation.

To minimise costs, the focus is on generating quality by assuring processes and procedures rather than by testing quality to assure products.

In handling commissions, product assurance at the German Aerospace Agency is organised not in the manner of a producing company, but in the manner of an engineering company that mainly executes commissions and acts fully on its own responsibility.

The standards for necessary product assurance are the European space standards (European Cooperation for Space Standardization – ECSS). The overall national product assurance requirements catalogue ensures that the European ECSS system is consistently applied throughout.

In product assurance, the E-Nose makes an important contribution to the health and safety of the crews of manned space objects. The electronic gas sensor system detects the qualitative and quantitative microbiological load caused by bacteria and fungal cultures.

E-Nose electronic gas sensor for detecting microbial contamination on the International Space Station ISS

In contrast to the traditional method of swipe sampling followed by processing in an incubator on Earth, the E-Nose enables rapid analysis of the situation directly on location. Following the successfully completed experimental phase on the International Space Station ISS in the spring of 2013, a further possible area of use has emerged: molecular gas analysis of breathable air could make this method standard for ongoing health monitoring of the crew, providing a non-invasive method that enables high repetition rates and could replace the expensive and complex mass spectrometers currently in use at a fraction of the cost.

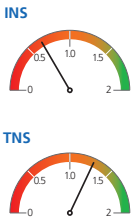
Standardisation

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, standardisation is also such an instrument. It helps open up markets and aids fast market access for innovations. Standardisation is increasingly being incorporated into research and innovation processes in Germany and Europe.

DLR has set itself the goals of achieving competitive advantages, pro-actively opening up areas of growth and intensifying international cooperations. At European and international levels this is achieved in large part by implementing research and work results through standards and norms.

Standardisation of research results within DLR is carried out alongside research and development work at the various institutes and facilities. It is coordinated and supported by the Standardisation department.

Why is DLR involved in developing standards?



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 Economics and Technology since 2007 and 2010 respectively.

The aim of this involvement 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. At the same time, actively participating in standardisation allows DLR to position itself as an interesting technology partner for German industry, and thus actively shape Germany's technological and economic development.

Qualifying EEE components for space flight

EEE components comprise both active and passive electronic, electrical and electromagnetic components ("EEE") which in space exploration are subject to particular demands regarding reliability, service life, vibration resistance, radiation resistance and temperature fluctuations, and must be qualified accordingly. EEE components account for as much as 30 percent of the hardware costs of a space flight system. 50 percent of the strategic components whose functioning is key to the performance capability and reliability of space flight equipment or systems are manufactured in the USA and subject to US export restrictions. As a result, the availability of EEE components for national space exploration projects is severely limited.

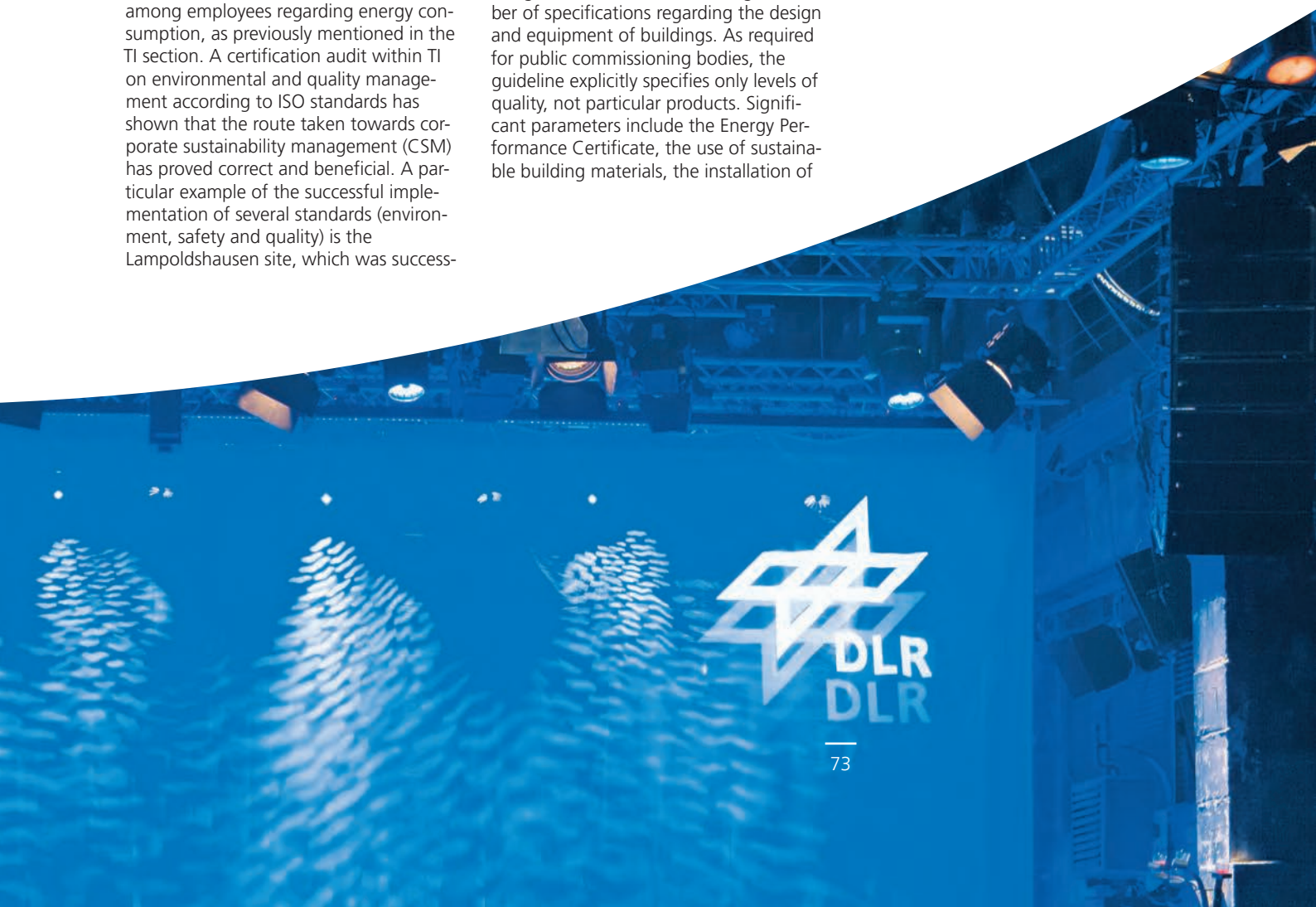
In order to increase the availability of EEE components from European sources, DLR defines and implements the national Technological Development and Qualification Programme for EEE Components and works with national component manufacturers to develop and qualify these components. In collaboration with European partners it has thus been possible in recent years to reduce dependency on US exports from 70 percent to 50 percent.

In 2013, DLR conducted nine evaluation and qualification projects relating to EEE components with a total budget of approximately 2.4m euros.

Environmental Protection and Safety

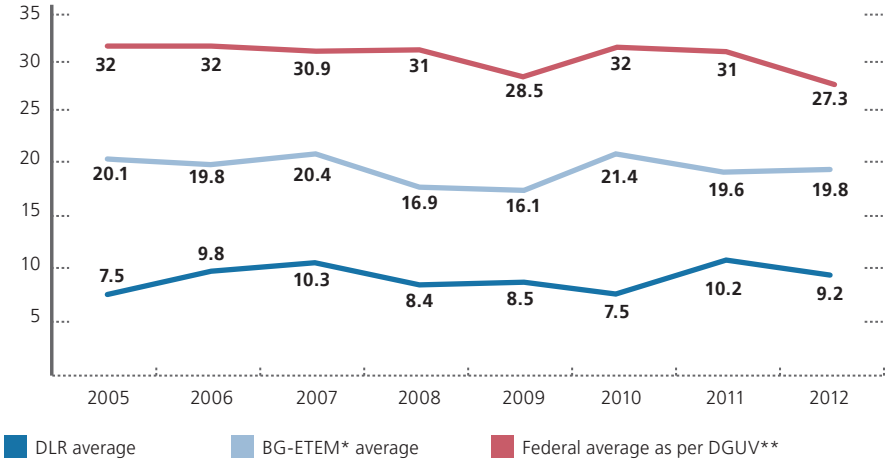
Environmental Protection

DLR not only conducts research for sustainability, it also conducts sustainable research. Now that the DLR guidelines on sustainability have been communicated at the sites, the corresponding activities are gaining momentum. Aligned to the German Sustainability Code, DLR is developing a procedure that is appropriate to academic research. A specially founded steering group coordinates the activities within DLR. Technical Infrastructure supports these DLR-wide developments and itself sets goals for the specific implementation of sustainability in its field. These include sustainable construction, certifying facilities as pilot projects, or conducting special projects of a sustainable nature such as raising awareness among employees regarding energy consumption, as previously mentioned in the TI section. A certification audit within TI on environmental and quality management according to ISO standards has shown that the route taken towards corporate sustainability management (CSM) has proved correct and beneficial. A particular example of the successful implementation of several standards (environment, safety and quality) is the Lampoldshausen site, which was successfully certified according to DIN ISO 9001, 14001 and 18001 again this year. At the turn of the year, staffing levels for the integrated management system in TI and in environmental protection in DLR were increased. Greater emphasis is to be placed on strategic aspects with the aim of implementing environmental protection in all relevant processes and at all relevant sites. Environmental targets and environmental performance indicators are being developed to aid in managing and controlling corporate processes and to enable links to the other dimensions of sustainability. In the above-mentioned field of sustainable construction, the Guideline for Designing and Equipping Buildings has been mandatory for DLR Construction Management since November 2012. It stipulates that social, ecological and economic factors are to be considered and harmonised throughout the building's life cycle. In addition to the economic use of funds, this also includes ergonomics, accessibility, energy consumption and resource protection. The guideline also includes a large number of specifications regarding the design and equipment of buildings. As required for public commissioning bodies, the guideline explicitly specifies only levels of quality, not particular products. Significant parameters include the Energy Performance Certificate, the use of sustainable building materials, the installation of energy-efficient products, halogen-free cables, pipes and artificial foams, to name just a few. Waterless urinals and photosensory mixer batteries for the washbasins are used to reduce water consumption, while bicycle racks are provided to promote better health. Additional environmental goals have been developed by Construction Management and will soon be included in training in fields such as reducing sealed surfaces through active area management, promoting green roofs, raising awareness of hazardous materials and contamination risks during construction and demolition work, and stricter adherence to environmental goals when instructing external companies. Environmental protection is thus becoming better established in Construction Management at DLR and creating synergies with the topic of sustainability.



Accident trends at DLR

1,000 person accident rate (working and commuting accidents per 1,000 members of staff)



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

Health and Safety

In the course of its continuous improvement processes, DLR is currently working intensively to optimise operational risk assessment. The higher staffing levels in DLR Health and Safety occasioned by the DGUV V2 permit better support from occupational health and safety specialists for the responsible managers in this important safety process. In addition, risk assessment documentation is to be replaced by a software-based procedure that supports effectiveness reviews, follow-ups to implemented measures and updating of risk assessments. DLR Health and Safety believes this modernisation will increase efficiency and effectiveness, which ultimately improves occupational health and safety for the entire staff. In addition, DLR expects it will have positive effects in the fields of fire prevention and environmental protection, which also benefit from efficient risk assessments. In this reporting period, awareness of safety and environmental protection was again continuously raised among managers and staff in order to create a safe working environment and remind employees to use resources such as water and energy responsibly. Measures included management seminars, training for specific target groups and specialised information events such as the Health Days at DLR, which offer health checks in cooperation with internal and external occupational healthcare professionals and information on health-related topics such as fitness and nutrition.

A further priority during the reporting period was the further development of DLR Crisis Management. The Crisis Management Handbook for dealing with crises was developed further. A draft version of the first (static) section has now been drawn up ready for discussion and company-wide adoption.

In 2012, DLR recorded a total of 68 notifiable accidents, of which more took place in the workplace (38) and fewer (30) during business travel or commute. There was again no fatal accident in this reporting period. Severe injuries requiring long periods of sick leave were also very rare; most of them involved complicated fractures. An average of 15.1 working days were lost per accident, and thus fewer than in the previous year. The majority of occupational accidents were falls, trips, cuts, abrasions and stab injuries.

The comparative indicator "accident ratio per 1,000 persons", which is important for DLR, was 9.2 at DLR in 2012 (previous year: 10.2) and thus relatively low. The figures from 2008 onwards have been corrected because accidents relating to travel were not included in the calculation basis. For comparison, the "accident ratio per 1,000 persons" recorded by the trade association "Energie Textil Elektro Medienerzeugnisse" (Energy, Textiles, Electricity and Media Products, BG-ETEM) among its members amounted to 19.8 in 2012 (19.6 in the previous year), while the Germany-wide average fell from 31 in 2011 to 27.3 accidents per 1000 insured persons in 2012.

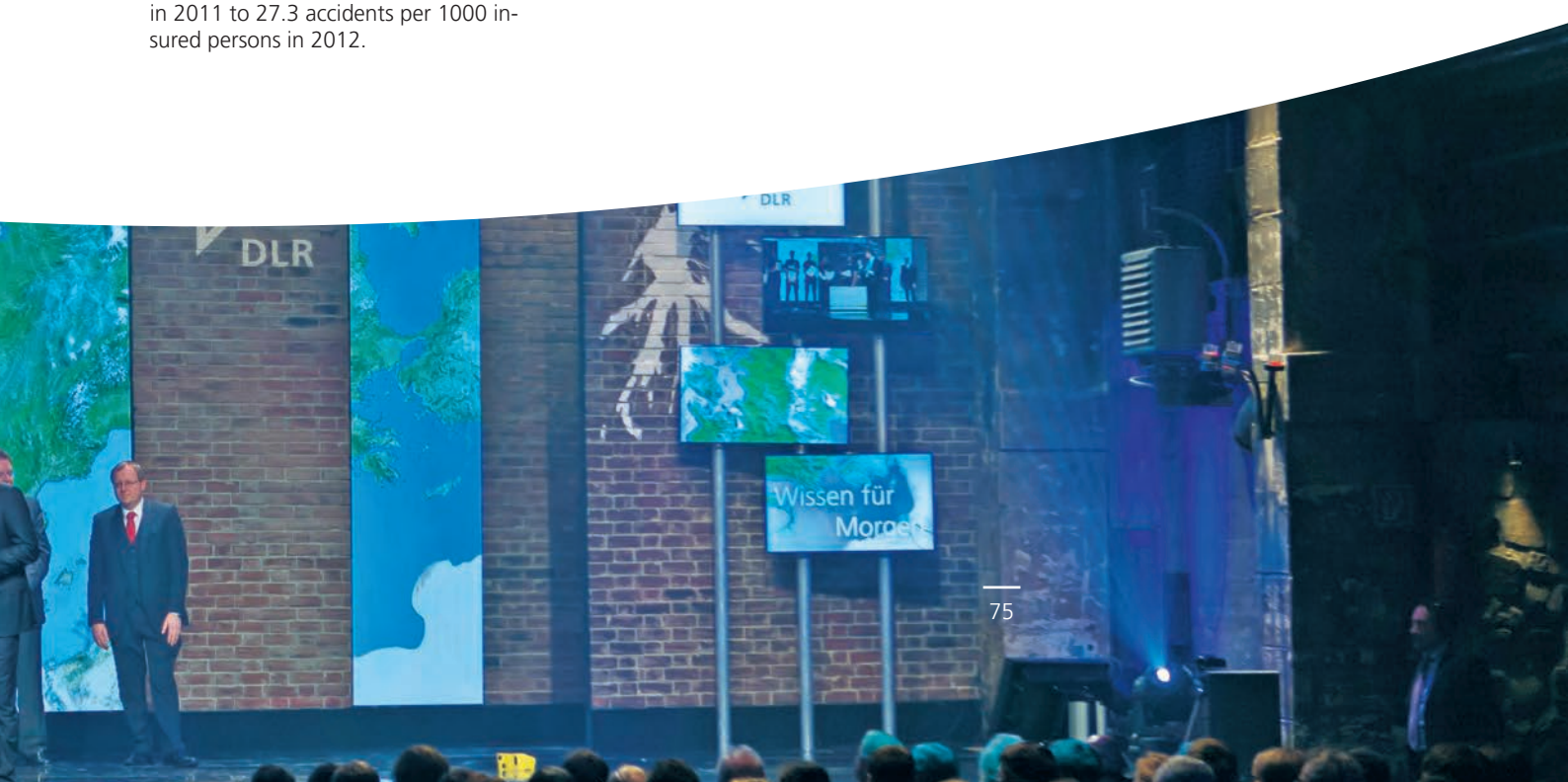
DLR Center of Excellence

The DLR Center of Excellence (CoE) is an internal scientific competition within DLR. The competition is not aimed at individuals; instead it rewards cutting-edge research conducted by working groups dedicated to large-scale research topics. The title DLR Center of Excellence can be awarded to institutes, facilities or organisational units, but also to cross-disciplinary working groups in DLR. The title is associated with a research budget of 500,000 euros over three years, which can be used as the winning group chooses. After this three-year phase, an evaluation is conducted which in the event of a positive assessment permits the current DLR CoE to retain the title for a further three years. The extension period is also funded with a total of 100,000 euros. The funding and the title end after a maximum of six years.
In 2012, the DLR Institute of Transport Research won the award for its research into improving the scientific basis for describing the functionality and future development of the transport system and its effects on the environment, society and the economy. This research focuses in particular on evaluating possible measures to limit undesirable side effects.

Decisive factors in awarding the title to the researchers working on this interdisciplinary research topic were the criteria of internal and external networking, doctorates, teaching activities and third-party funding. The DLR CoE 2011 on the topic of alternative fuels has the opportunity this year to retain its title for a further three years if positively evaluated.

The aim of the award is to honour and expand recognised top-class research. Internal networking and the creation of synergies outside institutes' own areas of expertise are of particular importance. The competition promotes major objectives of DLR's overall strategy: high expectations of quality and excellence, active subject-related networking policies designed to expand national and European leadership positions in its key research areas, and active technology marketing.

The competition has an extremely beneficial effect on the development of DLR and will certainly be continued in the future.



Partners

Presence on social networking sites, here facebook

The proud winners of the Science Slam with the Chairman of the Executive Board

DLR Corporate Communications

DLR's public outreach activities are the central focus of DLR Corporate Communications in all matters. They include media and press relations, cross-media public relations, planning, management and organisation of events, corporate identity and internal communications. The target groups of DLR Corporate Communications are the public, the media and decision-makers in politics, industry and science, as well as DLR staff.

