Annual Report

Research Report and Economic Development

2011/2012

DLR

Publication details

Published by	**German Aerospace Center (DLR)**
	Executive Board
Postal address	Linder Höhe 51147 Köln, Germany
Editor	Strategy and Alliances
Design	CD Werbeagentur GmbH, www.CDonline.de
Printed by	Druckerei Thierbach GmbH, Mülheim/Ruhr
Paper	Printed on: Contents – Circle matt white, 100% recycled paper, certified with the Blue Angel eco label and the EU Ecolabel
Press date	Cologne, Germany, November 2012
Reporting period	July 1, 2011 to June 30, 2012
Data status	as at December 31, 2011

www.DLR.de/en/

Research Report and Economic Development 2011/2012

German Aerospace Center (DLR)

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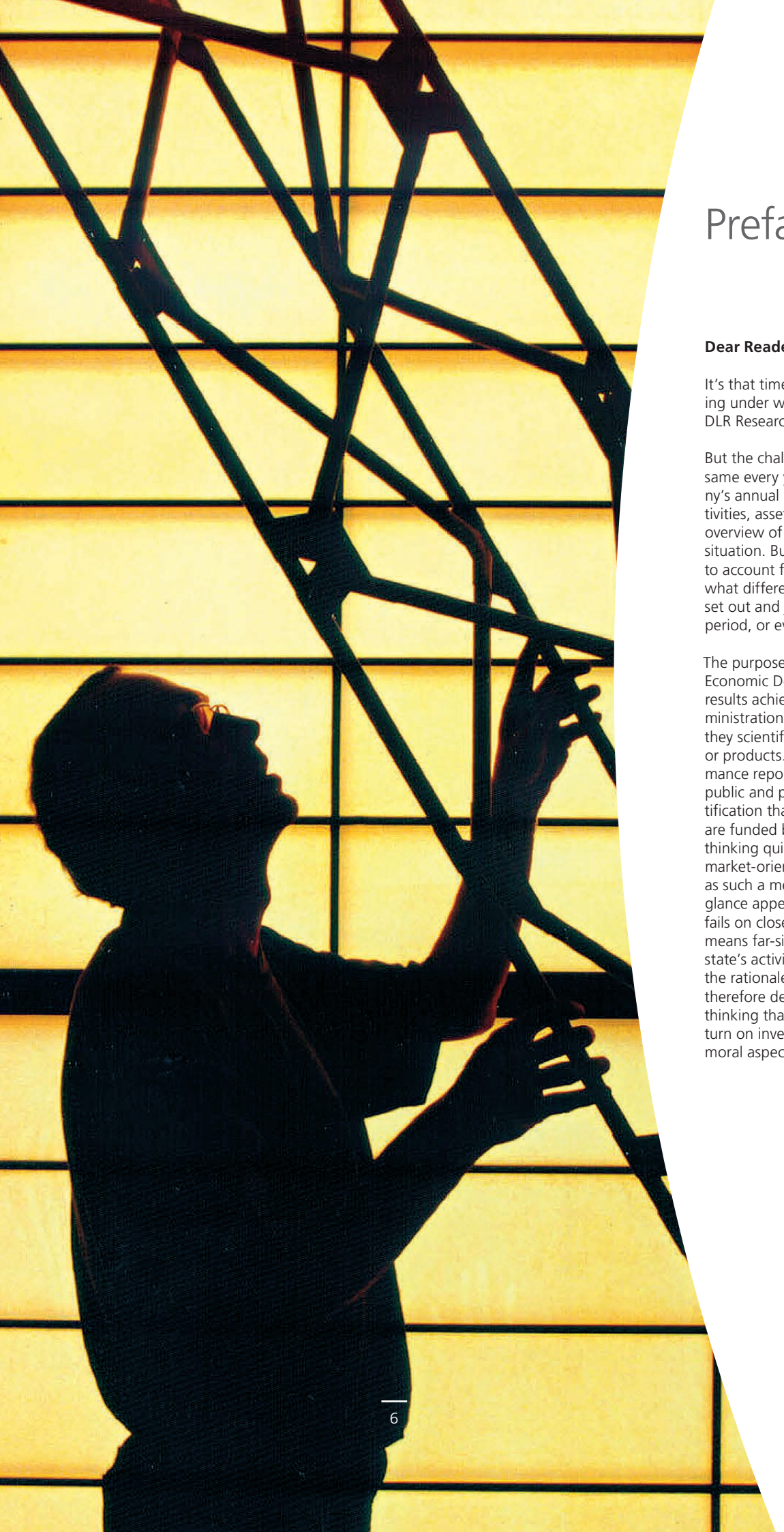

Preface

Dear Reader,

It's that time of year again... is the heading under which we might publish the DLR Research Report.

But the challenges we face are not the same every year. A commercial company's annual report is an account of its activities, assets and liabilities, providing an overview of its operational and financial situation. But requiring an organisation to account for itself may take on a somewhat different meaning: as a demand to set out and justify its actions over a given period, or even its entire existence.

The purpose of the Research Report and Economic Development is to present the results achieved by the Research and Administration divisions of One DLR – be they scientific findings, new procedures or products. Demands for such performance reports are made regularly in public and political contexts with the justification that ultimately these activities are funded by the tax payer. This line of thinking quickly leads to market-driven, market-oriented research. As reasonable as such a methodology might at first glance appear, its all-encompassing logic fails on closer inspection, and it is by no means far-sighted. In many areas, the state's activities should be pre-emptive; the rationale of spending tax money therefore defies the simplistic manner of thinking that focuses on short-term "return on investment"; societal, ethical and moral aspects must also be considered.

Attempts to measure the pulse of research by ever new parameters are nonetheless incessant. How would Albert Einstein have fared had he been subjected to such evaluation? Only many decades after he had conducted his pioneering work, and after he himself had altered and corrected some of his statements, is its significance not only to scientific thinking, but also for practical applications emerging: without the theory of relativity, satellite navigation quite simply wouldn't work, as it is based on the transmitted time signals. The general and the special theory of relativity describe the relationship between time, velocity and gravity; only if this relationship is taken into consideration does positioning achieve the necessary accuracy.

To avoid any misunderstandings: I am not arguing against the recording and presenting of research work and its results. But I do think that assessing it is by no means as trivial as is demanded in pub discussions or by similarly lukewarm intellects.

The DLR Research Report and Economic Development describes a wide range of activities and findings. It demonstrates how we approach the innovation chain from basic research to market-ready product, from invention to innovation, at DLR and with various partners. It is crucial that we defend DLR's positioning across this range against some attempts to curtail it, and document our capabilities through qualitative and quantitative representations.

Drawn up accordingly, the purpose of the Research Report and Economic Development extends far beyond its basic accounting function: its reports from the Aeronautics, Space, Transport and Energy programs and the horizontal theme Security, the highlights from our Administration and a collection of current facts and figures make it a compendium well worth reading, and one I hope any prospective users, partners, customers, and most importantly anyone interested in the pursuit of knowledge will enjoy.

Yours sincerely,

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

DLR at a Glance

Sites with Institutes and Facilities

Institutes and Facilities

- Aerodynamics and Flow Technology
- Aeroelasticity
- Propulsion Technology
- Structures and Design
- Vehicle Concepts
- Composite Structures and Adaptive Systems
- Flight Guidance
- Air Transport and Airport Research
- Flight Systems
- Microwaves and Radar
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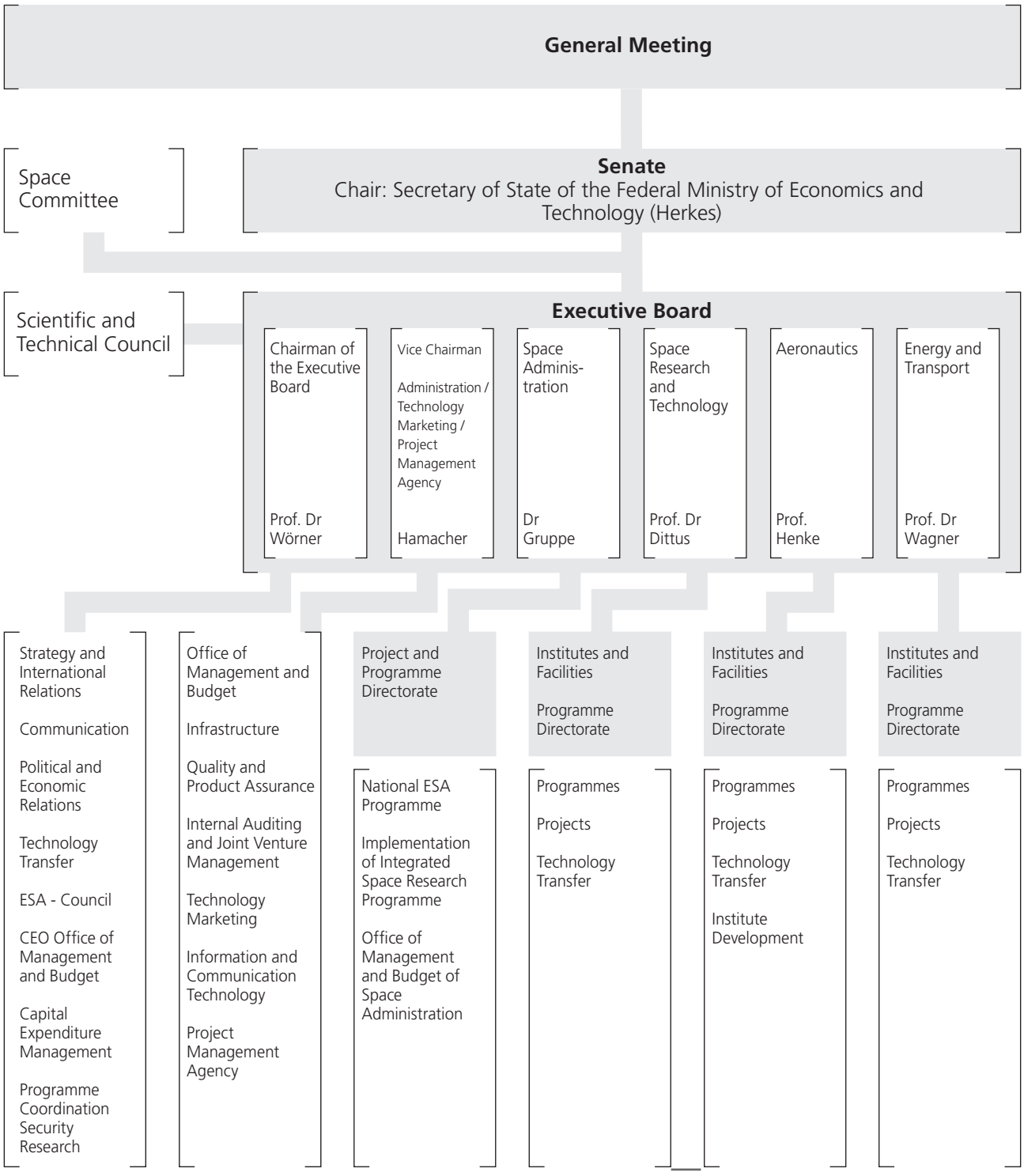
- Transport Research
- Transportation Systems
- Materials Research
- German Remote Sensing Data Center (DFD)
- DLR Air Transportation Systems
- DLR Space Operations and Astronaut Training
- DLR Simulations and Software Technology

Organs of DLR



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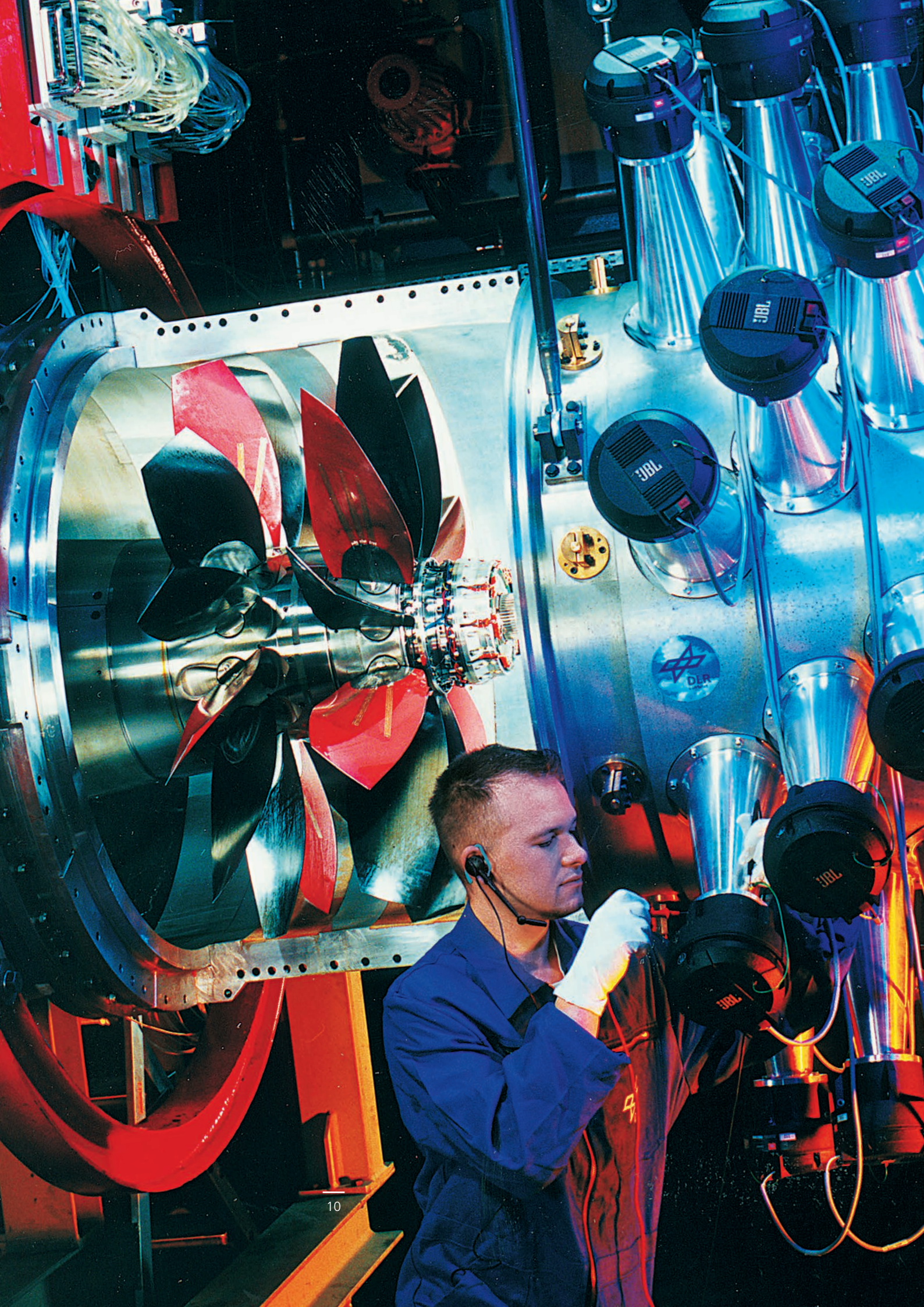
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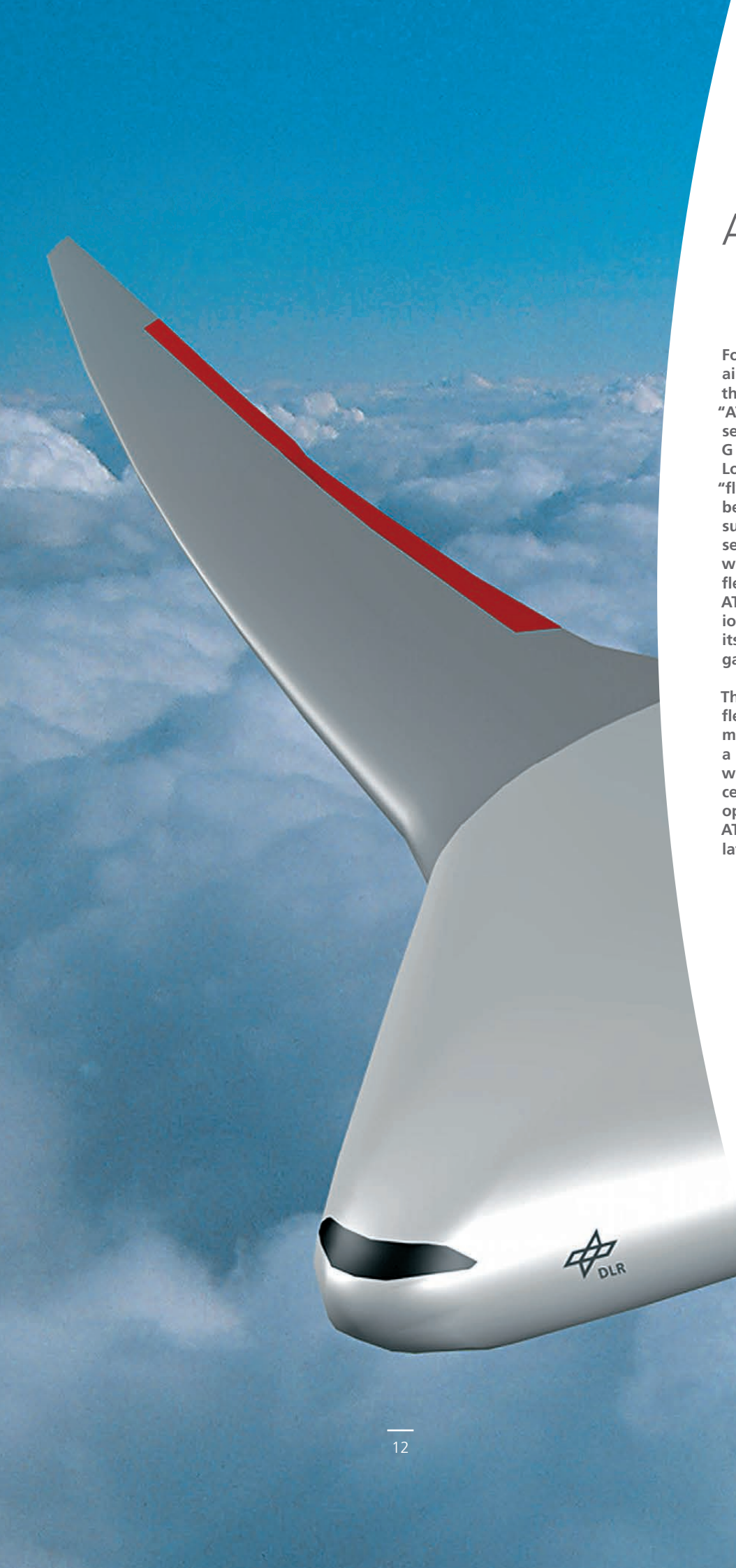
RESEARCH REPORT



Aeronautics

Following the expansion of the DLR aircraft fleet in recent years through the addition of the Airbus A320 "ATRA" (Advanced Technology Research Aircraft) and the Gulfstream G 550 "HALO" (High Altitude and Long Range Research Aircraft), the "flying simulator" ATTAS has now been retired after 26 years of highly successful research operations (see separate report). As no other fixed-wing aircraft in the DLR research fleet currently has the ability of ATTAS to simulate the flight behaviour of other – real or virtual – aircraft, its retirement will initially leave a gap in the experimental field.

The "rejuvenation" of the aircraft fleet however requires infrastructure measures such as the construction of a new aircraft hangar in Braunschweig or the new ARES simulator center at DLR Braunschweig, where operations will include preparing ATRA and the flying helicopter simulator FHS for flight experiments.

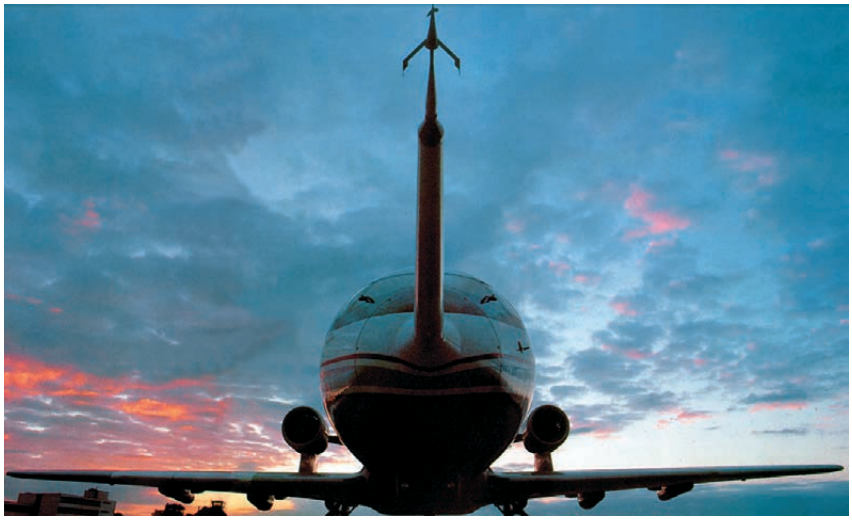
ATTAS – a look back

"Flying simulator" is retired

ATTAS (Advanced Technologies Testing Aircraft System) was designed as an in-flight simulator that allowed the aerodynamic properties and flight characteristics of other (even virtual) aircraft to be tested in flight. To achieve this, an experimental electro-hydraulic fly-by-wire control with the associated computer system was installed alongside the standard mechanical/hydraulic controls; this control could be activated and deactivated in flight. In addition, the aircraft featured direct lift control flaps, a measuring system and an experimental energy supply. Its safety concept, according to which the safety pilot's mechanical control was always active, allowed the use of experimental software in the fly-by-wire control without requiring a complex approval procedure.

In addition to actual in-flight simulation with altered aerodynamic properties (e.g. Fairchild-Dornier 728, blended-wing body, wake vortex simulation), ATTAS and its experimental equipment were used for a wide range of other research programs, e.g. testing laminar wing profiles and engine nacelles, sensor testing, load alleviation, analysis of engine exhaust gasses, examining and measuring wake vortices, testing air traffic control concepts and approach procedures, flight control systems, taxiing system designs, low-altitude flight control, displays, precision navigation, remotely controlling (simulated) unmanned aircraft and testing the necessary air traffic control and emergency procedures.

During the aircraft's period of operation, the avionics and experimental equipment on board ATTAS were constantly adapted to current requirements and the latest technical developments. Around the turn of the millennium, use of the fly-by-wire control in landing approaches was extended to the ground.



After 26 years of service in aviation research, the VFW614/ATTAS was decommissioned in June 2012.

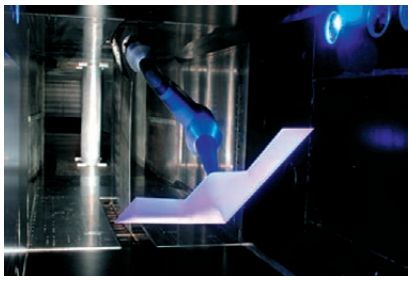
ATTAS – a plane with a very long nose

The nose boom on some DLR aircraft is by no means standard. The ATTAS nose boom was 3.80 metres long and featured an integrated 5-hole probe designed to measure pitch and sideslip angles by means of differential pressures. Because air flows around the fuselage and is deflected, precise measurements are only possible well forward of the aircraft body. The probe is an enhanced version of a mechanical flight log, which however is only usable in good weather. With the new electrically heated 5-hole probe, flights for in-flight simulation can be conducted regardless of the weather – even in rain or icy conditions.

FaUSST

Highly tapered flying wings

Future tactical aircraft will be unmanned. This development opens up new possibilities for their design, including options aimed at improving radar and infrared signatures. Against this background, the DLR project FaUSST – Fortschrittliche aerodynamische UCAV Stabilitäts- und Steuerungs-Technologien (Progressive aerodynamic UCAV stability and control technologies) – examines the aerodynamics of a highly tapered flying wing. The lack of horizontal and vertical tails reduces radar signatures but presents a significant aerodynamic challenge. To reduce infrared signatures, jet air intakes and nozzles are typically positioned on the upper side of the aircraft, which causes interference with the vortex-dominated flow field. The project examines basic questions relating to the stability and controllability of such a flying wing using the generic configuration DLR-F17, a tapered lambda-wing of modular design that permits various leading edge geometries, wing control flaps and air intakes with airflow. The configuration is partly designed, constructed and tested in international collaboration with NASA, ONERA and industry under the umbrella of the NATO research organisation RTO. Wind tunnel



High-speed model DLR-F17E in transonic wind tunnel: measuring pressure distribution with pressure-sensitive paint

experiments conducted in Germany, but also in the UK and the USA, examine how vortices affect flight characteristics at speeds up to Mach 0.9. The flow field is measured via PIV (particle image velocimetry), the pressures and momentum affecting the model are recorded with wind tunnel balances, and the flow footprint is visualised on the upper side of the model using pressure sensitive paint (PSP).

What is better, rounded or sharp leading wing edges? Which flow control measures are effective? How does the aircraft respond to sudden control flap movements? The findings are extremely important for the design and development of future flying wings. This cooperation between DLR's internal FaUSST project and the RTO activities is an example of how a successful, mutually beneficial international collaboration between large-scale research institutions with industry participation can work.

BALU

Research autoclave taken into operation in Stade

Sustainable use of resources, reducing emissions while maintaining energy efficiency and ensuring high product quality are some of the current challenges in producing components made of fibre-reinforced plastics for the aviation industry. With current technology and for the foreseeable future, producing high-quality components made of fibre-reinforced plastics will generally require the use of an autoclave. Examining this production process, optimising it and increasing its efficiency are key research areas of DLR at the Center for Lightweight Production Technology in Stade.

The aim is to optimise the cost- and time-intensive manufacturing process using appropriate quality assurance measures and component status related dynamic process control. In BALU – Biggest Autoclave Laboratory Unit –, which offers a usable length of 20 m at a diameter of 5.80 m and a maximum temperature of 420°C at a pressure of 10 bar, DLR has a research facility that enables research into new manufacturing technologies at industrial scales. The use of innovative sensor technologies which in addition to local temperature and pressure monitoring also permit the detection of degrees of hardening and temperature distribution expands the understanding of the process and shortens the iterative development phase of new components and manufacturing concepts.

The research autoclave's innovative control system includes a simulation module that is capable of predicting component quality in real time, counteracting plant inertia and allowing errors to be promptly detected, reduced or even prevented entirely through appropriate control strategies. Due to its unique features, such as viewing windows and a large number of integration options for add-on systems, the research autoclave is well equipped to meet future research challenges.

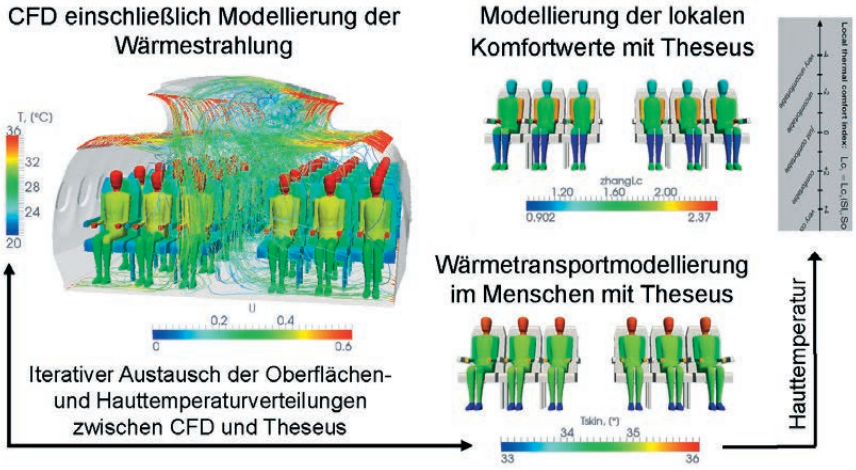
ECCO

Thermal comfort modelling

Thermal comfort of passengers is a significant criterion for airlines when deciding to purchase an aircraft. In developing new aircraft ranges, aircraft manufacturers are increasingly basing their cabin designs on numeric simulations of cabin flows. Previously, thermal surface boundary conditions were pre-specified for passenger models. The modern THESEUS model can now be used to predict thermal comfort. It takes into account not only the fact that the human body consists of various layers in which heat is distributed through the bloodstream, but also the effects of clothing, passenger activity and air humidity.