DLR in the press

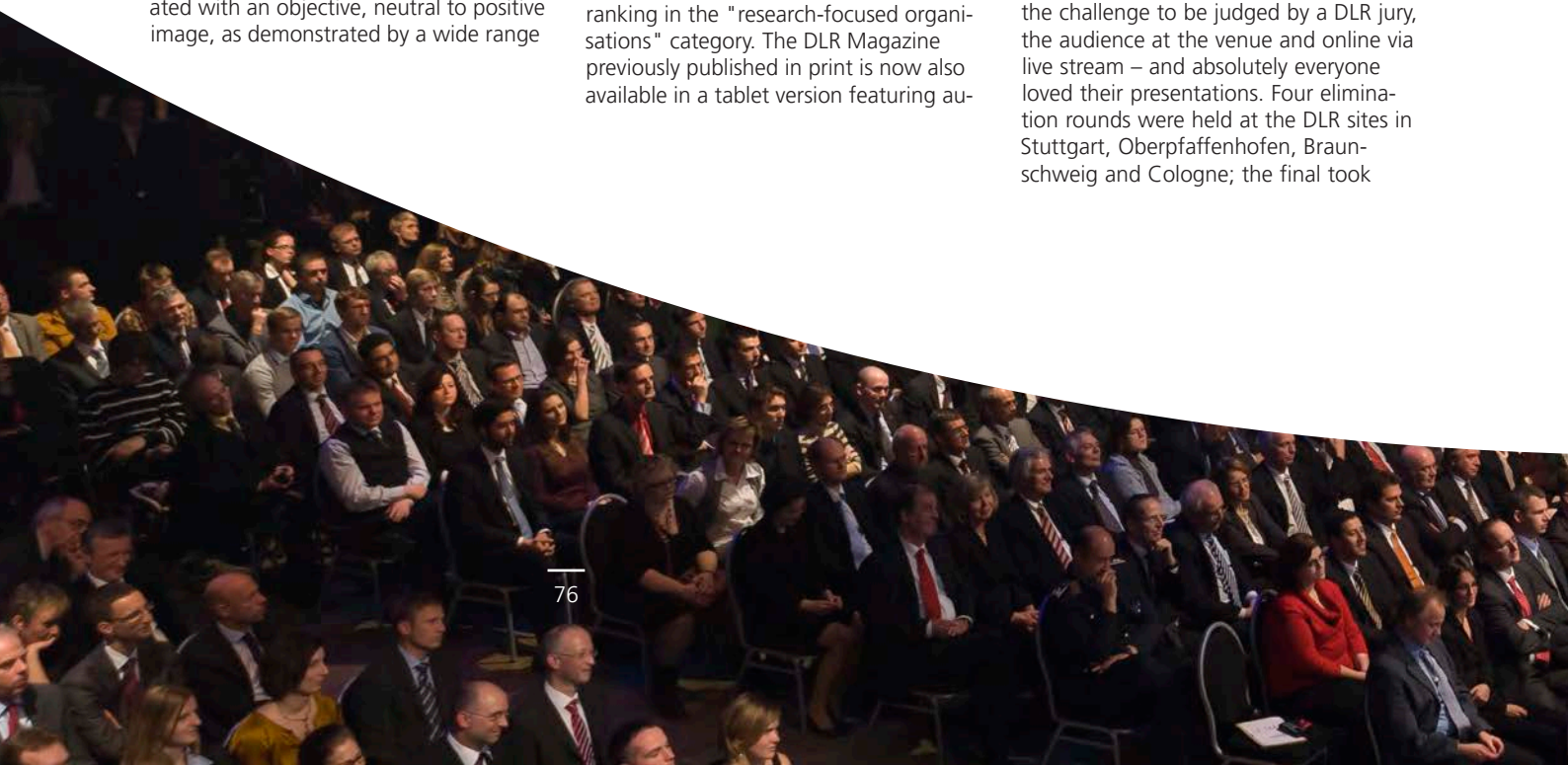
DLR's analyses show a stable media presence, with approximately 4,000 articles in all forms of media. These are associated with an objective, neutral to positive image, as demonstrated by a wide range of media requests for DLR to assess and evaluate current events and developments. Of particular interest to the media is current news from DLR that has societal relevance or includes local or regional aspects. Over 50 percent of all articles adopted DLR's press releases almost in their entirety; the same applies to our formulated core messages. This speaks to a continuously high transfer quality of the press releases we published.

Cross-media

DLR's website was visited 500,000 times in each month of last year, resulting in approximately 1.8 million page impressions. The number of people following DLR on social networks such as Twitter, Facebook, YouTube and Flickr is growing steadily. Last year, DLR's social media activities won first place in the Pluragraph ranking in the "research-focused organisations" category. The DLR Magazine previously published in print is now also available in a tablet version featuring audio, image and video documents. We also introduced CC-BY licensing, making it easier to use DLR-owned images and increasing reach both online, in particular on Wikipedia, and offline.

DLR_Science_Slam

Live bands, juggling, songs, dance numbers, live experiments, installations and a passion for research all featured heavily in the presentations by the 21 teams at the first DLR_Science_Slam, an internal science competition for the best (popular) science presentation of a DLR research topic; what counted was content, comprehensibility and originality. How and by what means the topics were presented was left entirely up to the participants. The only restriction: they had just ten minutes each. In all, 42 people from 20 institutes and facilities accepted the challenge to be judged by a DLR jury, the audience at the venue and online via live stream – and absolutely everyone loved their presentations. Four elimination rounds were held at the DLR sites in Stuttgart, Oberpfaffenhofen, Braunschweig and Cologne; the final took



Reception in Bonn-Oberkassel

Discussing the future of space exploration: Eugene Cernan with Prof. Dr Johann-Dietrich Wörner, Prof. Dr Hansjörg Dittus and Klaus-Peter Willsch MdB

place at DLR's Annual General Meeting with over 600 guests from science, industry, politics and society in attendance. For more than twelve weeks, the DLR_Science_Slam was the number one topic around the water coolers at DLR – earning DLR a nomination for the International German PR Award in the "Internal Communications" category.

Events

DLR Corporate Communications organised and held over 40 events in the past months. On behalf of the Executive Board, these included DLR's participation in the ILA Berlin Air Show and InnoTrans in Berlin, and the International Astronautical Congress in Naples. We also supported local and regional highlights at the DLR sites such as open days, foundation stone ceremonies, openings and commissionings, as well as visits from high-ranking representatives of politics, industry and science, such as Federal President Joachim Gauck. We also provided staff and organisational support for DLR's participation in national and international trade fairs and conferences.

Political and Economic Relations

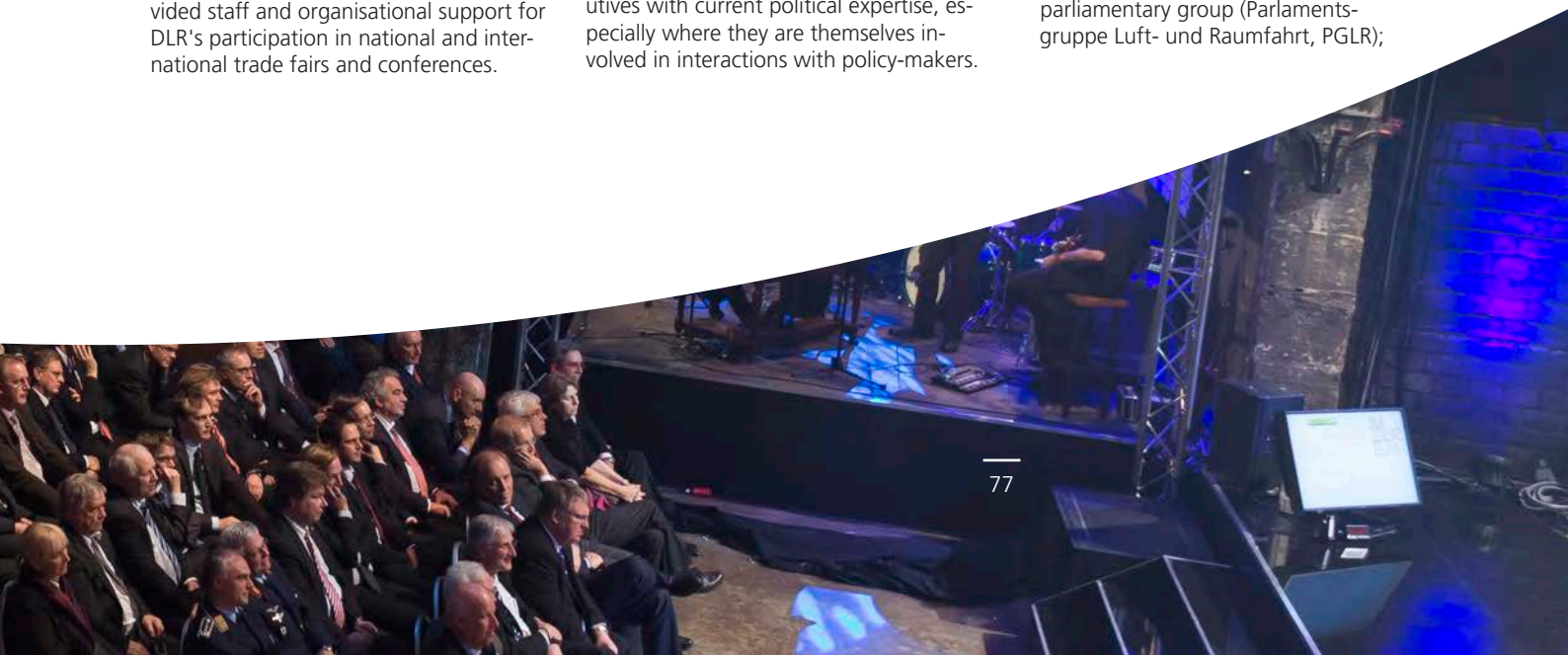
DLR's political and economic relations are based mainly on direct talks held in particular by the Chairman of the Executive Board with leading politicians at national, regional and local levels.
During the reporting period, talks on innovations, technology transfer, facilitating cooperations within the German and international research landscape, and matters relating to the Academic Freedom Act formed the core of the department's remit.

Externally, themed panels on these topics were organised in the German Bundestag; these activities also included presenting specific research results from DLR and their applications in everyday life to staff and advisors of the members of the Bundestag.
Internally, the job is to provide DLR executives with current political expertise, especially where they are themselves involved in interactions with policy-makers.

Political and Economic Relations also employed the traditional tools of political marketing to initiate various information events, and generated specific political marketing products that conveyed DLR's research areas and their innovative potential to DLR's core target groups of policy-makers, business, industry and the community in a target-oriented fashion.

The following is a list of selected activities:

- Numerous site visits by ministers, secretaries of state, federal and state parliamentary delegations and leading representatives of municipalities and/or municipal institutions of the federal states where DLR operates facilities. Further organised have been visits by members of the specialist community to the German Bundestag, such as visits from high-ranking representatives of NASA (e.g. working lunch with NASA astronaut TJ Creamer) or the visit by Member of the Bundestag Klaus-Peter Willsch, chairman of the Aerospace parliamentary group (Parlamentsgruppe Luft- und Raumfahrt, PGLR);



- On the occasion of the ESA Ministerial Council, organization of a parliamentary evening where controversial topics on the Council agenda, such as funding for ISS from 2013 onwards, further development of the Ariane rocket, development and operation of GMES, ExoMars and Lunar Lander were discussed under the motto "The ESA Ministerial Council 2012: Chances and Challenges for Space Exploration in Europe";

- Increased support for the Aerospace parliamentary group and its chairman, Member of the Bundestag Klaus-Peter Willsch, e.g. at the European Interparliamentary Space Conference (EISC) or Mr Willsch's appearances at conferences such as the 29th National Space Symposium in Colorado Springs in the USA, and during the subsequent talks with NASA and the German Ambassador in Washington D.C.;

- Supporting the German delegation in negotiations with the ESA Ministerial Council, at the International Astronautical Congress (IAC) in Naples, supporting DLR management in interactions with policy-makers at the Berlin Air Show (ILA) and in hosting a dedicated parliamentary day in connection with the Berlin Air Show;

More information:

Political and Economic Relations

- Addressing policy-makers through unusual formats and activities, e.g. informational fly-alongs on parabolic flight campaigns, including a dedicated project "Art Levitates" with world-famous artists, scientists and politicians. Providing information on key areas of DLR's work to policy-makers in state-of-the-art video clips, some of which were produced in 3-D;

- Corporate publishing in cooperation with the publisher of the Kürschner Handbücher Deutscher Bundestag and co-publication of the volumes Kürschner Luft- und Raumfahrt and Kürschner Energie;

- Researching and compiling the "Berlin-Bulletin", which summarises the most important information from the sessions of the German Bundestag pertaining to the research areas of DLR and makes it available to DLR management;

- The Space Foundation and DLR founded the US-German Aerospace Roundtable (UGART). The MoU also includes an agreement on supporting a parliamentary exchange programme between the two countries, coordinated by the Politics and Economic Relations department. The initiative was launched with, among other things, a meeting between the chairman of the Aerospace parliamentary group, Member of the Bundestag Klaus-Peter Willsch, and his counterpart, Congressman Steven Palazzo, in Washington D.C.

In the field of economics, limited personnel resources meant that only a small range of activities was conducted. These focused on cooperations and internal collaboration with DLR Technology Marketing, as well as external cooperation with Chambers of Trade and Commerce. The intention is to further expand cooperations between DLR, politics and business at federal state level – initially in NRW.

Helmholtz Association of German Research Centres

DLR is a member of the Helmholtz Association of German Research Centres, an association founded in 2002 to implement the previously institutional funding programmes of the ministries through the process of programme-oriented funding. In six research fields, the legally independent member centres compile their activities in programme applications that are subject to international evaluation every five years. The activities of the individual centres in each research field are in competition with each other. The programme applications are based on research policy guidelines from the ministries. Five-year funding awards are made by the ministries to the individual participating centres on the basis of votes. DLR as the only centre with research in aeronautics, space and transport is the sole competitor in the associated research field. In the Energy research field, DLR has to compete with seven other centres. Alongside organising the process of programme-oriented funding, the Helmholtz Association is tasked with performing joint lobbying on issues relating to the Association.

Programme-oriented funding

Following an intense period of three evaluations for the Aeronautics, Space and Transport research field, DLR was certified to be conducting internationally leading science. The votes for the three programmes gave DLR management important pointers as to how its globally networked research activities can be developed over the next five years. The head office of the Helmholtz Association, which organised the evaluation on behalf of the funding ministries, will derive

funding recommendations for the coming funding period from the votes. It appears likely that the activities of the Transport programme will be especially increased in order to more appropriately reflect its current societal importance. The level of funding for 2016 to 2018 however depends on the outcome of the debate on continuing the Research and Innovation Pact. The current Pact 2 ends in 2015 and guarantees a further increase of 5 percent until then. DLR's success in the Aeronautics, Space and Transport research field encourages us in our activities in the Energy research field, which will be evaluated in the coming year. Along with the established topics of power plant technology, solar research and storage, DLR will be submitting applications on wind energy. Rounding off our portfolio will be systems analysis activities, which not only offer indicators for the programmatic selection of topics in DLR, but also contribute to political and societal opinion-forming.

Initiative and Networking Fund

During the reporting period, DLR was successful with many smaller applications. Alongside four post-doc fellowships and two international cooperations there were also two larger successes. DLR received funding firstly to lead a junior research group on high-temperature management in hypersonic flight, and secondly for a spin-off measure in the field of predicting meteorological hazards for aircraft.

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.

Each year, the DLR institutes supervise more than 900 postgraduate students working on their PhD theses, while a further 400 students complete their Diplom theses at DLR facilities. The number of DLR researchers holding lectureships has increased significantly in recent years, reaching a peak of just under 300 lectures, tutorials, seminars etc. at universities and universities of applied sciences in 2010; this level was maintained in 2012.

National and European networks	2008	2009	2010	2011	2012
DFG participations	33	34	38	31	35
Sponsorship agreements	49	41	32	33	38

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 20 times, in Priority Programmes twelve times, and in Research Training Groups three times.

Sponsorships

Sponsorships are a successful instrument for rapid technology transfer through individuals and also enable highly qualified young talent to be secured for research and development in science and industry. The structure of a sponsorship is that the company takes on half the costs of training a young researcher, who is employed by DLR for a period of between three and four years to work in areas of equal interest to DLR and the company. A portion of this time is spent at the company. In 2012, a total of 38 sponsorships were overseen at DLR, which represented a slight increase compared to the previous year.

European Networks

7th EU Framework Programme

At the time of reporting, DLR was involved in 1168 project applications (203 of which coordinated by DLR), of which 459 (89 of which coordinated by DLR) had been approved. This corresponds to a success rate of 39 percent (44 percent DLR-coordinated) and is thus significantly higher than the general success rate.

Preparing Horizon 2020

Having actively accompanied the decision-making process for Horizon 2020, the first EU framework programme for research and innovation, DLR is now, after the legislative process has been concluded, actively involved in preparing the calls for proposals and implementing Horizon 2020 both in direct contact with the Commission and through its membership in European groups and associations. Together with Lower Saxony state secretary Dr Lange, Prof. Dr Wörner invited high-ranking personalities from German and European politics, the EU Commission, academia and research to attend the traditional New Year's Reception in Brussels, which was held on January 29, 2013 and titled "From Invention to Innovation". The reception took place in the lavish rooms of the Representation of Lower Saxony, which provided an appropriate setting for the event.

Cooperation with NLR

On June 17, 2013, the German Aerospace Center (DLR) and the National Aerospace Laboratory of the Netherlands (NLR) signed an agreement at the Paris Air Show in Le Bourget to cooperate on CFRP research. The two research organisations will work together to further develop production techniques for lightweight construction components used in the aeronautics and transport sectors. Both partners are already working on new methods for future CFRP construction techniques that contribute to lower fuel consumption and thus to reduced CO_2 emissions. The cooperation will focus on automated fibre placement/tape laying techniques, robot assisted manufacturing processes, autoclave technology, high-volume components, and virtual process planning and control.

Cooperation with ONERA

The ONERA-DLR Aerospace Symposium "ODAS 2013" took place from May 27 to 29, 2013, at ONERA's Paris/Palaiseau site, this time on the topic of "Propulsion". The purpose of the symposium, which was held for the 13th time this year, is to bring together doctoral candidates and younger researchers from both organisations in order to promote both scientific and staff exchange between DLR and ONERA.

Cooperation with CNES

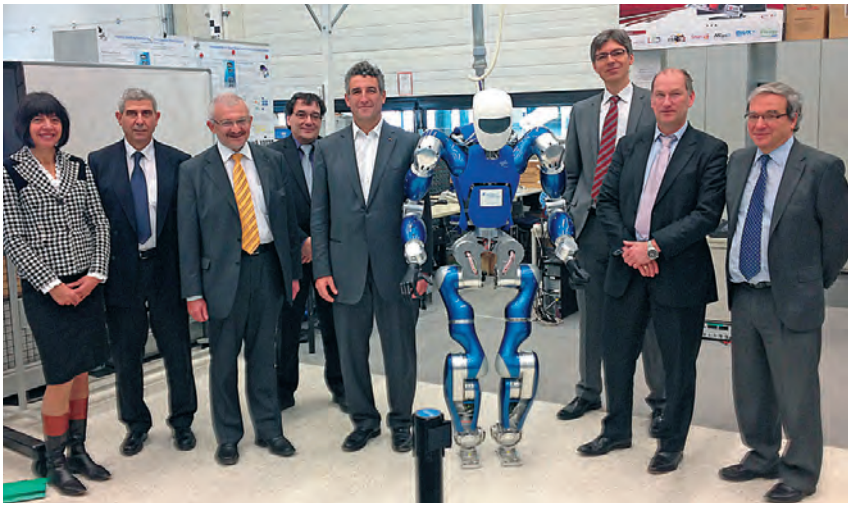
On April 26, 2013, new CNES President Jean-Yves Le Gall made his inaugural visit to DLR Chairman Prof. Dr Wörner in Cologne-Porz. This visit was followed by an initial subject-oriented meeting at Executive Board and programme director level in July 2013, also in Cologne-Porz.

Prof. Dr Wörner for DLR and Mr Le Gall for CNES sign the cooperation agreement for the DLR lander MASCOT, which will launch with the Japanese Hayabusa-2 mission

Regular exchange at various management levels and in subject-specific working groups is considered extremely important by the two major European space exploration nations. Therefore, the DLR-CNES high-level liaison committee convened in January 2013. It was this body's first meeting in several years. The aims of this exchange at overall management level (Executive Boards and programme directors) are predominantly to coordinate bilateral cooperation, discuss current strategic and political topics and make decisions on individual topics. The main points of discussion were early consultations on subjects on the agenda of the ESA Council of Ministers in 2014 and the progress made in the bilateral cooperation projects MERLIN (Methane Remote Sensing LIDAR Mission) and MASCOT (Mobile Asteroid Surface Scout). The committee also decided to organise a joint conference on carrier systems and to increase personnel exchange. Beforehand, the annual meeting of the programme directors responsible for research and technology, Dr Hubert Reile for DLR and Thierry Duquesne for CNES,

had taken place in August 2012 at the CNES technology site in Toulouse. Key topics of their discussions were Earth observation, communication/navigation, space science, robotics, propulsion systems, space systems and carriers. The meetings between programme directors are designed to facilitate regular exchanges of information and to identify new cooperation activities.

MASCOT is part of the Japanese sample return mission Hayabusa-2, which is expected to take off for the asteroid 1999JU3 (c-type) in late 2014. MASCOT will perform various in situ measurements, to which CNES will contribute the power subsystem, part of the telecommunication system including antenna development, analysis of the descent and landing mission, and the MicrOmega (optical microscope and NIR hyperspectral camera) tool, which is being developed at the Institut d'Astrophysique Spatiale in Orsay. The mission partners JAXA, DLR, CNES and the USA also began establishing the modalities for use of the scientific data and samples in 2012. In April 2013, phase C concluded with the Critical Design Review (CDR).
Phase A of the German-French climate mission MERLIN (Methane Remote Sensing LIDAR Mission), for which Germany is providing the methane measuring instrument while France will contribute the satellite bus, was formally completed in 2012. However, in late 2012 CNES decided to significantly enlarge the platform for system strategic reasons. The total weight of the satellite will therefore increase from 250 kg to approximately 400 kg. Corresponding adjustments to the bus systems and payload have been underway since early 2013, and the kick-off for Phase B took place in April 2013. 2016/2017 is currently estimated as a realistic satellite launch date.



ESA Director Franco Ongaro (centre) visits Oberpfaffenhofen

Cooperation with ESA

On September 18, 2012, Earth observation experts from ESA and all relevant DLR institutes met at DLR's Oberpfaffenhofen site for a mutual exchange on their respective R&T competencies. Talks on possible cooperation topics yielded the suggestion of a specialist workshop, which is now being planned bilaterally by ESA and DLR's Institute of Microwaves and Radar.

A first positive interim result for DLR is already emerging: the exchange between specialists from DLR and ESA last year resulted in an opportunity for DLR to contribute a companion to the L-band SAR mission SAOCOM. The aim of this Earth observation mission is to gather high-frequency data for creating soil humidity maps, and for disaster prevention and aid. It is intended to launch in 2014/2015.

In February 2013, Franco Ongaro, ESA Director of Technical and Quality Management and head of ESA-ESTEC, visited the DLR site at Oberpfaffenhofen. The visit was occasioned by the intentions of DLR and ESA to cooperate even more closely in robotics and discuss cooperation options in other relevant areas of research and technology (ESA Partnership Initiative). Utilisation of the existing "ESA reference laboratory" at DLR RMC (Robotic and Mechatronic Center) is to be expanded through increased personnel exchange and by collaborating in new fields of mutual interest.

Why is DLR committed to Europe?

The importance of the European Union is increasing steadily. Almost 80% of all national laws are already based on European guidelines. European research and innovation strategies in particular form the basis for national strategies and research programmes. This is why DLR is involved through its Brussels office in defining European research and innovation strategies/policies and implementing them in order to gain access to partners, know-how and additional resources.

European Groups

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

Following intensive preparations and with the participation of DLR, the Commission published its recommendations for Joint Technology Initiatives and Public Private Partnerships on July 10, 2013.

After Prof. Henke and 13 other partners signed the Letter of Intent for a Clean Sky successor at ILA 2012 in Berlin, DLR has been nominated to lead the Technology Evaluator and participated in developing the Joint Technical Proposal, i.e. the work programme for Clean Sky 2. This additionally means that DLR will have a seat on the Governing Board for the entire duration of Clean Sky 2.

DLR is involved in the Hydrogen Fuel Cell JTI through the N.ERGHY association of research institutes and will be participating actively both in shaping the calls for proposals and later in the calls for proposals themselves.

In early June 2013 DLR became a member of the European Green Vehicles Initiative Association (EGVIA) headquartered in Brussels. The aim of EGVIA is to promote and facilitate pre-competitive research in the fields of energy efficiency and alternative engines for road vehicles. In the long term, EGVIA is to form a contractual Public Private Partnership on the European Green Vehicles Initiative (EGVI) with the European Commission in order to implement European framework programmes on its behalf in research, development and demonstration along the entire value creation chain.

ACARE/Flightpath 2050

At the Berlin Air Show in September 2012, the chairmen of the Advisory Council for Aviation Research and Innovation (ACARE), Mr Enders and Prof. Dr Wörner, presented the first ACARE Strategic Research and Innovation Agenda (SRIA) to the Commission (Director General Mr Ruete) and the member states (State Secretary Mr Hintze). The aeronautics research community thus laid the foundation for the next public and private programmes that ACARE will focus on implementing in the future.

During the Le Bourget Airshow, the ACARE General Assembly additionally adopted a new structure. The previously temporary technical groups will be made permanent in order to act as expert networks bringing technical expertise to analysing the achieved goals of Flightpath 2050, be capable of responding quickly to external requests, and thus continue to fulfil ACARE's remit as Advisory Council for Europe.

To underline this function, following an assessment of all European technology platforms (ETP) the Commission has confirmed that ACARE fully meets the ETP criteria and continues to be one of the leading ETPs.

With these successes, Tom Enders concluded his chairmanship of ACARE in Le Bourget. Peter Hartman of KLM was elected as his successor and will now manage ACARE jointly with the two other vice-chairs, Prof. Dr Wörner and Marc Ventre of SAFRAN.

EREA – Association of European Research Establishments in Aeronautics

On December 3, 2012, Prof. Henke as EREA chairman welcomed approximately 100 guests from the European Parliament, the European Commission (among them new Transport director Ms Soares in the Research and Innovation Directorate), industry, research and member states at the EREA annual reception.

The EREA Board Meeting on the following day concluded the discussions on the strategic alignment of EREA, which had begun in September, and the revised strategy was approved. Alongside joint representation of interests vis-a-vis the European institutions, technical cooperation between the centres is to be improved. The concept of the EREA Future Sky Joint Research Initiative was completed and discussed with Commission representatives as an appropriate tool for this purpose. Future Sky is based on joint programme approaches which are to be co-funded through the regular tools of the Framework Programme. As a pilot application for the first call for proposals in Horizon 2020, EREA has drawn up an initial joint programme on the topic of safety.

The chairman and co-chairman of ACARE, Dr Thomas Enders (Chief Executive Officer of EADS) and Prof. Johann-Dietrich Wörner (DLR Chairman of the Executive Board) presented the research agenda to Dr Matthias Ruete, Director General for Transport at the European Commission, and the Aviation and Space Coordinator of the German Federal Government, State Secretary Peter Hintze

Moreover, the EREA Board has accepted CEIIA (Portugal) and VKI (Belgium) as new full members.

EERA – European Energy Research Alliance

In November 2012, Prof. Dr Wagner was appointed co-chair of EERA. During their two-year period in office, he and Mr Leppävuori (VTT, Finland), who was elected chair shortly before, will focus on further developing and consolidating EERA, and especially on establishing an efficient and simple administration system and improving EERA's links to the member states and the European Commission. DLR will use its contacts and extensive experience of other large-scale European initiatives (e.g. JTI, ACARE etc.) to support and advise EERA in its development.

ECTRI – European Conference of Transport Research Institutes

The European Conference of Transport Research Institutes (ECTRI) is intensively involved in shaping the European Research Area. Its efforts are currently directed mainly at identifying priorities and preferences for research topics in the transport sector and at communicating these to the European Commission before Horizon 2020 is fully defined. Under the management of Dr Christian Piehler, Head of the DLR Transport Programme, an ECTRI task force has developed extensive recommendations for the initial work programmes in Horizon 2020 and submitted them to the European Commission in late May 2013.

International Conference on Women's Issues in Transportation

The 5th International Conference on Women's Issues in Transportation (WIIT) will take place in Paris in mid-April 2014 under the motto "Bridging the Gap". Prof. Barbara Lenz, Head of the DLR Institute of Transport Research, and Dr. Christian Piehler, Head of the DLR Transport Programme, are involved in preparing and managing the conference. WIIT is embedded into the Transport Research Arena 2014. On behalf of the European Commission, this bi-annual conference brings together leading scientists and research managers with representatives of industry, administration and politics in order to discuss the predominant lines of research in terrestrial transport in the coming years.

Dr Christian Piehler (left), Head of DLR's Transport Programme and President of ECTRI, after signing a cooperation agreement with Dr Horst Schulze, President of the Forum of European Road Safety Research Institutes (FERSI)

ETRA – European Transport Research Alliance

Together with leading research organisations including ECTRI, FERSI and FEHRL, DLR was involved in establishing a European Transport Research Alliance (ETRA) in September 2012. The Research Alliance is a voluntary forum designed to accompany and support the creation of a European Research Area in Transport (ERA-T) through exchanges of information and opinion. It is hoped that agreeing topics of mutual interest will lead to higher visibility and better perception of transport research at a European level and contribute to reducing undesired duplications in research, infrastructures and youth promotion through cooperation and collaborative networking.

International Cooperation

Brazil

Both in space exploration and in aeronautics research DLR maintains excellent contacts to the Brazilian aeronautics and space exploration centre DCTA, but also to Embraer, the world's third-largest aircraft manufacturer. In March 2013, a two-day kick-off workshop was held at Embraer to launch a three-year project by the DLR Institute of Flight Systems on aircraft icing and online systems identification.

China

From August 19 to 23, 2012, a DLR delegation headed by Prof. Henke travelled to China for the 26th Joint Committee Meeting with the Chinese Aeronautical Establishment (CAE). Topics of discussion included the cooperations with DNW and ETW, the progress made in developing the mid-range commercial airliner COMAC 919, the development of the European Framework Programmes regarding cooperations with China, the latest developments at IFAR (International Forum for Aviation Research) and a possible cooperation in the field of propulsion systems. A highlight of the trip was a meeting with AVIC Commercial Aircraft Engine Co Ltd. (ACAE). A return visit from ACAE to DLR took place on November 21, 2012. ACAE is developing the propulsion system for COMAC's civilian aircraft fleet. The negotiations focused on the possibilities for improving the gas-dynamic parameters of the engines and on ways of reducing noise emissions.

The cooperation between the Traffic Management department of the DLR Institute of Transportation Systems and its Chinese partner, the Research Centre for Software Engineering Technology (ASEC), was honoured with the city of Hefei's highest award for international coopera-

tion. The certificate was presented on April 12, 2013, by the municipal government in Hefei.

Following a first joint forum in 2011, a second event was held from April 16 – 18, 2013. Experts from Germany, China and other countries (UK, USA, Japan) met to discuss global developments relating to "Safe transport and safe infrastructure". For DLR, Mr Bretschneider was appointed to the academic board of the "Key Laboratory of Intelligent Transportation, Anhui Province" for the first period and is thus entitled to actively participate in shaping research topics in the field of Intelligent Transportation Systems (IST) in Anhui Province.

France

On the occasion of the 50th anniversary of the Elysée Treaty, the permanent missions of Germany and France to the UN in Vienna initiated an event dedicated to the cooperation between the two countries in space exploration. The event was opened by UN Ambassador Scharinger and his French colleague Marion Paradas. Dr Gruppe represented DLR at the panel discussion "Franco-German Cooperation: Progress in Space – Benefits on Earth". The event was held on the premises of the European Space Policy Institute (ESPI) and met with an enthusiastic response. Most attendees were representatives of the missions in Vienna, among them many ambassadors. Together with the French Space Agency CNES, DLR contributed significantly to organising the event.

India

At the invitation of the Indian space agency ISRO, a bilateral workshop took place in Bangalore on March 6 and 7. The aim of the workshop was to re-intensify cooperation between the two organisations by developing potential cooperation topics and projects. The DLR delegation was lead by Dr Hubert Reile, Programme Director Space Research and Technology, and included researchers from several DLR institutes. A key focus of the workshop was on topics relating to Earth observation, which, like the other topics, are to be defined in more detail through further exchanges among the researchers.

Signing the contract on the Hayabusa-2 mission

Japan

The strategic partnership DLR sought specifically with JAXA was intensified further. In July 2012, Prof. Hansjörg Dittus travelled to Japan in order to sign a cooperation agreement with JAXA on a preliminary study for a possible joint L-band mission (Tandem-L), and visited the JAXA site in Sagamihara to learn more about the current state of space exploration research in Japan and specifically about the asteroid mission Hayabusa-2, in which DLR is participating with the "MASCOT" landing unit. In addition to numerous meetings between JAXA and DLR experts in a wide range of fields (radar, exploration, innovation, information security, legal issues, launchers, aeronautics etc.) and a welcome increase in personnel exchanges to more than five researchers

50 years of Franco-German cooperation

The publication "50 years of Franco-German Cooperation in Research, Technology and Innovation" issued by the German Federal Ministry of Education and Research and the French Ministry of Research was published in Berlin on April 11 and in Paris on April 15. Following the last anniversary brochure ten years ago, this brochure presents the development of scientific and technological cooperation between Germany and France since the signing of the Elysée Treaty and particularly over the last ten years to the wider public. DLR and CNES/ONERA compiled the contributions on space exploration and aeronautics.

Inaugural visit of the new JAXA president Dr Okumura (7th from left) with his delegation and DLR colleagues in Cologne

per year, several members of JAXA's Board of Directors visited DLR. During the Berlin Airshow 2012, Dr Kazuhiro Nakahashi (Executive Director of the Aerospace Research and Development Directorate) travelled to DLR Braunschweig to learn more about DLR's aeronautics research; in October 2012, Dr Masanori Homma (Executive Director, Space Applications Mission Directorate) visited the DLR site in Oberpfaffenhofen. The highlight was the visit of the new president of JAXA, Dr Naoki Okumura, who came to DLR Cologne in June 2013 for talks on intensifying relations between JAXA and DLR. During his meetings, Dr Okumura confirmed JAXA's desire to intensify relations with DLR.

The annual trilateral aeronautics meeting (JAXA, DLR, ONERA) was held in Paris in November 2012, where Prof. Dr Rolf Henke discussed bi- and trilateral cooperations with his colleagues. As in other areas, cooperation in aeronautics research was also intensified.

The highlight of the cooperation with Japan was the opening of the DLR office in Tokyo in February 2013. 150 guests from research, academia, business and politics attended the official opening ceremony at the residence of the German ambassador. The responses from the guests and the discussions before and after the opening ceremony clearly indicated the high value Japan accords cooperation with DLR.

Canada

In November 2012, a delegation of the DLR Space Administration led by Programme Director Christoph Hohage visited the Canadian Space Agency CSA. During the consultations, a bilateral project for joint industrial product development of Earth observation systems and a project in the field of teleroboting were agreed.

In January 2013, the DLR Chairman of the Executive Board, Prof. Dr Wörner, renewed the cooperation agreement between DLR and the Canada Centre for Remote Sensing, CCRS, at a ceremonial event. Numerous bilateral projects between DLR institutes and Canadian partners were agreed during the accompanying two-day workshop.

Kazakhstan

The annual meeting of the KazCosmos – DLR steering committee took place in Oberpfaffenhofen from June 4 to 9, 2013. The DLR delegation was led by Dr Schmidt-Tedd. The Kazakh delegation included both KazCosmos employees and representatives of the National Centre for

Space Research and Technology in Almaty. The Kazakh colleagues subsequently travelled to Berlin for talks with the German-Kazakh Society of Friends and TU Berlin. The talks in Oberpfaffenhofen focused on the cooperation between DLR and KazCosmos in the field of Earth observation and the technologies it requires. In addition, possibilities for providing Kazakh specialists with further training at DLR were discussed.

Mexico

The General Director Assistant of the Mexican space agency AEM, Enrique Pacheco Cabrera, visited DLR in late June and met with members of DLR's Executive Board. The Mexican partners are interested in participating in the DLR FireBIRD mission. The project could serve to intensify cooperation between organisations in Mexico and DLR institutes and German industry.

Poland

In 2012, Poland attracted increased attention in the space sector as an ILA partner country and by joining ESA. In cooperation with the Space Research Center of the Polish Academy of Sciences (CBK-PAN) and the German Aerospace Industries Association (Bundesverband der Deutschen Luft- und Raumfahrtindustrie e.V. – BDLI), DLR organized the first Polish-German space research symposium at the Berlin Airshow 2012. The event, which was opened by member of the DLR Executive Board Dr Gerd Gruppe, provided an overview of suitable cooperation topics in space exploration and enabled German and Polish researchers to connect with each other.