To couple this model with a computational fluid dynamics (CFD) program developed as part of the DLR project ECCO (Enhanced Cabin Comfort Computations), the first step is to specify temperature values for passengers' body parts. Then thermal flows are determined for these passenger models and submitted to THESEUS, which calculates the equivalent temperature, their surface and skin temperatures, and from these a local comfort index. In the next step, the surface temperature values are used in the CFD calculations as temperature boundary conditions for the body parts.

Calculations were performed both for the cabin of an A320 with six rows of seats and 36 passenger models and for



Thermal comfort modelling using the A320 cabin as an example

ACT/FHS in hover (ADS-33 mission element)

the cabin of the Do728 test rig with three rows of seats and 15 passenger models. The comfort predictions covered both perceived body temperature, ranging from "very cold" to "very warm", and comfort levels from "very uncomfortable" to "very comfortable".

Active sidesticks

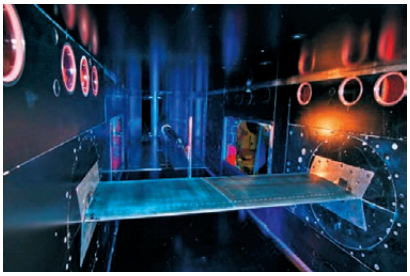
Effects of active inceptors on flight characteristics

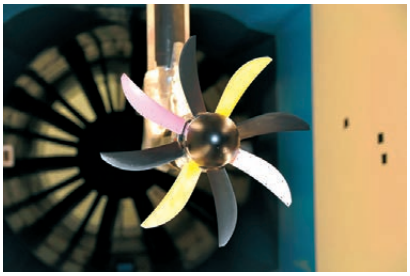
Fly-by-wire flight control systems permit complete decoupling of a helicopter's control axes, dramatically improving flight characteristics and significantly reducing pilot strain. Future helicopter models will therefore increasingly be equipped with this technology. Active sidesticks offer the opportunity to take full advantage of the potential of fly-by-wire technology by not only improving ergonomics, comfort and crash safety, but also redefining the primary human-machine interface. They allow control forces to be adapted to the respective flight situation and enable information about flight envelopes or system limitations to be transmitted intuitively through haptic signals such as vibrations, situation-related force-deflection curves or soft stops.

The effects of the characteristic parameters of active inceptors, such as the force-deflection rule or decay, on flight characteristics have been the subject of research for many years. However, findings in this area exist mainly for fixed-wing aircraft. In a project initiated under the German-American Memorandum of Understanding, DLR and the US Army performed systematic and complementary flight experiments and ground simulator studies pertaining to this issue, DLR using the ACT/FHS with short active sidesticks and the US Army using its RAS-CAL with long active pilot sticks in standard configurations. These flight experiments took place on the US Army base in Ames in February 2011 and at the Bundeswehr Technical Center in Manching in October 2011.

The results indicated that in order to achieve the best possible flight characteristics the stick parameters have to be adapted to the vibration level and the agility of the respective helicopter, and to the required task. An initial draft for criteria from which to derive these characteristics was drawn up. The aim of this work is to expand the ADS-33 ruleset to include corresponding design guidelines.

SIMCOS model with blowing actuators


SIMCOS model at DNW-TWG


Propeller with pressure (magenta) and temperature (yellow) sensitive coating in the wind tunneltunnel

SIMCOS

Active flow control on main rotor profile successfully tested in wind tunnel

The introduction of modern transonic profiles for helicopter main rotors has facilitated significantly improved flight performance and noticeably reduced fuel consumption. In flight conditions which place heavy strain on the rotors, such as fast spiralling or flights at high altitudes and high external temperatures, these improvements were however accompanied by increased dynamic stall on the retreating blade, causing wide variations in pitch moment with large absolute values. This phenomenon led to increased vibrations and higher strain on the swash plate actuators and control rods, which in addition led to increased wear and tear resulted in a limited flight envelope.

Against this background, the Franco-German SIMCOS (Advanced Simulation and Control of Dynamic Stall) project was initiated by DLR and ONERA in order to better understand and control the complex flow phenomena involved in dynamic stall. The project employs both passive and active methods; DLR is examining the technique of active blowing. Based on preliminary numeric studies using the DLR-TAU-Code, a wind tunnel model for the DNW-TWG transonic wind tunnel measuring 1 m x 0.3 m and featuring 42 high-frequency, individually switchable blowing actuators was designed, manufactured and tested. The model was equipped with unsteady pressure sensors in order to quantify the effect of the blowing actuators.

The DNW-TWG wind tunnel campaign took place in Göttingen in December 2011. For a Mach range of 0.3 to 0.5, blowing achieved a significant reduction in maximum pitch moment, namely an increase in average lift of 20%, reduced drag and a reduction in maximum pitch moment of 60%. These wind tunnel data will now be used to validate the CFD processes, to better understand the physical phenomena involved, and finally to define steps for transferring these findings to flight.

iPSP2

Contactless optical pressure and temperature measuring on propeller blades

Developing more environmentally friendly and powerful aircraft engines is one of the most important goals of modern aeronautics. There are however still a number of unanswered questions regarding the ability to measure the performance of a propeller in a wind tunnel. With current technology, total loads and moments can generally be determined using internal balances; precise information regarding pressure and temperature distribution on propeller blades is however frequently unavailable because there is no room for conventional pressure pipes or temperature sensors within the model. Moreover, punctual pressure and temperature measurements are not suitable for detecting specific flow structures on propeller blades which however occur frequently with propellers, such as separation bubbles.

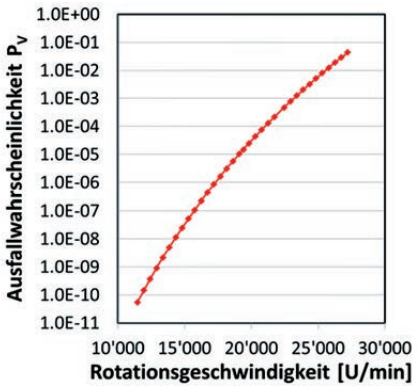
The contactless optical measuring methods PSP (Pressure Sensitive Paint) and TSP (Temperature Sensitive Paint) provide a solution to this problem. These procedures take advantage of specific characteristics of certain organic molecules in order to make pressure or temperature differences visible on objects in flow fields, and can even be used to examine propellers rotating at high speeds.

In collaboration with the University of Hohenheim, the DLR project Instationäres PSP, Phase 2 (Unsteady PSP Phase 2, iPSP2) succeeded in developing PSP and TSP paints that were successfully used in wind tunnel measurements. TSP for example enabled the first visualisation of laminar turbulent transition on the surface of a propeller blade rotating at up to 15,000 rpm. At the same time, PSP technology made it possible to quantitatively measure pressure distribution on the propeller blade.

Reliability of turbine components

Probabilistic methods for measuring failure probability

Given the variations in material properties, manufacturing conditions and geometric manufacturing tolerances, and the operating conditions and resulting strain on materials and components, purely deterministic calculation methods are not sufficient to evaluate the behaviour of highly stressed engine parts. As failure-critical, highly stressed turbine components must according to FAA regulations be designed to a maximum permissible failure probability, efficient and precise calculation of failure probability under realistic operating conditions is an important and so far insufficiently achieved objective.



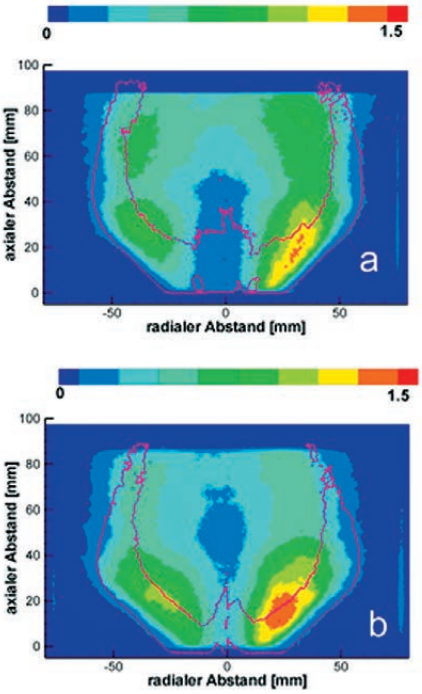
Failure probability (Ausfallwahrscheinlichkeit) of the turbine blades as a function in ratation speed (Rotationsgeschwindigkeit)

The Institute of Materials Research is developing probabilistic methods for this purpose based on a hybrid approach in which the dispersed influencing variables are divided into two groups: those whose effect on failure probability can be calculated semi-analytically and precisely, and those for which this is not possible. This at least partially semi-analytic and thus more efficient procedure significantly accelerates the calculation of failure probability overall. First example calculations for turbine blades under initially simplified loads have yielded calculation times that are faster by a factor of at least 10,000 compared to current methods.

BOSS

In situ measuring of soot emissions from lean burners under realistic operating conditions

Reducing nitrogen oxide through lean combustion is a technique currently being examined intensively for use in engines with high pressure levels. The pollutant balance for this type of combustion is however only better than that of standard technologies if its sooting behaviour is understood and controlled. For lean combustion to be stable, the lean burner must be supplemented with an integrated pilot burner; this pilot burner may occasionally burn over-stoichiometrically in the partial load range, which can cause excessive soot emissions.



Due to the innovative flow conduction of the lean burner concept, identifying the soot production zones and how they are linked to the flow field is of particular interest. As soot emission depends in a strongly non-linear way on operating conditions, and here in particular on combustion chamber pressure, it is necessary to examine sooting behaviour at

relevant operating conditions. The Big Optical Single Sector (BOSS) combustion chamber operated by the Institute of Propulsion Technology in collaboration with Rolls Royce Germany is ideal for performing these experiments. The necessary tests required further development of the laser-induced incandescence technology and of particle image velocimetry for high-intensity flames, which then made it possible to examine the relevant operating states.

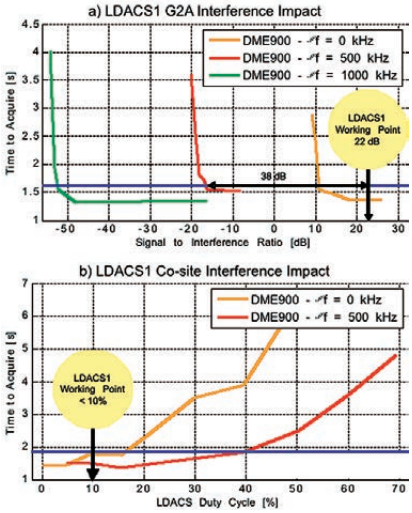
The image shows the primary zone of two burners; the direction of flow is from bottom to top. The pseudocolour scheme indicates the distribution of the soot volume fraction for burners with different air distributions and identical pilot burner related air-fuel ratio. The magenta-coloured isoline encloses the area of heat release. The results show the potential of this examination method to help derive approaches for reducing soot emissions by understanding design-specific characteristics.

LDACS1

Compatibility measurements for the DLR L-band aeronautical communications system

With the assistance of Deutsche Flugsicherung GmbH (DFS), the LDACS1 (L-Band Digital Aeronautical Communications System, Type 1) candidate technology for the future L-band aeronautical communications system, in the development of which DLR was heavily involved, has been tested for compatibility with the L-band navigation system DME (Distance Measuring Equipment); compatibility of these two systems represents a significant requirement for the future L-band aeronautical communications system.

The LDACS1 laboratory demonstrator developed and implemented by the Institute of Communications and Navigation



Interference effects of LDACS1 on DME using the Rockwell Collins DME900 DME system as an example:
a) G2A and
b) Co-site

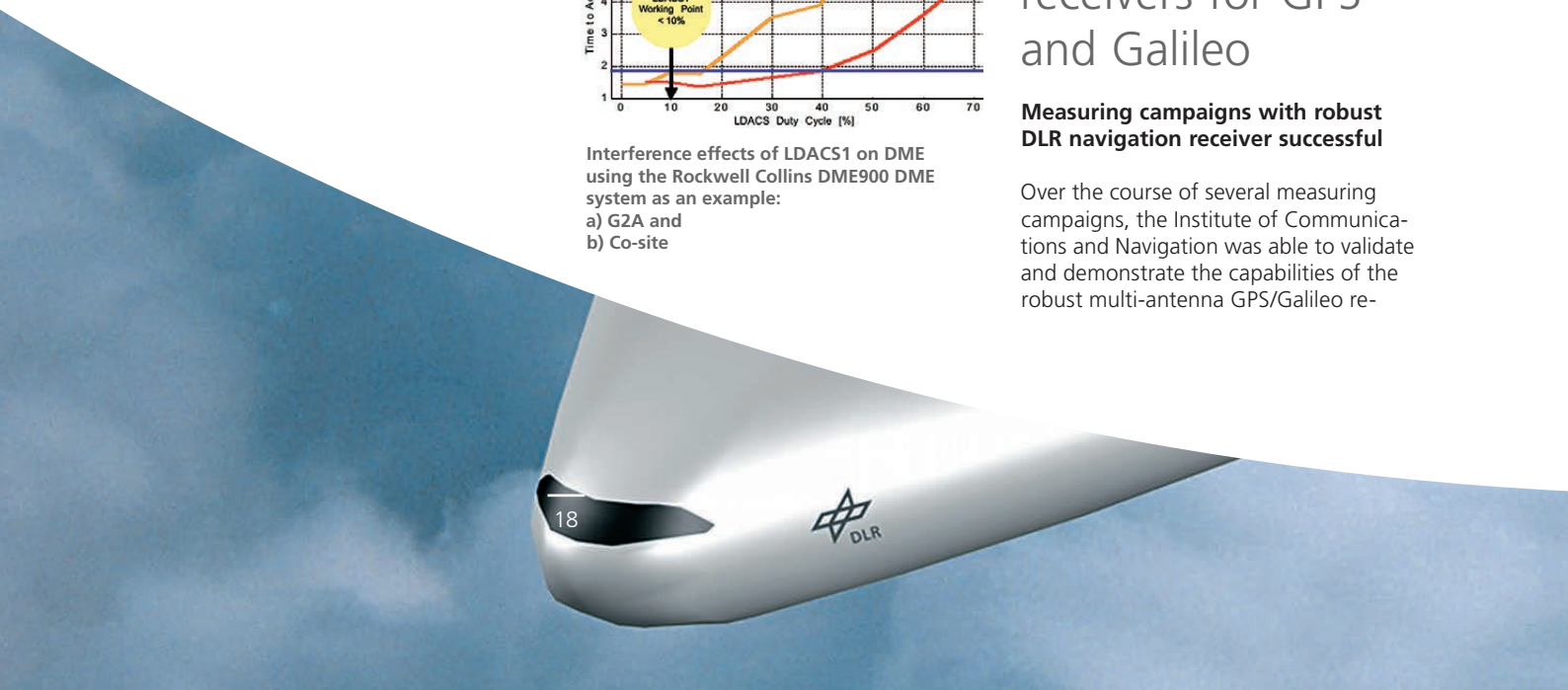
was used for the compatibility tests and measured against a set of realistic interference scenarios; both the effects of LDACS1 on the DME and the interference effects on LDACS1 caused by the DME were observed. The tests examined the two most important scenarios for interference effects of LDACS1 on the DME – Ground to Air (G2A) interference of an LDACS1 ground station on the on-board DME of an aircraft, and co-site interference of an LDACS1 on-board transmitter on the on-board DME. The results are of particular interest for the planned inlay procedure, in which LDACS1 channels are inserted directly between the DME channels with a frequency offset of Δf=500 kHz. In both interference scenarios, G2A and co-site, the achieved results for the planned inlay procedure were far from the specified limit values, e.g. the 38dB safety margin for G2A, at the operating point.

In addition, the results for interference effects of the DME on LDACS1 showed that despite DME interference, the required signal quality on the LDACS1 receiver was achieved at the operating point. The results so far are thus very promising. It is to be expected that further L-band measurements will also show compatibility.

Multi-antenna receivers for GPS and Galileo

Measuring campaigns with robust DLR navigation receiver successful

Over the course of several measuring campaigns, the Institute of Communications and Navigation was able to validate and demonstrate the capabilities of the robust multi-antenna GPS/Galileo re-



Flight experiments with DLR's robust multi-antenna GPS/Galileo receiver

Remote Tower Center Simulation at the DLR Institute of Flight Guidance

ceiver developed by DLR. For this purpose, measurements using real interference signals were conducted at the Galileo test and development environment (GATE) in Berchtesgaden. Even under the influence of these interference signals the DLR multi-antenna receiver was able to navigate reliably, while commercially available receivers were no longer in a position to receive so much as a single satellite signal.

In collaboration with TU Munich, the Institute also performed flight experiments at the Braunschweig Research Airport in order to test new reception methods for the robust navigation receiver which ensure signal reception and reliable navigation even under difficult conditions. In these experiments, special manoeuvres were flown in order to examine GNSS (Global Navigation Satellite System) signal shading through the aircraft itself, e.g. through the wings if the aircraft is banking heavily. The institute's GALANT receiver was used to record raw data from a group antenna with four elements; the data were then evaluated in a post-processing phase. Vector tracking, in which the servo loops in the receiver are tracked simultaneously for all received signals, was expanded to include reception via the group antenna. The results show that this method allows reliable positioning even under difficult conditions involving partial signal shading, while this was frequently no longer the case using standard procedures.

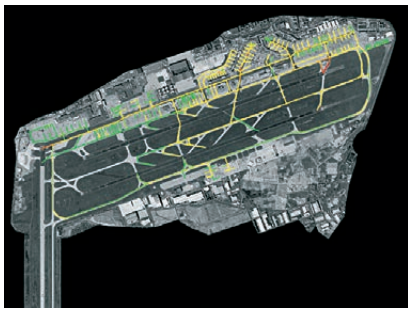
Remote Tower Center

Measuring stress of air traffic controllers when remotely controlling airports

Remote monitoring of airports is a promising concept for controlling small airports with little traffic, as monitoring these is highly expensive for the German air traffic control organisation Deutsche Flugsicherung (DFS). Monitoring several airports from a central office appears to be a particularly efficient option. In order to test the feasibility of this idea at an early stage, the DLR Institute of Flight Guidance developed a high-fidelity simulation of a "Remote Tower Center".

On behalf of DFS, the institute's validation experts examined the extent to which remotely monitoring several airports caused additional stress in air traffic controllers. The feasibility of the concept depends decisively on whether it remains possible to ensure the safety of air traffic at these airports despite being monitored remotely. Relevant "human factors" required to evaluate this issue are the workload of each air traffic controller and what is referred to as the "situation awareness" of the controllers. High stress and incorrect assessments of the traffic situation can cause errors – errors that may quickly prove fatal in aviation.

A total of 22 DFS air traffic controllers tested the new operating concept, working in traffic scenarios with different levels of traffic at three different airports. The test assessed the effects of a Remote Tower Center on the way air traffic controllers work. The data were acquired via questionnaires, through expert observers, and by evaluating radio traffic and aircraft data from the simulation. In addition to the logistical challenge of such a survey, the subject of remote monitoring remains a highly sensitive issue because Remote Towers will significantly change air traffic controllers' working environments, causing serious concerns. This was a further reason that DLR as an objective scientific institution was commissioned to test the feasibility of remote monitoring from a Center.



CO2 emissions from taxiing aircraft at Frankfurt airport – summed up for one day of operation

Electric taxiing systems

Examining the benefits of electric motors in aircraft landing gear

Despite a wide range of technical and operational improvements, aircraft continue to cause exhaust gas emissions when they taxi at airports, as they generate the necessary thrust using their engines. In order to reduce these emissions, electrically operated landing gear motors are currently being developed that would permit aircraft to taxi with their engines off. The effects of this technology on fuel consumption and pollutant emissions were examined at the Institute of Flight Guidance using fast time simulations.

In addition to savings on kerosene and reduced emissions, electric taxiing, which also allows backwards motion, enables aircraft to leave their parking positions without being towed, rising further questions about the effects the new technology will have on airport operations. To examine both issues, Frankfurt/Main airport and the future capital city airport Berlin Brandenburg were replicated in fast time simulations. The processes involved in pushback and engine start-up as well as acceleration during taxiing were simulated in detail for the first time in order to evaluate differences between electrically and conventionally taxiing aircraft.

Based on the assumption that all passenger aircraft up to the size of the Airbus A321 were equipped with electric taxiing systems fed by their auxiliary power units (APU), the simulation showed that over 48 tonnes of kerosene could be saved at Frankfurt/Main airport on an average day. In addition, a slight reduction in taxiing times was observed, which was due to tractor-independent pushback. Airlines are showing great interest in electric taxiing systems, as they contribute significantly to reducing costs in an environment characterised by increasing cost pressures and high kerosene prices.

Falcon measuring the microphysics and optical thickness of contrails from an A340

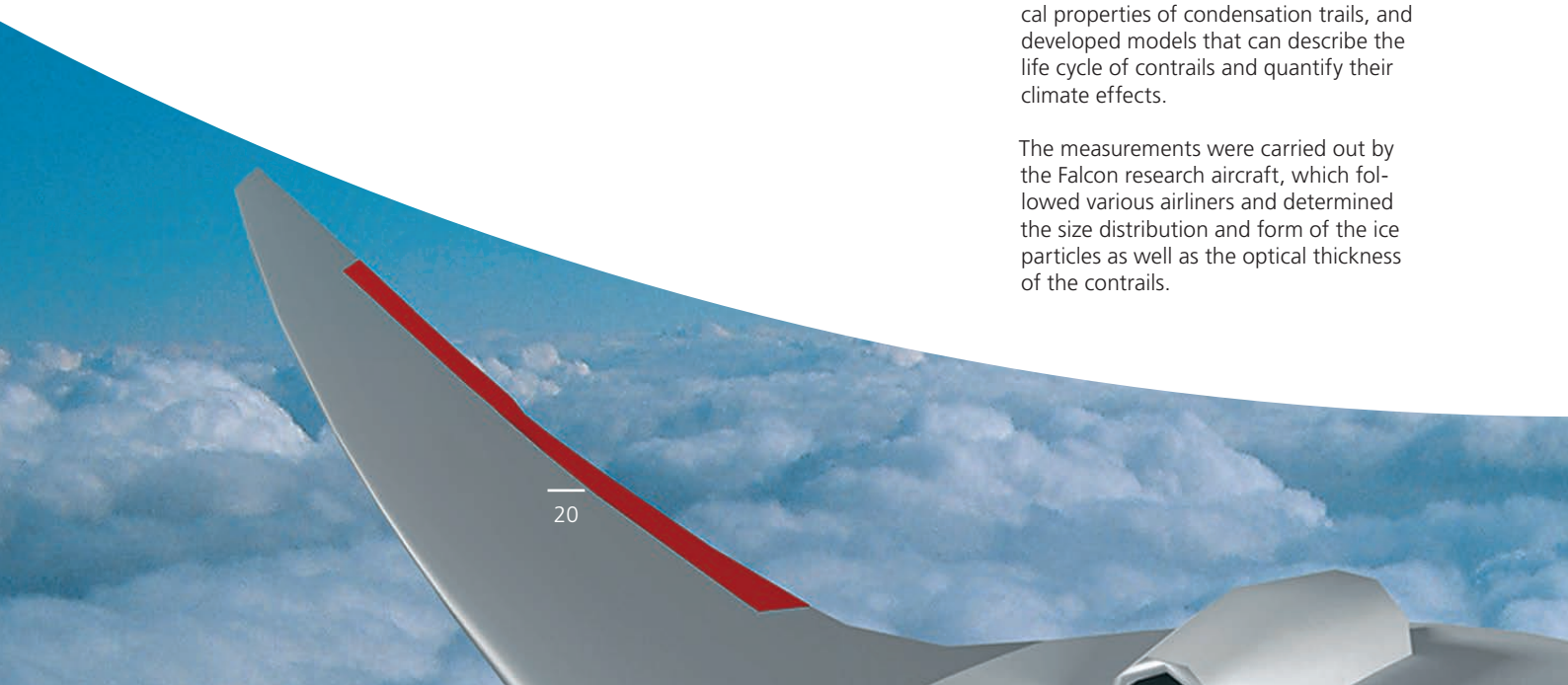
Contrail cirrus

Strategies for more climate-friendly aviation

In sufficiently cold and damp air, aircraft can cause condensation trails in the upper troposphere. Under suitable meteorological conditions these may persist for several hours and expand. The resulting thin ice clouds (contrail cirrus) may have warming or cooling effects; on a global average however they cause a warming of the atmosphere. Appropriate flight path planning can reduce the creation of climate-damaging contrails, but this requires the ability to determine and predict their formation, development and radiative effect.

The CATS (Climate Compatible Air Transport System) project has carried out extensive measurements of the microphysical properties of condensation trails, and developed models that can describe the life cycle of contrails and quantify their climate effects.

The measurements were carried out by the Falcon research aircraft, which followed various airliners and determined the size distribution and form of the ice particles as well as the optical thickness of the contrails.



A module for simulating the coverage and radiative effects of contrail cirrus was added to the ECHAM climate model operated at the Institute of Atmospheric Physics. This module made it possible for the first time to calculate the global climate effect of contrail cirrus at current air traffic levels of 30 mW/m². According to these calculations, the radiative forcing of contrail cirrus is greater than that of the accumulated CO2 in the atmosphere caused by air traffic. In order to predict individual contrail cirrus, the project developed the CoCIP (Contrail Cirrus Prediction Tool) and expanded the ECHAM5 model. With CoCIP, the simulated contrail cirrus and their effect on the radiation field in the area of the North Atlantic corridor could for the first time be compared in detail with satellite observations. In future, these models will be used to develop strategies to minimise the climate effect of condensation trails (see p. 36).

Outlook

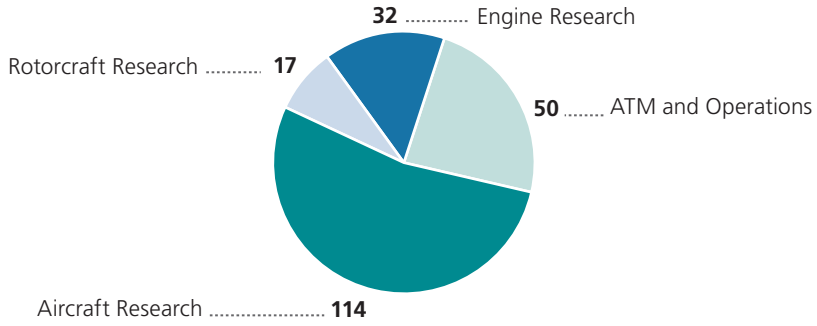
The ARES (Advanced Research Simulator) simulator center, which is to commence operations in late 2012, will provide improved project support through state-of-the-art simulation technology. One of its core tasks is to prepare flight experiments for the FHS research helicopter and the ATRA research aircraft, integrating the experimental equipment of these two. Newly created simulator cockpits for the EC135/FHS and the A320/ATRA, to which specific operator cabins have been added, will be used for this purpose. HiL (hardware-in-the-loop) simulation of aircraft in general and optimisation of the simulation technology are expected to be further key areas of activity. The facility is comprised of a fixed simulator and a motion simulator, between which the cockpits can be switched. The use of 15 high-resolution LED projectors creates a virtual field of view of 240 degrees horizontally and 90 degrees vertically. The motion system consists of a pneumatically assisted electric 60-inch hexapod system with a payload of 14t. The simulators are housed in a newly constructed warehouse offering the necessary infrastructure.

Aeronautics: Revenues in millions of euros

	2011 Actual	2012 Planned	2013 Planned
Basic funding	134	135	140
Third-party funding	81	78	67
Total revenues	**215**	**213**	**207**

Expected revenue for the year 2012

Total 213 Million euros — 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 program covers Germany's participation in the programs of the European Space Agency (ESA), participation in EUMETSAT, the National Space Program, the DLR R&T program "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 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**

Space Administration highlights

"Heinrich Hertz"

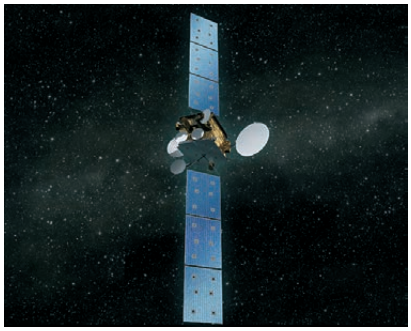
On July 5, 2011, the DLR Space Administration at the German Aerospace Center (DLR) and the Federal Ministry of Defence (Bundesministerium der Verteidigung, BMVg) signed an agreement covering the inclusion of independent government payloads on the satellite "Heinrich Hertz". In addition to the scientific and technological part of the mission, which is managed by the DLR Space Administration on behalf of the Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie, BMWi), "Heinrich Hertz" offers additional and independent payload capacities (known as "hosted payloads") which are to be used by the BMVg for communication purposes. The agreement governs the coordination of BMVg mission participation by DLR according to the Delegation of Space Activities Act. The predefinition phase is scheduled to begin in late 2011; the satellite launch is planned for 2016.