In addition, Dr Gruppe and his Polish colleague, CBK Director Prof. Banaskiewicz, signed a Letter of Intent at the DLR booth at the Berlin Air Show in the presence of Philipp Rösler, Federal Minister of Economics and Technology, regarding a Polish-German university satellite mission. The agreement stipulates that two German (TU Berlin, University of Würzburg) and two Polish universities work together to build one nano satellite each. In a joint mission, these satellites will then test e.g. formation flight technologies. The project includes student exchanges and support for developing space exploration curricula. Project preparations are now underway; several project meetings between the participating universities in Poland and Germany have already taken place.

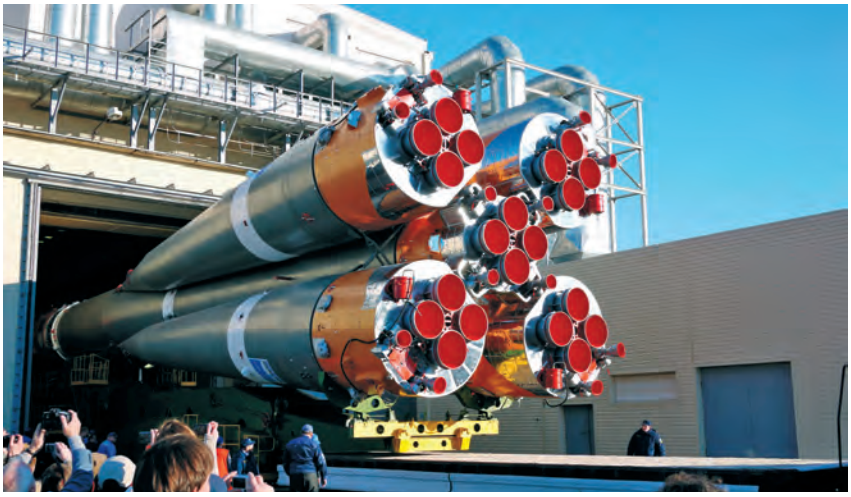
Russia

Ahead of the Berlin Airshow 2012, the now traditional bilateral young researchers' workshop "The Challenge of Graduation at DLR and TsAGI" (TsAGI – Central Aerohydrodynamic Institute) took place in Berlin from September 9 to 10.

Officials from the Republic of Bashkortostan in the Russian Federation and the Ufa State Aviation Technical University (UGATU) requested advice from the Federal Environment Agency on developing the skills of specialists from Bashkortostan in the use of remote satellite sensing for regional environmental monitoring. DLR was commissioned to provide these consulting services. The aim of the project was to inform a delegation of academics and staff from the Ministry of Natural Resources and the Environment of the Republic of Bashkortostan on the use of remote sensing in environmental protection and to discuss specific possibilities for applying the technology to the Russian questions.

On April 19, 2013, a Soyuz rocket successfully transported the first successor to the long-standing Russian research satellite series BION into space.

The scientific payload on BION-M1 also included two projects sponsored by DLR: the "Omegahab" for examining a functioning ecosystem under zero gravity and three picosatellites developed at German universities. The "Berlin Experimental and Educational Satellites" BeeSat-2 and BeeSat-3 were designed by students at Technische Universität Berlin, while SOMP-1 (Students' Oxygen Measurement Project) is a project of Technische Universität Dresden. With an edge length of ten centimetres, the cuboid small satellites weigh approximately one kilogram. Two days after the research satellite launched, they were disconnected from BION-M1 in intervals of 16 seconds. All three projects include development, construction and, after launch, mission operations for the small satellites.



The carrier rocket with the already integrated BION-M1 satellite and picosatellites is rolled out of the hangar in Baikonur

South Africa

Bilateral relations with the South African space agency SANSA, which have seen steady positive development since the IAC 2011 in Cape Town, were intensified further at a workshop held on July 12 and 13, 2012, in Oberpfaffenhofen.

Visits to various institutes offered our guests an overview of the wide range of research at DLR. New contacts were made in several areas, and cooperation options in communication and navigation and in atmospheric research were discussed. Then work concentrated on the two areas in which cooperation is well advanced: remote sensing and ground station operation. On the second day, a group accordingly visited DLR's new S-band antenna in Weilheim. A cooperation in this area is of particular interest to DLR due to South Africa's many years of experience in the field.

South Korea

In mid-June 2013, a delegation of the South Korean Agency for Defense Development (ADD) visited the Cologne site for two days with the purpose of getting to know each other better and identifying further potential fields of cooperation at scientific and industrial levels. Representatives of DLR and ADD signed a Memorandum of Understanding on scientific and technological cooperation designed to initiate a long-term partnership. ADD is of interest to several DLR institutes as a cooperation partner in security research.

Czech Republic and Belgium

On February 21, 2013, the (then) Czech prime minister, Dr Petr Nečas, visited the Oberpfaffenhofen site together with the Bavarian prime minister, Horst Seehofer. This was followed on March 11, 2013, by the visit of the Walloon prime minister, Rudy Demotte, to Cologne.

Both heads of government took advantage of their visits to the respective German state governments to offer the representatives of aeronautics and space exploration companies and research institutions in their delegations the opportunity to cooperate more closely with DLR.

USA

In August 2012, the NASA rover "Curiosity" landed on Mars. In collaboration with Christian-Albrechts-Universität in Kiel, DLR is contributing the Radiation Assessment Detector (RAD) to this mission. During the reporting period, DLR also agreed to participate with its geological measuring tool HP3 in the next NASA Mars mission, "Insight", in 2016.

Before the beginning of the Berlin Airshow 2012, the NASA Associate Administrator for Aeronautics Research, Dr Jaiwon Shin, visited DLR in Braunschweig in order to learn more about DLR's aeronautics research activities on site. Dr Shin and Prof. Rolf Henke then signed a bilateral cooperation treaty on air traffic management.

In late November 2012, DLR's annual Christmas Reception was held in Washington, D.C., with approximately 120 guests from science, business and politics. During the event and over the following days, members of the DLR Executive Board held numerous meetings with important US partners such as NASA Administrator Charles Bolden and representatives of the US Congress. A further highlight was the signing of a cooperation agreement in the field of Earth observation between DLR and the United States Geological Survey.

In May 2013, Prof. Dr Hansjörg Dittus visited NASA AMES and Stanford University, among other institutions, to discuss current and potential new cooperation projects with these long-standing partners.

Dr Jaiwon Shin (8th from left) visits DLR Braunschweig

IFAR – International Forum for Aviation Research

Now comprising 24 leading aviation research institutions from Europe, Asia, Australia and America, IFAR is the only global platform to represent approximately 90 percent of global aeronautics research. The member organisations aim to jointly meet the challenge of enabling environmentally and climate-friendly aviation across countries and continents. With exchanges of knowledge and experience, joint research projects and a dedicated technology and communications platform, IFAR paves the way for new partnerships and cooperations in science, business and politics, focusing on technologies relating to climate impact, noise and local emissions, alternative fuels, efficient flight management, weather and natural phenomena, flight operations and flight safety. IFAR receives support from the EU via the 7th Framework Programme.

IFAR was founded in 2010 on the initiative of DLR. Its members meet for a summit at highest management levels once a year; at the invitation of TsAGI, the Central Aerohydrodynamic Institute, RF, the 4th Summit took place in Moscow in 2013. The delegates agreed to continue the initiated work on climate, noise, alternative fuels and support for young researchers, and to expand the organisation's remit to include increasing the efficiency of the air transport system and the future of aviation research. The IFARlink communications and technology platform (› www.ifarlink.aero) is now entering its first broad application phase for the members' employees. Ahead of the summit, DLR and NASA reached an agreement on their mutual funding of IFAR, ensuring that IFAR's interests continue to be actively advanced by two of the world's major aeronautics research institutions.

Until 2013, Prof. Joachim Szodruch, former member of the Executive Board of DLR, was chairman of IFAR. He is now a member of the IFAR Leading Team together with the new chairman Dr Jaiwon Shin, of NASA, and the new deputy chairman Dr Kazuhiro Nakahashi, of JAXA.

The IFAR Secretariat is operated jointly by DLR and NASA under DLR management.
› www.ifar.aero

OECD Global Forum on Space Economics

In October 2012, the result of a study on the use of satellite technologies to counteract global threats was presented to a high-level audience, which also included DLR, at the conference "Monitoring Global Threats: The Contribution of Satellite Technology". The study showed that space applications in Earth observation, telecommunications and navigation are already very well suited to assisting various business sectors in responding to global threats. There nonetheless remains room for improvement, for example with regard to targeted geographic coverage.

Another workshop at the OECD Space Forum in March 2013 was dedicated to "Assessing the state of space industry and its economic impacts: Methods and results from selected OECD countries". It met with an extremely positive response from European and international space agencies, embassies and industry associations. The workshop presented the various approaches to capturing industry-related data and discussed the methods and possibilities of interpreting them.

Why is international cooperation important to DLR?

Many of DLR's central research questions are of an international nature. This means they can also only be solved in an international context. International cooperation makes it possible to combine strengths, utilise complementarities and implement financially costly projects. International partnerships generate new knowledge at DLR, strengthen our skills and allow us access to research infrastructures and new ideas. Moreover, international cooperations enable DLR to accompany political initiatives of the Federal Government and support the international business of German industry if required.

It also discussed impact assessments for investments in the space sector, a field in which particularly significant methodological uncertainties exist. In contrast to the direct benefits, its complexity makes significant statements on indirect economic and societal effects relatively difficult to derive.

The space agencies presented their current activities to the annual Steering Group of the OECD Space Forum in October 2012. Germany's cooperation with China in microgravity research was particularly noted.

Eurisy

Eurisy is a non-profit organisation whose membership includes approximately 30 public and private space agencies in Europe, among them DLR. Eurisy's activities are aimed at embedding space exploration and its applications more strongly in society. In cooperation particularly with regions and SMEs it presents innovative satellite applications to new end users.

DLR presented its Global Atlas for Solar and Wind Energy (see p. 49) at the Eurisy conference on satellite-based solutions

Left to right: Mr Lassig (AA), Mr Hobe (University of Cologne), Mr Stubbe (DLR), Ambassador Scharinger (AA), Mr Schmidt-Tedd (DLR), Mr Schrogl (ESA).

for SMEs using renewable energy sources in September 2012. The Eurisy Members' Day 2012 focused on discussing activities to support SMEs, DLR held a presentation on the basic principles of industrial policy in space administration and on specific measures for SMEs.

The General Assembly in June 2013 adopted Eurisy's strategic alignment for 2014 to 2016 in accordance with its mission statement "Acting Collectively to Bridge Space and Society". Its aim is to place the benefit of space applications for society and economic development on the political agenda of the European Commission, among other things.

In addition, an amendment to the statutes was made, pertaining mainly to changes to the composition of the Eurisy Council. Alongside the Eurisy organisations, external experts from the European Economic and Social Committee (EESC), the European Economic Association (EEA) and the Organisation for Economic Co-operation and Development (OECD) can now also be included.

UNCOPUOS

In February 2013, the Scientific and Technical Subcommittee of UNCOPUOS concentrated on the relevant key themes such as reducing space debris, satellite navigation, near-Earth objects, assistance for international disaster response and global Earth observation for the purpose of environmental and health protection. A consensus is emerging that reducing – not merely avoiding the creation of – space debris is a major challenge for the future and must be addressed more actively than is currently the case.

Germany presented its main space exploration activities and its contributions to the key topics. Technologies for possible use in removing space debris and actively retrieving objects in space (DEOS) and near-Earth object research (DLR-led EU project NEOShields) were successfully presented in side events.

At this year's Legal Subcommittee, Ambassador Scharinger presented the second volume of the "Cologne Commentary on Space Law (CoCoSL)", which was drawn up in close cooperation between DLR and Cologne University.

The German delegation also promoted its recommendations for improving and condensing the agenda of the Legal Subcommittee in order to increase the committee's efficiency. Combined with the fact that Prof. Schrogl will be chairman of the Legal Subcommittee for Germany from 2014, this development signals some positive changes to the work of the Legal Subcommittee.

The main Committee meeting in June 2013 was dominated by a celebration to mark the 50th anniversary of the first space flight by a woman, Valentina V. Tereshkova of Russia. It was accompanied by a panel discussion featuring ten female astronauts who now work in – space-related – roles in fields such as business, law and medicine, space exploration, technology, regulation and legislation.

In his talk "Changing the Perspective: Atmospheric Research on the ISS", Prof. Dittus advocated further scientific utilisation and focused on atmospheric observations. Analysing these observations can help better understand climate change and its connection to natural disasters.

In its four expert groups on space debris, regulatory regimes, sustainable space utilisation and space weather, the interdisciplinary Working Group on the Long-Term Sustainability of Space Activities was able to advance initial drafts of recommendations and guidelines to such an extent that it will be able to submit an initial draft report of all results to the meeting of the Scientific and Technical Subcommittee next year as originally intended.

UN-SPIDER

UN-SPIDER and the International Charter Space and Major Disasters have agreed a closer cooperation that permits UN-SPIDER itself and affiliated organisations, the "Regional Support Offices", to become authorised users of the charter. This will make it possible to significantly reduce response times in invoking the Charter in the event of future disasters.

This year's UN-SPIDER expert workshop "Space based information in early warning systems" took place in June 2013 in Bonn with 51 attendees from 20 countries. The workshop was an important event in particular in view of its subject, which has been newly established at the Bonn office.

In addition, the ASE Planetary Congress was held predominantly in the Cologne/Bonn area for a week in early July 2013. Numerous talks offered the various UN units located in Bonn and in particular UN-SPIDER the opportunity to position themselves very well in the field of "Sustainable use of space and protection of Earth and the environment".

Why is DLR an active member of UN organisations?

UNCOPUOS, founded in 1959, was set up with the aim of continuously improving international cooperation on the peaceful use of outer space. The maxim of UNCOPUOS is that space research and technology should serve humanity. With 74 member states, UNCOPUOS is the largest political space exploration platform. We use it to present German positions, aims and competencies and identify utilisation potentials at the international level. We are also involved in shaping guidelines and recommendations on globally pressing issues such as meeting the potential threat of near-Earth objects or space debris, and legal matters.

Dr Christiane Lechtenbörger
is responsible at DLR for all topics relating to the UN organisations

People

Staffing levels in DLR continued to rise in 2012. Compared to the previous year, employee numbers grew by about 350 to approximately 7,400 employees. This increase was almost entirely among scientific staff. Another positive development is the further two-percent rise in female management staff, from 14 to 16 percent. Trainee places were also increased by a further five percent; in all, DLR employed 253 trainees last year.

Human Resources Development

Human resources development in DLR is based on requirements- and demand-oriented planning which is increasingly aligned with organisational development consulting, as is impressively documented by the consistently growing demand for and implementation of measures with organisational content in recent years. In early 2013, this significant development was acknowledged by renaming the organisational unit into HR and Organisational Development.

HR and Organisational Development is responsible for a wide range of offerings and tasks:

- General advice on all matters relating to further training, personnel management and support;
- Local and cross-site training and PD programmes focusing on social and management-related skills;
- Language and IT training designed to meet the needs of specific target groups within DLR;
- Differentiated HR development offerings for managers and junior managers;
- Team workshops on organisational development, e.g. change management, strategy development, leadership and collaboration, customised training for teams;
- Coaching for managers, employees and small groups;
- Management feedback to optimise leadership and collaboration;
- Mentoring to individually support and develop junior employees as they take on new 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. 99) and
- Cooperations 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 627 events were held in 2012. 61 percent of employees took part in at least one human resources development programme for managers or one of the 131 team and organisational development workshops. Each employee used an average of 1.9 days for these internal further training options; for the entire staff this amounts to 15,924 further training days – twice as many as in 2005!

In project management, one of the key areas of internal qualification, 156 employees took part in the basic compact training course alone – the highest number ever. 18 employees additionally attended our seminars to prepare for PMP® certification – this is also the highest number since the corresponding offering was made available.

In spring 2013, DLR took part in a benchmarking study initiated by the NASA Academy of Program/Project & Engineering Leadership and carried out by Human Systems Australia. With its comprehensive education programme in the field of project management, DLR is a recognised partner and desirable benchmark in the community. The results of the study will be presented to the participants in 2014.

Supporting junior managers in the acute situation in which they take on management responsibility is the declared aim of the mentoring programme. In the spring, eleven tandems between young employees taking on leadership or outstanding project management tasks and high-ranking managers at DLR were again formed and inducted into their mentoring year and the comprehensive framework programme at an official opening event.

At the same time, a total of 77 high potentials named by institute managers were given the opportunity to enter into a moderated dialogue with the Executive Board and discuss strategic developments and decisions at DLR. This dialogue between the Executive Board and young employees has become one of the established instruments of a participatory and management-oriented form of communication at DLR, and has gained a reputation that reaches far beyond our organisation.

Employees	2010	2011	2012
Employees	6,835	7,046	7,385
Scientific staff (total)	3,913	4,080	4,273
Scientific staff employed by institutes and facilities	3,140	3,569	3,744
Permanent/fixed-term contracts	3,321/3,514	3,534/3,512	3,707/3,678
Junior researchers	55	51	47
Doctoral candidates (internal/external)	763	879	947
Trainees	248	244	253

After the successfully evaluated conclusion of the pilot phase, the Talent Management Programme was for the first time launched for all DLR employees.

The Talent Management Programme is a high-quality, highly individualised human resources development tool designed to identify employees with excellent achievements and development potential and promote in particular their cross-disciplinary skills with the aim of preparing them for leadership tasks.

Managers can nominate talents based on defined criteria, but employees can also apply on their own initiative. The selection procedure consists of a comprehensive potential analysis, at the end of which a panel consisting of members of the Executive Board, HR Management and the Central Staff Council selects up to 25 people who are then taken into a two-year programme.

This process is followed by an assessment centre as the basis for further individual sponsorship coordinated with the respective manager. The first DLR-wide call for applications has so far drawn 75 responses.

Intensive discussions – the Executive Board enters into a dialogue with young talent

Human Resources Marketing

Alongside its presence in the print and online media, over the past year Human Resources Marketing attended eleven higher education fairs, had its own booth in the Career Center at the Berlin Air Show ILA, attended four careers events and four open days, and visited eleven universities as part of the ESA Promotion Tour. The event series DLR_Student_Insight, the most recent instalment of which took place in late June 2012 in Oberpfaffenhofen, will be continued in November 2013 at the Braunschweig site.

Currently in a pilot phase are DLR exit interviews, which were designed in cooperation with Human Resources Development and are being tested at the Oberpfaffenhofen site in order to learn how departing employees see DLR. This test phase will be evaluated in late 2013.

In addition, Human Resources Marketing pursues three lines of action in its work:

- Internal and external implementation of employer brand positioning:
  The new imagery for Human Resources Marketing materials was implemented consistently across all forms of communication in employer marketing and for our trade fair booth. The attractiveness and appropriate placement of job advertisements is a criterion that can significantly affect applicant numbers. A key priority of the department's work was therefore the newly developed handbook for designing DLR job advertisements, along with an accompanying seminar. It has been successfully implemented since October 2012. These activities are complemented by training relating to our employer brand as part of junior management training.