SIMBOX

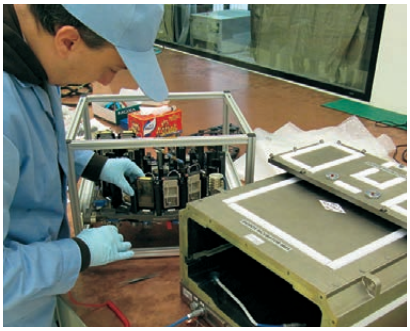
On October 31, 2011, the SIMBOX experimental facility developed and constructed in Germany was launched into space on board the Chinese spacecraft Shenzhou-8, which took off from Jiuquan spaceport in Inner Mongolia on a "Long March" rocket. The SIMBOX contained 17 biological and medical experiments which German scientists carried out together with their Chinese colleagues. After completing its 17-day mission, the Shenzhou space capsule with the SIMBOX landed in the Gobi desert on November 17. The Shenzhou program, the centerpiece of manned Chinese space travel, saw the Chinese space agency CMSEO collaborate for the first time with another nation. The DLR Space Administration in Bonn controlled the German part of the mission.

"Edoardo Amaldi" travels to ISS

Nine days later than planned, ATV-3 "Edoardo Amaldi" embarked on its supply mission to the ISS on March 23, 2012. It docked at the ISS during the night from March 28 to March 29, 2012. The ATV is operating as intended. A first orbit raising manoeuvre for the ISS was performed successfully on March 31. If all goes to plan, ATV-3 will leave the International Space Station on August 27 and burn up on re-entry into Earth's atmosphere on its return flight. The third incarnation of the ATV (Automated Transfer Vehicle) series is named after the Italian physicist and space exploration pioneer Edoardo Amaldi.



Artist's rendering of the Heinrich Hertz satellite



SIMBOX during "matching test" at the GESSA laboratory in Beijing: installing the centrifuge in the incubator

"Edoardo Amaldi" regularly raises the orbit of the ISS. Source: DLR

Space Administration: Funding budget in million euros

	2011 Actual	2012 Planned	2013 Planned
National program (incl. share of management of BMWi contract)	237	270	272
ESA (total incl. BMVBS et al.)	717	742	766

Participation in the development of the German Space Situational Awareness Center (GSSAC)

Since September 1, 2011, the DLR Space Administration has been developing the Space Situational Awareness Center in Uedem on the lower Rhine in cooperation with the German Air Force. The Space Administration is responsible for the civilian part of the GSSAC, and has formed the new Space Situational Awareness Center (RD-WZ) department within the Space Administration for this purpose. The GSSAC has already had several opportunities to demonstrate its capabilities when monitoring the re-entry of the American reconnaissance satellite UARS, the German X-ray satellite ROSAT (see p. 68) and the Russian Mars probe Phobos-Grunt.

SpaceEU Conference

The event "SpaceEU – Understanding, Matchmaking, Global Bridging" took place from February 28–29, 2012, in Brussels. The National Contact Point Space in the DLR Space Administration contributed significantly to its organisation. Over 450 attendees from 38 countries took the opportunity to find out more about European space exploration topics, network among the European space community and meet representatives of space exploration nations outside the EU. In addition to ESA and the EU, the EU member states that have their own space programs (France, Germany, the UK, Italy, Spain) presented their activities. A further session provided a platform for other EU member states and countries associated with the 7th EU Framework Programme. There were also presentations by the large European space corporations and the non-European space exploration countries USA, Russia, Japan, China, Ukraine, Canada and South Africa. "SpaceEU" additionally served as the closing event of COSMOS, the network of national space contact points funded by the EU. This network of approximately 25 contact points in Europe is coordinated by the DLR Space Administration.

Third national conference on satellite communication

The future of the German satellite communication industry was the subject of a two-day expert conference that took place on March 28/29, 2012, at the Kameha Grand Hotel Bonn. A total of 200 representatives of businesses, ministries, research institutions and ESA discussed the effects of the Federal Government's space strategy on satellite communication in Germany and ways to increase Germany's competitiveness. In his video address at the beginning of the event, the Federal Minister of Economics and Technology, Philipp Rösler, clearly highlighted satellite communication as a key technology that secures a large number of high-tech jobs and should be expanded. The main talks were on the communication satellites of the future, the limits of terrestrial communication, the requirements of the Federal Armed Forces regarding satellite communication, and high-frequency technologies.

In addition to the nine main lectures there were over 40 short expert talks and two podium discussions offering the plenum the opportunity to join the debate.

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

First operative Galileo satellites

On October 21, 2011, the first two fully functional Galileo satellites were sent into space from the European spaceport in Kourou, French Guiana. The satellites were launched on a modified Russian Soyuz rocket, which took off from Kourou for the first time.

The Soyuz launches from Kourou will make European space transport more flexible and competitive. Germany's most visible contribution to the "Soyuz in Kourou" program is the launcher assembly and test building, which – like the building for Ariane – was constructed by German technology company MT Aerospace AG.

The two Galileo satellites were also produced in Germany, by Atrium GmbH from Ottobrunn. All the remaining satellites will also come from Germany; they will be built either by Astrium or by OHB Systems AG in Bremen. In its final configuration phase from the year 2019 onwards, Galileo will consist of 30 satellites in orbit, two ground control centers and a number of command and control stations around the world. The next two satellites are to be launched at the End of 2012. The constellation is expected to number 18 satellites and begin operating by 2014, making worldwide satellite navigation without the American GPS system possible for the first time. After their successful launch, the responsibility for monitoring and controlling the first two Galileo satellites was transferred to the Galileo Control Center of DLR Gesellschaft für Raumfahrtanwendungen (GfR) in Oberpfaffenhofen according to plan.

Double debut: on 21 October 2011, the first two Galileo satellites were launched from the ESA spaceport in Kourou on board a Russian Soyuz rocket. This was also the first time a Soyuz rocket took off from Kourou.

Asteroids, the "embryonic" planets

The Dawn asteroid mission is currently orbiting Vesta, a body with the following notable features: measuring between 458 and 587 kilometres in diameter, its day lasts 5 hours and 20 minutes and its year is 3.6 times as long as an Earth year; in the center of a basin several hundred kilometres in diameter at the asteroid's south pole rises a mountain almost 20 km in height, one of the highest known elevations in our solar system. Many photos, images and further information can be found at:

520 days – simulated flight to Mars

Also on November 4, 2011, the doors of a container at the Moscow Institute for Biomedical Problems (IBMP) that had remained firmly closed since June 3, 2010, opened to release the participants of the Mars 500 experiment back into the world safely and in good health. The six "astronauts" had completed a 520-day virtual journey to Mars. During this longest space simulation experiment ever conducted, the astronauts tested a number of DLR experiments (see p. 62) and experienced the stress and isolation of a long flight in a very confined space.

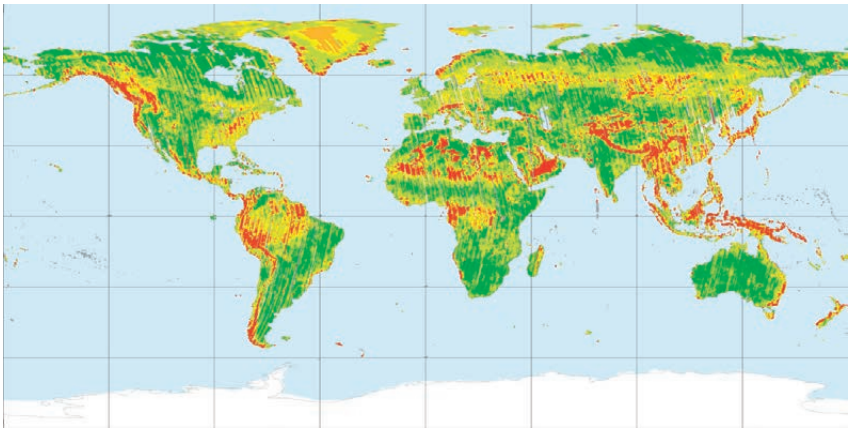
First complete recording of the Earth's land masses

After one year, the two German Earth observation satellites TanDEM-X and TerraSAR-X have fully mapped Earth's land masses for the first time. The strips recorded by the two radar satellites are being processed into 50 by 30 kilometre elevation models which will create the world's first uniform, highly precise digital elevation model of the Earth in 3D.

The satellite mission is the only one of its kind worldwide. The launch of TanDEM-X on June 21, 2010, was followed by a six-month test phase during which it was brought into formation with its partner satellite TerraSAR-X, which shares the same design and was launched in 2007. Productive operation, i.e. the actual collecting of data for the high-precision elevation model, began on December 14, 2010.

By 2013, both satellites are expected to have covered Earth several times in order to compensate for irregularities. For some areas of the Earth's surface, for example most of Australia, the satellite duo already has data of sufficient quality from its first overflight.

DLR controls both radar satellites, is generating the elevation model and is responsible for the scientific use of the TanDEM-X data. Management of the project overall lies with the DLR Space Administration.



The illustration shows the relative elevation error of the first global TanDEM-X coverage cycle. Areas marked in green already meet the 2-metre requirement. In the yellow areas, a second recording will ensure the required accuracy. The areas marked in red (mostly mountainous or forested terrain) require further recordings at different viewing angles.

TEXUS 48 – Launched from Kiruna

On November 27, 2011, the DLR research rocket TEXUS 48 took off from the Esrange space center near Kiruna in Sweden. During its approximately 13-minute flight, the rocket reached an altitude of 263 kilometres, during which near zero-gravity was achieved for approximately six minutes.

The main purpose of the mission, named CRYSTAL (Cryo Stage Technology Advanced Laboratory), was to test new technologies for improved fuel supply in rocket upper stages. For the first time ever, two experimental TEXUS (Technologische Experimente unter Schwerelosigkeit, Technological experiments under weightless conditions) modules were filled with liquid nitrogen before take-off, which served as a test fluid during the experiments. In a further experiment, researchers at the University of Stuttgart-Hohenheim examined the ability of 48 fish larvae to orient themselves under zero gravity. This module also functioned perfectly, and all fish survived both flight and landing in good condition.

The TEXUS 48 research rocket launching from Esrange near Kiruna

Space robotics

The "Second National Conference on Space Robotics" took place on March 6 and 7, 2012, at the Federal Ministry of Economics and Technology in Berlin under the patronage of Federal Minister Dr. Philipp Rösler. 200 leading experts from industry, academia and politics attended the event organised by the DLR Space Administration. Its aim was to advance the debate on the latest developments and discuss the future of this key area of space technology.

Space robotics have been a main focus of the National Program for Space and Innovation, implemented by the DLR Space Administration, since 2009. One of the conference's key topics was the DEOS mission (DEutsche Orbitale Servicing Mission, German orbital servicing mission). In addition to technological developments for future missions in Earth's orbit and for space exploration, the transfer potential of space robotics to applications outside space exploration was a key topic of discussion.

The conference was accompanied by a special exhibition "Roboter, unsere Wegbereiter ins Weltall" (Robots, our pioneers in space) at the Deutsches Museum in Bonn, which was opened by Federal Minister Rösler, remotely supported by the robots Justin (DLR) and Aila (German Research Center for Artificial Intelligence), from Berlin as a demonstration of what is already technically possible today. On March 13, Peter Hintze, Federal Government Coordinator of German Aerospace Policy and Parliamentary State Secretary in the BMWi, attended the exhibition.

DLR Parabolic Flight Campaign

During the 19th parabolic flight campaign from February 6 to 17, 2012, in Bordeaux, twelve experiments per day were conducted on each of three flying days. These included two German (DLR) and one Japanese experiment which served to prepare the Japanese Hayabusa 2 mission (a cooperation between JAXA and DLR R&T) and were designed to test the separation of landing vehicles from the "mothership" and the locomotion of landers on the "asteroid" surface. To optimise these tests, the research campaign was the first ever to fly 2 x 15 zero-gravity parabolas with no negative interference acceleration.

The researchers carried out their experiments successfully and were very pleased with the large amount of data and results they collected.

STERN

Since Monday, April 2, 2012, students at TU Berlin and the University of Bremen have had the opportunity to demonstrate their practical abilities in the development of a rocket of their own. The two universities are the first of an expected nine participants in the STERN (Studentische Experimental-Raketen, Student experimental rockets) program initiated by DLR. Once the rockets have been designed, developed, constructed, and undergone the necessary tests (e.g. wind tunnel and engine tests), they will be launched from the Esrange Space Center in Kiruna in northern Sweden. The STERN youth program aims to provide students with a practical introduction to their future working environment, and is managed by the DLR Space Administration in Bonn. The universities' activities are supported by the DLR Mobile Rocket Base (MORABA) and the DLR Institute of Space Propulsion in Lampoldshausen

GREAT receiver

SOFIA, the Stratospheric Observatory For Infrared Astronomy, successfully completed its first series of scientific flights with the "German Receiver for Astronomy at Terahertz Frequencies" (GREAT) in November 2011. With its high resolution, the GREAT spectrometer is specifically suited to examining the composition of interstellar gases and the life cycle of stars. The initial results, which were published on May 10, 2012, in a special issue of the journal "Astronomy & Astrophysics", demonstrate the versatility of this new research instrument: two types of molecules were for the first time proven to exist in space, and an examination of different phases of star formation was performed that would not previously have been possible. SOFIA is a joint project of the US space agency NASA and DLR.

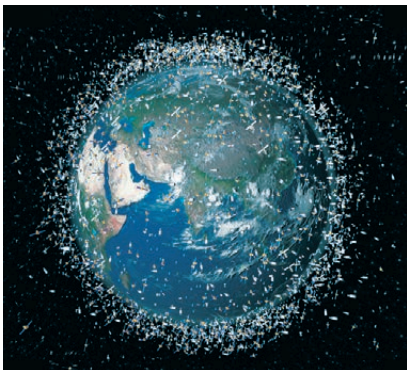
On the reverse side, the remote infrared spectrometer GREAT is mounted on the telescope flange in the pressure chamber. During flight, GREAT moves within a range of plus/minus 20 degrees from the vertical position.

Projects from DLR's Space Research and Technology division

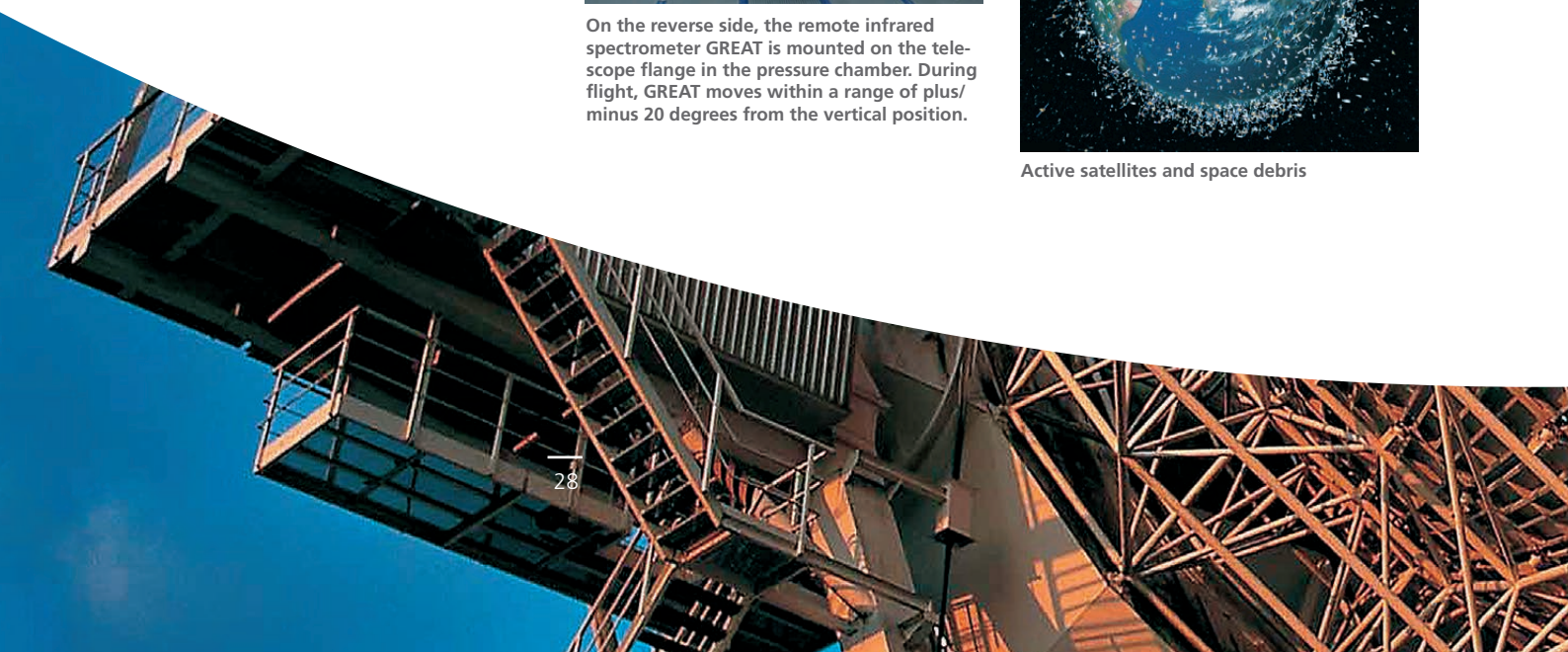
Space debris

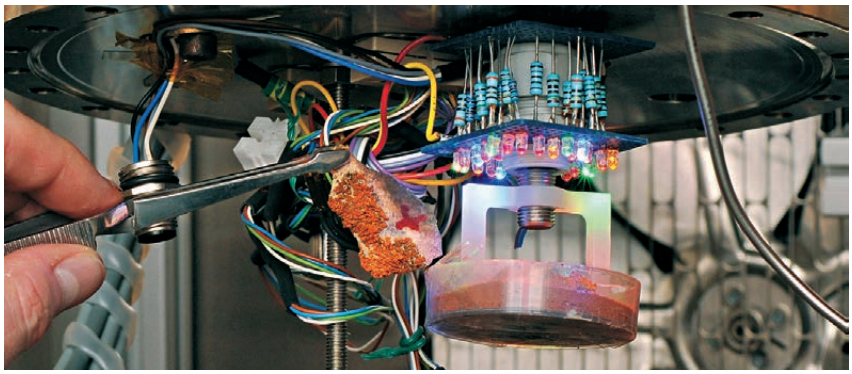
Focus on laser tracking

The orbits of disused rocket components were surveyed with a laser for the first time in Europe. The necessity of observing space debris and calculating its orbits is increasing every year, as objects such as disused satellites or rocket upper stages collide in space and break into ever smaller parts. So many debris items are already orbiting Earth at altitudes of 800 to 1400 kilometres that they may damage active satellites. The available figures are based on estimates, as it is not currently possible to precisely track this space debris. Researchers at the DLR Institute of Technical Physics are currently developing an optical observation system that uses a powerful laser with pulses capable of detecting even objects measuring just a few centimetres in diameter and determining their orbit (see p. 48).



Active satellites and space debris





Using various mineral components, the researchers recreated an area of Martian ground and simulated the atmosphere on Mars (composition and pressure) in the chamber. Special radiation sources replicated solar radiation on the planet's surface. The organisms also had to survive temperature variations from -50° to +23° Celsius.

Surviving on Mars

Lichen from Earth would be up to it

For 34 days, researchers at the DLR Institute of Planetary Research in Berlin simulated conditions on Mars and subjected various organisms to this environment. Particularly in crevices and cracks in the simulated Mars surface the microorganisms adapted to their environment and survived. This may indicate that such adaptation strategies would also permit life in niches on Mars. The experiment was conducted as an international project within the Helmholtz Alliance "Planetary Evolution and Life", which deals with questions such as how life-sustaining specific planets are – and what makes them life-sustaining or hostile to life.

The 13-metre antenna requires outstanding manufacturing precision and motion accuracy. The parabolic reflector is manufactured to a tolerance of one tenth of a millimetre and can withstand external temperatures of all seasons.

New dimension in Weilheim

Larger, stronger and more precise

A new satellite receiver station has been installed at the DLR Weilheim site. The new Ka-band antenna measuring 13 metres in diameter was officially inaugurated in June 2012. Its main purpose is to test how well new satellites work in space. At 91 decibel Watts its output is top of the range. For comparison, Ka-band antennae are generally operated with a reflector measuring five to six metres in diameter, which limits their output to 83 decibel Watts. A further feature of this antenna is that it is additionally equipped with a measuring system that records the capacity of satellites both after launch and during ongoing operation. This in-orbit testing measures the parameters of a satellite without affecting its actual operation. A large number of projects will benefit from this powerful antenna in the coming years and decades. Construction of the Ka-band antenna was jointly funded by Luxembourg and Germany with 4.5 million euros each, and carried out in cooperation between DLR and Luxembourg-based company SES Techcom.

Nerve signals

Paralysed woman controls robot arm with her mind

For almost 15 years, a 58-year-old woman from the United States was paralysed due to a stroke. A robot arm developed by the DLR Institute of Robotics and Mechatronics, which she controlled via an implant in her brain, enabled her to drink from a bottle unassisted again for the first time. It took just a few moments before the test subject was able to grasp the bottle with the robot arm, guide it to her mouth and then drink coffee through a straw. A software program decoded her neuronal signals and transformed them into commands for the robot arm and its five-fingered hand. The DLR researchers presented the results of their cooperation with American partners Brown University, the US Department of Veterans Affairs and Massachusetts General Hospital, Boston, in the renowned weekly academic journal Nature in May 2012.

Shefex II

Success with over 300 sensors

DLR researchers are pleased with the first results from the flight of Shefex II on June 22, 2012. The spacecraft flew as previously calculated, and extensive and valuable data were gained from all experiments. After the flight, a ship was intended to salvage part of the spacecraft west of Spitsbergen, but missing data from the final seconds of its flight and harsh weather at sea made this difficult. The researchers are now considering whether it might be possible to locate and retrieve the spacecraft from the sea floor. To evaluate their experiments, the scientists are drawing on the large amount of data recorded down to an altitude of 29 kilometres by the stations at the launch site and on a nearby mountain. The experimental phase began at an altitude of approximately 100 kilometres with re-entry into the atmosphere and was intended to end at an altitude of 20 km. As opposed to Shefex I, which flew in 2005, the researchers were able to actively control the spacecraft this time. It was already apparent during the flight that Shefex II performed the control manoeuvres as intended.
The researchers are also pleased with the exact flight of the spacecraft, which was developed and flown for the first time in this constellation by the mobile rocket base MORABA. The experience gained from Shefex II is to be integrated into the follow-up project Shefex III – a spacecraft whose re-entry into the atmosphere is to last up to 15 minutes. The purpose of the Shefex projects is to enable scientists to study technologies which will reduce the costs of spacecraft re-entry.

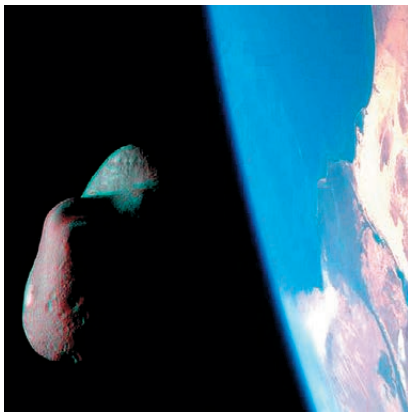
Transforming nerve signals into movement – paralysed woman controls DLR robot arm with her mind

Shefex II spacecraft at the Norwegian rocket base Andoya

NEOShield

Sytematic Asteroid defence

It's not clear when the last large asteroid struck Earth, but impact craters are ubiquitous, and scientists are certain that further collisions will occur in the future. Over the next three-and-a-half years, the international "NEOShield" (Near Earth Object Shield) cooperation, founded in January 2012 and combining a total of 13 partners from research and industry under the leadership of DLR, will examine how asteroid and comet strikes can be prevented. A prerequisite to achieving this is that the researchers understand the physical characteristics of NEOs precisely. DLR's planetary researchers will therefore be contributing their knowledge of the composition, structure and surface properties of asteroids and comets to the project. In addition, the team will be analysing observation data from the past two decades. So far, over 8,000 NEOs have been discovered, and 70 new ones are found every month. The ultimate aim of the project is to establish clarity on a large number of issues; the asteroid researchers for example hope to specify how threatening asteroids can be observed from the ground in future and which missions in space would be suitable for determining their characteristics. Depending on the amount of time available between the discovery of an asteroid and its possible entry into the Earth's atmosphere, and on the size of the asteroid, various methods could then be deployed which the researchers will be examining in detail.



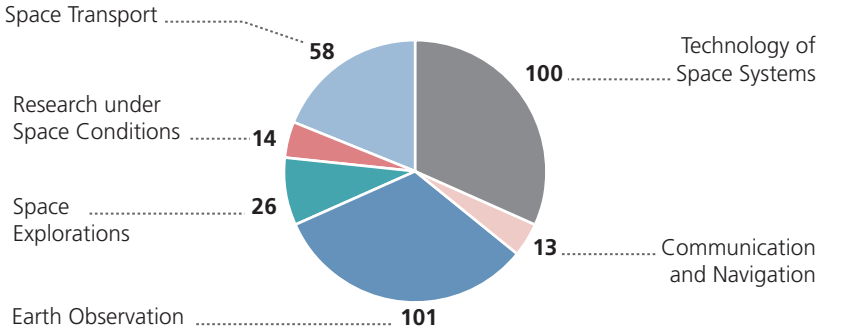
Undesirable constellation of Earth, nearby asteroids and comets in a montage highlighting the purpose of NEOShield

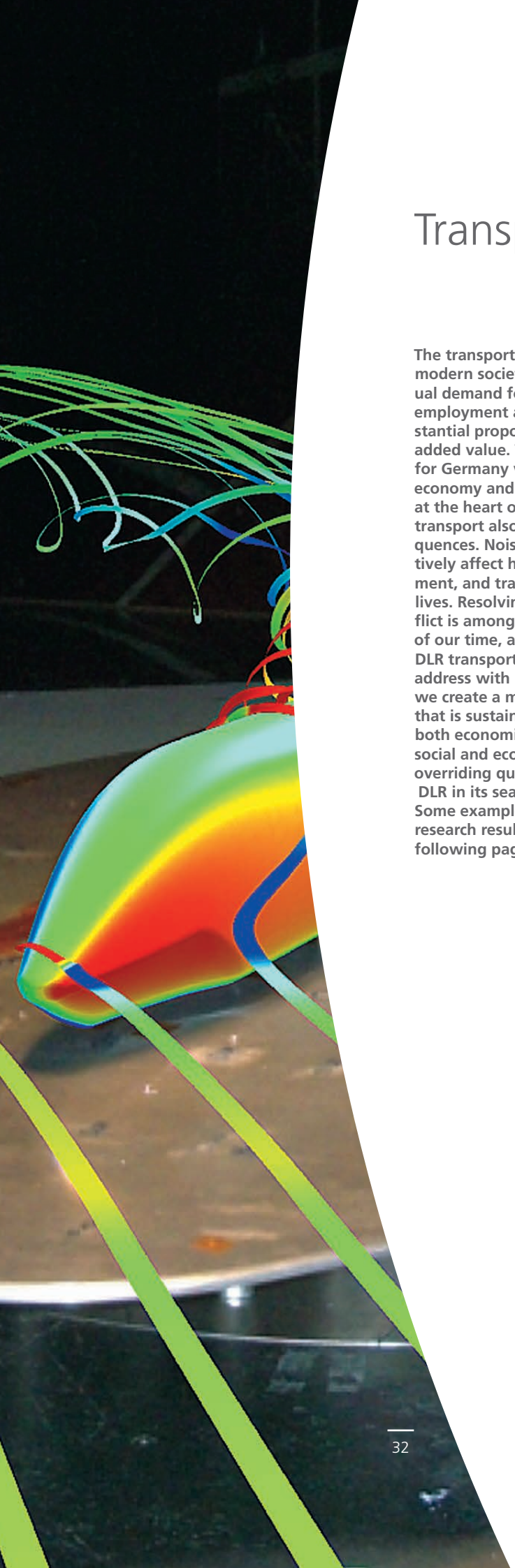
Space R&T Revenues in millions of euros

	2011 Actual	2012 Planned	2013 Planned
Basic funding	156	166	174
Third-party funding	137	146	140
Total revenues	**293**	**312**	**314**

Expected revenues for the years 2012

Overall total 312 Million euros — All figures in million euros





Transport

The transport sector is essential to modern societies. It satisfies individual demand for mobility, provides employment and generates a substantial proportion of economic added value. This is especially true for Germany with its export-driven economy and central transit position at the heart of Europe. However, transport also has undesirable consequences. Noise and emissions negatively affect humans and the environment, and traffic accidents cost many lives. Resolving these areas of conflict is amongst the major challenges of our time, and precisely what the DLR transport program seeks to address with its research: how do we create a modern transport system that is sustainable in the long term, both economically and in terms of its social and ecological impact? This overriding question accompanies DLR in its search for specific answers. Some examples of our wide-ranging research results are presented on the following pages.