- Raising the profile of DLR as an attractive employer:
  We significantly improved our online presence by relaunching the DLR Job Portal in July 2012. With its modern design, the new portal presents DLR's high attractiveness in a very visible manner on the Internet. An English-language version of the Job Portal was successfully launched on May 30, 2013. We have also begun to develop and produce a video for the Internet in order to make the attractiveness of DLR as an employer even better apparent to the target group.

- Supporting the institutes in recruiting staff:
  A test cooperation with a selected online job portal was positive, and we therefore launched a one-year cooperation in August 2012. Alongside further increasing our online presence, this cooperation significantly reduced our advertising costs, particularly in comparison with print advertisements and with our somewhat less coordinated publications on other online job sites. As maintaining an online presence is only useful if the site is easy to find, we worked with the institutes and facilities of DLR to ensure appropriate keywords and search engine optimisation were used for the job postings. Moreover, we significantly improved the way incoming electronic applications from the DLR Job Portal are handled, particularly with regard to making them faster to process by HR.

At the inauguration of the DLR_School_Lab RWTH Aachen, pupils presented an energy-saving "Smart City".

DLR Human Resources Policy

On April 15, 2013, the Executive Board adopted a new human resources policy substantiating the DLR Guidelines. This policy forms a stable, binding and transparent framework for DLR and its employees and is the foundation from which strategic human resources policy goals and resulting measures are derived. In accordance with the overall strategy and the DLR Guidelines, human resources policy describes the culture and values to be observed in mutual interaction between DLR and its employees, and is understood as a self-commitment. Targets are described for nine areas of collaboration; DLR works to achieve these through specific measures. The areas of collaboration include attractiveness as an employer, family-friendly human resources policies and equal opportunities, leadership and cooperation, human resources development, service orientation, flexibility, healthy staff, internationality/mobility and diversity of career paths.

Education and Outreach

DLR brings its lines of action for promoting new talent together in the DLR_Campus initiative. The measures are aimed both at children and youths and at students and graduates.

For children and youths, the number of DLR_School_Labs is continuing to grow: the 11th laboratory for school pupils was founded at RWTH Aachen in June 2013. In all, the DLR_School_Labs welcome over 26,000 pupils a year (as of 2012). In addition, DLR operates numerous further lines of action aimed at children and youths – from cooperations with publishers who specialise in kindergarten materials through work experience at DLR institutes to teaching materials on DLR topics which are sent out regularly to approximately 4,000 secondary schools. In addition, DLR again held teacher workshops and other events during the current reporting period – with a particular highlight on July 3, 2013, when numerous astronauts and cosmonauts from around the world who were attending an international congress in Cologne travelled to towns throughout Germany to tell hundreds of pupils about their flights into space.

DLR institutes are committed to supporting university students by offering internships and supervising graduation theses. In addition, they conduct other measures such as ideas competitions or summer schools. In July and August 2013, 26 students from several European countries took part in the 14th International Summerschool of the Ariane partner cities in Lampoldshausen – hosted by DLR in cooperation with Heilbronn University. It focused on teaching background knowledge in rocketry – with many practical exercises. At the same time, DLR supervised 20 students from Germany and the USA in Neustrelitz during the Space Weather Summer Camp – an annual event held in cooperation with the University of Alabama in Huntsville.

HR Development and Mobility	2010	2011	2012
Training days per employee	2.2	2.0	1.9
Mentoring pairs	11	10	11
Postings abroad (months)	531	518	449

Celebrating after their successful rocket launch: the participants of the international Ariane Summerschool in Lampoldshausen

Since its launch in July 2009, over 500 post-graduate students – more than half of all DLR employees working to complete post-graduate degrees – have registered for the DLR_Graduate_Program, DLR's programme for doctoral candidates. The programme covers essential management and social skills that benefit graduates in writing their PhD theses, engaging in scientific activity within DLR, and in their future careers. Our qualification programme consists of 44 different cross-institute training courses and workshops, held on approximately 130 days a year. The first nine people have already completed the programme. Since 2012, external graduates from the University of Stuttgart and TU Braunschweig have also been participating in the programme under the umbrella of the DLR@Uni initiative. Similar arrangements were made for attendees of the Munich Aerospace Graduate School, which was set up in 2013 by DLR in cooperation with TU Munich, the University of the Federal Armed Forces in Munich and Bauhaus Luftfahrt. Moreover, the DLR_Graduate_Program was opened to former winners of the Young Researchers' Competition Jugend Forscht.

Diversity and Equal Opportunities

Effectively shaping equal opportunities, regardless of gender, age, cultural background, special needs, creed or individual life situation: this central strategic goal is the core responsibility of the new Diversity Management department in DLR.

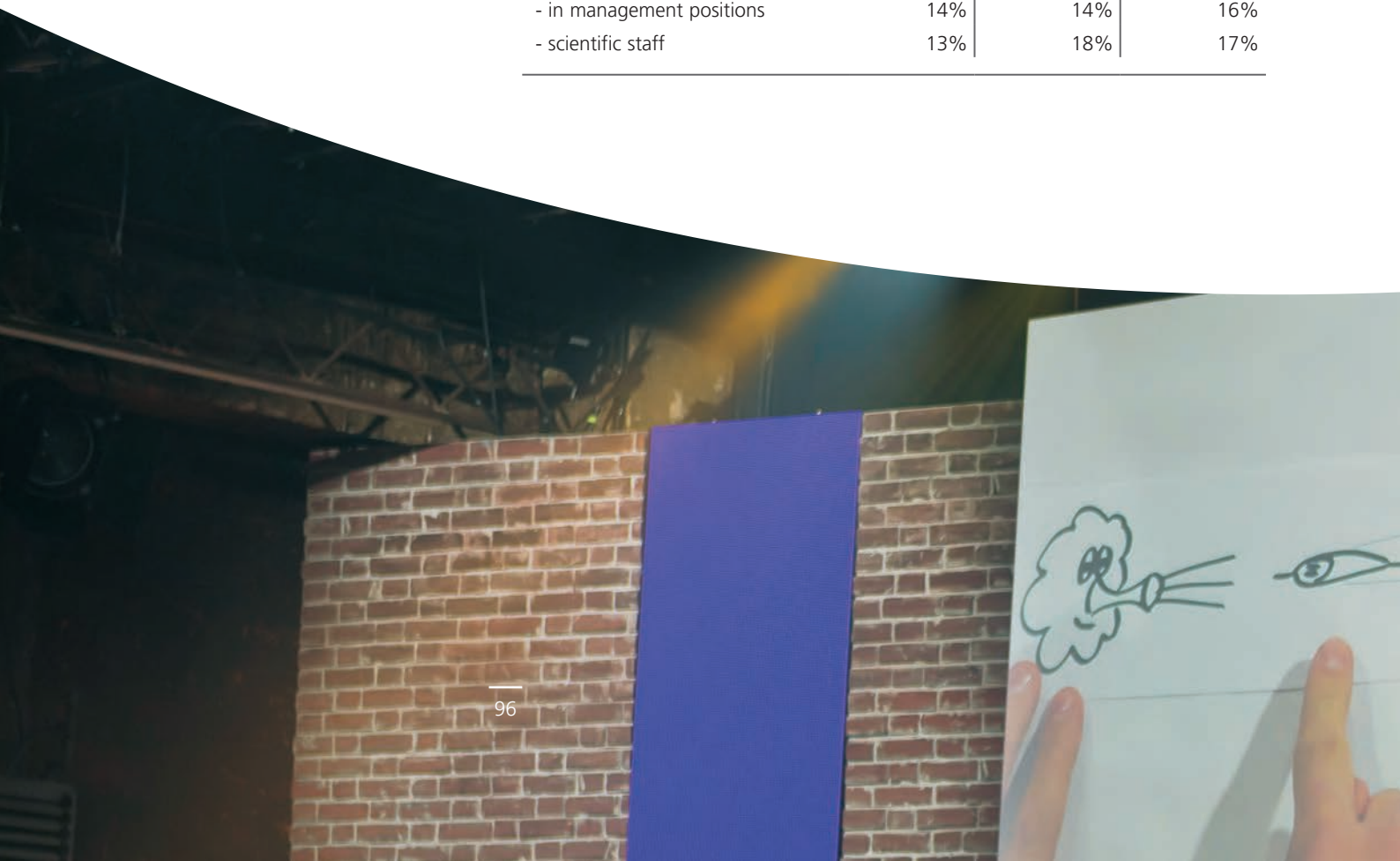
The new department "Diversity and Equal Opportunities" is overseeing the implementation of this goal as a horizontal theme throughout all planning and decision-making processes. Within this department, the Equal Opportunities Office provides comprehensive advice and services to DLR employees. Activities in this area continue to focus on offering a better balance between work and family life. The number of available daycare places, for example, is constantly being increased. For the first time, the Stuttgart site now also offers places for under-3-year-olds (u3) for children of DLR employees. The total number of u3 daycare places reserved by DLR has thus continued to increase in 2013 to over 50 across Germany. The number of fathers taking parental leave is also growing.

The need to provide care not only for children, but also for older relatives is also increasingly affecting DLR staff. Our external partner AWO is on board to help meet the challenges arising from this demographic development, and alongside services for parents, which are in high demand, now also offers a portal with information relating to care for the elderly.

Increasing the proportion of women in science and science-supporting areas remains a priority goal within Diversity Management. Creating equal opportunities for women and men at all levels of research, services and administration is a prerequisite for developing and making the best use of individual potentials. Outstanding achievements and the ability to innovate require appropriate conditions, and this necessitates dealing constructively with issues of diversity and equal opportunities.

By introducing diversity management DLR is affirming its commitment to these aims and strengthening its regionally and internationally visible profile as an attractive employer in the global competition for the brightest minds.

Employees	**2010**	**2011**	**2012**
Proportion of women			
- in total	30%	31%	30%
- in management positions	14%	14%	16%
- scientific staff	13%	18%	17%

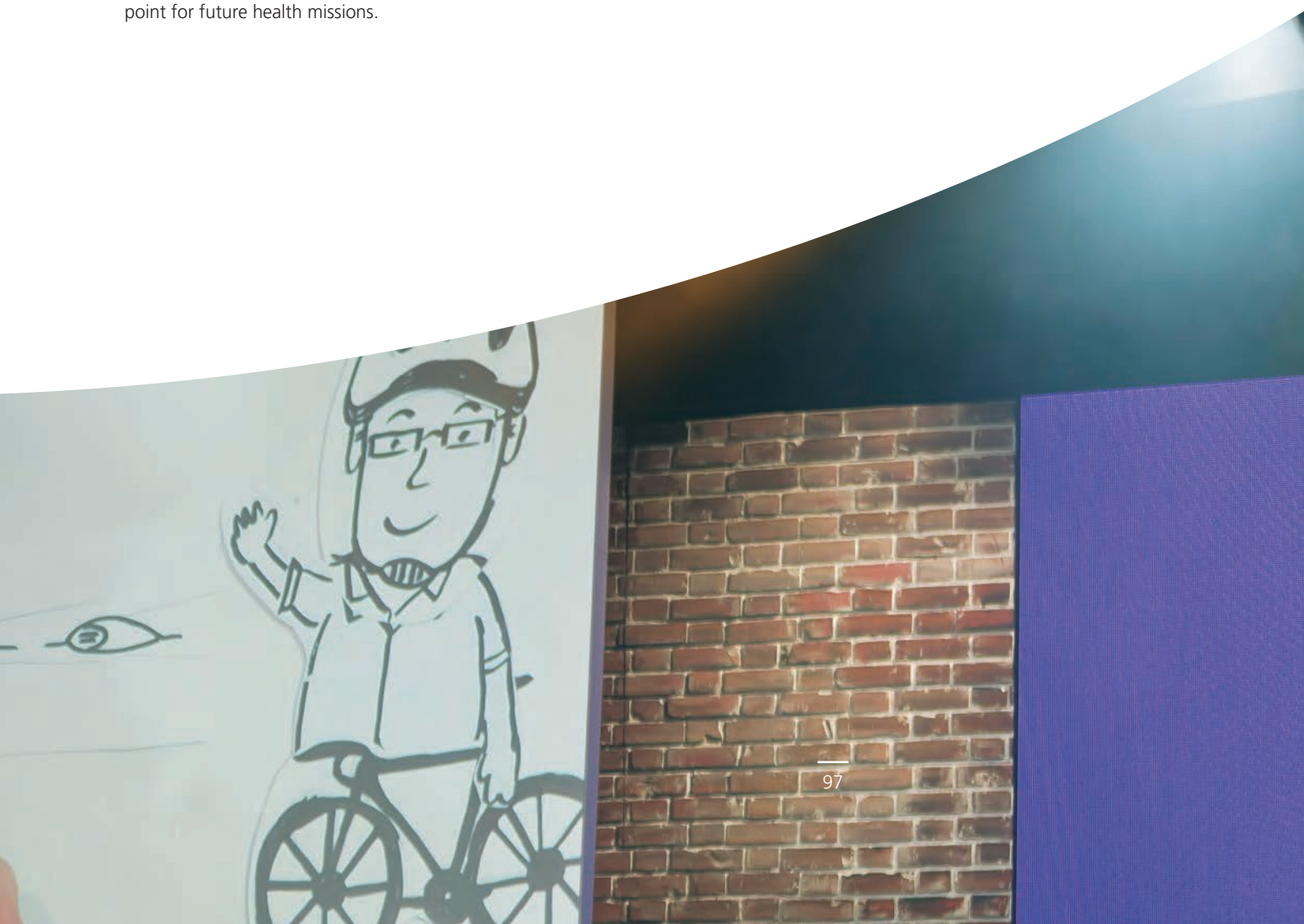


Occupational Health and Safety

Good health is an important requirement for meeting the growing challenges we face in our personal and working lives. Since 2010, Occupational Health and Safety has succeeded in introducing a comprehensive range of health services with a long-term and holistic concept. Statistical surveys, targeted employee surveys and a meta-analysis of all surveys performed last year that included job satisfaction aspects form the basis for centrally managed and cross-site interventions. They serve to improve employees' physical, mental and social health as a prerequisite for job satisfaction, motivation and performance. Following the successful step competition "Mission DLR Fit", the "DLR Cup" health event organised by Occupational Health and Safety this year again proved that keeping healthy can be fun – a good starting point for future health missions.

DLR Cup 2013 – Playing for fitness

The Raumschub Cup was a beloved tradition among sports-loving DLR staff for many years until it "fizzled out". In June 2013, the spirit of this historic format returned – this time under the heading "Play for fitness – DLR Cup 2013". In cooperation with the site managers, Occupational Health and Safety and Internal Communications at DLR came together to develop a new concept: a central health event featuring a football tournament and lots of space to meet and mingle. Over 500 DLR employees from all sites flocked to Cologne's Südstadion. After 74 games, the coveted trophy went to the EIN-DLR-TRACHT BRAUNSCHWEIG team. For video and photos, please see ❯ DLR.de/cup



German Staff at ESA

The German Bundestag and the Federal Government continue to pursue the aim of increasing the proportion of German personnel at international organisations and European institutions. With regard to ESA there is still some catching up to do, as the proportion of German personnel there has consistently amounted to around 19 percent over the past ten years and thus remains significantly lower than the proportion of funding that Germany has contributed, which has continuously increased to currently approximately 26 percent. In comparison, the proportion of French personnel corresponds approximately to its share of funding, while Italy is increasingly overrepresented, most recently at the end of 2012 with 18.5 percent of staff compared to 12.1 percent of contributed funding. It should however be noted that of the applicants for positions at ESA over the years, less than 10 percent of candidates came from Germany. On a positive note, despite the low percentage of applicants, the proportion of new appointments has increased significantly every year, most recently in 2012: 7.2 percent of applicants were German, compared to 16.9 percent of new hires, indicating that German applicants have disproportionately high chances of succeeding in an ESA selection procedure. This shows that the tools DLR has so far developed to increase the share of German personnel, in particular its consulting services and its targeted promotion of German applicants, are successful.

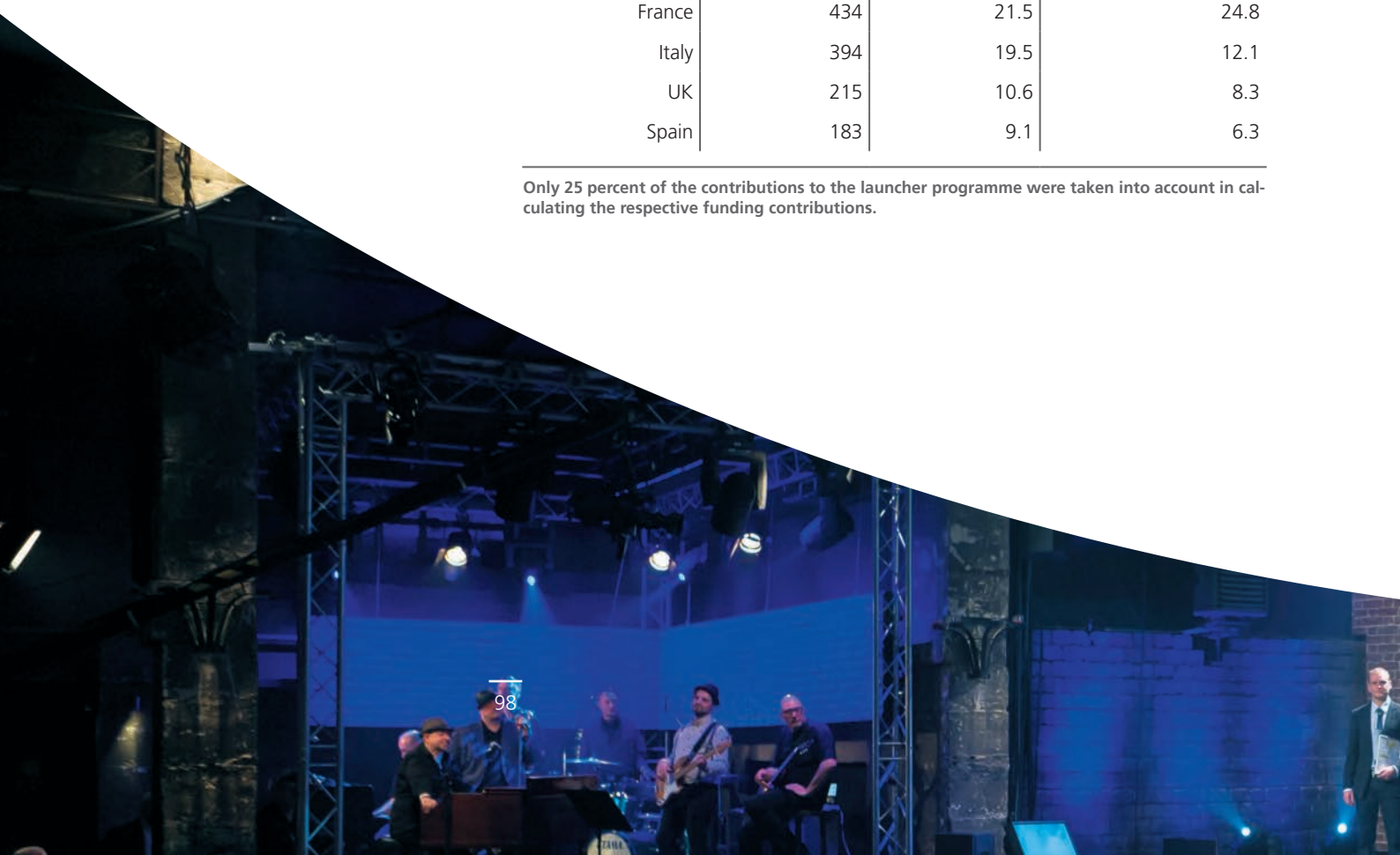
In 2009, a new instrument was introduced: the German Trainee Programme GTP. The GTP is designed to improve the proportion of German personnel at ESA in the medium and long term. Financed by DLR using funds from the national space programme, the GTP is a fellowship programme enabling young German researchers to complete secondments to ESA of up to two years.