RailSiTe® in use

Railway testing laboratory

Unique in Germany

In RailSiTe® (Railway Simulation and Testing) DLR has a test laboratory that has now been accredited as Germany's only independent test laboratory for ETCS components. This accreditation not only highlights the outstanding quality of the work, but is also important for the recognition of the test results in the approval of new railway technology components by national authorities.

The ETCS, short for "European Train Control System", is designed to harmonise European rail transport and make rail travel faster and more affordable, and is currently being gradually introduced on new and existing railway lines in order to establish a standardised international system.

RailSiTe® railway testing laboratory simulates entire train journeys, integrating real on-board computers by various manufacturers. In order to test devices for compliance with the ETCS technical specifications, DLR examines approximately one hundred sequences, each comprising several hundred test steps. The process and the results are carefully logged, allowing manufacturers to demonstrate ETCS-compliant functionality for the approval of new devices.

Pothole position and evasion recommendation are transmitted to other vehicles in the area

Airport and Control Center Simulator in Braunschweig

Satellites and potholes

Networking for safer vehicles

Reliable exchange of safety-relevant information between road vehicles is a prerequisite for future vehicle generations, which will be highly automated in order to reduce driver strain especially in critical situations and thus avoid accidents. To demonstrate the basic functionality of new communication technologies and standards, DLR has developed a comparatively simple example application, the Cooperative Road Damage Evasion Application, for which it was awarded the special prize in the European Satellite Navigation Competition 2011.

If a vehicle equipped with the corresponding sensor drives through a pothole, the hole is detected and its position is transmitted to other vehicles in the vicinity, allowing the following vehicles to be warned and evade the pothole. In general, the driver will be provided with a recommendation to swerve to the right or the left, depending on whether the vehicle is approaching the pothole with its left or right wheel. If oncoming traffic permits, the driver can then avoid the pothole through a small steering adjustment. Ultimately, this protects the chassis, increases driving comfort and avoids enlarging the pothole.

Greater punctuality in air traffic

Management system optimises airport processes

According to Eurocontrol, the European Organisation for the Safety of Air Navigation, delays in air travel cause costs of up to 1.5bn euros a year. The individual agencies operating at airports, such as air traffic control, airlines and airport operators, currently each work with their own system and are barely networked, resulting in frictional losses and waiting times. In the Total Airport Management Suite (TAMS) project, DLR researchers working with partners from industry have developed an innovative approach in which all the individual systems are integrated, sources of disturbance are indicated and solutions recommended – and for the first time ever, both land- and airside systems are interlinked. Funded by the Federal Ministry of Economics and Technology (BMWi), the project demonstrated numerous positive effects, such as lower costs, shorter waiting times for passengers, reduced pollutant emissions and less noise.

The TAMS project developed the core concept and validated the overall system, working with its future users in order to ensure the necessary realism. In addition, the involved partners provided interdisciplinary support in drafting the technical design. The passenger management system also developed by DLR is the first to enable seamless integration of air- and landside airport processes. Passenger stream simulation provides a faster view of future developments in the airport terminal and thus forms a basis for efficient and forward-looking resource and process management.

Railway infrastructure

Railway infrastructure

Supporting a powerful and affordable sizing

Due to their longevity, the pressure to make economically and operationally "sound" investment decisions when constructing, refurbishing or expanding railway infrastructures is high, as the choice ultimately made will determine safety, performance, quality and cost for a long period of time. It should therefore be based on a systematic and comprehensible evaluation of the alternatives. To enable this, DLR has developed the software tool Railonomics®-Infra, which combines the strengths of computer-assisted operational simulations in performance assessments with various methods for economic evaluation.

A recently completed application test demonstrated the significant potential of Railonomics®-Infra in assisting decision-making processes. A segment of approximately 40 km was analysed for a large infrastructure operator. By 2020, this segment is to be upgraded on the basis of a pre-specified timetable according to demand. A detailed simulation of the planned infrastructure and the target timetable enabled DLR to show that the current plans are insufficiently sized. Regular congestion on the line would have been inevitable.

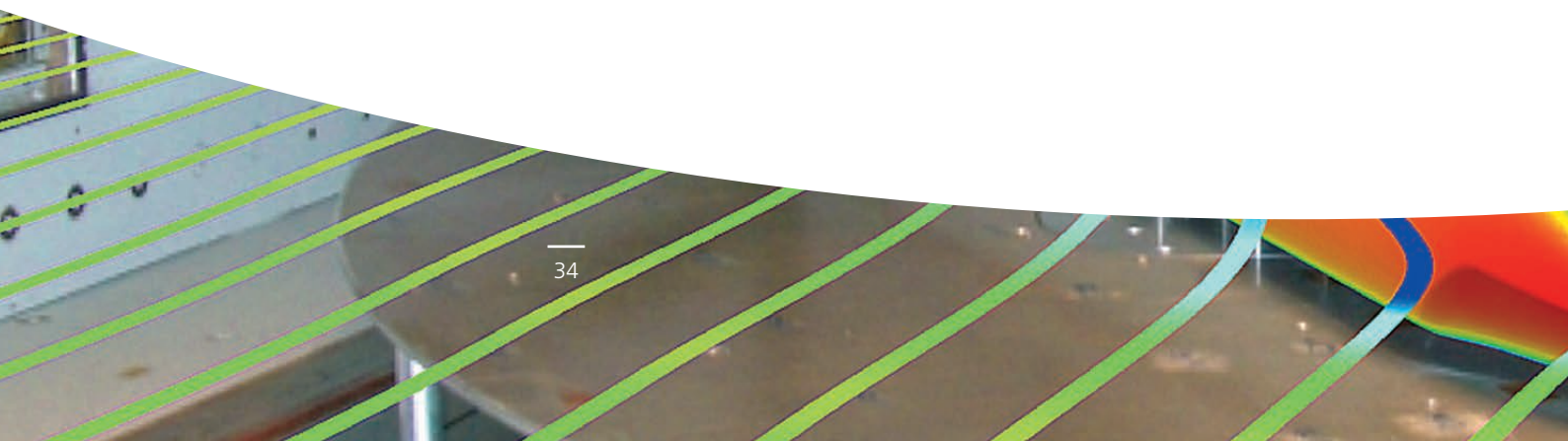
In alternative scenarios, the route was therefore equipped with a range of infrastructure components which were then evaluated with regard to their various life cycle costs and their respective benefits using Railonomics®-Infra. An unexpectedly positive outcome was seen with a variant where an additional track of only 1 km length increased capacity significantly and in addition to the planned passenger transport levels created additional capacities for the expanding freight traffic sector. The icing on the cake was that over the next 30 years, the extra income from the train journeys additionally possible during rush hour alone would amount to three times the additional life cycle costs of the added track.

SUMO

Simulating traffic microscopically

Traffic simulation is an important tool for assessing traffic management measures and predicting traffic development. DLR has been developing its microscopic simulation model and the open source software Simulation of Urban Mobility (SUMO), which is based on it, since 2002. SUMO can now realistically simulate not only vehicles such as cars, HGVs, buses, trams and even trains and their infrastructure, but also individual persons. As road users, these complete a journey consisting of walking, waiting and using vehicles.

SUMO is not only able to simulate intermodal transport, but can also be coupled with the DLR demand model TAPAS. SUMO has an interface that provides access to individual components of the simulation such as streets, crossroads, traffic lights or vehicles. In research on vehicle to vehicle and vehicle to infrastructure communications it thus also serves as an interface to external communication simulations. It has further proven useful in rapid prototyping of conventional traffic management measures. SUMO can also be used to calculate CO, CO2, PMx, HC and NOx emissions, fuel consumption and noise caused by traffic. Values can be aggregated by lanes, roads or vehicles, or over time.



SUMO – ausgewählte Applikationen

SUMO is downloaded by external users approximately 10,000 times a year. In Germany, the simulation is used by TU Munich, TU Dresden, TU Darmstadt, TU Braunschweig and at Fraunhofer FOKUS, among others.

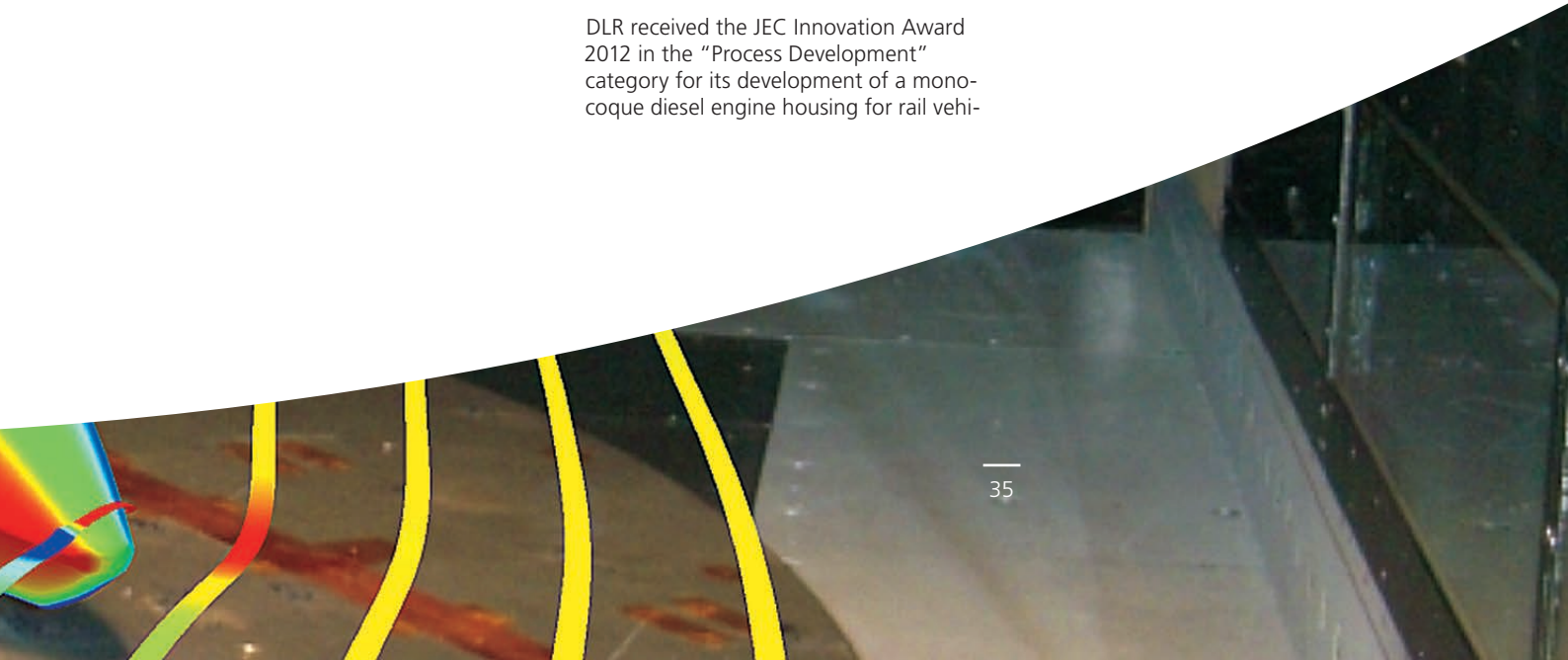
Presentation of the German Hightech Champions Award 2012

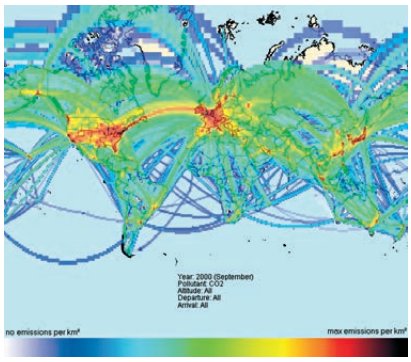
Successful lightweight design

Sandwich elements for a Hightech Champion

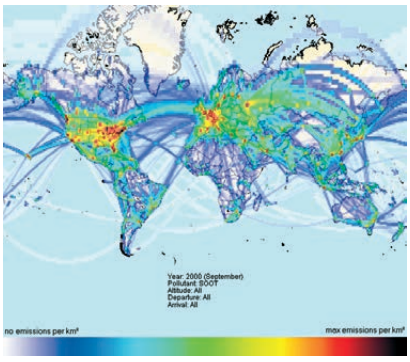
DLR has been named German Hightech Champion 2012 in the field of "Sustainable Transportation" by the Fraunhofer Gesellschaft for its design of a complete lightweight vehicle. The vehicle saves a significant amount of fuel due to its low weight, can be equipped with a variety of alternative power trains and also ensures very high passenger safety. The car chassis with two seats and an overall weight of 500 kilograms can easily be developed into a five-seater or a small van. It has a relatively simple structure and consists almost entirely of what is known as sandwich elements. While traditional chassis comprise between 200 and 300 complex sheet metal parts, this design makes it with approximately 50 simple elements. The awards went exclusively to business cases for which application-oriented products and processes were developed and evaluated according to their market potential.

DLR received the JEC Innovation Award 2012 in the "Process Development" category for its development of a monocoque diesel engine housing for rail vehicles, which replaces the standard materials of steel and aluminium with a fibreglass-reinforced polyurethane sandwich structure where appropriate; at the same time, fewer components are used, achieving a specific weight reduction of 35%. Sandwich core and coating materials, manufacturing processes, fire protection systems, construction principles and calculation methods were developed for the demonstrator, which is 4.5 metres long and 2.5 metres wide. The housing was developed by the PURtrain project commissioned by the Federal Ministry of Education and Technology and executed in collaboration with seven partners, among them Bombardier Transportation, KraussMaffei Technologies and the Karlsruhe Institute of Technology.





Worldwide CO_2 emission inventory



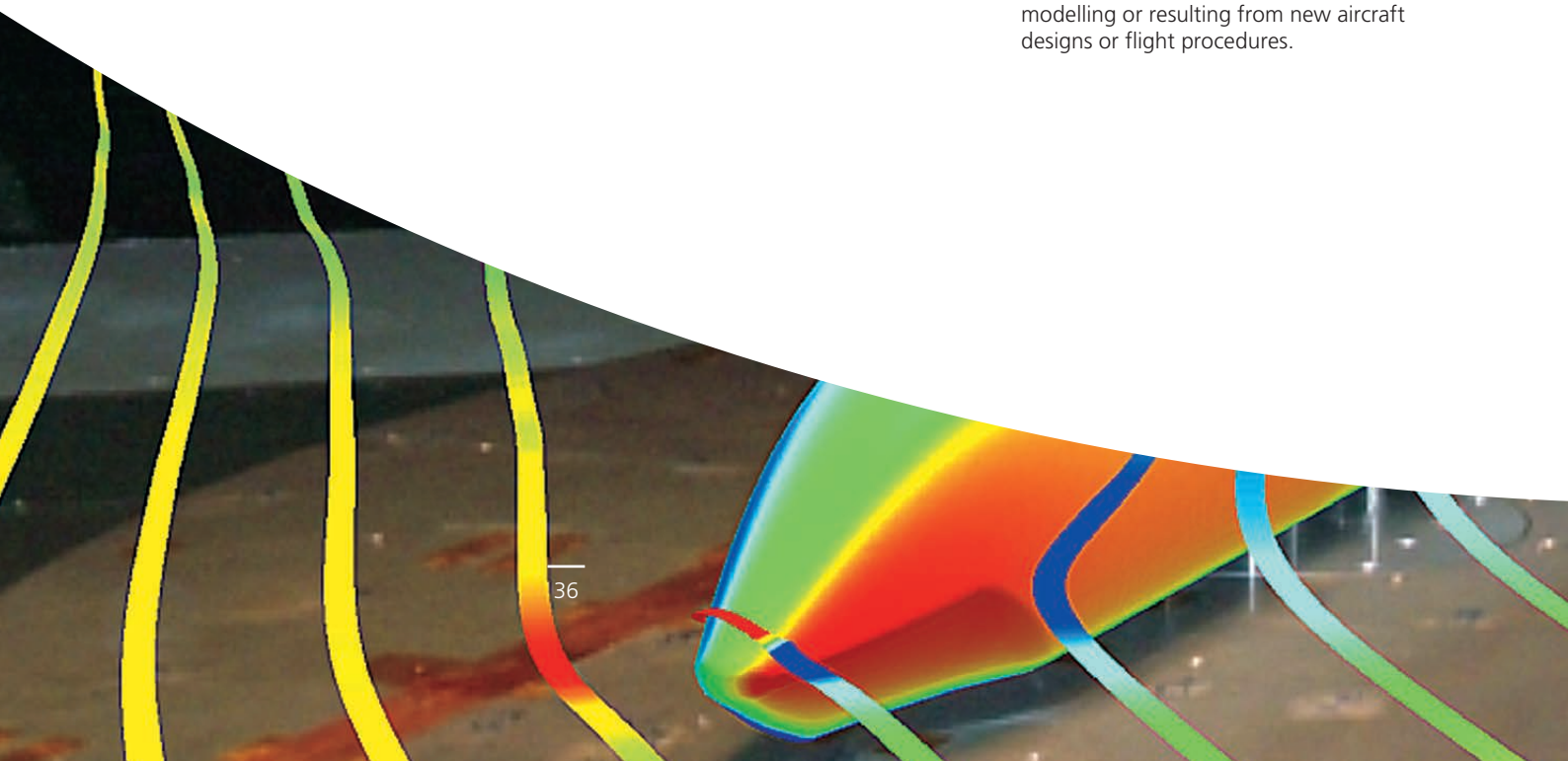
Worldwide soot emission inventory

Air traffic

Climate-Relevant emissions in 4D

The climate-relevant emissions caused by air traffic occur primarily at high altitudes, where non-CO2 emissions have a significantly greater climate effect than at ground level. Under certain conditions, air traffic may also generate climate-relevant cirrus clouds. For their climate models, climate researchers therefore require precise information on the place, time, amount and composition of emissions caused by air traffic. The newly developed and validated calculation model 4D-Race generates air traffic emission inventories to serve as a basis for determining climate effects. It detects not only long-lived CO2 emissions distributed across three-dimensional space and time, but also corresponding emissions of short-lived air pollutants such as NOX, SOX and soot. Among the advantages of this four-dimensional encoding is that it permit the effects to be studied. The effects of solar radiation on the chemicl reactions of air traffic emissionsin the atmosphere, which change over the course of the day.

Worldwide air traffic, which comprised approximately three million flight movements in January 2012 alone, can be observed in its entirety with 4D-Race. To facilitate specific investigations, emission inventories can be determined for certain regions, periods, aircraft or engine types. 4D-Race also allows the temporal and spatial resolution of an emission inventory to easily be adapted to the question at hand. In the technical implementation of 4D-Race, a modular and expandable design was of particular importance to ensure that it would be possible to respond to future requirements for climate modelling or resulting from new aircraft designs or flight procedures.



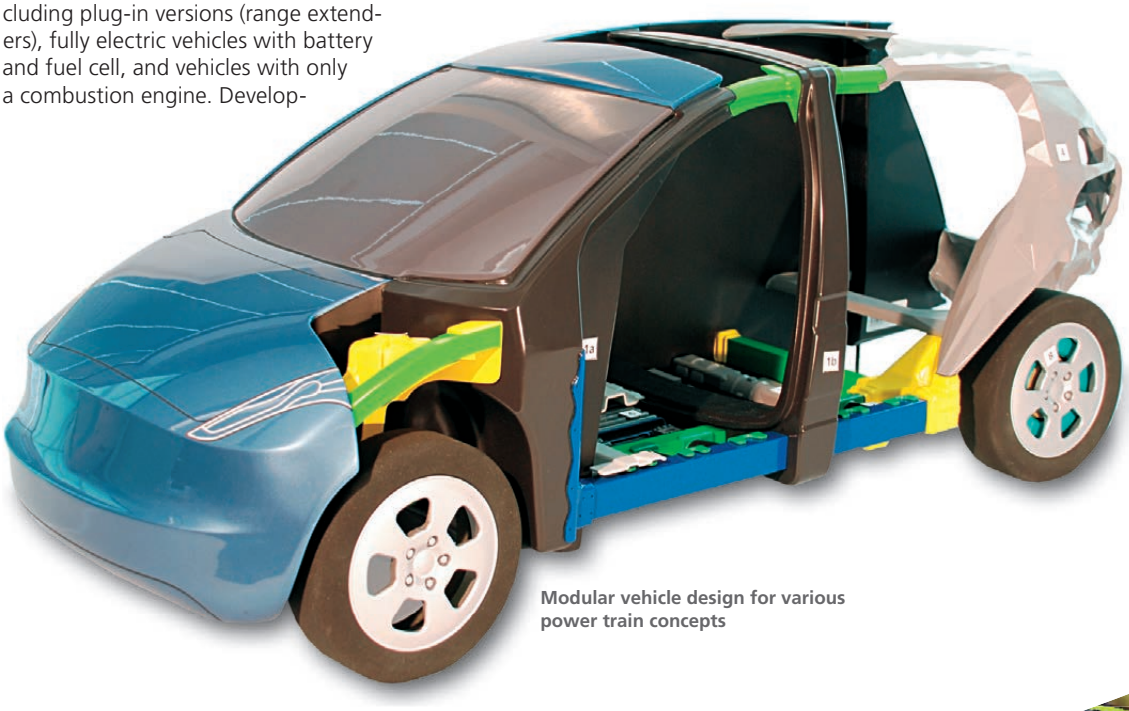
Survey

E-mobility and employment

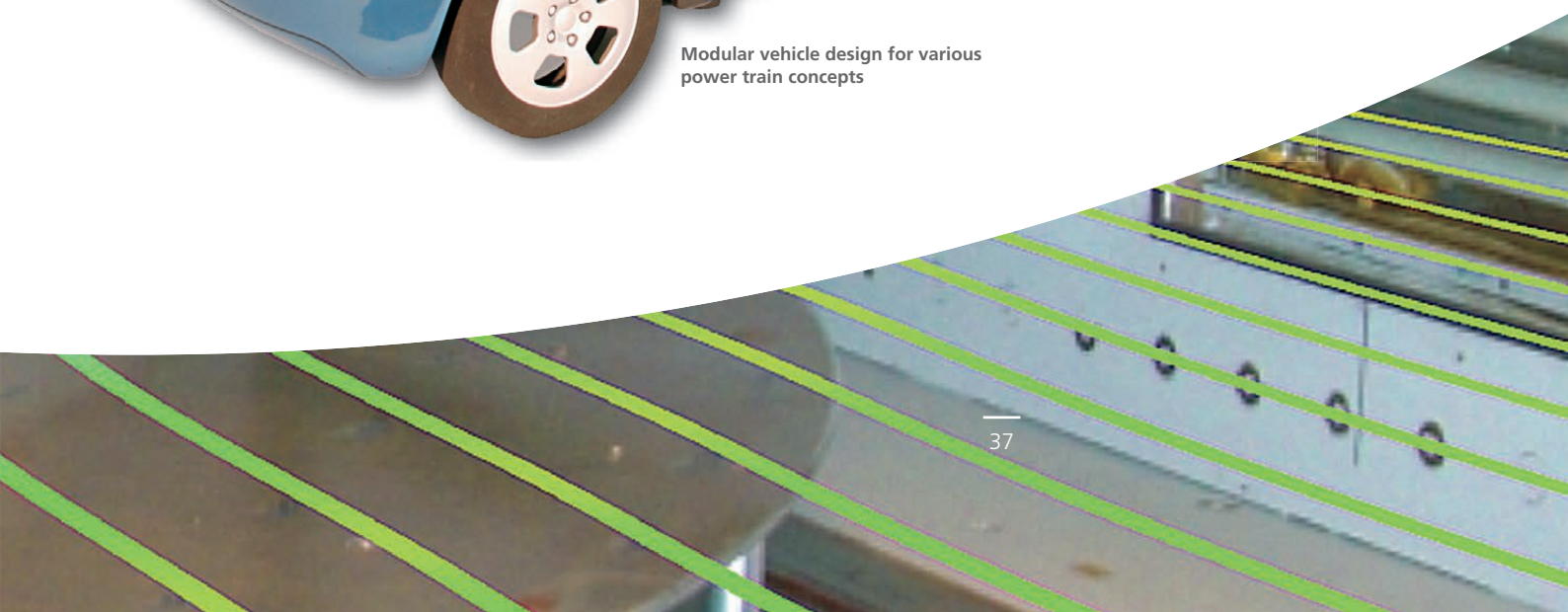
On behalf of the Hans Böckler Foundation, IG Metall Baden-Württemberg and Daimler AG, the Transport program collaborated with the Fraunhofer Gesellschaft to develop a survey titled "Auswirkungen der Elektrifizierung des Antriebsstrangs auf Beschäftigung und Standortumgebung" (Effects of power train electrification on employment and the business environment) or ELAB, which was the first survey to analyse the effects of new vehicle technologies on employment in power train production as far as the year 2030. For this survey, six different power train concepts were defined as significant for the future and examined: mild hybrids, full hybrids including plug-in versions (range extenders), fully electric vehicles with battery and fuel cell, and vehicles with only a combustion engine. Development trends in the key electric mobility technologies were identified for each power train concept, and relevant components – from hybrid drives through electric motors all the way to fuel cell systems – dissected virtually down to component level.

On this basis, the research partners conducted an analysis of necessary production and assembly processes in order to map future changes in power train production. Based on four DLR market scenarios, each featuring a different mix of the four power train concepts, conclusions were then derived regarding possible effects on employment throughout the automotive value creation chain.

DLR's results indicate a stable to increasing overall level of employment in all market scenarios that were studied, while at the same time profound changes within the value creation chain are possible. In all, the survey provides a well-founded basis for further debate at societal, political and business level on the future orientation of power train production.



Modular vehicle design for various power train concepts



E-City Logistics

User acceptance in intra-urban commercial traffic

Intra-urban traffic is where electric vehicles can make the most of their strengths, as they travel locally without generating emissions, cause very little noise and generally do not cover long distances. In its project E-City Logistics, DLR examined the Electric Mobility Pilot Region Berlin/Potsdam to determine whether and under what conditions the use of electric vehicles achieves the necessary user acceptance among drivers, dispatchers and customers to present a serious alternative to conventionally powered vehicles.

In a field experiment, DLR and its partners were able to prove that the use of electric HGVs for intra-urban deliveries can contribute to the desired effects and at the same time represents a good, but currently expensive alternative to traditional HGVs for delivery companies. The study has shown that electric vehicles are a feasible option particularly for courier, express and parcel services. Due to lower noise and exhaust emissions, acceptance among residents and end customers was very high; the same was true among drivers, who considered the improved conditions e.g. due to the lack of engine noise and the ease of handling to be very positive. Because of the high number of stop points on a typical courier service route, in this case electric motors can make the most of their system-based advantages compared to traditional drive technologies.

In view of these findings and the additionally very low operating costs, electric vehicles already represent an interesting option for businesses. In the longer term, this has two important implications: high levels of user acceptance and the corresponding demand on the market would support the economic production of electric vehicles for intra-urban commercial transport. Larger manufacturing volumes on the other hand would reduce prices and thus increase demand. A significant number of electric vehicles in use could lead to a noticeable reduction in local vehicle emissions in the future, bringing the advantages of electric mobility fully to the fore.

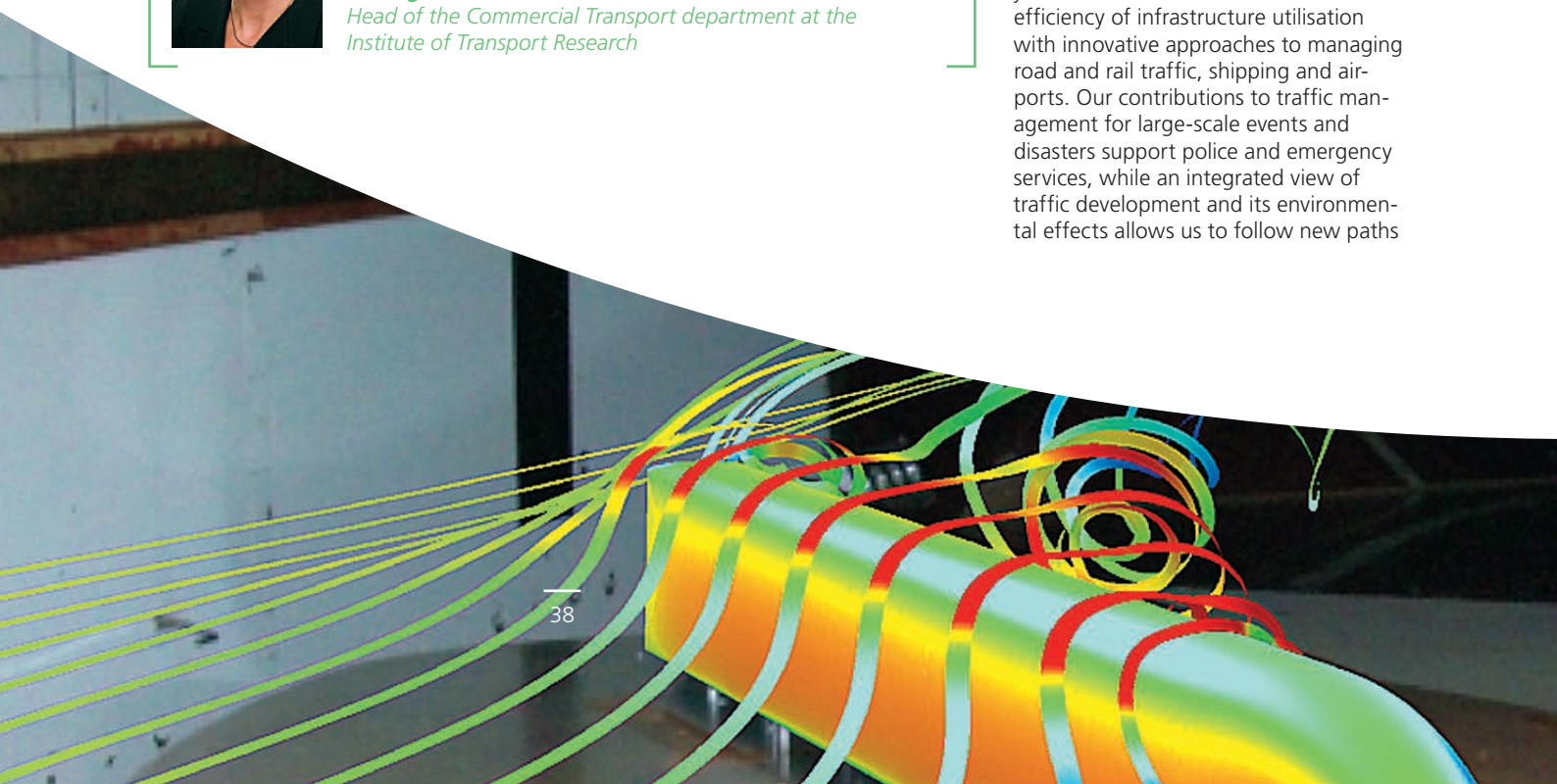
"In a field experiment, DLR and its partners were able to prove that the use of electric HGVs for intra-urban deliveries can contribute to the desired effects and at the same time represents a good, but currently expensive alternative to traditional HGVs for delivery companies in some areas."

Dr.-Ing. Verena Ehrler,
Head of the Commercial Transport department at the Institute of Transport Research

Outlook

The overarching goal of DLR's transport research is to work towards a fast, reliable, safe, yet economically and ecologically sustainable transport system. To this end, we research and develop state-of-the-art technologies, concepts and strategies. We use our transport-specific expertise to systematically tap into DLR-internal know-how in the fields of aeronautics, space and energy for transport applications, focusing our energies on the program's three research topics: terrestrial vehicles, traffic management and the transportation system.

Cars, utility vehicles, trains, next-generation and generation-after-next locomotives with lower energy consumption, lightweight structures, optimised aerodynamics, increased safety, improved comfort and less noise will remain the focus of the research in the coming reporting year. We increase the effectiveness and efficiency of infrastructure utilisation with innovative approaches to managing road and rail traffic, shipping and airports. Our contributions to traffic management for large-scale events and disasters support police and emergency services, while an integrated view of traffic development and its environmental effects allows us to follow new paths



in researching transport system interactions. As a service for the national and European community, we additionally run the Clearing House for Transport Data. Cooperation between 25 institutes in the Transport program area and a free flow of information enable us to systemically study highly complex interdisciplinary themes. In this context, our research on electromobility and mobility in the cities of tomorrow is of particular significance.

The dynamic research into electromobility that has been conducted for a long time in the Transport program has been consolidated into a systemic approach. With financial support from the Federal Ministry of Economics and Technology, nine interdisciplinary DLR institutes have come together to strengthen existing electromobility research activities in the Transport program and add selected complementary aspects in the fields of vehicles, assistance, markets and users, focusing on increasing the acceptance and use of electromobility by extending its range, and on identifying further user requirements and taking them into consideration in research and implementation. Our ability to cover the entire range of relevant research topics within DLR is a great advantage in this respect. DLR also contributes his skills to an association with other centers in the Helmholtz Association, within which DLR jointly contribute to the aim of the Federal Government to make Germany a leading provider and lead market for electromobility.

DLR has intensified its research on its research on mobility in the cities of tomorrow, where an integral approach enables us to consider not only the transport system itself but also reciprocal effects in traffic and urban development, and thereby derive new mobility concepts. This appears all the more important because in recent years metropolitan areas have begun to develop in Germany and Europe in which cities and greater urban areas are merging. At the same time, differences between urban districts in terms of facilities and attractiveness are increasing.

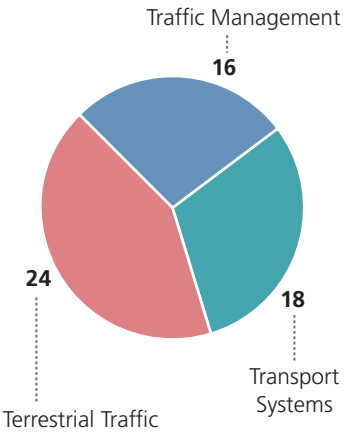
Changes to urban structure are creating new challenges in both passenger and commercial transport that public transport, which is bound by long-term infrastructures, is increasingly less able to satisfy.

Transport: Revenues in millions of euros

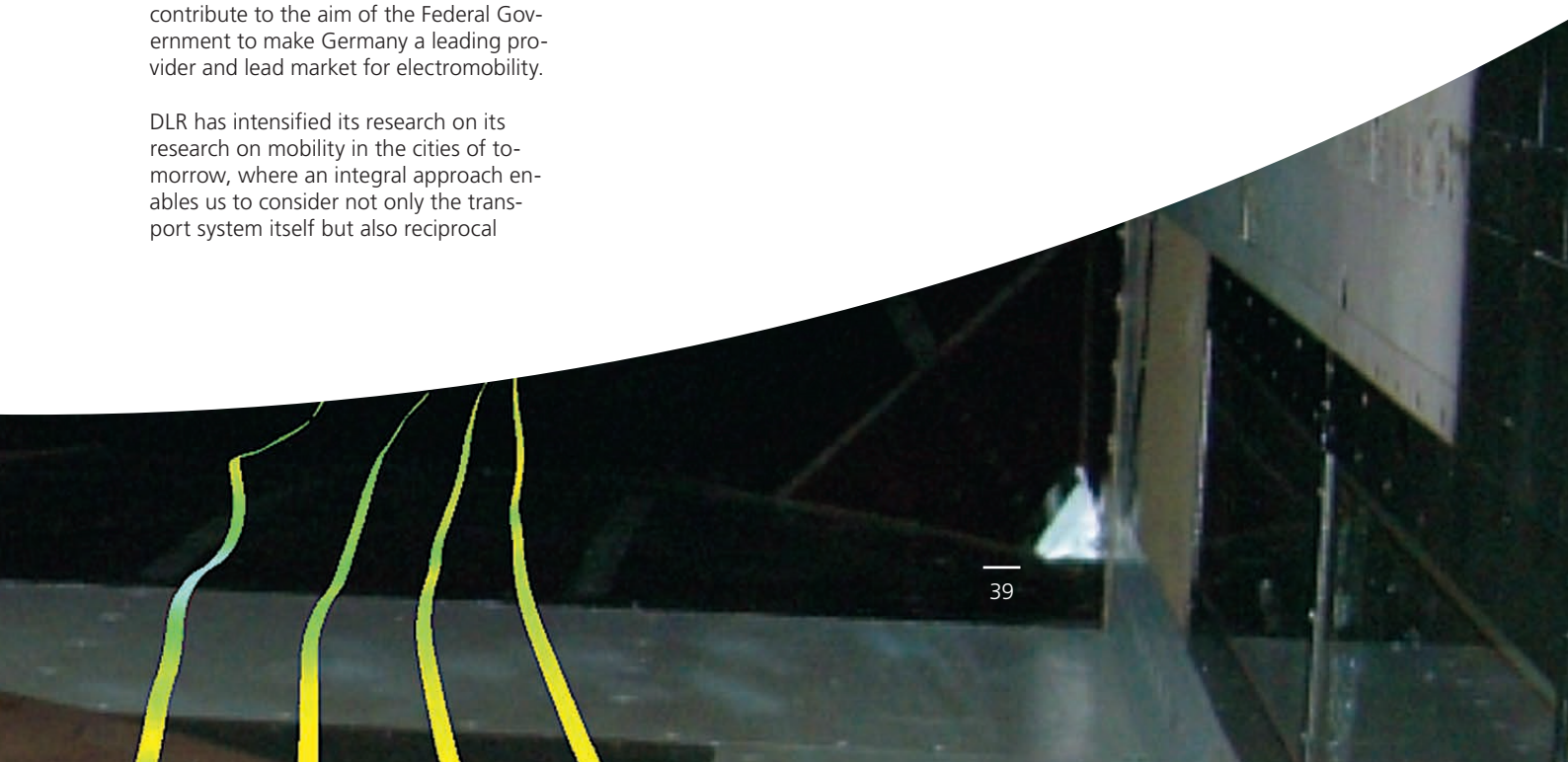
	2011 Actual	2012 Planned	2013 Planned
Basic funding	36	40	42
Third-party funding	15	18	17
Total revenues	**51**	**58**	**59**

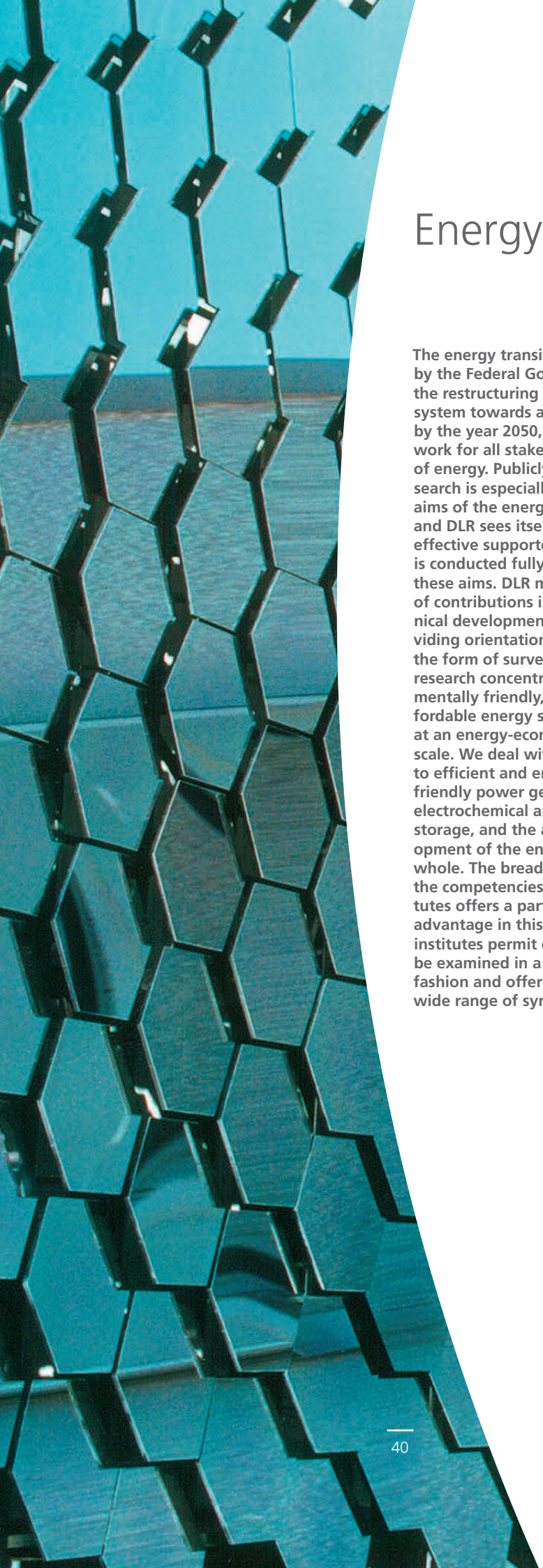
Expected revenues for the years 2012

Overall total 58 million euros



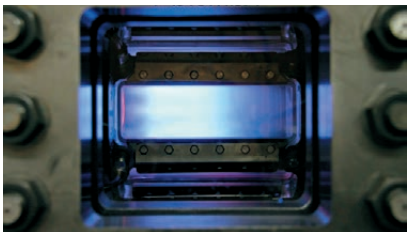
All figures in million euros





Energy

The energy transition policy adopted by the Federal Government, that is, the restructuring of our energy system towards a sustainable one by the year 2050, provides the framework for all stakeholders in the field of 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 the 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.



View into the glass combustion chamber of the high-pressure test rig with FLOX® burner in operation

Fuel staging

Innovative FLOX® burner

Gas turbines are a key element in quickly compensating for fluctuations in the future energy supply system. To increase the load flexibility of the innovative FLOX® burner design for gas turbines, a fuel staging system was integrated and tested in collaboration with industrial partner Siemens. The FLOX® high-temperature combustion system is characterised by low emissions, high fuel flexibility and a wide operating range. The use of an additional pilot burner is designed to enhance these qualities further while also enabling the gas turbine to be started up safely.

Experiments conducted at the Institute of Combustion Technology's High Pressure Combustor Test Rig tested the operating concept of distributing fuel between the pilot and the main stage; they showed that the operating range could be enlarged while maintaining very low nitrogen oxide and CO emissions, meeting a further important milestone for the FLOX® burner concept on its way to product development. The limits of the piloted system's operating range, its thermoacoustic properties and optimal staging concepts were studied using a visually accessible combustion chamber model. With the help of optical diagnostics, fundamental links between flame level, thermoacoustics and minimal emissions could be demonstrated. These findings will enable further adjustments and optimisations to staged combustion chamber systems.

CeraStorE building at the Cologne-Porz site

Solar thermal power plant in South-East Asia

CeraStorE

A new building for energy research

In late 2011, the Competence Center for Ceramic Materials and Thermal Storage Technologies in Energy Research (CeraStorE) was completed in Cologne-Porz. The construction and investment costs of 7.2m euros were covered by the state of North Rhine-Westphalia with funds from the Economic Stimulus Package II. Over a total area of 2000 m², researchers at the DLR Institutes of Materials Research, Solar Research and Technical Thermodynamics will collaborate in an interdisciplinary fashion.

Key research topics at CeraStorE are the development of long fibre reinforced oxide ceramic materials for stationary gas turbines, processes and materials for solar thermal chemical production of synthetic fuels, and thermal and thermochemical storage concepts and demonstrators. The research work of the three parent institutes is closely interwoven in CeraStorE, promoting scientific exchange and creating extraordinary synergies. Its combination of systemic know-how and materials expertise affords CeraStorE a unique position within and outside DLR.

Direct vaporisation

DLR is co-developing and employing the principle for the first time in a parabolic trough power plant

In January 2012, a parabolic trough power plant in the Thai province of Kanchanaburi fed its full capacity of five megawatts into the grid for the first time. It is the first parabolic trough power plant to generate the steam driving its turbine directly in the parabolic troughs. This plant brings DLR's many years of research on direct vaporisation in parabolic troughs to fruition in a commercial project. Instead of thermal oil, water flows in the absorber tubes onto which the parabolic troughs bundle the solar rays. The tubes are under an increased pressure of 30 bar; the resulting steam is overheated to 330 degrees Celsius. Transferring the heat directly through the water allows a power plant's process temperature and thus its efficiency to be increased. In the long term, solar direct vaporisation can thus reduce the costs of solar power plants.

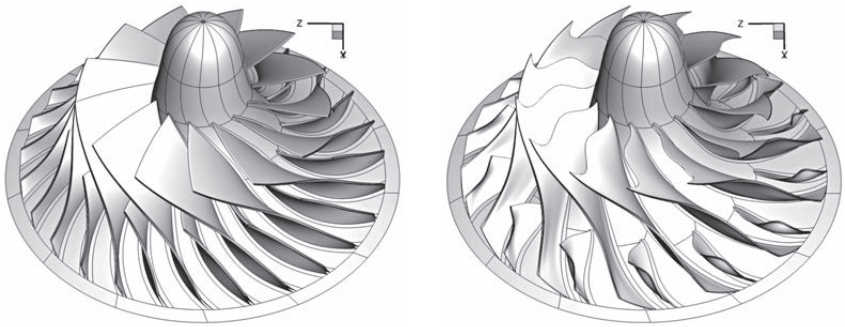
The plant, which covers an area of 100,000 square metres, was taken into operation at the end of last year. Researchers from the Institute of Solar Research were involved both in the development of individual components and in the overall design of the plant. The plant's collector field was built by German company Solarlite and is operated by Thai energy provider Thai Solar Energy. In a research project launched at the same time, DLR and Solarlite hope to advance the principle of direct vaporisation on the Plataforma Solar in Almería with the aim of improving its controllability to such an extent that the water can be fully vaporised and overheated in a single pass. Currently, part of the water is recirculated in the collector field.

AutoOpti

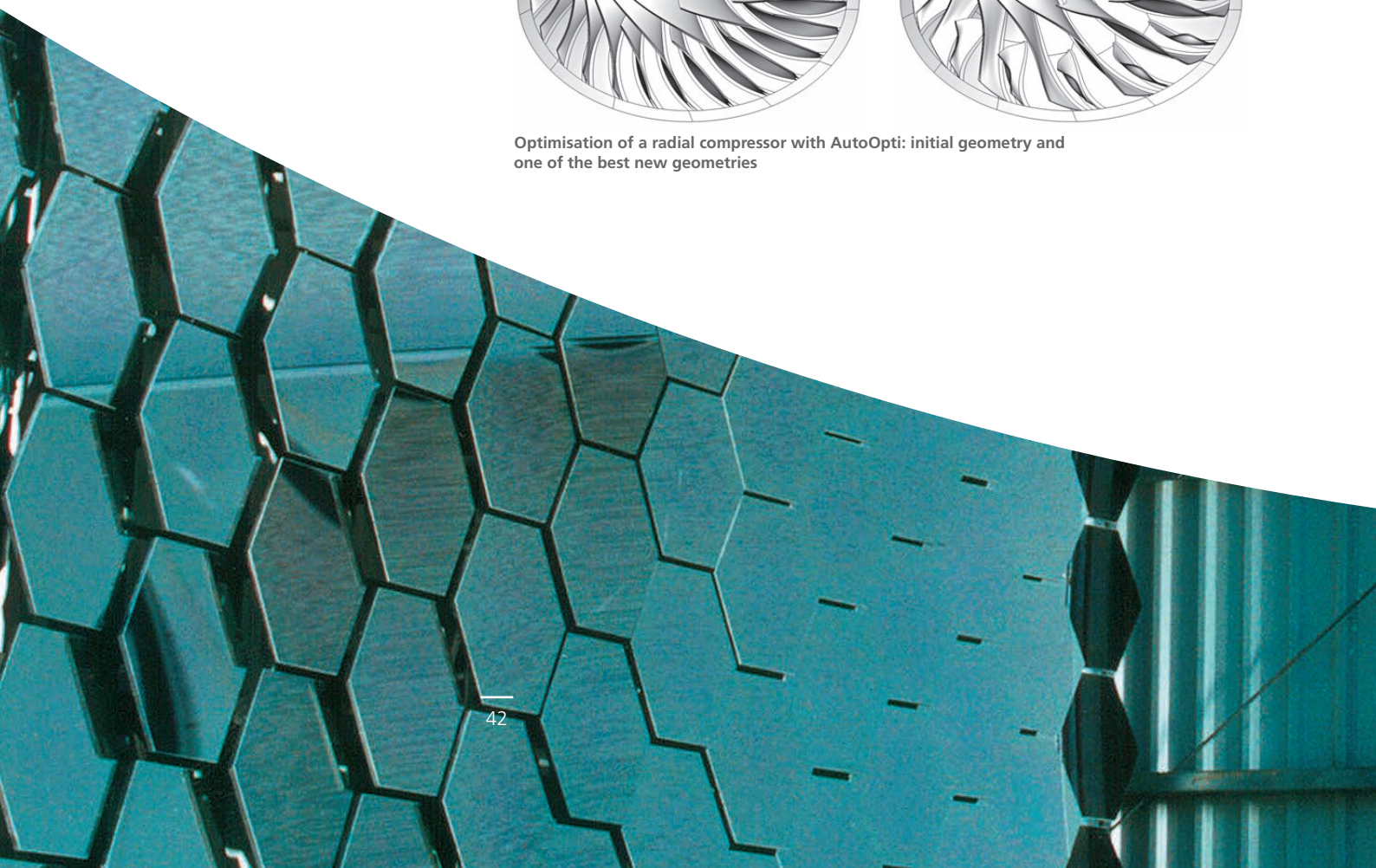
Increasing the effectiveness of radial compressors

Radial compressors are used wherever high staged pressure levels combined with relatively low throughputs and a compact design are required. The automated numerical optimiser "AutoOpti" developed at the Institute of Propulsion Technology now enables efficient aerodynamic enhancement of these fluid flow engines. It can also integrate noise creation and emission as well as structural mechanics into the optimisation process. The first objective of the current project was to design a radial rotor disc with greater efficiency, a wider operating range and reduced interaction noise compared to the highly successful "SRV4" disc previously developed and manufactured by the institute.

For the optimisation process, the objectives of maximising efficiency and expanding the engine characteristics are each replicated by a corresponding target function; the two objectives frequently compete with each other. During optimisation, the two target functions are evaluated separately and plotted against each other. Users can then choose how to weight the results to suit their requirements. Ultimately, significant improvements were achieved compared to the initial geometry. The geometry M6237 for example achieves an impeller efficiency of 91.5 % compared to 88.8 % for the starting geometry – and also delivers a 1.8% broader engine characteristics range index. An invention disclosure has already been submitted. Following completion of the numerical optimisation, a compressor with this geometry is now being constructed and will then be measured in detail.



Optimisation of a radial compressor with AutoOpti: initial geometry and one of the best new geometries

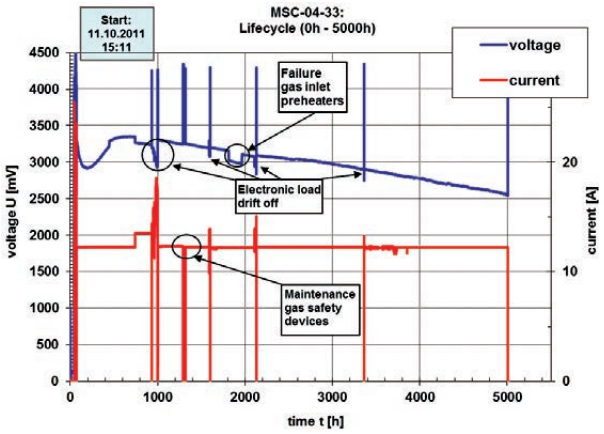


High durability of 2500 hours

DLR solid oxide fuel cells have the stamina

In its development of solid oxide fuel cells (SOFC), the Institute of Technical Thermodynamics is pursuing a design for affordable and thermally cycleable thin layer cells manufactured using plasma spray processes. The cells are deposited onto a substrate which is integrated into a low-cost cassette structure by a welding process. The cassette design was developed in collaboration with industry and allows working temperatures to be reduced to under 800°C.

In the course of developing metal-supported cells in a cassette stack a proven durability of 2500 hours was achieved. A four-layer stack has been running on nitrogen/hydrogen mixtures at an operating temperature of 800 °C since September 2011 and shows a stack voltage degradation rate of ~4%/1000h. Life expectancy when used for on-board power supply in utility vehicles is approximately 5000 hours. Important for the stack structure is the thermal treatment of the cassettes, which leads to flattening (topography control – see illustration). A second stack with an expected lower degradation rate due to integrated protective layers has already been constructed. The results demonstrate the fundamental suitability of the metal-supported concept in terms of long-term durability, redox stability, mechanical stability and suitability for mass production.

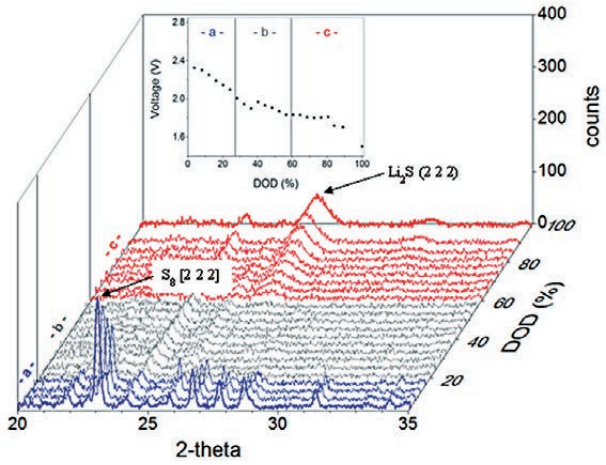


Long-term experiment with a 5-cell stack with metal-supported cells integrated into the cassettes by welding

"Miss REMix": energy for a doctorate

How could the electricity supply of the future work if the aim is to use a high proportion of renewable fuels? Is it possible to always reliably provide sufficient electricity despite varying levels of power generation? For her doctoral thesis, completed in 2012, Yvonne Scholz developed the REMix (Renewable Energy Mix for Sustainable Electricity Capacity) energy system model, which can simulate energy supply systems with high proportions of renewable energy sources. "REMix finds frequent application on current issues relating to the energy transition policy, where it becomes clearly apparent that electricity, heat and mobility have to be examined and planned in an integrated manner. So there is still much to be done! Thanks to the excellent working conditions at the Systems Analysis and Technology Assessment department and the excellent REMix team I am optimistic that we can make further important policy advisory contributions."

Yvonne Scholz, *postdoctoral researcher at the Institute of Technical Thermodynamics*



In-situ X-ray diffractograms during discharge of an Li-S battery at a rate of 300 mAh/g. Three different discharge areas can be distinguished:
a) S reacting to form polysulphates (blue),
b) Further reaction of the poly-sulphates (grey),
c) Formation of Li2S (red). The discharge curve is seen in the inset with an initial capacity of 1276 mAh/g.

Powerful

New electrodes enable high battery capacities

Due to their high energy density, lithium-sulphur batteries are among the promising new battery systems, particularly for electromobility. DLR is developing lithium sulphur batteries as part of the Energy Storage and Hydrogen initiatives of the Helmholtz Association. The technical challenge in implementing these batteries lies in stabilising the active electrode structures whilst cycling.

A stable capacity of approx. 400 mAh/g over 100 cycles has currently been achieved, significant progress compared to the standard LiCoO2 material with 190 mAh/g. With new, structured electrode contacts we can achieve close to the theoretical value of 1675 mAh/g in initial capacity, which indicates the further potential of the technology (see illustration).