This measure aids German graduates and career starters in gaining first employment at ESA. The GTP stipulates that 10 trainees annually are employed at ESA for one or two years in roles and programme areas specifically selected by Germany. Since 2010, approximately 40 trainees have been seconded to the ESA sites HQ, ESOC, ESTEC, ESRIN and ESAC. Alongside their ESA colleagues, they work in the fields of Earth observation, technology, human spaceflight, launchers, science, satellite operations, robotics, navigation and mission analysis.

German staff at ESA – a comparison

Member states	Number of employees	Employees [%]	Financial contribution [%]
Germany	379	18.8	25.9
France	434	21.5	24.8
Italy	394	19.5	12.1
UK	215	10.6	8.3
Spain	183	9.1	6.3

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



Future Development of DLR

Centre Development

Strengthening cooperation, promoting cohesion, increasing scientific output: these are major challenges that DLR is addressing with increased focus through a strategy summarised as the 4*I – invention, innovation, interaction and internationality (see p. 65).

Invention received attention through the external evaluation performed every five years with the help of the Helmholtz Association in the Aeronautics, Space and Transport research field, which returned an excellent evaluation result. Ideas for the following five years are already being discussed and refined internally in order to additionally position DLR securely for the future, and the important issue of sustainability is being examined by a working group set up specifically for the purpose.

Numerous projects and prototypes accompanied by Technology Marketing met the challenges of Innovation, allowing DLR to again present itself as a source of ideas and technologies. DLR knowledge is also reflected in national and international norms and standards.

The aim of Interaction is to improve cooperation within DLR, which is being systematically expanded across the researching institutes, Space Administration as a research funding body, and the Project Management Agencies as well as Administration and the Technical Services. Advancements were made for example in knowledge management; these included a pilot project to introduce an electronic platform wiki and the establishment of DLR-wide knowledge exchange workshops. A further element is the Chairman of the Executive Board's annual tour of all DLR sites. A DLR-internal survey on the subject of culture showed the extent to which the values in the Guidelines developed in the previous year are shared and observed. Despite good adherence to the guidelines, improvements are always possible, as demonstrated by the expansion of the organisational unit on equal opportunities, which reports directly to the Executive Board, to include the aspect of diversity. Relaunching the DLR-wide football tournament stands for ONE DLR at a social level.

Alongside many other successful cooperations, the opening of the DLR office in Tokyo, Japan, may serve as exemplary proof of the internationality of DLR, demonstrating how DLR networks, operates and is in demand around the world. DLR is responding to its increasingly international workforce by offering further training courses in English within DLR.

Living ONE DLR – not just in terms of guidelines, but as everyday life in its many facets; specific, if expandable activities. ONE DLR's achievements so far include increased efforts to internally address the issues of cooperation and cohesion and externally present DLR as a widely attractive employer, but also as an excellent bearer of knowledge.

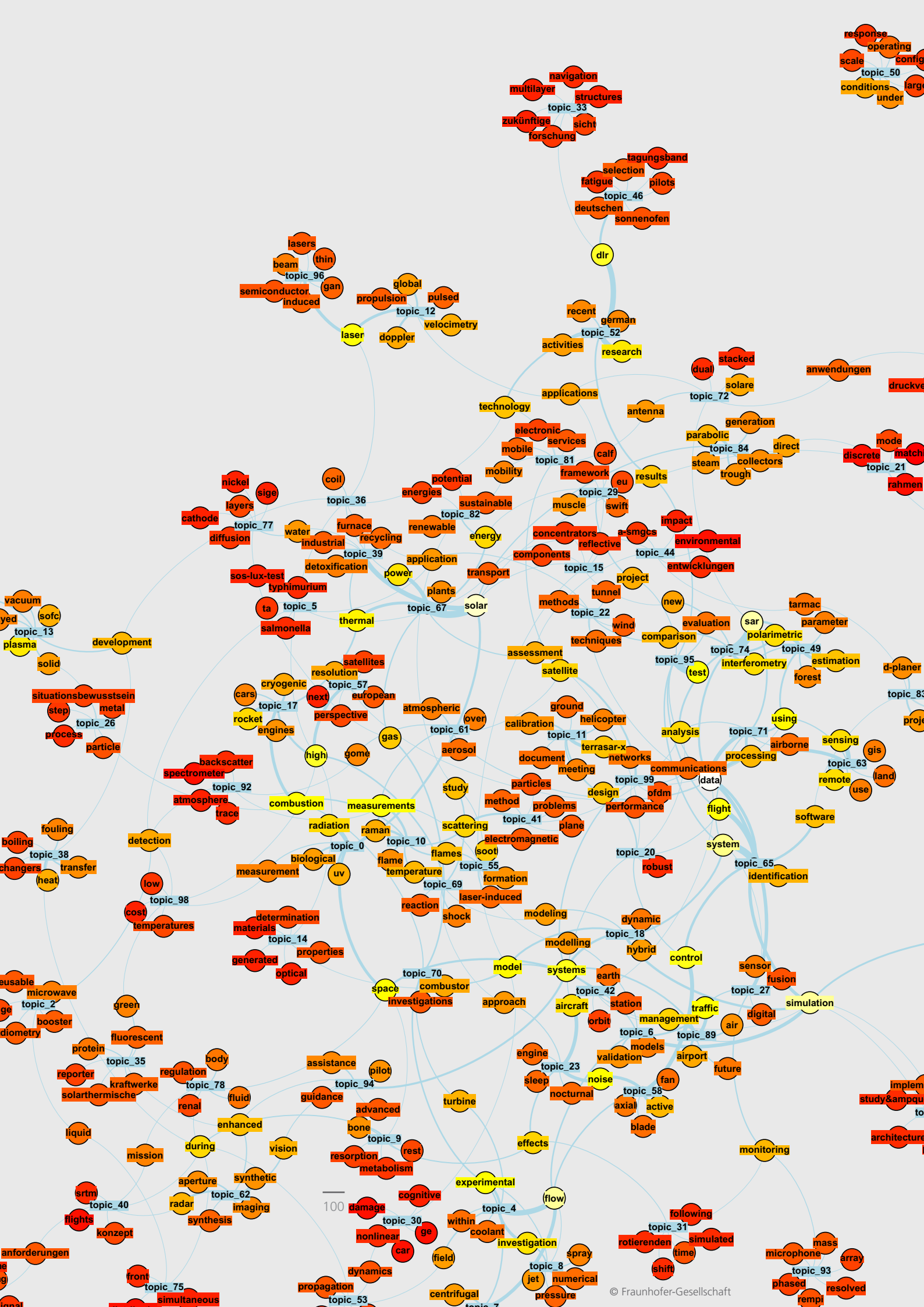
Sustainability Management

The guideline of sustainability requires that economic, environmental and social aspects are always considered when making decisions or taking action, with the aim of developing our community in such a way that neither those alive today nor future generations are disadvantaged. Public stakeholders have a particular responsibility here, as they act on behalf of society and are therefore particularly obligated to this comprehensive societal principle.

DLR has always seen itself as a responsible stakeholder, and hopes to deliver high value for industry, environment and society through its work. Nonetheless, the full breadth of this aim and self-image was for the longest time pursued only implicitly, and barely discussed or communicated, reflecting the public and political consciousness of the times.

One line of action to widely establish sustainable policies in organisations is to create transparency with regard to relevant targets, methods and data. To this end, the German Sustainability Code (GSC) was developed in 2011; following international examples, it is designed to serve as a standard for communication and comparability of corporate sustainability. In the autumn of 2012, the Federal Ministry of Economics and Technology enquired of DLR whether it currently applies the GSC or intends to apply it in the future. The Executive Board then initiated a DLR-internal project in which a panel of experts is assessing with which existing or yet to be defined objectives, procedures and KPIs a sustainability management system could be implemented in DLR.

It is becoming apparent that several goals, procedures and performance indicators previously established in DLR already cover aspects of sustainability; others can be expanded. Discussions are also taking place within DLR about expanding the traditional three dimensions of the guideline. It is worth noting that as a research institution, DLR should be expected to not only conduct its work in a sustainable manner, but to also consider sustainability in its research content wherever possible. It is not yet clear whether the GSC in its current form is a suitable tool for this purpose, or whether it might be better to find an adapted form tailored to the specific circumstances pertaining to public research institutions. DLR has therefore decided to wait for the results of the project "Leitfaden Nachhaltigkeitsmanagement" (Sustainability Management Guideline), for which funding has been requested from the Federal Ministry of Education and Research and in which DLR is participating. Work on the DLR-internal project on sustainability management will continue concurrently.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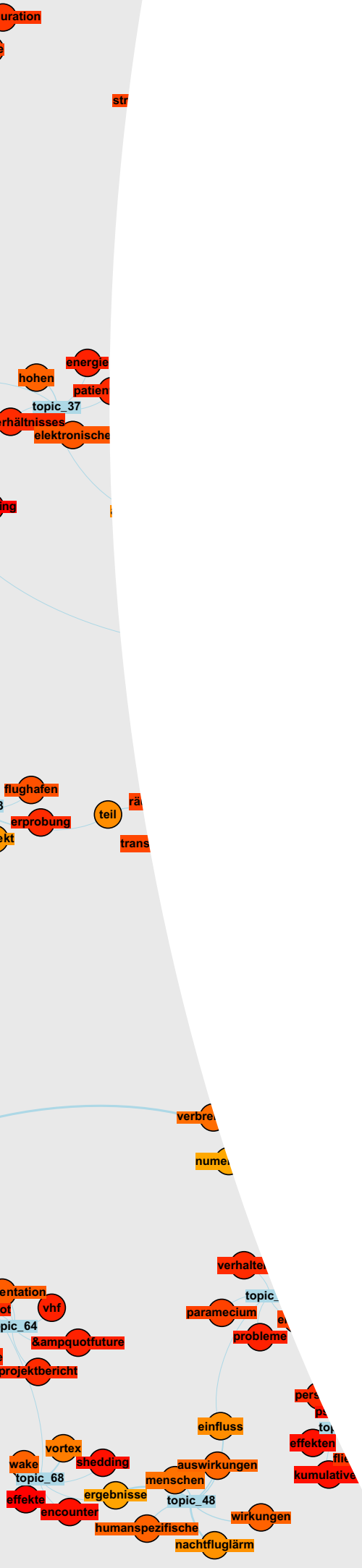
FACTS & FIGURES



Some of DLR's Infrastructures

Braunschweig

AIM Anwendungsplattform Intelligente Mobilität (Applications platform for intelligent mobility)

With funding from the federal state of Lower Saxony, the city of Braunschweig and other partners, DLR is creating a large-scale research facility unlike any other in Germany. This applications platform for intelligent mobility will be used for networked research, development and application in intelligent transport and mobility services. AIM reflects the full range of transport research: from collecting empirical data through tests in simulations or laboratories to actual testing in real traffic, developing and testing driver assistance systems, intermodal transport management or sociological traffic analyses. The platform's basic infrastructure will be expanded and adapted to new tasks depending on the research questions at hand.

Braunschweig

Robotic DLR Research Helicopter

Supported by a sophisticated simulation environment, the robotic DLR research helicopter superARTIS, which was taken into operation in 2012, is used to develop and test complex automated flight missions. Such flight missions could be useful particularly for security-relevant applications in the future. The DLR Institute of Flight Systems in Braunschweig, which operates superARTIS, focuses on independent environment recognition, flight-path planning and high-precision dynamic flight control.

Göttingen

Tunnel Simulation Facility

The aerodynamic behaviour of high-speed trains passing through tunnels is examined at DLR's globally unique tunnel simulation facility, where model trains are catapulted to a speed of 400 kilometres per hour over a distance of more than 60 metres. The side wind test facility examines the forces and pressures affecting trains travelling in side winds. Measuring techniques include conventional force and pressure measuring tools, hot-wire and hot film processes, and state-of-the-art laser optometric instruments such as Particle Image Velocimetry.

Jülich

Solar Test and Demonstration Power Plant Jülich

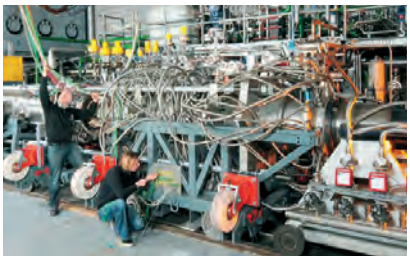
At the Jülich site, over 2,000 movable mirrors reflect incoming solar rays onto the tip of the 60 metre high solar power tower, where their thermal energy is concentrated at high temperature and transformed by a chain of processes into electrical energy in the lower part of the tower. Research and development is focused mainly on mirror systems for directing and concentrating solar rays, on solar absorber and energy storage systems in practical application, and on theoretical and experimental EDP-based analyses and developments in the field of flow mechanics and heat transfer.

Cologne

:envihab

The newly opened :envihab offers researchers 3,500 square metres of space in which to examine the effects of extreme environmental conditions on humans and seek possible countermeasures. The activities at :envihab focus predominantly on space and flight physiology, radiation biology, aviation and space psychology, operational medicine, biomedicine and analogue terrestrial scenarios. Eight separate modules contain a short arm human centrifuge for analysing the effects of increased gravity on the cardiovascular system, muscles and bones; laboratories to examine the effects of reduced oxygen and pressure levels; a whole body MRI/PET scanner; areas where test persons can be specifically subjected to psychological stress and recreational situations; and micro- and molecular biology research tools.

Cologne



Engine Test Rigs

In order to effectively assist national and European industry in developing technologies and products, DLR offers unique testing facilities for all engine components. DLR operates a range of test rigs and the necessary infrastructure to conduct combustion chamber tests under realistic conditions (compressors, air heaters, recooling capacities, fuel supply). Tests are conducted on low-emission burners using optical measuring techniques, and on circular combustion chambers at full scale and with various fuel compositions.

Lampoldshausen

Optical Test Range

The optical test range (Laserfreistrahlstrecke, FSS) at the DLR site in Lampoldshausen is a unique research facility used by the DLR Institute of Technical Physics. Its purpose is to examine how laser radiation propagates over large distances; DLR researchers can also analyse and optimise laser beam properties and long-range laser effects under realistic atmospheric conditions. FSS is particularly useful in designing laser systems for security and defence technology.

Oberpfaffenhofen

Center for Satellite Based Crisis Information (ZKI)

The ZKI is a service provided by the German Remote Sensing Data Center (DFD) in DLR. DLR is the only facility in Germany that is able to receive Earth observation data from a wide range of sources and refine them immediately into data products. This includes providing highly topical satellite image maps in the event of natural and environmental disasters, for humanitarian aid campaigns and civil defence around the world. This service has existed since 2004 and saves valuable time in disaster management. Because ZKI is embedded into a research environment, it allows the latest developments to be brought directly to application. On January 22, 2013, DLR and the Federal Ministry of the Interior (BMI) officially launched the cooperation for regular operation of ZKI.

Oberpfaffenhofen

DLR Research Aircraft

The DLR Flight Facilities operate the largest civil fleet of research aircraft in Europe. Their aeroplanes and helicopters are stationed at the DLR sites in Braunschweig and in Oberpfaffenhofen. DLR's aerospace engineering facility is certified to independently perform maintenance and development work on these aircraft. The research aircraft fleet comprises 13 aircraft ranging from a multi-jet commercial airliner (Airbus A320) through helicopters (EC-135) to gliders.

Stuttgart

HOTREG

High-temperature heat stores are the key to increasing flexibility and efficiency in many industrial and power plant applications. Regenerator storage offers significant potential for high-temperature applications over 500 degrees Celsius with gaseous heat transfer media. Developing this technology for use in various heat processes requires new storage media and design concepts to be experimentally verified and qualified. DLR's test bed for examining regenerator storage is designed for this purpose.