In-situ X-ray diffraction (XRD) enabled us for the first time to prove and observe the formation of Li2S (see illustration). When exposed to the atmosphere, Li2S is not stable due to its hydrolysis to LiOH; its presence has therefore not previously been proven by other groups. From a 60% depth of discharge (DOD) it is possible to observe the formation of Li2S and, when charging, the formation of elementary sulphur in a new structural configuration in the DLR cells, enabling the targeted optimisation and examination of various electrode configurations.

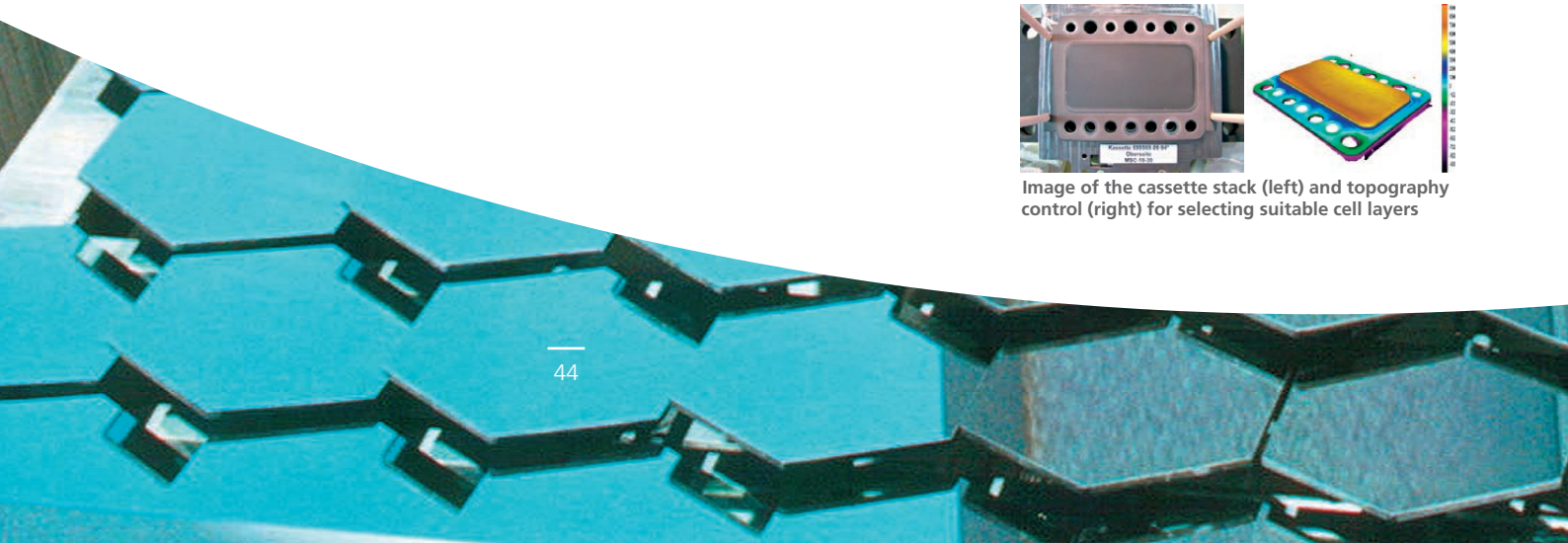
DLR@UniST

The DLR@UniST cooperation project serves to intensify the collaboration between DLR and the University of Stuttgart. A key program area is Energy, in which the project "Nutzung nachwachsender Rohstoffe für die dezentrale Stromerzeugung" (Use of renewable raw materials for decentralised power generation) was defined. The DLR Institutes of Combustion Technology and Technical Thermodynamics are cooperating with the Institutes for Interfacial Engineering and for Combustion and Power Plant Technology of the University of Stuttgart.

The project examines an integrated, process engineering concept for transforming biogeneous raw materials into gaseous fuels for subsequent electricity generation in fuel cell and gas turbine systems. The addressed technologies range from processing suitable biomasses through technologies for generating product gases and procedures for processing product gases all the way to characterising their combustion behaviour, for example for use in micro gas turbines and in gas engines. Alongside the process engineering line, numerical development and analysis tools including chemical combustion models are also being developed.

From July 2012, the work was assisted by the Helmholtz Energy Alliance "Synthetische flüssige Kohlenwasserstoffe – Speicher mit höchster Energiedichte" (Synthetic hydrocarbon fluids – storage with excellent energy density). In addition to the DLR@UniST partners, the chair of chemical process engineering of the University of Bayreuth is also participating in this research.

Image of the cassette stack (left) and topography control (right) for selecting suitable cell layers



Outlook

The current results relating to the optimisation of gas and steam turbines show that the efficiency of electricity generation can still be improved while at the same time increasing flexibility – both at large-scale power plants and in decentralised facilities. 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.

Cost reductions in photovoltaics have currently increased the pressure to more quickly implement innovative techniques arising from DLR research for use in affordable heat stores 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.

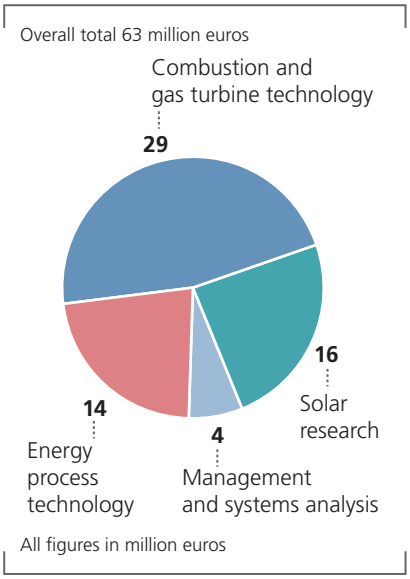
DLR research in the field of high-temperature heat stores, batteries and chemical storage including electrolysis is being expanded further. The work on batteries is taking place in close collaboration with partners at the Ulm Helmholtz Institute. In the field of chemical storage, work on load-flexible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

Energy: Revenues in millions of euros

	2011 Actual	2012 Planned	2013 Planned
Basic funding	22	25	26
Third-party funding	48	38	51
Total revenues	**70**	**63**	**77**

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°C, high-temperature resistant ceramic components for solar tower power plants and gas turbines, and reversible reaction systems for solar hydrogen generation.

Expected revenues for the years 2012



Security

Over the past decades, global security architecture and the risks to security in society have changed fundamentally. Direct and indirect threats such as terrorism, organised crime or piracy, shortages of raw materials and energy, climate change and the associated natural disasters present new challenges to internal security and defence. In order to adequately meet these challenges in the future, DLR has created security research as a horizontal theme which combines, plans and manages defence- and security-relevant research and development activities and coordinates them with DLR's partners in government, academia and industry. It covers both innovative organisational concepts and corresponding strategies for action, focusing on multi- and interdisciplinary projects that connect the research areas of DLR. In these projects, security research at DLR contributes to developing, testing and evaluating technologies and to assessing and consulting on security-relevant applications with the aim of supporting and protecting people. DLR is active for example in the fields of airport security (Aeronautics/Transport), satellite based crisis management (Space), decentralised energy supply (Energy) and in transportation management for large-scale public events and disasters (Transport), to each of which it brings expertise in significant system areas such as Earth observation, robotics and communications. The following results are examples from the Security horizontal theme that were achieved in the past year.

Security in emergencies

Disaster assistance in Cyprus

On June 11, 2011, 98 ammunition containers exploded on a navy base in Cyprus. 13 people were killed, and a nearby power plant that provides 50% of the island's energy supply was severely damaged. After the detonation, the Cypriot government activated the EU Civil Protection Mechanism, whereupon the Monitoring and Information Center (MIC) operated by the European Commission sent a team of experts (EUCP team) to Cyprus to assess the situation. The Cypriot authorities also activated the European SAFER (Services and Applications for Emergency Response) project, within the scope of which the DLR Center for Satellite Based Crisis Information (Zentrum für satellitengestützte Kriseninformation, ZKI) created an initial satellite map. The EUCP team subsequently requested additional support from unmanned aircraft in order to acquire more detailed images for the required situation report. The MIC forwarded this request to the Federal Office of Civil Protection and Disaster Assistance (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, BBK), which in turn commissioned DLR. Three employees of the DLR Institute of Communications and Navigation in Oberpfaffenhofen travelled to Cyprus as part of the EUCP team of experts from eight EU member states. The researchers used UAVs (Unmanned Aerial Vehicles) to explore the situation at the power plant, which was threatening to collapse, and provide images and videos of the individual buildings and rooms. The deployed equipment included an octocopter, a quadrocopter and, as a terrestrial vehicle, a rover; all vehicles carried high-resolution cameras for photo and video imaging.

Use of UAVs in Cyprus

Helmet-mounted display in the DLR cockpit simulator

Safety in helicopters

New HMD helmet display developed

Flying and landing helicopters under limited visibility conditions, for example during operations in the desert or in the snow, is always especially challenging for pilots. Whirling up dust or snow when landing on unsurfaced ground can massively restrict pilot visibility during the most critical landing phase on the final 20 to 30 metres of descent, and thus presents a significant danger during mountain rescue flights or desert operations. Help in these situations is now at hand in the form of the Helmet Mounted Display (HMD), a screen attached to the helmet which will assist pilots in these difficult situations in the future. While standard indicating instruments require pilots to constantly refocus their attention between the exterior view and the instrument panel, the helmet-mounted display compensates for this, displaying important flight guidance information such as altitude, speed, course and spatial position in the pilot's field of view along with information on possible obstacles, such as pylons. In a series of tests, helicopter pilots from the German Armed Forces, the Federal Police and the German automobile club ADAC flew through various test scenarios in the cockpit simulator of the DLR Institute of Flight Guidance using the new helmet display. Once the results have been evaluated, real in-flight tests with the DLR research helicopters will follow.

The display, which was acquired with the assistance of the Federal Office of Defense Technology and Procurement (Bundesamt für Wehrtechnik und Beschaffung, BWB), is intended to enable flights under minimal visibility, allowing air and mountain rescue services to embark on their often life-saving flights even in darkness, snow, foggy or dusty conditions.

Motion sensors

Safety also for emergency responders

Inertial sensors allow activities such as sitting, walking or lying to be detected extremely reliably for any human being. At the DLR Institute of Communications and Navigation in Oberpfaffenhofen, researchers are working on a Human Activity Recognition System that can appraise human activities and forward the results to a receiver. The technology is based on a sensor that can be worn at the hip and produces data which are forwarded to a computer in real time.

In future, the technology is to be applied in both domestic and professional scenarios. It would allow directors of operations in the police and emergency services to gain an overview of the activities of their staff at all times. A motion sensor worn at the hip by each responder ensures that the entire team and the command and control center can see in real time whether a team member has for example fallen or is in danger. The system currently developed by DLR consists of two components: a sensor module that records motion data, and a smartphone or mini computer to which it is connected and which evaluates the wearer's current physical activity in just a few milliseconds.

Inertial sensor module (hip) and display of activity on a smartphone

The technology functions independently of GPS signals, so it is also available in areas where there is limited or no connection to navigation satellites. The DLR Institute of Communications and Navigation has valuable previous experience in the use of small inertial sensors. In the NavShoe technology, for example, the researchers integrated an inertial sensor module into a shoe, enabling the wearer to be precisely located within buildings. Development of the current Human Activity Recognition System is funded by the European Union.

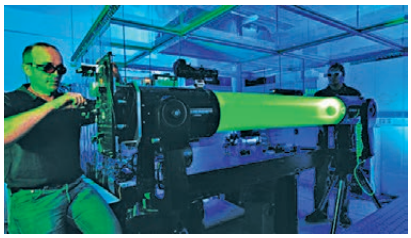
"The activity assessment was an expanded result of our work on indoor navigation for pedestrians. We used inertial sensors for indoor navigation and had to know whether the pedestrian was walking or running. To our surprise, our signal processing procedures were also able to detect other motion patterns very reliably. And that's what lead to our Human Activity Recognition System, which can be used in a wide range of safety-critical applications."

Prof. Dr.-Ing. Uwe-Carsten Fiebig
Institute of Communications and Navigation

Protecting infrastructures

Lasers against space debris

The number of small debris items in space increases by several ten thousand every year. DLR researchers are currently developing an optical monitoring system with a powerful laser that emits pulses capable of detecting even objects measuring just a few centimetres in diameter and determining their orbit. The concept has already been successfully tested in collaboration with the Graz laser station in January 2012. It was the first time in Europe that orbits of disused rocket components were surveyed with a laser. In future, a more powerful laser could also dislodge these objects from their orbit and cause them to re-enter Earth's atmosphere, where they would burn up. The necessity of monitoring space debris and calculating its orbit is increasing every year. Disused satellites and missile upper stages collide in space and break into ever smaller parts. Such a vast number of large and smaller items are already on near-Earth orbits that active satellites regularly have to perform evasive manoeuvres to avoid colliding with space debris. This however requires comprehensive detection and therefore continu-



Research at the laser demonstrator in the laboratory

ous orbit observation of all relevant debris. The physicists at the DLR Institute of Technical Physics in Stuttgart have therefore set themselves an ambitious goal which they aim to reach by 2014: they are constructing a transmitter and receiver unit and a laser that sends 1000 pulses per second from the ground into space in order to record the light reflected by the debris particles with extreme precision. After drawing up a catalogue containing as many of these small debris items as possible and recording their current positions, the next step – towards reducing space debris – could follow. Extremely powerful lasers may also provide a solution here. If a laser beam hit a debris item, material on its surface would vaporise, decelerating it. Reducing its speed by only 200 metres per second would cause the object to slowly descend in the following years and eventually burn up when it reached the denser atmosphere. This method could be ready for initial deployment in approximately ten years. If space debris is not reduced, so many objects will be orbiting Earth in 20 to 30 years that space flight on the important near-Earth orbits will become virtually impossible.

Outlook

With its scientific, public authority and industrial partners, the German Aerospace Center has set itself the aim of solving technological, systemic and organisational challenges to increase safety and security at sea in the widely scoped research project "F&E für die Maritime Sicherheit und entsprechende Echtzeitdienste" (R&D for maritime safety and corresponding real-time services).

The research program entails comprehensive approaches to addressing existing problems and weaknesses in the safety of the maritime transport system – specifically in safe navigation, interference-free communication and maritime traffic routing and monitoring –, and also deals with various aspects of security, particularly scenarios in which ships, ports, large-scale maritime facilities or crucial coastal infrastructures are threatened by terrorist attacks, technical failures or natural disasters, or where their damaging or destruction would have further safety-relevant consequences for people and the environment.

The overall aim of the activities of this joint project is to deliver innovative solutions and findings in fundamental areas of the maritime system, particularly in creating complex maritime situation reports in real time, protecting and improving the maritime communication and navigation system, enhancing the potential to respond to organised crime on the seas, and assisting emergency responders in the event of damage or disaster.

Project Management Agency

Project Management Agency for Aeronautics Research

The Project Management Agency for Aeronautics Research (PT-LF) supports the Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie, BMWi) in implementing the German Aeronautics Research Program (Luftfahrtforschungsprogramm, LuFo), and the states of Bavaria, Hamburg, Lower Saxony, Brandenburg and Rhineland-Palatinate, which complement this federal program with their own funding programs and projects.

After the economic crisis, the Federal Government further reinforced its commitment to civil aviation research and increased the funds available for aeronautics research by up to 240m euros in its fourth call for LuFo IV, which was launched in 2011. In all, the BMWi has thus made available almost 840m euros in funding through LuFo IV for the period from 2007 to 2015. The Federal Government's Aeronautics Research Program is now comparable in volume to that of the joint technology initiative "Clean Sky" initiated within the European Framework Programme, which will receive funding amounting to approximately 800m euros over the same period.

With this funding the Federal Government is affording companies, large-scale research institutes and higher education institutions conducting aeronautics research sufficient latitude to begin urgently required technological development work that they were previously unable to pursue with sufficient intensity due to the difficult economic environment. The key focus of PT-LF in the reporting period was on executing the application and approval phase for LuFo IV-4 for these new development lines. The associated research projects had already been selected for funding in an external evaluation process during the previous reporting period.

The aeronautics research activities of the Federal Government and the federal states are embedded in the European Framework Programme. In order to ensure that these activities are coordinated at regional, national and European levels, PT-LF has on behalf of the Federal Ministry of Economics and Technology assumed the role of national contact point for the field of aeronautics re-

search in the 7th EU Framework Programme for Research and Technological Development.

The technological abilities acquired nationally continue to make German businesses and research institutes popular partners in European research consortia, as is impressively demonstrated by the above-average monetary return from the European Framework Programme to Germany in 2011. In the call for level 1 projects, this return reached almost 30%, representing a significant increase compared to the previous year.

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.

In 2011, budgetary restrictions of individual member states due to fiscal constraints have for the first time become apparent as challenges to intensified transnational cooperation, limiting the ability of the affected partners to provide sufficient funding for national research programs in which transnational cross-program cooperation is possible.

For this very reason, the importance of coordinating national programs and funding mechanisms is increasing further, which continues to meet with great interest outside the AirTN network. In view of this emerging disparity of research funding availability among the AirTN partner countries, the importance of effectively coordinating national research efforts is even greater than before. The necessary funding instruments and mechanisms largely exist within AirTN, have in part already been tested, and must now be brought into wider application.

Project Management Agency for Aeronautics Research: Revenues and funding budget in millions of euros

	2011 Actual	2012 Planned	2013 Planned
Revenue			
Third-party funding	3	5	5
Funding budget			
Federal Ministry of Economics and Technology	125	142	134
Ministry of Economics Free State of Bavaria	18	19	10
Ministry of Economics Brandenburg	3	2	2
Hamburg Department of Economics	3	5	4
Ministry of Economics Lower Saxony	14	19	9

PT-LF is also supporting the BMWi within GARTEUR (Group of Aeronautic Research Europe), the oldest research network of the leading European aviation nations and core of AirTN, after Germany's chairmanship has passed to Sweden.
More information is available online at:
› www.airtn.eu

As a project management agency for the BMWi, PT-LF has succeeded in maintaining its central position as a service provider and knowledge bearer in the field of aeronautics research at a European, national and regional level. It is therefore able to effectively support the BMWi in its efforts to efficiently fund aeronautics research in Germany in a coordinated fashion and avoid duplicate funding. This special role is unique among comparable institutions in the European partner countries.

The Project Management Agency in DLR

PT-DLR, short for the Project Management Agency in DLR, has been working in the service of research, education and innovation at both national and international levels for over 30 years. Its clients currently include the Federal Ministry of Education and Research, the Federal Ministry of Economics and Technology, the Federal Ministry of Health, the Federal Ministry of Family, Senior Citizens, Women and Youth, the Commission of the European Union, the Federal Agency for Nature Conservation, state ministries and various private entities.

At the end of 2011, PT-DLR employed approximately 870 people. Total research funding managed by PT-DLR increased noticeably again this year; with a volume of approximately 1,060m euros for the first time it crossed the threshold of one billion euros. In all, approximately 10, 200 projects were sponsored in 2011.

Funding planning: Revenues in millions of euros

	2011 Actual	2012 Planned	2013 Planned
Third-party funding*	65	67	67
Funding budget	1,060	1,100	1,150

*incl. profit, excl. VAT

The range of topics is extraordinarily diverse and covers most of the currently relevant fields of science and technology such as healthcare, environmental and sustainability research, information technology, technical innovations in business, research on shaping the world of work and on service provision, and cultural and education research. The Project Management Agency also incorporates the national contact points for EU programs and the European research initiatives COST and EUREKA, as well as the EU Bureau of the Federal Ministry for Education and Research (BMBF). The BMBF International Bureau at PT-DLR oversees international cooperations in research and education with all regions of the world. The Public Auditors of the Federal Ministry of Education and Research for projects co-financed by the ESF are also part of the Project Management Agency.

Due to its many years of experience in the fields of research and education funding as well as in project management, PT-DLR maintains excellent contacts to research agencies and institutions, professional committees and renowned experts in the national and international research community. It provides technical and specialist expertise in order to support its respective clients in making Germany fit for innovation at national, international and EU levels, as both the internationalisation strategy of the Federal Ministry of Education and Research and the importance of the European dimension for Germany have grown significantly over the past year.

In 2011, PT-DLR was again able to further strengthen and successfully expand its position as Germany's largest project management agency in the fields of re-

search, development, education and innovation, gaining for example the Federal Agency for Nature Conservation as a new client, whose programme bureau for the federal program "Biological Diversity" was set up within the Project Management Agency. Furthermore, the Federal Ministry of Economics and Technology has contracted PT-DLR to manage a new project on "Electromobility". The PT premises in Berlin were expanded and established at a central location at Alexanderplatz, improving communication paths to PT-DLR's clients in Berlin, among other things.

PT-DLR has further expanded its strengths in the fields of innovation, interdisciplinarity and international cooperation over the past year. For example, the Project Management Agency 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 broad range of subjects, PT-DLR is well equipped to conceptualise and manage interdisciplinary research projects even within short timeframes. International research collaboration is a feature of almost all areas in which PT-DLR operates, and is also embedded in two dedicated research funding departments.

In early 2011, the Federal Ministry of Education and Research (BMBF) announced that project management contracts for the BMBF are to be offered for Europe-wide tender in future. PT-DLR has responded to this significant change in the procedures of its still largest client and initiated internal, structural adjustments in order to adapt to the altered conditions created by this competitive situation. These include further strengthening internal competencies and making them more accessible through organisational measures, with regard in particular to interdepartmental communication and staff mobility.

Based on a comprehensive assessment of the role of the Project Management Agency in and for the overall organisation DLR, PT-DLR will remain an integral component of the DLR organisation.

Projects and funds managed in 2011

	Number of projects	in millions of euros
Health research	2,159	277.7
Information technology	1,909	226
Environment, culture, sustainability	1,553	179.4
Education research, integration, gender research*	1,537	180.5
International Bureau	1,470	27.5
Innovative capacity and research transfer	881	66.5
Technical innovation in business	549	82.4
European programs	142	9.8
Years of Science	20	5.5
Total	**10,220**	**1055.3**

* co-financed with ESF (European Social Fund) funds of 53.6m euros in 2011

A detailed overview of all PT-DLR's work and programs can be found in its annual report for 2011 at
› http://www.dlr.de/pt/en/desktopdefault.aspx/tabid-4270/6848_read-6936/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ECONOMIC DEVELOPMENT

Results

Third-party funding

In the reporting year 2011, DLR again saw its third-party funding increase: it grew by a further 35.4m euros to a total of 436.3m euros, reaching a record level and accounting for 55% 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% 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. 60) 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 BMBF has declined due to a number of activities drawing 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 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% compared to the previous year and came to 21% 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% to 31% in 2011. At an average of 20%, 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 the funding volume for individual projects has increased in recent years. The number of EU coordinator projects has fallen to 18% – 4% less than the previous year. In absolute numbers however this represents a decline by only three projects.

Third-party funding	2009	2010	2011
Total revenue from third-party funding	381m euros	401m euros	436m euros
Proportion of overall revenue from third-party sources	49%	54%	55%
Earnings trend in revenue from R&T activities in Germany	12%	-6%	-5%
Percentage of earnings from foreign clients (profit volume)	25%	24%	21%
Revenue from EU funding	21.7m euros	22.6m euros	26.1m euros
Success rate of EU applications (accepted/submitted)	37%	36%	31%
Coordinator quota on approved EU projects	22%	22%	18%

Research

Scientific quality is one of the most important criteria at the German Aerospace Center. Alongside the acquired third-party funding, significant indicators of this quality are the scientific findings made public in journals, presentations and courses. 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 remained the same as in the previous year, although the number of journal articles again increased. The upwards trend in completed Diplom theses we have been seeing for years continued; the unusually high number of habilitations also represents a positive development.

Technology Marketing

One aim of DLR Technology Marketing is to shape innovations jointly with cooperation partners from industry, based on, among other things, the DLR innovation system designed under the leadership of the Technology Marketing department and introduced in early 2012 by the Executive Board: Innovation2gether – working together for market success.

Cooperating with DLR allows businesses to benefit not only from access to DLR's know-how, but also from faster response times to the innovation requirements of market participants (time-to-market). Industrial partners also have the opportunity to protect market segments through licensing. A head start, market development and protection are decisive competitive advantages.

DLR in turn benefits from the market success of its competencies and technologies through licensing; feedback from industry and markets is also integrated into its future research and development work, enabling DLR to strengthen its role as a technology supplier and economic innovation driver and thereby offer industry and society a visible benefit of research.

DLR Technology Marketing has consistently and successfully developed its methods of technology transfer in recent years. Examples include the comprehensive ideas management system implemented in DLR in 2010. The existing Science2Business model has been expanded to include over 20 partnerships, leading to an ever increasing number of market-driven innovation projects.

Due to its experience, methodological expertise and leading role in the Helmholtz Association, the department's technology marketing skills are also increasingly in demand from external parties. TM is for example managing the joint project "Enabling Innovation" (developing a modular set of methods to enable institutes and research institutions to evaluate their own innovative capacities) on behalf of a DLR project management agency; the project will enter an advanced phase to market the tool to German non-university research organisations in the second half of 2012.

Our successful innovations are also gaining recognition internationally. DLR is the first German organisation to receive not one, but two awards from the American Space Foundation. The DLR researchers received one award for developing an early warning system for forest fires called FireWatch and successfully marketing it through the Technology Marketing

Research-related results	2009	2010	2011
Publications in peer-reviewed journals	577	654	721
Peer-reviewed publications in proceedings, books, etc.	460	563	491
Talks at scientific conferences, workshops, lectures*	0.55	0.51	0.58
Appointments to universities	13	14	17
Lectureships	244	296	295
Diplom theses	396	487	542
PhD theses	105	85	105
Habilitations	4	1	6

* per member of scientific staff employed at institutes and facilities

department. At the same time, the Space Foundation recognised both DLR and its licence holder IQ wireless GmbH as "Innovating Organizations" for this technology. By inducting them into the "Space Technology Hall of Fame", the Space Foundation annually recognises technologies that were originally developed specifically for space exploration and are now finding practical civilian application as market-ready products that not only increase people's quality of life, but can also save lives.

Examples of successful technology marketing

The ideas competitions held by the Technology Marketing department and culminating in the DLR IDEA AWARDS are increasingly leading to innovation projects with outstanding market potential.

The innovation project "IRIS – Optische Indoor-Navigation zur Schiffsinspektion" (Optical indoor navigation for ship inspection), which is carried out in cooperation with and co-funded by strategic innovation partner Germanischer Lloyd (GL), aims to develop and validate a functional demonstrator that digitally connects inspection results in the form of photographs and measurements of identified weaknesses (e.g. cracks, areas of corrosion) with their automatically detected location. In addition to reducing the time and resources required at GL, such a device is also of interest to shipping company owners in order to better estimate the scope and cost of necessary repairs.

Based on the DLR technology platform "MiroSurge", the "MIRO-Lab" innovation project is working with surgeons both to expand the technology platform and to develop and validate new minimally invasive robotic operation procedures. The DLR MIRO system had already come to the attention of the Wall Street Journal in 2008, when it referred to the project as the possibly first "formidable competitor" for the daVinci system developed by DARPA, funded with venture capital of up to 100m USD/year and marketed by the company Intuitive Surgical. The MiroSurge system is a configurable robotic technology platform for surgery. The project is financed by DLR and the Helmholtz Validation Fund.Another DLR IDEA AWARD 2011 winner is the innovation project Mirko-Vol. In cooperation and with equity funding from strategic innovation partner DHL, DLR is developing a multi-sensor package that makes it possible to monitor the load volume of passing HGVs. DHL has an urgent demand for high quantities of such a solution. To increase its own efficiency and avoid unnecessary goods traffic on roads, DHL hopes to use this technology both for HGVs leaving DHL's loading docks and in cities with high levels of traffic congestion.

Company start-ups

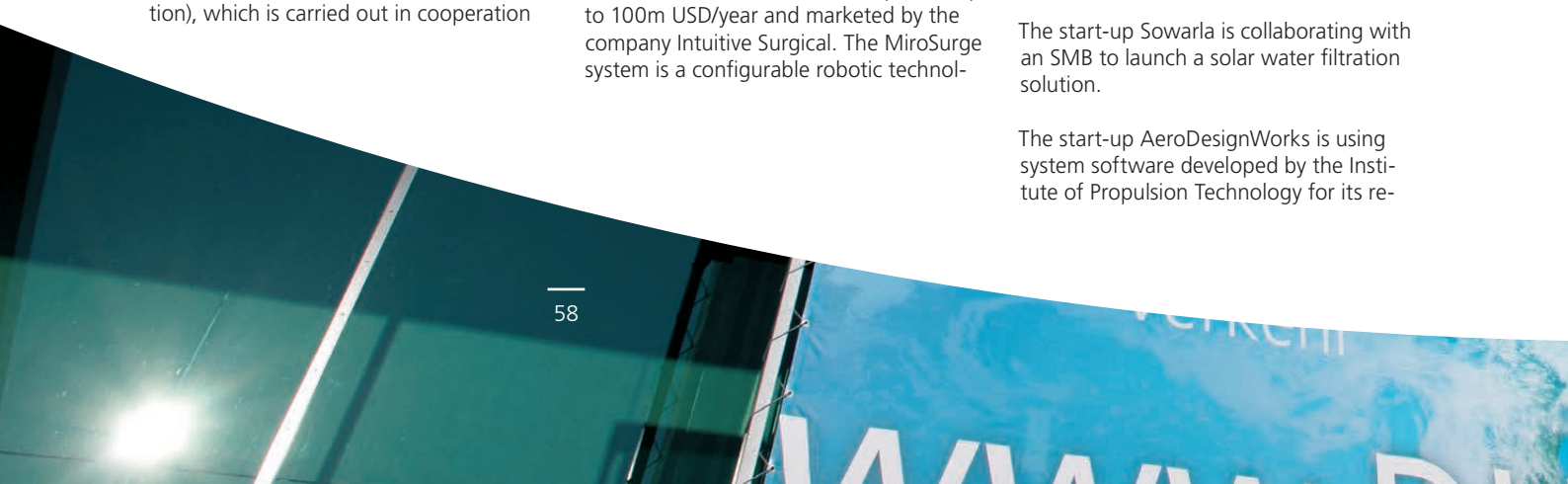
Technology transfer from the institutes and facilities of DLR occurs in part through licensing to young companies founded to implement innovations. An "open innovation" approach allows business and industry to participate in DLR's research results.

DLR supports company start-ups to accelerate technology transfer because the innovative capacity in particular of small and medium-sized industrial companies is not very highly developed. Utilisation of research results leads to increased competitiveness via innovations, which of course require funding and appropriate organisational conditions.

In future, DLR intends to work even more intensively with start-up networks at its locations, for example with the university start-up network at the University of Cologne by joining the network, which was set up as a registered association by the Cologne higher education institutions, and by participating in training young entrepreneurs.

The start-up Sowarla is collaborating with an SMB to launch a solar water filtration solution.

The start-up AeroDesignWorks is using system software developed by the Institute of Propulsion Technology for its re-



search into more powerful turbines in order to simulate fans and compressors that offer a high optimisation potential for increasing efficiency in industrial development processes, and provides corresponding engineering services to the industry in question.

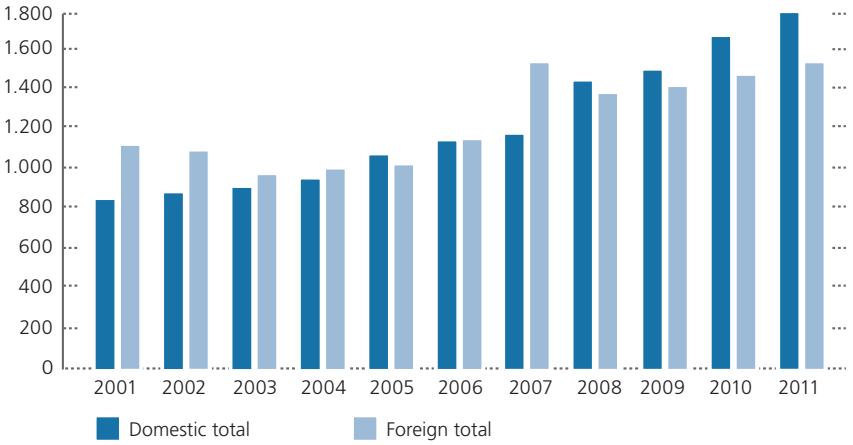
Overall, the method of technology transfer through company start-ups has proven expensive and risky, but highly successful compared to other research institutions in the Helmholtz Association. Companies that make use of DLR's excellent capabilities in remote sensing, in communications, navigation and robotics are developing into technological industry leaders around the world.

Intellectual property rights

The field of intellectual property rights and licences entails developing and maintaining DLR's intellectual property rights portfolio and managing all commercial marketing agreements, including the granting of licences. DLR's intellectual property portfolio now encompasses approximately 3,300 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. At 258, the same amount of invention disclosures were made in 2011 as in the previous year.

Every year, the German Patent and Trade Mark Office publishes a list of the fifty most active patent applicants in Germany. DLR ranked 22nd on this list in 2011 with 233 applications. The only other research institution on the list is the Fraunhofer Gesellschaft in Munich with 364 applications (ranked 16th). Setting these numbers in relation to the number of employees working for the two research institutions presents the following picture: DLR (approximately 7,000 employees) made one patent application for every 30 members of staff, while the Fraunhofer Gesellschaft (approximately 20,000 employees) made one application for every 54 members of staff. This ratio surely demonstrates that DLR has the capability to significantly advance the state of the art in its research areas.

Proprietary rights in Germany and abroad



Licences

In 2011, licensing generated a turnover of approximately 4.5m euros; income from licensing was thus approximately 300,000 euros higher than in the previous year.

Technology marketing and company start-ups – one of DLR's strengths

The innovation project "RCAS – Railway Collision Avoidance System" is one of the winners of the DLR IDEA AWARD 2011. The project is developing an existing technology to market readiness via a cooperation with railway operator Bayerische Oberlandbahn, and marketing it through the DLR spin-off "Intelligence on Wheels (IoW)", which is now headquartered in Gilching. "We are very pleased that our listing in the companies register has brought us a significant step closer to transferring the RCAS research topic to live operation."

Prof. Thomas Strang and Andreas Lehner
Intelligence on Wheels founders

Structure and Organisation

Technical Services

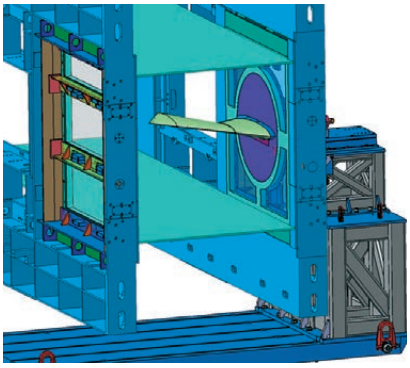
An important milestone for TI was its third-party evaluation as part of the STEP (Streben nach Excellence in den Prozessen der Administrativen und Technischen Infrastruktur (ATI) – Striving for excellence in administrative and technical infrastructure processes) project in August 2011. The aim of the survey was to examine the development level of the management system of TI using the EFQM model as a frame of reference. The potential improvements identified as a result reflect TI's own assessment, and specific measures to implement them have been prioritised and initiated.

Derived from the objectives of the Executive Board, sustainability is a strategic key topic for TI. In a first step, it is being implemented as a matter of priority by Construction Management. The great significance of this topic results not least from the higher statutory requirements regarding security, environmental protection and sustainability which the funding provider demands of DLR. Sustainability in this respect entails equal consideration of ecological, economic and social aspects. TI is currently adapting its strategies in all three areas accordingly.

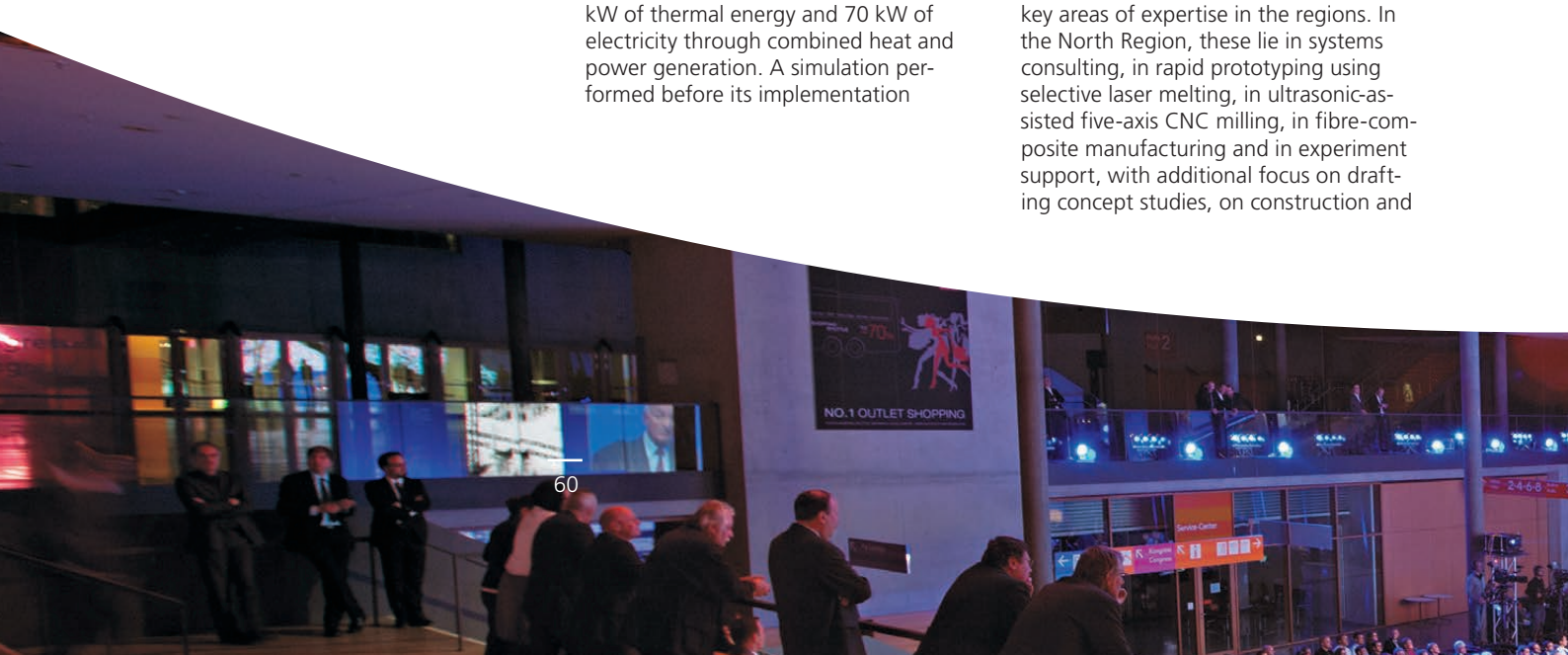
The performance of the Construction Management department remains consistently high. After completing the acquisition of the buildings of the Max Planck Institute at the Göttingen site, the department has begun the necessary planning process for their future use by the DLR institutes. In Braunschweig, the mandatory tendering procedures for commissioning specialist planners for the urgently required new casino building have been completed. Construction Management is holding a building planning competition for the construction of the new office complex in Cologne (which is to replace administration building 1) in the form of a Europe-wide invitation to tender. Also in Cologne, the topping-out ceremony was held for ":envihab", the new building of the Institute of Aerospace Medicine. The handover of this extraordinary building is expected to take place in early 2013.

The urgently required new building in Neustrelitz was completed in June 2012. It will meet the increased demand for server rooms, office space and conference rooms at this site. An outstanding feature of this new building is the energetically sustainable media supply for the new data center. The implementation of this supply solution, termed "Green IT", is exemplary. As opposed to standard data centers, which are cooled mainly using fossil energy and release exhaust heat into the environment unused, a regenerative concept was developed and implemented for the new center. At the heart of this concept are two absorption chillers which generate coldness e.g. from an intake of hot water. The main heat source is a solar thermal power plant with an output of 90 kW; supplementary power is provided by two block heating plants which each generate 115 kW of thermal energy and 70 kW of electricity through combined heat and power generation. A simulation performed before its implementation showed that compared to conventional data center operations this system can save approximately 360 t/a CO2 and 50% primary energy, corresponding to cost savings of approximately 100,000 euros a year. The operating phase will now have to show whether the prognosticated values are achieved or perhaps even exceeded.

The Technology Systems House (Systemhaus Technik, SHT) fully met the immense challenges arising from the DLR projects carried out during the reporting period. The (institutional) framework of the SHT is however currently under further review to ensure that the SHT is able to establish itself as an effective DLR facility in the long term. Internally, SHT successfully continued to expand its technological orientation and establish key areas of expertise in the regions. In the North Region, these lie in systems consulting, in rapid prototyping using selective laser melting, in ultrasonic-assisted five-axis CNC milling, in fibre-composite manufacturing and in experiment support, with additional focus on drafting concept studies, on construction and



Construction of the wing test rig at TWG Göttingen



Quality management	2009	2010	2011
Existing certifications	28	30	30
Number of accreditations	10	11	11
Number of DLR auditors	10	11	11
Audits performed	38%	49%	45%
Space Administration supporting projects	23	23	26

on static and dynamic FEM calculations. Specialists were also trained as development engineers in the field of CE marking. In the South Region, SHT specialised in layout and circuit design and calculation with LabVIEW, systems programming for procedures, and CNC milling. The West Region is expanding its know-how mainly in the fields of consulting, rapid prototyping with selective laser melting including materials testing, five-axis CNC milling and CAM applications with CA-TIA, hyperMILL® and Pro/ENGINEER.

A technologically and scientifically outstanding project to which SHT has contributed is the DLR project FaUSST.

SHT developed the IWEX (Instationäres Wirbelexperiment, unsteady vortex experiment) half-model for this project and designed it specifically for forcibly energised pitching movements. It is to undergo unsteady testing at the Transonic Wind Tunnel Göttingen (TWG) operated by Deutsch-Niederländische Windkanäle (DNW). The experiment will be accompanied by numerical simulations and is intended to provide a simulation database regarding the aeroelastic stability of such configurations at actual sizes.

Quality Management, Standardisation and Environmental Protection

Quality management

Assuring quality in science and research is an important corporate policy objective which DLR aims to achieve by means of a quality management system. This systematic organisation of operating processes is currently rarely applied in research institutions, and DLR's company-wide quality management system is a unique feature within the HGF.

DLR intends to use this system to continuously increase its competitiveness and customer retention, to further stabilise its legal position and increase its efficiency by standardising its 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 by the end of 2013. So far, 22 facilities have established quality management systems, while a further 24 are currently setting them up.

Certificates for management systems are the result of an audit by an independent third party, generally the accredited certifying board. The Deutsche Akkreditierungsstelle (DAKKS) is the appointed national organisation responsible for accreditations. Certification and accreditation are the basis for and frequently a prerequisite of approval by public authorities. DLR holds all three forms of approval.

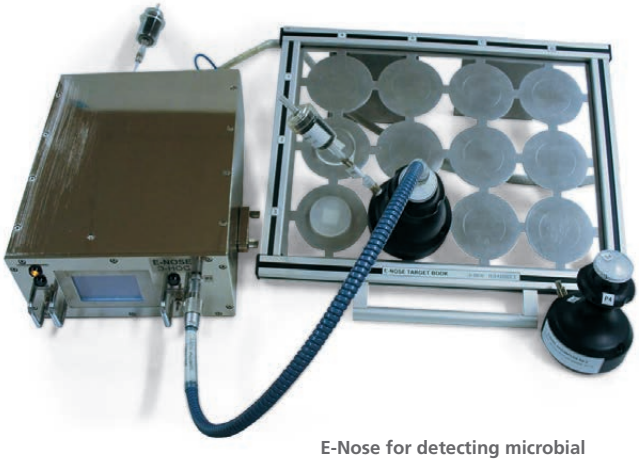
Several subsystems have integrated sector-specific certificates (VDA 6.2, ISO 13485, OSHAS 18001, ISO 14001, DIN ISO 27001) over and above the minimum standard. In addition, DLR has accredited laboratories at its Simulation and Software Technology facilities and at the Institutes of Space Systems and Transportation Systems (RailSiTe®), and holds approvals from the Federal Aviation Office at the Design Organisation, in Flight Operations and at the Institute of Aerodynamics and Flow Technology.

In 2011, DLR's audit plan was met by 96%. DLR currently employs a total of eleven auditors; a further 42 DLR auditors are now in training in order to expand the basis for performing internal audits by increasing the number of qualified personnel.

The management of the Quality and Product Assurance department changed at the beginning of 2012; the Executive Board has also appointed a new Quality Management Representative. These posts continue to be held jointly by one person.

92% of all institutes and facilities have a quality representative in the Working Group of Quality Representatives (AKQ). During the reporting period, DLR began to modernise its existing quality management system. A concept to systematically organise DLR's management processes is currently in development.

DLR is a member of the European Foundation for Quality Management (EFQM), and provided an assessor to support the European Excellence Award (EEA) in 2011 and 2012. In addition, the EFQM assessor qualification offered as part of DLR's training program 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.



E-Nose for detecting microbial contamination

Product assurance

The Project Support department is responsible for the technical aspects of controlling in space exploration projects. Its main aim is to comprehensively limit risk when carrying out space exploration projects. The department sees itself as an interface between clients and project teams and as a project-accompanying instance.

Its main instrument for providing product assurance is the specification of requirements. Coordination meetings with potential clients in the space industry and the Space Administration are held at regular intervals, and the requirements specified in these meetings form a major contractual component over the course of the project.

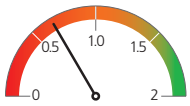
Two current projects may serve as examples of the Space Administration's field of activity in quality and product assurance:

The partners involved in the project have great expectations regarding the use of the electronic **E-Nose** on the ISS. This electronic gas sensor system for detecting microbial contamination is expected to fly to the ISS on a Russian carrier rocket in early December 2012 and be taken into operation in January 2013. The E-Nose was developed in a cooperation project with the Russian Institute for Biomedical Problems (IBMP) and the Project Support department. The electronic gas sensor was used for the first time in the MARS-500 simulation experiment, in which its fitness for purpose was successfully demonstrated (see p. 26). Based on these promising results, the use of the E-Nose in the Russian segment of the

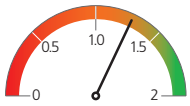
ISS was agreed with the IBMP and the Russian space authorities Energija and Roskosmos. The electronic nose uses ten different sensors to detect substances hazardous to health which are based on bacteria or fungal spores. Its deployment on the ISS is of particular importance with regard to ensuring the stable health of the astronauts on board. In closed systems such as the space station, most allergens are transmitted via respiration air, and are frequently the cause of concentration problems, lethargy or headaches. The use of the E-Nose thus offers extensive opportunities to significantly improve conditions for astronauts during their stays on the ISS.

INS/TNS success rate

INS



TNS



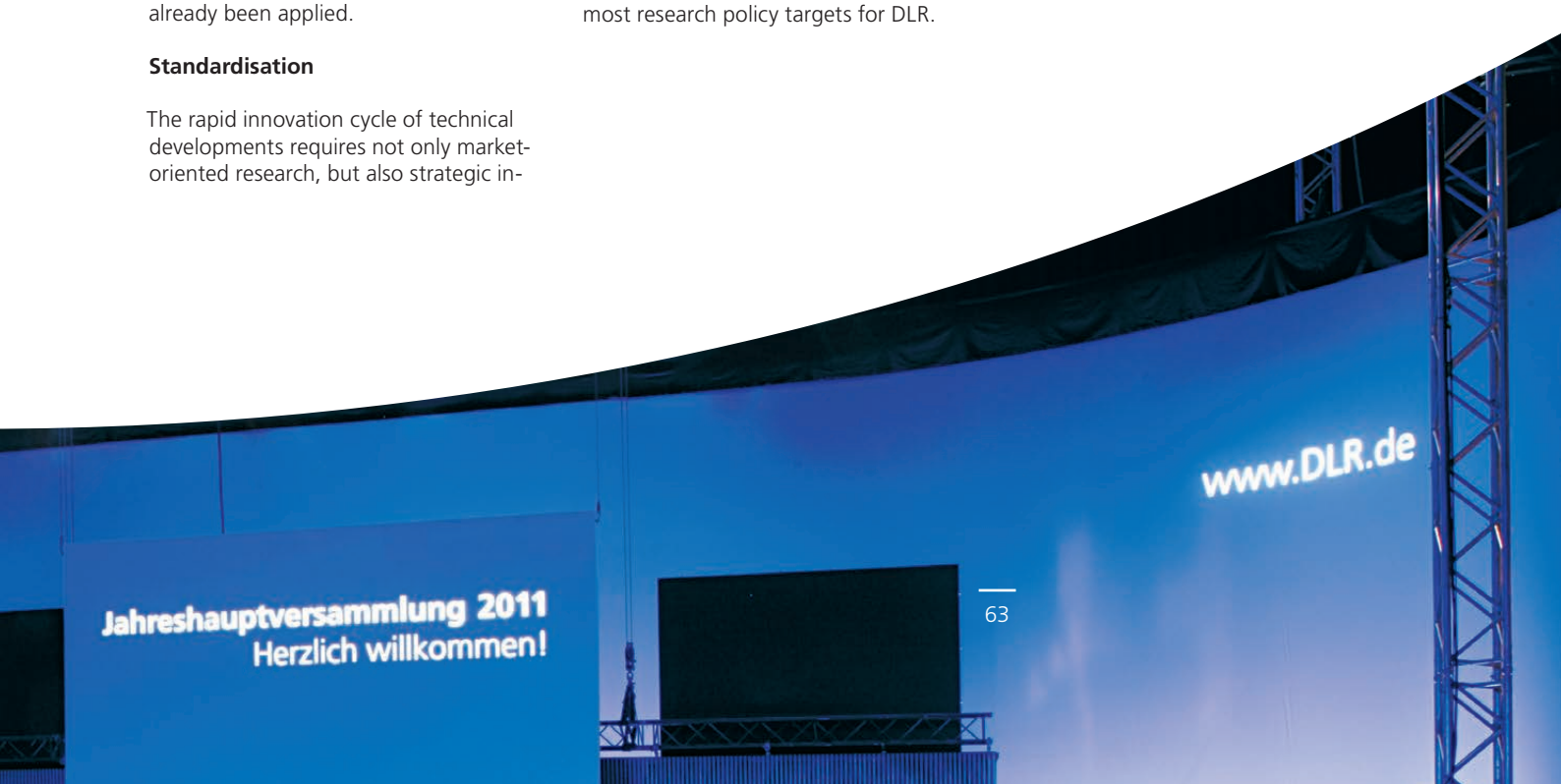
The Federal Ministry of Economics and Technology launched the project initiative "Innovations by Norms and Standards" (INS) in 2006 and the research-focused initiative "Transfer of Research and Development Results by Standardisation" (TNS) in 2009. DLR institutes and facilities from the Space, Energy and Transportation programs have been participating in these initiatives since 2007 and 2010 respectively. Their aim is to promote standardisation activities and the transfer of technologies to applications. Compared to the number of projects commissioned overall, an above average amount of INS and TNS projects were awarded to DLR.

Well over 600,000 debris items are floating in space, significantly increasing the danger of a collision on Earth or between satellites. The **Space Debris concept**, which focuses on dealing with returning debris items, was drawn up in response to this situation. Based on the German space strategy and with due consideration of international guidelines, experts from the Space Administration and the German space industry were consulted. The resulting concept provides a structured basis for counteracting the growing threat of returning debris items (see p. 48). The working groups established for the project are further refining the requirements which have already been applied.

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 supports fast market access for innovations. Standardisation is no longer exclusively the domain of the manufacturing industry; it is increasingly being incorporated into research and innovation processes in Germany and Europe. As part of its standardisation policy, the Federal Government requires public research institutions to take standardisation aspects into account in their research and technology programs. Requirements specified by the BMWi are reflected in most research policy targets for DLR.

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, achieving these goals is significantly assisted through the implementation of research and work results by means of norms and standards, and has been included by the Executive Board in its strategic alignment.



Qualifying EEE components for space flight

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

In a procedure coordinated at European level, DLR participates in European Space Components Coordination (ESCC) to compile joint standards and specifications for the qualification, procurement and use of EEE components in space exploration. DLR defines and implements the national technology development and qualification program for EEE components, and works with national component manufacturers to develop and qualify components. Together with our European partners we have thereby succeeded in reducing our dependency on US exports from 70% to 50% in recent years. To increase the availability of EEE components, DLR collaborates with China and Japan. Qualification by a national Assembly and Test House facilitates the use of suitable commercial components, and studies are conducted to determine the suitability of new component technologies for space exploration uses. In 2012, DLR is conducting ten evaluation and qualification projects in the field of EEE parts with a total budget of approx. 2.8 million euros.

Environmental protection and safety

In Technical Infrastructure, the integrated management system underwent a routine audit by an external certification board in 2012. The system is based on the requirements of DIN EN ISO 9001 and DIN EN ISO 14001, and also covers safety aspects, reflecting OHSAS 18001 (occupational health and safety management system). The audit emphasised that TI's move towards corporate sustainability management (CSM) has proven to be correct and beneficial. It represents DLR's contribution to the Federal Government's strategy on corporate social responsibility.

DLR's construction activities are increasingly based on sustainability, furthering the aims of environmental protection and the protection of natural resources and of ensuring technical quality and thus safety. Among other measures, members of staff were trained to become experts in this field. DLR now has on its staff a qualified consultant of the German Sustainable Building Council (Deutsche Gesellschaft für Nachhaltiges Bauen, DGNB) and a coordinator for sustainable building according to the Assessment System for Sustainable Building (Bewertungssystem Nachhaltiges Bauen für Bundesgebäude, BNB). Since late 2011, DLR has been a full member of the German Sustainable Building Council, and is therefore able to sit on the corresponding committees and participate in shaping standards for sustainable construction in the interests of DLR, e.g. in criteria relating to new laboratory buildings. In this context DLR has also decided to participate in the pilot certification for the DGNB scheme "new laboratory buildings", thereby proving the quality of its new laboratory building for the Institute of Space Systems in Bremen in terms of environmental, economic and sociocultural criteria and determining and specifying benchmarks for future certifications. The building in Bremen is to be one of the first physical laboratory buildings to receive a Certificate in Bronze. By arrangement with the Federal Ministry of Economics and Technology (BMWi), the Federal Ministry of Transport, Building and Urban Development (Bundesministerium für Verkehr, Bau und Stadtentwick-

Did you know ...

... that DLR is already doing a lot for sustainable building today, and is even the first organisation to conduct a pilot certification for a laboratory building by the German Sustainable Building Council (DGNB)?

lung, BMVBS) invited DLR to take part in the pilot phase of the Assessment System for Sustainable Building with its planned office and administrative building in Cologne-Porz. DLR was happy to accept this invitation. Construction of the new office building will now be planned sustainably from the outset with the aim of achieving certification by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (Bundesinstitut für Bau-, Stadt- und Raumforschung, BBSR). The architectural competition, which contains a wide range of evaluation criteria on sustainable building, is currently underway.

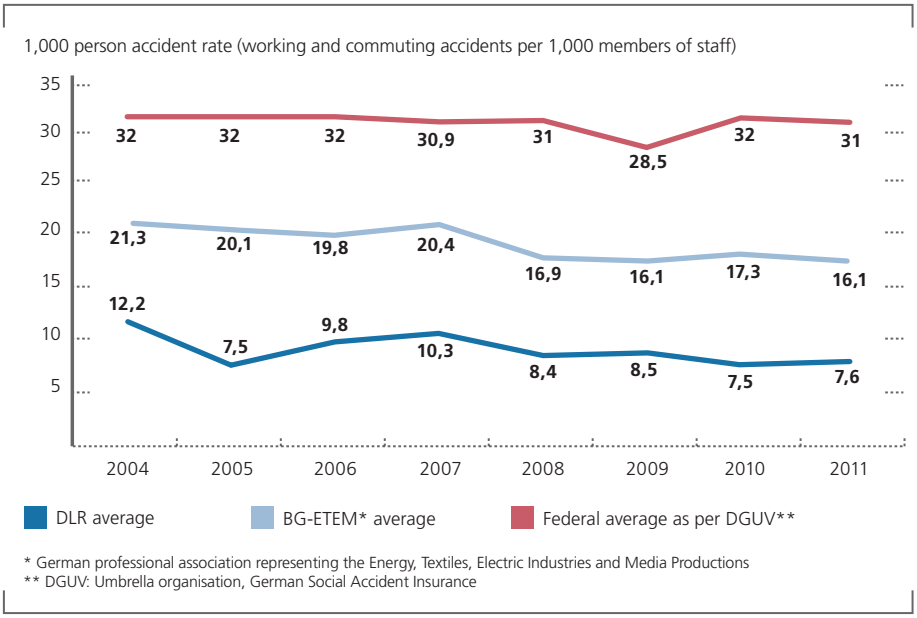
DLR is participating in the Europe-wide trade in CO_2 licences with its research facilities and research aircraft. Although the facilities are used e.g. in the field of resource conservation in jet engines, and the aircraft fly e.g. climate monitoring and environmental measurement missions, DLR pays fees to fund environmental protection.