Commendations and Awards

Internal Awards

DLR Quality Prize

- Ms Barbara Steude,
  Institute of Communications and Navigation
- Mr Markus Prochazka,
  Institute of Space Propulsion
- Mr Joachim Aeckerlein,
  Institute of Aerospace Medicine

DLR Science Prize

- Prof. Dr Christiane Voigt
- Dr Tina Jurkat
- Mr Philipp Jeßberger
- Dr Andreas Petzold,
  (now at Forschungszentrum Jülich GmbH)
  Institute of Atmospheric Physics
- Dr Pau Prats-Iraola,
  Microwaves and Radar Institute

DLR Senior Scientists

- Prof. Dr Irena Hajnsek,
  Microwaves and Radar Institute
- Dr Adrian Doicu,
  Remote Sensing Technology Institute
- Prof. Dr Richard Degenhardt,
  Institute of Composite Structures and Adaptive Systems
- Dr Roland Ewert,
  Institute of Aerodynamics and Flow Technology

DLR Research Semester

- Dr Simone D'Amico,
  Space Operations and Astronaut Training
- Mr Elmar Beeh,
  Institute of Vehicle Concepts
- Mr Joël Brezillon,
  Institute of Aerodynamics and Flow Technology
- Dr Andreas Dörnbrack,
  Institute of Atmospheric Physics
- Mr Balázs Matuz,
  Institute of Communications and Navigation
- Dr Ralf Möller,
  Institute of Aerospace Medicine
- Dr Niklas Peinecke,
  Institute of Flight Guidance
- Dr Christoph Richter,
  Institute of Solar Research
- Dr Anke Roiger,
  Institute of Atmospheric Physics
- Dr Marwan Younis,
  Microwaves and Radar Institute
- Mr Jürgen Wohlfeil
  Institute of Robotics and Mechatronics

Prizes awarded by the Society of Friends of DLR (SoF)

Otto Lilienthal Research Semester

- Dr Michael Angermann, Institute of Communications and Navigation, Oberpfaffenhofen,

  for his role in designing and developing FootSLAM and the impetus he provided for the work on "Swarm Intelligence"

Fritz Rudorf Prize

- Ms Carola Schmit, Head of the Staff Department in Berlin
- Mr Volker Rheker, interdepartmental unit "Corporate Office"

Hugo Denkmeier Prize

- Dr Xiaoxiang Zhu, (youngest doctoral candidate)

  for her work on "Very High Resolution Tomographic SAR Inversion for Urban Infrastructure Monitoring – A Sparse and Nonlinear Tour"

Innovation Prize

for the "Vibro Tac" project as a cooperation project between DLR and Sensodrive GmbH in Weßling

- Mr Simon Schätzle
- Mr Thomas Hulin
- Mr Tobias Ende
- Mr Tilo Wüsthoff
- Dr Bernhard Weber
- Mr Carsten Preusche

DLR_School_Lab

- Davina Klevinghaus and Ruben Trimpop (Märkisches Gymnasium Schwelm, 1st place)
- Winnie Xu, Rebecca Diethelm and Benjamin Diethelm (Wilhelm-Gymnasium Braunschweig, 2nd place)
- Josephine Pröls (Martinus Gymnasium Linz am Rhein, 2nd place)

  applied themselves with great dedication and excellent results to the topic "A Journey to Mars"

Prize of the Chairman of the Society of Friends of DLR

- Mr Thomas Schwarzmaier (youngest patent applicant of the year), Institute of Remote Sensing Technology, Oberpfaffenhofen,

  for his work on "A Method and Device for Finding and Detecting Animals Hidden in Agricultural Fields and Meadows"

DLR Senior Scientists of 2012

- Prof. Dr Irena Hajnsek, Microwaves and Radar Institute
- Dr Adrian Doicu, Institute of Remote Sensing Technology
- Prof. Dr Richard Degenhardt, Institute of Composite Structures and Adaptive Systems
- Dr Roland Ewert, Institute of Combustion Technology

A Journey to Mars – the DLR_School_Lab Prize 2012 awarded by the SoF and its winners

Selection of External Awards in 2012

Award	Prize winner
Nominated for the Federal German President's Award for Innovation in Science and Technology	Prof. Alberto Moreira, Dr Gerhard Krieger, Dr Manfred Zink
Erwin Schrödinger Prize, Helmholtz Association	Prof. Patrick van der Smagt
eCarTec Award – category Product Concept and Vision, Bavarian State Ministry of Economic Affairs, Infrastructure, Transport and Technology	Prof. Gerd Hirzinger, Mr Jonathan Brembeck
Space Technology Hall of Fame, Space Foundation	Dr Ekkehard Kührt, Dr Joerg Knollenberg, Prof. Herbert Jahn, Mr Thomas Behnke
RTO Scientific Achievement Award, NATO	Mr Andreas Schütte, Dr Andreas-Rene Hübner, Dr Robert Konrath, Prof. Norbert Kroll, Mr Detlef Rohlf
American Geophysical Union Fellowship	Prof. Tilman Spohn
AgustaWestland International Helicopter Fellowship Award, American Helicopter Society	HART II Intl. Workshop Team, headed by Dr Berend Gerdes van der Wall
Best Jubilee Video Award, Int. Conf. on Intelligent Robots and Systems	VIACTORS Consortium, DLR as coordinator
Clean Tech Media Award – category Aviation, VKP engineering GmbH	Dr Josef Kallo, Dr Johannes Schirmer
Literature prize, Information Technology Society in VDE	Dr Achim Dreher
Karl Doetsch Young Researcher Award, Campus Research Airport Braunschweig	Mr Bram van de Kamp
JEC Innovation Award	Mr Gerhard Kopp
ISGP/ESA Young Researcher Award	Ms Sonja Brungs
DWV Innovation Award for Hydrogen and Fuel Cells, German Hydrogen and Fuel Cell Association	Mr David Ruprecht
Friedrich Wilhelm Prize, RWTH Aachen	Dr Martina Neises-von Puttkamer
Friedrich List Prize, TU Dresden	Dr Christian Winkler
Teaching Award of the University of Konstanz	Dr Thomas Voigtmann
3rd place in the Otto F. Scharr Prize for Energy Technology, University of Stuttgart	Mr Dennis Wittmaier
Dr Werner Petersen-Preis der Technik, University of Kiel	Mr Alaa Mourad
Übermorgenmacher, Federal State of Baden-Württemberg	Ms Anja Frank, Mr Hendrik Weihs, Dr Hannah Böhrk, Mr Henning Elsäßer

Affiliates and Joint Ventures

With its responsibility for affiliates and joint ventures, the Staff Department of DLR is tasked with managing and controlling the various participations and memberships DLR holds in other companies and organisations. It is the central point of contact particularly in administrative matters relating to DLR's participations and memberships at every stage, from initiation through administration to processing. The department is also the central point of contact regarding particular liability risks in company law that may arise from DLR's institutional collaboration in networks and cooperations.

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

German-Dutch Wind Tunnels (DNW) Foundation, Noordoostpolder/Netherlands

50 percent
› www.dnw.aero

European Transonic Windtunnel GmbH (ETW) (European Transonic Wind Tunnels), Cologne

31 percent
› www.etw.de

TeleOp Gesellschaft mit beschränkter Haftung (TeleOp Limited Liability Company), Weßling

25 percent
› www.teleop.de

Anwendungszentrum GmbH (Application Center) Oberpfaffenhofen, Gilching

25 percent
› http://bit.ly/1cTgfGi

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
› http://www.ea-aw.org

WPX Faserkeramik GmbH (WPX Fibre Ceramics), Cologne

10 percent
› www.whipox.com

Zentrum für Angewandte Luftfahrtforschung GmbH (ZAL Center of Applied Aeronautical Research), Hamburg

10 percent
› www.zal-gmbh.de

Innovationszentrum für Mobilität und gesellschaftlichen Wandel (InnoZ) GmbH (Innovation Centre for Mobility and Societal Change), Berlin

6.5 percent
› www.innoz.de

ZTG Zentrum für Telematik im Gesundheitswesen GmbH (Competence Centre for Healthcare Telematics), Bochum

6 percent
› www.ztg-nrw.de

DUALIS MedTech GmbH, Weßling

4.9 percent
› http://www.dualis-medtech.de/en/

More information:

DLR Affiliates and Joint Ventures

Members and Committees

As of June 30, 2013, DLR had 43 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
- Uwe Baust, Düsseldorf
- Jürgen Breitkopf, Munich
- Reinhold Busen, Oberpfaffenhofen
- Bernhard Conrad, Hamburg
- Prof. Dr Hansjörg Dittus, Cologne
- Marco R. Fuchs, Bremen
- Prof. Dr Michael Grewing, France
- Dr Gerd Gruppe, Bonn
- Prof. Dr Peter Gruss, Munich
- 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 Schmullius, Jena
- Prof. Dr Stephan Staudacher, Stuttgart
- 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 Economics and Technology, 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, Infrastructure, Transport 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, Research and Technology 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
- CAE Elektronik GmbH, Stolberg
- 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, Fürstenfeldbruck
- 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 (local authority)
- 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

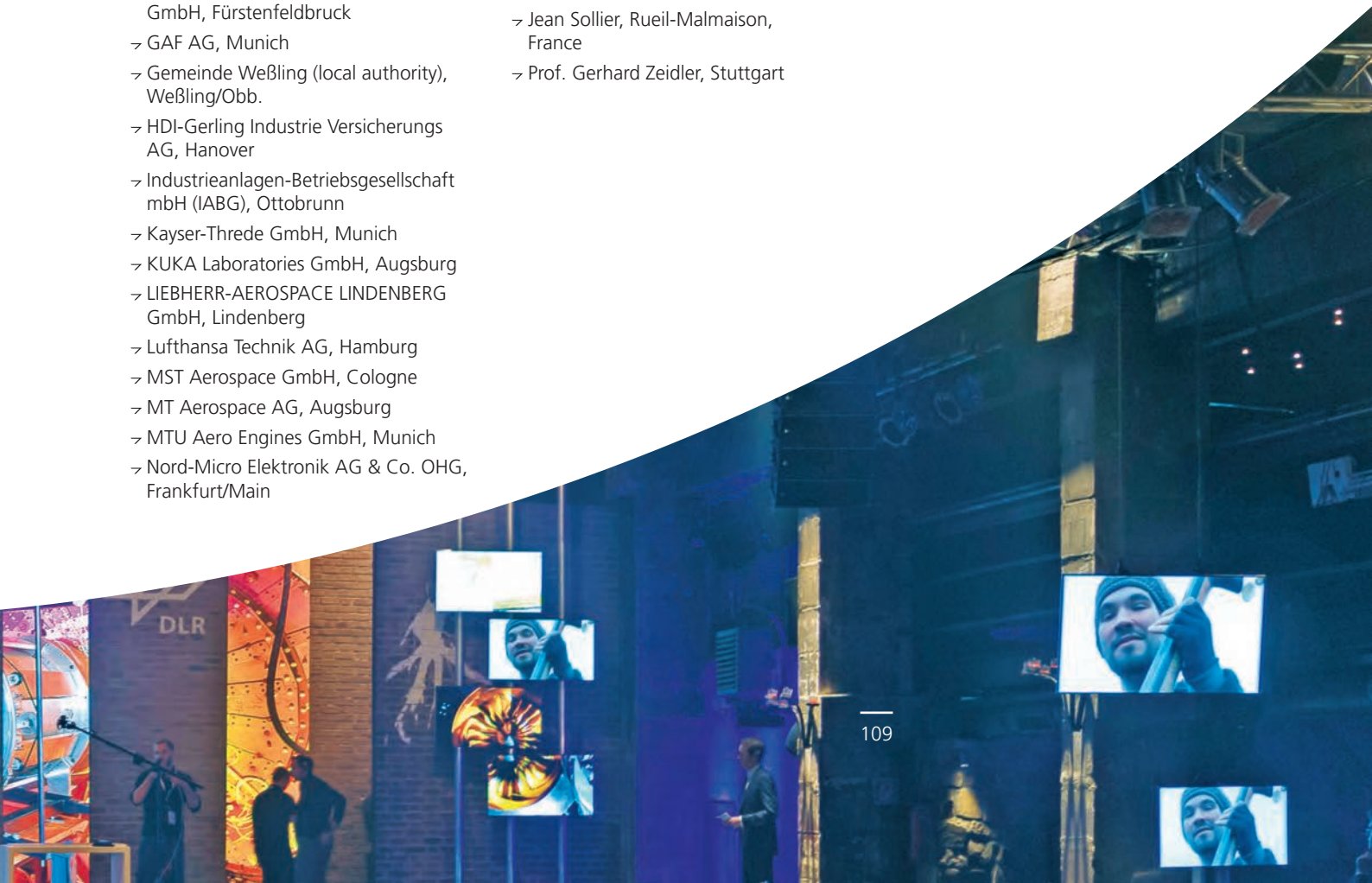
Scientific Members

- 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, 2013

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



Senate

As of June 30, 2013, the following persons were members of the Senate:

From the scientific sector

- Prof. Dr Manfred Aigner
- Prof. Dr Marion Bartsch
- Dr Reinhold Busen
- Prof. Dr Michael Grewing
- Prof. Dr Peter Gruss ex officio
- Prof. Dr Uwe Klingauf (Vice Chairman)
- Prof. Dr Liqiu Meng
- Prof. Dr Reimund Neugebauer
- Prof. Dr Christiane Schmullius
- Prof. Dr Stephan Staudacher
- Prof. Dr Peter Strohschneider

From the economics 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
- VLR I Michael Häusler
- State Secretary Anne Ruth Herkes (Chairwoman)
- Under Secretary Günther Leßnerkraus
- Under Secretary Dr Ronald Mertz
- Under Secretary Gerold Reichle
- Ulrich Schüller
- Under Secretary Dr Beate Wieland

(not entitled to vote in 2013)

- Counsellor of State Gerd-Rüdiger Kück

Why does DLR have a Senate?

The Senate corresponds to the supervisory board of a commercial enterprise. It monitors DLR's activities and at the same time acts as an advisory body. The Senate consists of 33 members, one third of whom come from the scientific sector, one third from the economics and industrial sector, and one third from the state sector. One of the main responsibilities of the Senate is to appoint the full-time members of the Executive Board. The Executive Board of DLR briefs the Senate on the past year and reports to it at each Senate meeting.

Senate Committee

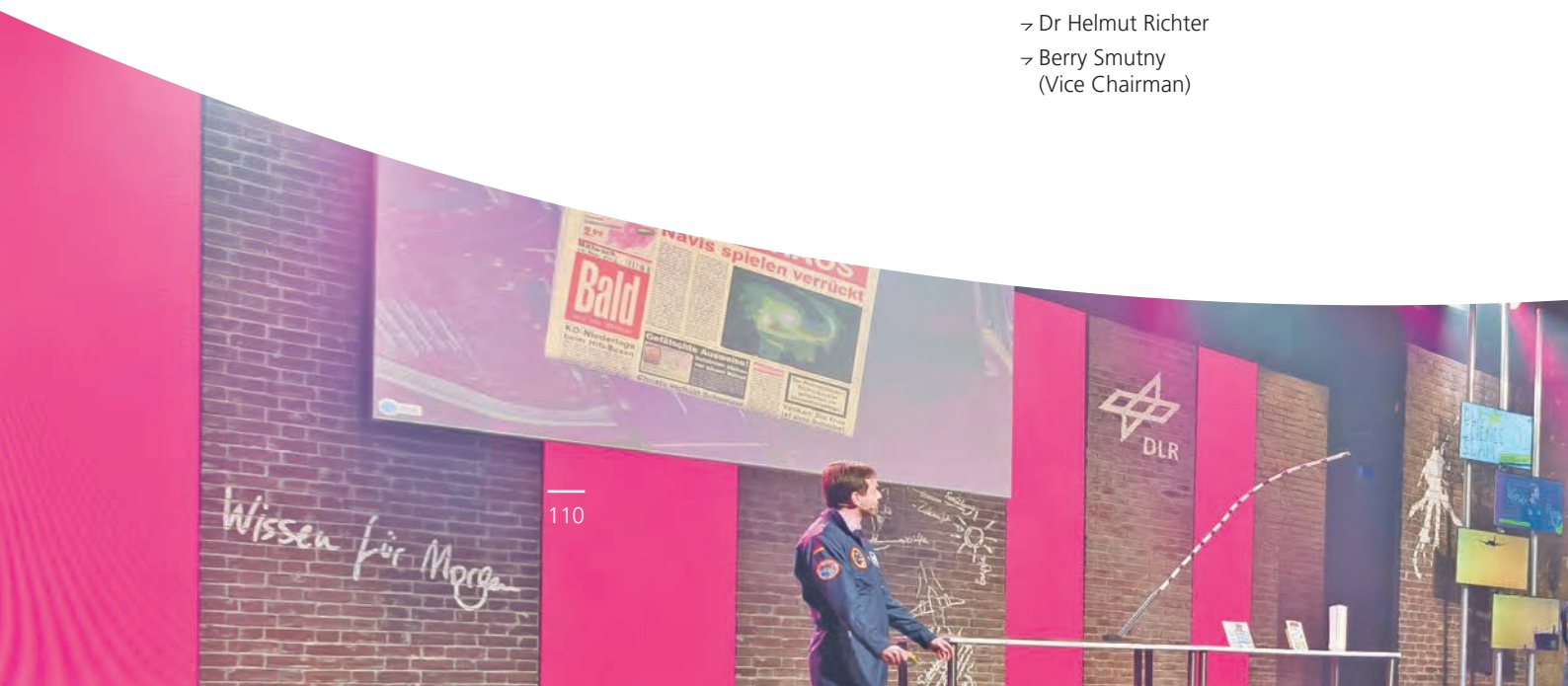
As of June 30, 2013, the senate committee comprised six members from the scientific sector, six members from the economics and industrial sector and six members from the state sector.

From the scientific sector

- Dr Martin Bruse
- Prof. Dr Angelika Heinzel
- Prof. Dr Rolf Radespiel
- Prof. Dr Christiane Schmullius (Chairwoman)
- Prof. Dr Heinz Voggenreiter
- Prof. Dr Gebhard Wulfhorst

From the economics and industrial sector

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



From the state sector (entitled to vote in 2013)

- Klaus Berard
- Dr Walter Dörhage
- Deputy Assistant Under Secretary Helge Engelhard
- Senate Counsellor Bernd Lietzau
- Under Secretary Dietrich Nelle
- Deputy Assistant Under Secretary Norbert Michael Weber

(not entitled to vote in 2013)

- VLR I Michael Häusler
- Deputy Assistant Under Secretary Bernd Hoepner
- Deputy Assistant Under Secretary Dr Axel Kollatschny
- Chief Deputy Assistant Under Secretary Dr Peter Mendler
- Deputy Assistant Under Secretary Dietmar Schneyer
- Deputy Assistant Under Secretary Dr Ulrich Steger

Space Committee

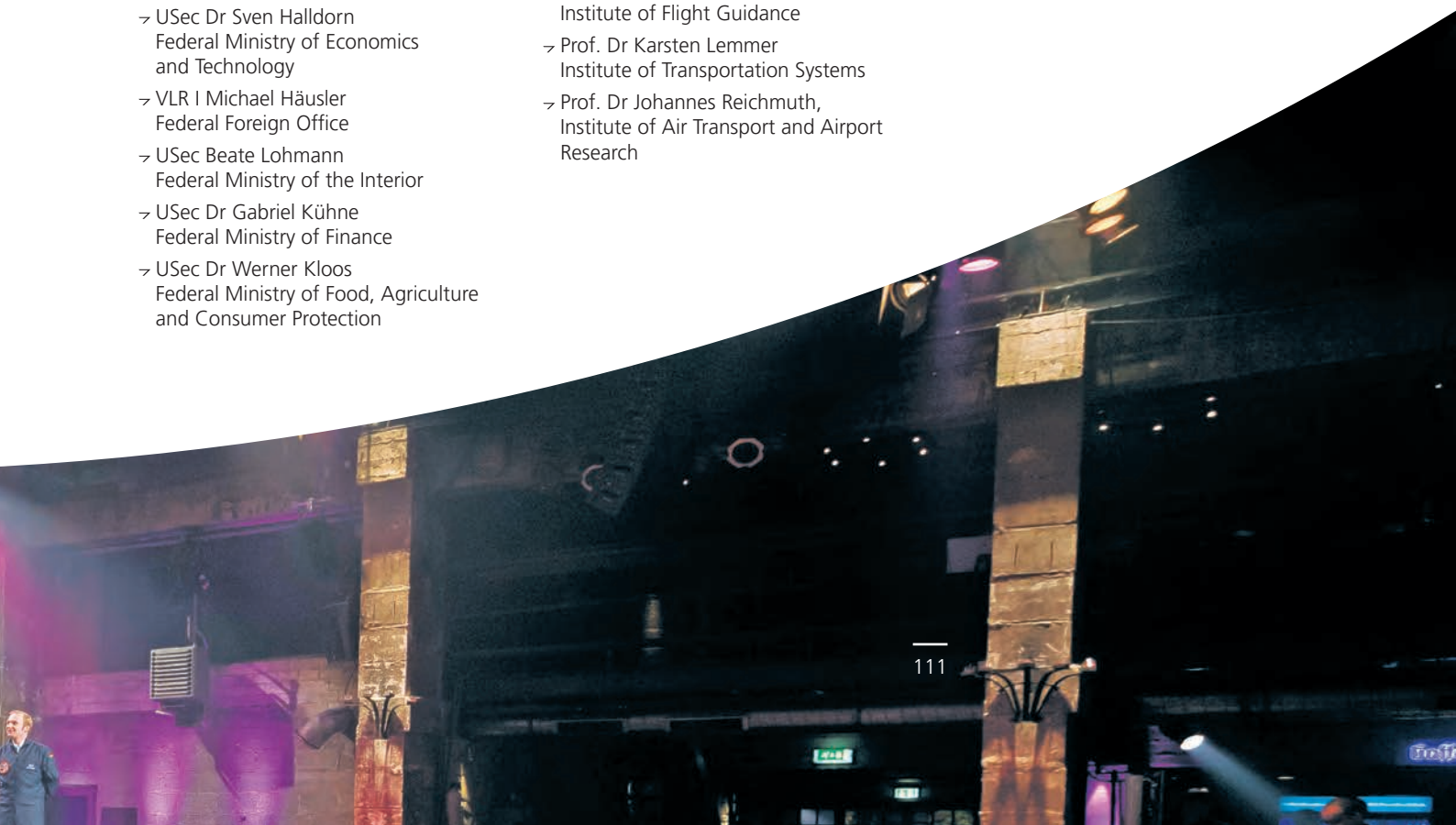
As of June 30, 2012

- USec Dr Sven Halldorn Federal Ministry of Economics and Technology
- VLR I Michael Häusler Federal Foreign Office
- USec Beate Lohmann Federal Ministry of the Interior
- USec Dr Gabriel Kühne Federal Ministry of Finance
- USec Dr Werner Kloos Federal Ministry of Food, Agriculture and Consumer Protection
- DA USec Norbert Weber Federal Ministry of Defence
- USec Gerold Reichle Federal Ministry of Transport, Building and Urban Development
- USec Dr Peter Müller Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
- USec Dr Dietrich Nelle Federal Ministry of Education and Research
- RegDir Frank Wetzel Industrial Policy, Federal Chancellery

Scientific and Technical Council

Members of the STC as of 30 June 2013

- Prof. Dr Alin Albu-Schäffer, Institute of Robotics and Mechatronics
- Prof. Dr Felix Huber Institute of Space Operations and Astronaut Training
- Prof. Dr Stefan Levedag, Institute of Flight Systems
- Prof. Dr Dirk Kügler Institute of Flight Guidance
- Prof. Dr Karsten Lemmer Institute of Transportation Systems
- Prof. Dr Johannes Reichmuth, Institute of Air Transport and Airport Research
- Dr Marina Braun-Unkhoff Institute of Combustion Technology
- Dr Joachim Götz Institute of Flight Systems
- Firas Lethaus Institute of Transportation Systems
- Sven Kaltenhäuser Institute of Flight Guidance
- Dr Thomas Holzer-Popp German Remote Sensing Data Center
- Dr Stephan Ulamec Institute of Space Operations and Astronaut Training



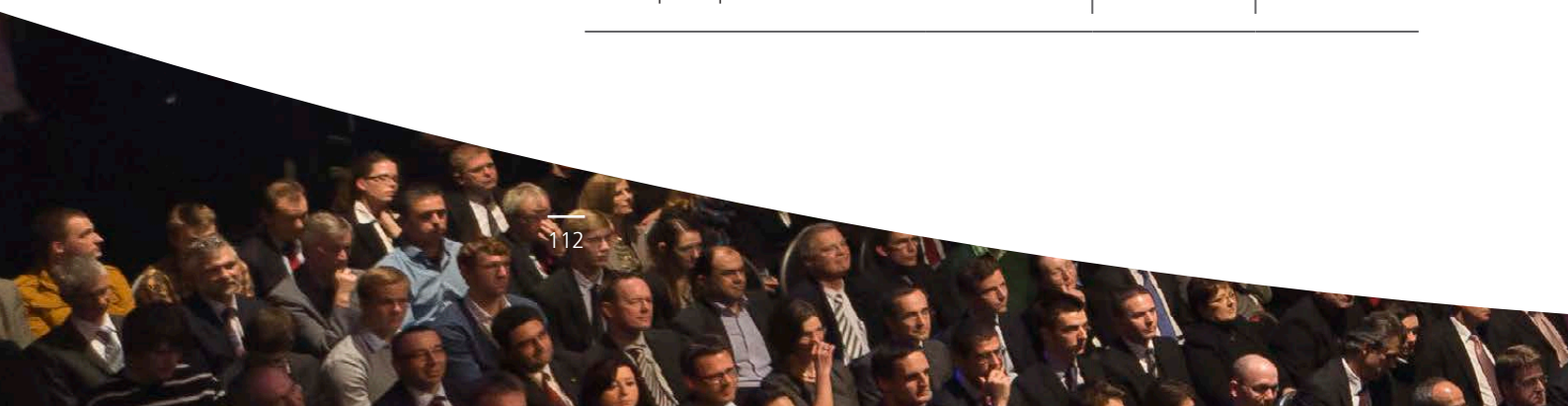
Overview of Operating Figures

Third-party funding	2010	2011	2012
Total third party revenue	401m euros	436m euros	419m euros
Proportion of overall revenue from third-party sources	54%	55%	53%
Earnings trend in revenue from R&T activities in Germany	-6%	-5%	-2%
Percentage of earnings from foreign clients (profit volume)	24%	21%	21%
Revenue from EU funding	22.6m euros	26.1m euros	26.8m euros
Success rate of EU applications (accepted/submitted)	36%	31%	30%
Coordinator quota on approved EU projects	22%	18%	16%

Research-related results	2010	2011	2012
Publications in peer-reviewed journals	654	721	656
Peer-reviewed publications in proceedings, books, etc.	563	491	647
Talks given at scientific conferences, workshops, lectures*	0.51	0.58	0.56
Appointments to universities	14	17	15
Lectureships	296	295	289
Diploma theses	487	542	438
PhD theses	85	105	109
Postdoctoral qualifications	1	6	3

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

Technology Marketing	2010	2011	2012
Investments in technology transfer projects	4.0m euros	4.5m euros	4.5m euros
New in-house technology transfer projects	14	17	10
Revenues from licenses	4.2m euros	4.5m euros	5.1m euros
Start-up companies	2	2	3



Management instruments	2010	2011	2012
Total project work	73.5%	74.8%	77%

Quality management	2010	2011	2012
Existing certifications	30	30	29
Number of DLR auditors	11	11	14
Audits performed	49%	45%	72%

National and European networks	2010	2011	2012
DFG participations	38	32	35
Sponsorship agreements	32	33	38

International cooperation	2010	2011	2012
International visiting scientists*	3.0%	2.4%	2.9%

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

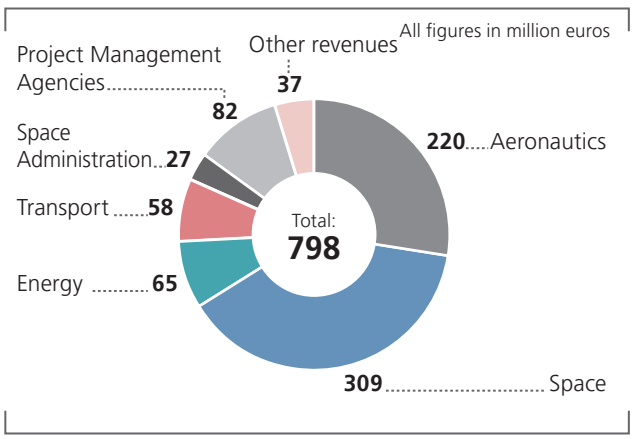
Employees	2010	2011	2012
Employees	6,835	7,046	7,385
Scientific staff (total)	3,913	4,080	4,273
Scientific staff employed by institutes and facilities	3,140	3,569	3,744
Permanent/fixed-term contracts	3,321/3,514	3,534/3,512	3,707/3,678
Proportion of women			
- in total	30%	31%	30%
- in management positions	14%	13%	16%
- scientific staff	13%	18%	17%

Education and Outreach	2010	2011	2012
Junior researchers	55	51	47
Doctoral candidates (internal/external)	763	879	947
Trainees	248	244	253

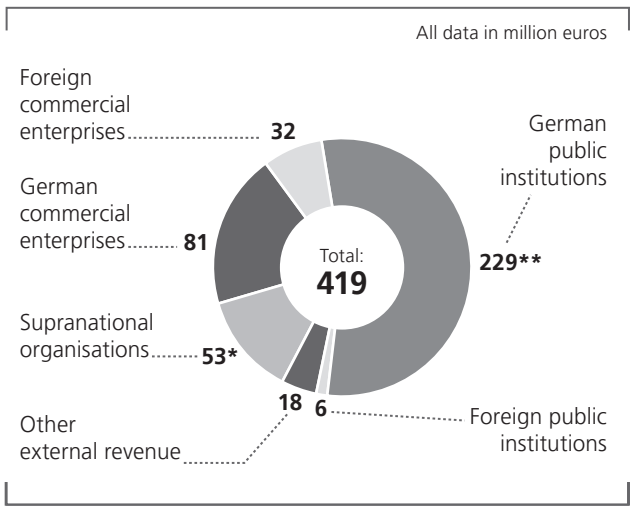
HR development and mobility	2010	2011	2012
Training days per employee	2.2	2.0	1.9
Mentoring pairs	11	10	11
Postings abroad (months)	531	518	449

Use of Funds

Overall revenue 2012

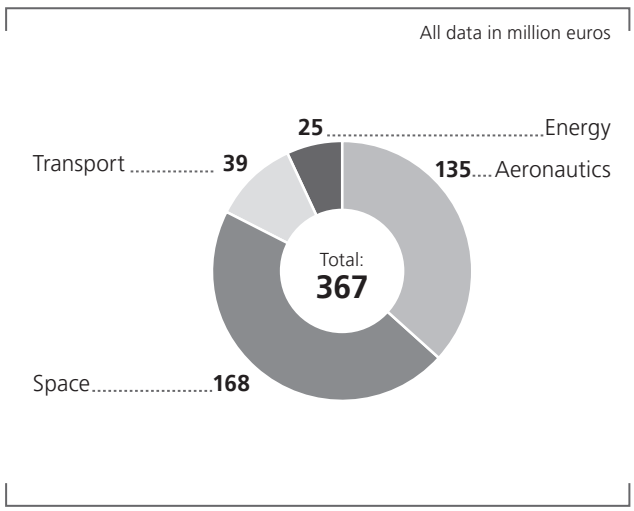


Third-party funding related to origin 2012

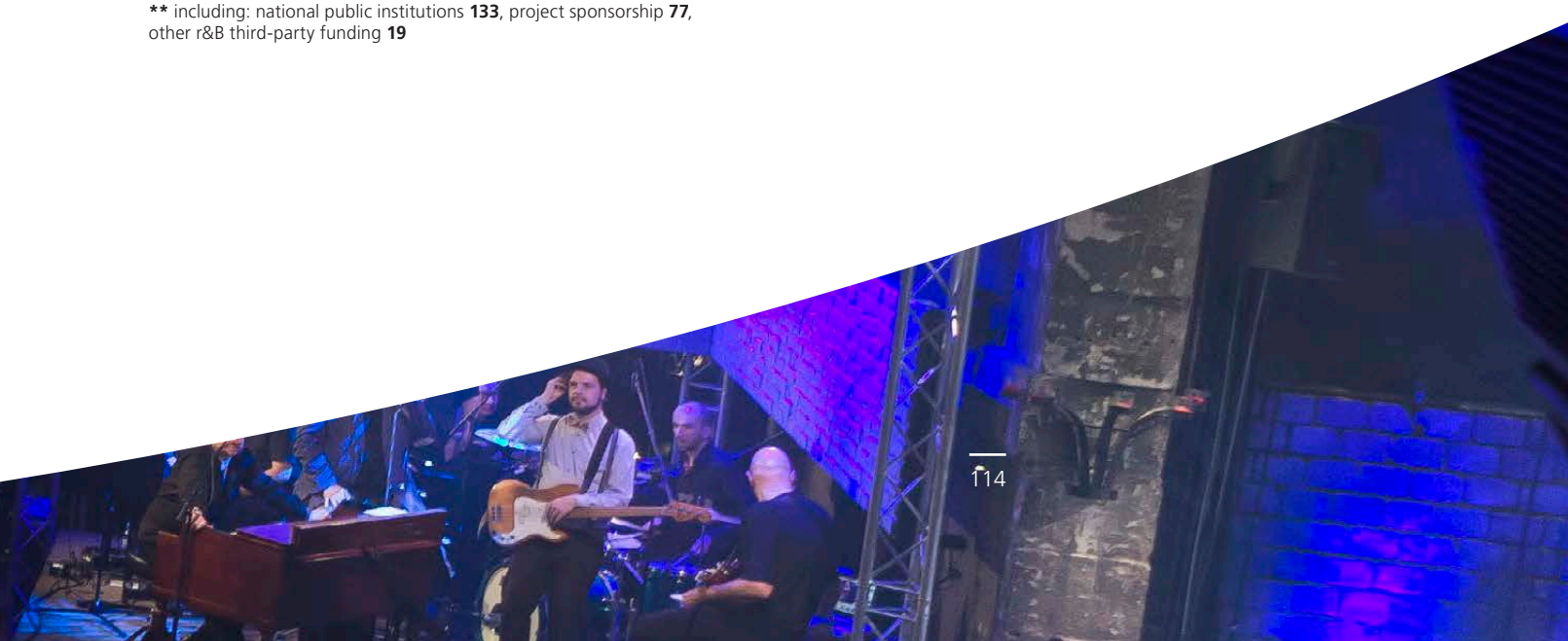


***** including: ESA **27**, EU **26**, other **1**
****** including: national public institutions **133**, project sponsorship **77**, other r&B third-party funding **19**

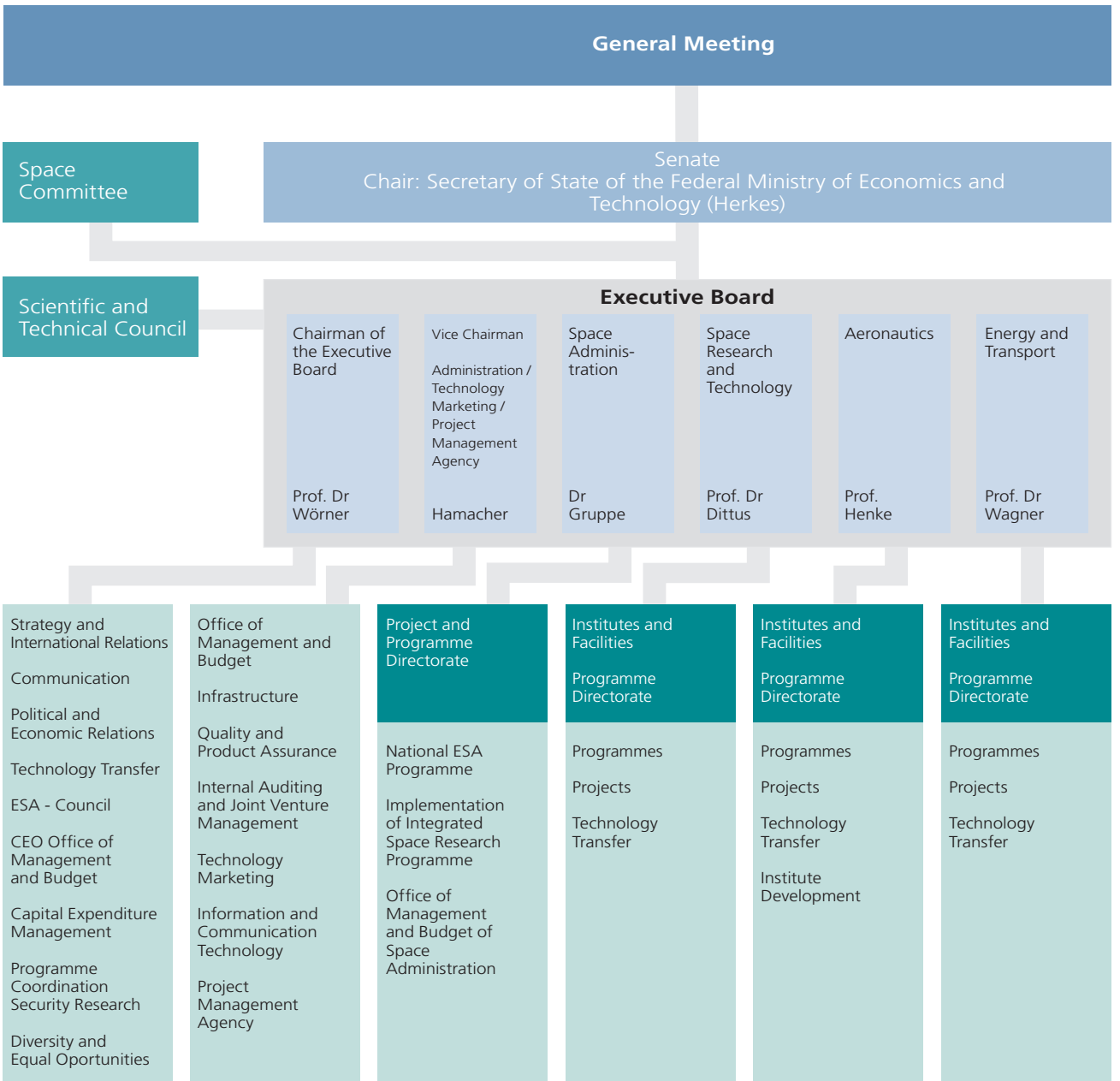
Institutional Funding 2012*



* incl. assigned investments, without HGF fonds and ETW



Organs of DLR



status: July 2013

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 execution organisation.

DLR has approximately 7400 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.

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DLR **Deutsches Zentrum für Luft- und Raumfahrt**

Strategy and International Relations

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