A newsletter on the latest topics is published every two months. DLR is also further expanding legal databases and information systems in cooperation with the Helmholtz Centers. Over the reporting period, managers and employees were continually made aware of environmental issues in order to encourage them 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.

Joint procedures for operating in a resource-efficient manner were developed in close collaboration with internal and external network and cooperation partners such as universities and within the Helmholtz Association.

In the field of risk communication, the active crisis management group is being continually developed further in order to coordinate matters such as pandemic readiness and other safety-related and environmental measures pertaining to potential damage events, and to provide timely information to employees and other target groups. Flu vaccinations continue to be performed annually at the DLR sites; uptake among employees remains constant at approximately 10%.

Accident trends at DLR



The BG-ETEM average was added to the graph based on information from its annual report for 2011 (published in mid-2012). The Germany-wide average for this indicator according to DGUV (German Social Accident Insurance) was not available when the graph was prepared; the figure for 2011 has been extrapolated based on provisional figures from DGUV published online on April 5, 2012.

In 2011 there were a total of 53 reportable accidents at DLR, almost half of which occurred not at work but during work-related travel, en route between the workplace and home, or in other areas considered work-related, such as corporate sports activities (29 accidents). There were no fatal accidents; serious injuries involving an extended period off work were rare. 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, sprains, cuts and stab injuries.

The comparative indicator "accident ratio per 1000 persons", which is important for DLR, was 7.6 at DLR in 2011 (previous year: 7.5) and thus relatively low. For comparison, the "accident ratio per 1000 persons" recorded by the trade association "Energie Textil Elektro Medienerzeugnisse" (Energy, Textiles, Electricity and Media Products, BG-ETEM) among its members was 16.1 in 2011 (17.3 in the previous year). Performance indicators for large-scale research facili-

ties have been generated and compared within the Helmholtz Association (HGF) since 2008. The accident ratio per 1000 persons determined there was 9 in 2011.

For safety and environmental standards please see:
› www.dlr.de/dlr-sicherheit/en/

DLR Center of Excellence

The DLR Center of Excellence (CoE) is an internal scientific competition within DLR. It should not be confused with the Excellence Initiative for Cutting-Edge Research at Institutions of Higher Education of the Federal Ministry for Education and Research (BMBF). The DLR competition rewards cutting-edge research conducted by working groups working on large-scale research topics. 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.

The aim of this award is to honour and expand recognised top-class research. Internal networking and the creation of synergies outside institutes' own area of expertise are of particular importance. The competition promotes important 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 R&T fields, and active technology marketing.

In 2011 the award went to the DLR Institute of Aerospace Medicine for its research into the effects of space conditions on the human body and health. This research not only provides valuable findings on how astronauts can maintain their health under space conditions; the negative effects of zero gravity, such as muscle loss, bone resorption and circulatory problems, are also closely linked to issues encountered in terrestrial and clinical medicine that are becoming increasingly important due to an ageing population.

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

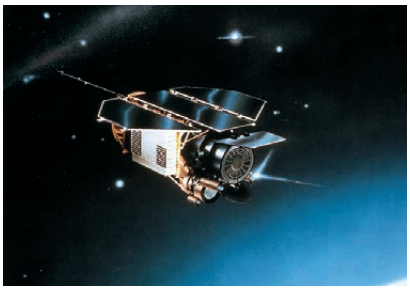
Partners

DLR Corporate Communications

DLR Corporate Communications is responsible for all aspects of DLR's public outreach, such as medial communications and press relations, cross-media public relations, planning, management and execution of (large-scale) events, corporate identity and internal communications. Target groups of DLR Corporate Communications are in equal measure the general public, the media and decision-makers in politics, industry and science, as well as DLR employees.

Corporate Design and Corporate Identity

During the reporting period, DLR's visual design guidelines were revised and made available to DLR employees via intranet and print media, accompanied by various internal communication measures, giving the already very successful external image of "One DLR" a more modern, fresher look and achieving a further important milestone.



ROSAT

Successful ROSAT emergency communication

On October 23, 2011, at 3:50 a.m. CEST, the German research satellite ROSAT re-entered Earth's atmosphere over the Bay of Bengal. "With the re-entry of ROSAT, one of Germany's most successful scientific space missions has come to its final conclusion. The dedication of all those involved at DLR (in R&T, at the Space Situational Awareness Center and in the Space Administration) and of our national and international partners was exemplary. I owe them all my sincerest thanks", said Prof. Wörner. Transparent press and public relations activities, in which extensive background information and constant updates to the special website http://www.dlr.de/dlr/en/desktopdefault.aspx/tabid-10424/ and DLR's social media channels played a significant part, enabled DLR to generate a neutral to positive public opinion.

German Aerospace Day 2012

German Aerospace Day 2011

Approximately 85,000 visitors flocked to the DLR site in Cologne for the "German Aerospace Day" on September 18, 2011, where DLR, the European Space Agency ESA and their partners presented their aeronautics, space, energy and transport research projects to the public. Visitors had the opportunity to view the DLR research aircraft, the Airbus A380 and the airborne observatory SOFIA on the Zulu Stand, and allowed researchers and engineers to show them the jet engines of the future and terrestrial applications for aerospace medicine. Astronauts like Alexander Gerst, who train at the ESA European Astronaut Center for ISS, described their work and life in space. "The German Aerospace Day was again a great success this year. We are very pleased that our visitors are so interested in DLR's research", said Prof. Wörner, Chairman of the Executive Board of DLR. "The large number of visitors and their huge interest has shown how highly DLR's research is valued in Germany."

DLR on the web

DLR on the web

Page impressions and unique visitor numbers for the DLR web portal increased steadily due not only to the attractiveness and relevance of its content, but also to the use of modern communication tools such as Twitter, Facebook and Google+ as well as new formats such as the SpaceTweetup. Currently, www.dlr.de/en/ has approximately 1.6 million page impressions and 500,000 unique visitors per month. A social media analysis of the German Aerospace Day 2011 was also completed during the reporting period. The figures show that digital public relations work is highly relevant and significant, and large-scale events for the general public, such as the German Aerospace Day, offer excellent synergy effects in this respect. After the DLR web portal had already gone live with a new design and new functionalities in July 2011, the over 60 websites of the DLR institutes, facilities and other organisational units were also updated to the new corporate web design during the reporting period. A mobile version of the DLR web portal for all common types of smartphones and operating systems was also launched.

Political and Economic Relations

"The most important aspect of human communication is conversation." In political communications, this statement by a Munich communication scientist is invariably true. DLR's political and economic relations are therefore primarily based on direct interactions, initially between the chairman of the Executive Board and, by arrangement with the chairman of the Executive Board, DLR's program directors, and ministers, state secretaries and members of parliament; furthermore between employees of the Political and Economic Relations department and ministerial and parliamentary staff; and overall with the core of Berlin and state politics. DLR ensures the transparency of this staff work, which is assigned directly to the chairman of the Executive Board, through internal reports and through the chairman's report to the DLR Senate.

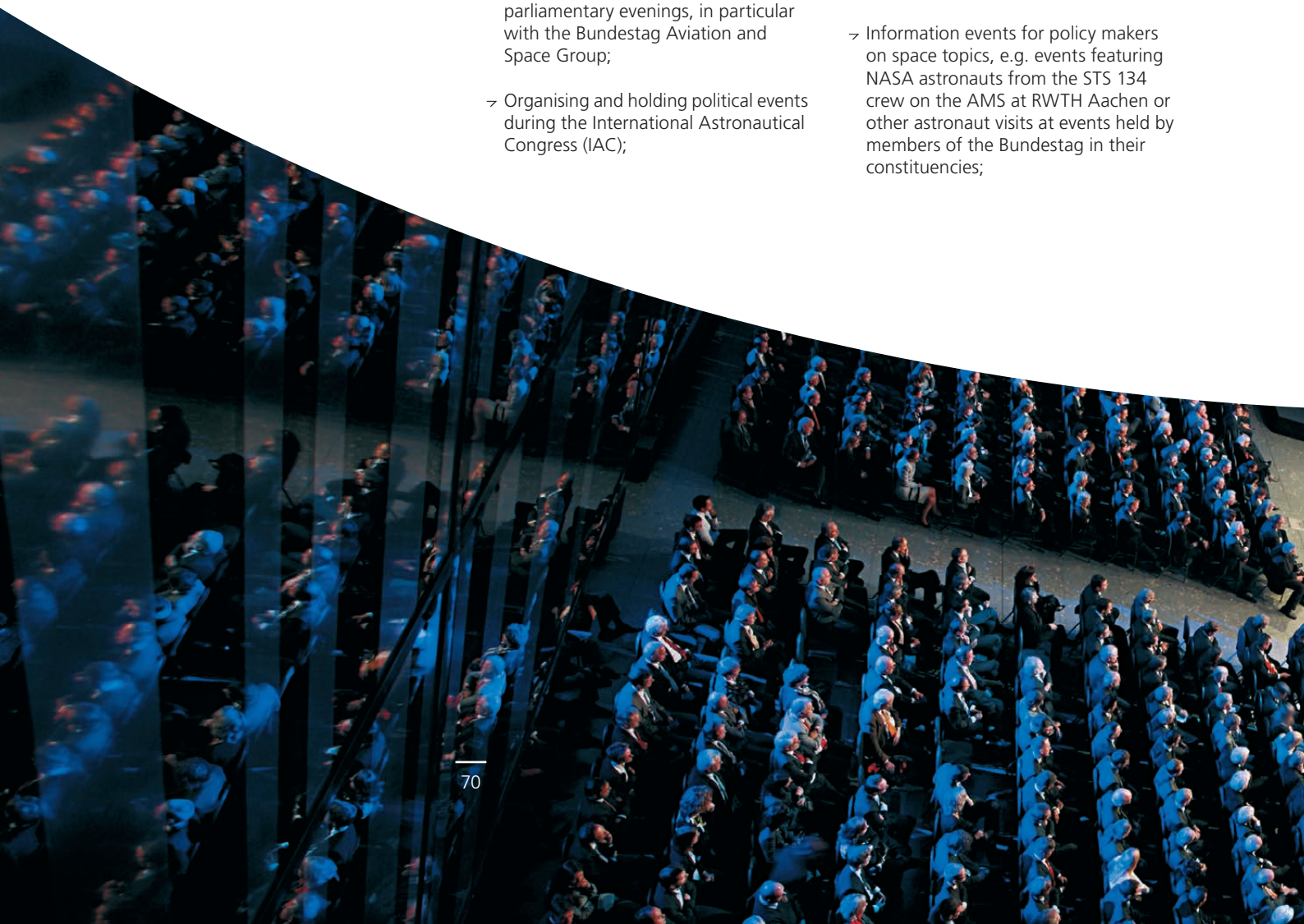
Discussions at the highest levels accordingly formed the core of this field of work during the reporting period. Various meetings with politicians were facilitated and organised to this effect, and expert advice was provided to members of DLR's leading circles insofar as their members were directly involved in contacts to policy makers. Finally, the Political and Economic Relations department used the traditional tools of political marketing to initiate various information events and generate specific communication products to familiarise the core target groups of DLR, namely politics, industry, business and the community, with DLR's research areas and their potential for innovation in a targeted fashion.

A delegation lead by Members of the Bundestag Jürgen Trittin and Oliver Krischer in front of two of the 2153 movable reflectors (heliostats) that reflect the solar tower

Environmental policy at DLR: Dr. Helge Schlieben, Member of the Bundestag Dr. Michael Paul, Parliamentary State Secretary Ursula Heinen-Esser and Prof. Dr.-Ing. Johann-Dietrich Wörner

The following selected activities may serve as examples from the reporting period:

- Background talks with numerous politicians, e.g. Minister Ramsauer, Members of the Bundestag Rossmann, Ernst, Trittin, Lindner, Petra Müller and many more at DLR;
- Visits from the mayors of Cologne and Bonn to DLR;
- Background talks with Parliamentary State Secretary Heinen-Esser at DLR on projects relevant to environmental policy;
- Background talks and visits by members of the European Commission and the European Parliament;
- Organising and holding several parliamentary evenings, in particular with the Bundestag Aviation and Space Group;
- Organising and holding political events during the International Astronautical Congress (IAC);
- Organising and holding political events during the European Interparliamentary Space Conference (EISC);
- Corporate publishing with NDV: Kürschner "Luft- und Raumfahrt" (to follow in 2012: Kürschner "Energie");
- Introduction of an information tool for DLR managers, the "BerlinBulletin", containing current information on the work of the German Bundestag;
- Introduction of the information meeting "DLR trifft…!" (DLR meets...!) on current DLR research and management topics for employees of political decision-makers;
- Working breakfasts with selected parliamentary working groups of the German Bundestag;
- Information events for policy makers on space topics, e.g. events featuring NASA astronauts from the STS 134 crew on the AMS at RWTH Aachen or other astronaut visits at events held by members of the Bundestag in their constituencies;



- Preparation of the special project "Art Levitates", which aims to bring together policy makers, science and art in an innovative framework, as part of the 20th parabolic flight campaign of DLR in September 2012.

Due to limited personnel resources, activities in the field of economic relations were only possible to a minor extent. The focus here is on cooperations and internal collaboration with the Technology Marketing department and externally with chambers of industry and commerce, and also on intended cooperations between DLR, policy makers and industry at state level.

More information:

Political and Economic Relations

Helmholtz Association of German Research Centres

Developments in program-oriented funding

Four years after the beginning of the second period of program-oriented funding, planned research activities in the Aeronautics, Space and Transport research field are being presented in applications for the third round. The submissions take into account both national and European research programs. The horizontal themes Electromobility and Security in particular are being coordinated for assessment in 2013, as these topics deal with urgent issues that require increased cooperation with other centers in the Association. Energy, the second research field in which DLR is involved, examines the topics of rational energy transformation and use, renewable energies and system analyses. The activities begun in the field of ceramic materials for energy technologies and thermal storage technologies combine not only two research areas but also research and production. The resulting new technologies are being developed to market readiness in early and close cooperation with industry.

Initiative and Networking Fund

Together with TU Clausthal and ETH Zurich, DLR has founded a virtual institute on the subject of solar synthesis gas production. Part of the funding for its research in the next five years will come from the Initiative and Networking Fund of the Helmholtz Association. Over the same funding period, the cooperation between DLR and other member centers of the Association will receive funding from the Initiative and Networking Fund for its alliance to develop hydrocarbon fluids as energy stores with excellent energy density. Energy storage is a key issue for the energy supply of the future. A second alliance dedicated to examining how humanoid walking machines can be dynamically controlled completes the success of DLR in acquiring additional financing from the Association's fund.

National Networks

Collaborations with universities

Collaborating with universities is a strategic goal of DLR. Joint projects in almost every area of activity ensure the optimal utilisation of available resources in programmatic research, and working with staff from other institutions enhances the training of highly qualified new talent for industry and science. This cooperation benefits both DLR and the universities. For universities, the scientific and technical infrastructure available at DLR is in many cases a prerequisite for a wide range of research projects, while DLR gains access to up-and-coming scientists and new research topics.

Within the scope of the Excellence Initiative, collaboration between universities and DLR is becoming increasingly important, yet at the same time the nature of these cooperations is changing. The trend is towards institutionalisation and goes far beyond purely technical collaboration on joint scientific projects. DLR's collaborations with TU Braunschweig, the University of Stuttgart and TU Munich have already been intensified and institutionalised, factoring in site-specific key topics. Within the Helmholtz Alliance DLR@Uni, the Helmholtz Association is funding the following site-specific research networks: "Campus Forschungsflughafen" (Campus Research Airport) in Braunschweig, the research campus DLR@UniStuttgart "Gemeinsam die Zukunft gestalten" (Shaping the future together), and "Munich Aerospace", a cooperation between DLR, TU Munich, the University of the Federal Armed Forces and Bauhaus Luftfahrt. The collaborative approach of the Helmholtz Alliance DLR@Uni is designed to strategically expand research activities between DLR institutes and universities in the respective regions. Beyond the funding from the Helmholtz Association, within DLR the DLR@Uni instrument defines a framework for content-based cooperation between DLR and universities which is not limited to purely scientific collaboration in joint projects.

Each year, the DLR institutes supervise more than 900 postgraduate students working on their PhD theses, and another 500 students complete their Diplom theses at DLR facilities. The number of DLR scientists with 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 2011.

Joint appointments form a central element of personnel-based connections with higher education institutions, as they increase the potential for research and teaching. All heads of DLR institutes are appointed jointly with a higher education institution, meaning that alongside his or her post at the institute, every head of a DLR institute takes on a university professorship with a reduced teaching load at the respective university. Increasingly, head of department posts at DLR are also being filled in the form of joint appointments.

Participation in DFG programs

Integration into the programs 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 participated in Collaborative Research Centres sixteen times, in Priority Programmes eleven times, and in Research Training Groups four times.

Sponsorships

Sponsorships are a useful instrument for rapid technology transfer through individuals, and also enable highly qualified young talents to be secured for research and development in academia 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. A total of 33 sponsorships were overseen at DLR in 2011, halting the declining trend for the time being. Following a high point between 2004 and 2008, the number of sponsored individuals has now reverted to the level of 2002.

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

European Networks

7th EU Framework Programme for Research

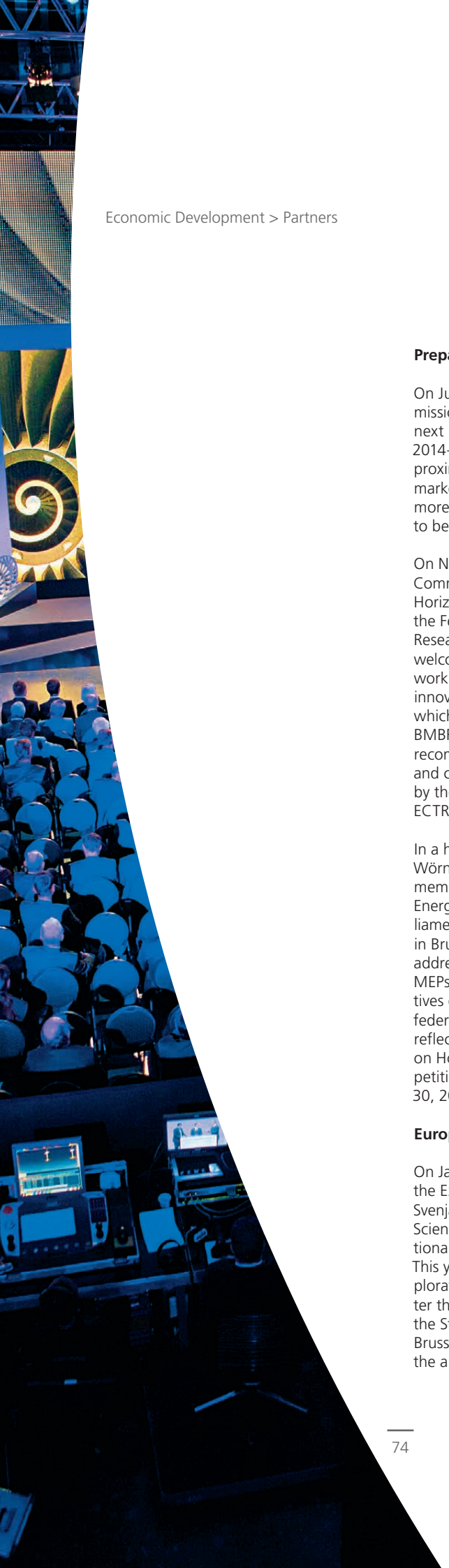
DLR again submitted several applications in response to calls for proposals in the 7th Framework Programme last year with good success, although particularly in aeronautics the very high level of oversubscription and the resulting low average success rate of only 13% for Level 1 projects meant that DLR's success rate of 20% was lower than in previous calls for proposals. DLR is however involved in all four funded Level 2 aeronautics projects.

The National Contact Point, which resides in DLR, advises German companies and research institutions in the EU Framework Programme. Averaged over the past four years, Germany's monetary return in the field of space exploration amounted to 14.6% of the available space exploration funding.

At the same time, DLR was again actively involved in preparing the work programs for the final calls for proposals of the 7th Framework Programme, due to be published in July 2012, both directly and via its participation in European technology platforms (ACARE, ERRAC) and groups (EREA, ECTRI, N.ERGHY, EERA). The Commission is already drafting these final calls according to its proposal for the next EU framework programme Horizon2020.

In all, DLR submitted 941 project applications to the 7th Framework Programme by the summer of 2011, of which 361 received funding. At just under 40%, DLR's average success rate is significantly higher than the general success rate in FP7 (approximately 20%).

This is also confirmed by the Commission's 4th FP7 Monitoring Report. In the ranking of participants in EU programmes by number of concluded contracts, DLR is 9th on the list of the best European research institutions and 16th on the overall list. It should however be borne in mind that DLR submits proposals mainly in its program areas Aeronautics, Space, Energy, Transport and Security, while the institutions ranked higher than DLR, such as CNRS, FhG or Max Planck, cover a far wider range of topics and are significantly larger than DLR. Institutions comparable to DLR, such as ONERA or NLR, are not among the top 80 on the overall list; the first industrial company in the ranking appears at no. 99.



Preparing Horizon2020

On June 29, 2011, the European Commission presented its proposals for the next multiannual financial framework for 2014–2020 (EU Budget), in which approximately 80 billion euros are earmarked for Horizon2020. In addition, more money from the Structural Funds is to be used for research and innovation.

On November 30, 2011, the European Commission published its proposal for Horizon2020. In an initial statement to the Federal Ministry of Education and Research (BMBF), DLR fundamentally welcomed the expansion of the Framework Programme to include research and innovation, and outlined the aspects which DLR considers crucial. Beyond the BMBF, DLR has published its position and recommendations in a dedicated paper and contributed to other position papers by the various European groups such as ECTRI, EERA and EREA.

In a hearing on March 20, 2012, Prof. Wörner presented DLR's position to members of the Industry, Research and Energy Commission of the European Parliament, based on which the DLR Bureau in Brussels has expanded on the aspects addressed there in discussions with the MEPs' offices, but also with representatives of the Federal Government and the federal states. Some of these aspects are reflected in the Partial General Approach on Horizon2020 adopted by the Competitiveness Council of Ministers on May 30, 2012.

European relations

On January 30, 2012, the chairman of the Executive Board, Prof. Wörner, and Svenja Schultze, Minister for Innovation, Science and Research, hosted the traditional New Year's Reception in Brussels. This year, the event focused on space exploration, and in particular on GMES. After the director of the Representation of the State of North Rhine-Westphalia in Brussels, Rainer Steffens, had welcomed the approximately 120 guests on behalf of the Minister and Prof. Wörner, Paul Weissenberg, Deputy Director General at the European Commission (DG ENTR) described the role of the European Commission in European space policy.

Expanding on this topic, Dr. Gruppe presented the current German plans in accordance with the national space strategy. The final talk was given by Prof. Dittus, who explained the multi-layered competencies of DLR as a research and service institution, specifically in the field of remote sensing.

The following reception at the State Representation offered the speakers and guests, among them Axel Voss, Member of the European Parliament, an excellent opportunity to continue their discussions in a more relaxed setting.

On the day after the New Year's Reception, the DLR Executive Board took the opportunity of their presence in Brussels to attend an extensive schedule of meetings. In the early morning, the members of the Executive Board resumed their discussions with MEP Axel Voss on European space policy from the previous evening based on the lectures and statements made at the reception. They also commented on the European Commission's draft proposal for Horizon2020 from DLR's point of view in order to provide the European Parliament with content-related input for the imminent negotiations.

Then Executive Board members Prof. Dittus and Dr. Gruppe met with Dr. Torsten Riedlinger, national expert delegated by DLR to the Commission, and received his report on current developments directly from the Commission. Meanwhile, Prof. Wörner continued his discussions on European transport research, begun during the previous year, with Director General Matthias Ruete (DG MOVE); these discussions focused on the implementation of the Transport white paper, particularly with regard to the role and form of transport research in Horizon2020.

To conclude their visit, the DLR Executive Board and representatives of the BMWi met with deputy Director General Paul Weissenberg to discuss the EU's future involvement in space exploration.

In all these negotiations, DLR advocated that funding be secured both for Galileo and for GMES as the second EU flagship project in the next multiannual EU financial framework period (2014–2020).

European Cooperation

Cooperation with NLR

In December 2011, the AT-One Assembly of Members agreed to review the cooperation agreements, which are now several years old, adapt them where necessary to any circumstances that may have changed in the meantime, and subsequently also review the organisational form of the cooperation and alter it as necessary.

Cooperation with ONERA

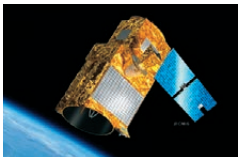
In December 2011, the DLR Executive Board member for space research and technology, Prof. Dr. Dittus, met with the chairman of ONERA, Denis Maugars, with the aim of intensifying collaboration in space exploration and identifying fundamental areas of cooperation. Examples of such areas of cooperation are research into technologies for scientific missions, robotics and automation, joint concept studies and the exchange of young researchers.

In aeronautics, the organisational procedures of the young researchers network (YODA) are to be modified based on the experience gained since its inception in 2010. The parties determined on the one hand to focus on a maximum of two scientific issues per year and on the other hand to align the schedule of the network's meetings to the annual ONERA-DLR Aerospace Symposium (ODAS). This year's ONERA-DLR Aerospace Symposium on the subject of "Safety in Aeronautics" took place from June 4–6, 2012, at DLR in Braunschweig.

Cooperation with CNES

The Franco-German space exploration partnership has currently achieved a high visibility through the MERLIN (Methane Remote Sensing LIDAR Mission) climate satellite. This mission, a direct cooperation between DLR and CNES, was approved by the Franco-German Ministerial Council in February 2010 and is to launch in 2016. In addition, CNES has agreed to collaborate on the DLR lander MASCOT, which is part of the Japanese Hayabusa 2 mission, a sample return mission to the asteroid 1999JU3. MASCOT will perform various in situ measurements, for which CNES will contribute a number of subsystems and the scientific instrument MicrOmega. The launch of Hayabusa 2 with MASCOT is currently planned for late 2014. The first meeting between the program directors Dr. Reile and Thierry Duquesne took place in Cologne in September 2011. Alongside getting to know each other, the meeting focused on discussing current and potential new cooperations. Key topics were Earth observation, communication/navigation, science, propulsion systems, space systems and carriers. In December 2011, a meeting at executive level took place between Prof. Dr. Dittus and Yannick d'Escatha in order to get to know each other and make arrangements for bilateral cooperation. In view of the decisions of the ESA Ministerial Council in November 2012, the Franco-German Ministerial Council issued a joint declaration on space policy in which it announced the formation of two joint working groups: firstly, the working group "Carrier Rockets" will be reinstated in order to analyse the future orientation of the European carrier sector, taking into account the latest developments such as the economic and financial crisis and the impending intensification of competition on the carrier market; secondly, a working group on the new European ISS compensation element, which is to compensate for NASA's transport services to ISS after the ATV deployments, was set up.

Franco-German research on climate gases



The Merlin climate mission is designed to achieve a better understanding of the global cycle of the climate gas methane and thus make a Franco-German contribution to climate change research. Germany will provide the methane measuring instrument, while France will contribute an improved version of its space-tested MYRIADE small satellite bus and operate the satellite. The DLR Institute of Atmospheric Physics is managing the German contribution; the DLR Space Administration is coordinating the German activities and cooperating directly with CNES. In May 2012, the preliminary requirements review was performed successfully, completing Phase A. DLR and CNES have now begun to coordinate Phase B.

European Groups

Joint Technology Initiatives

In the JTI Clean Sky, DLR's term as associate representative came to an end at the close of 2011; DLR is thus also no longer a member of the governing board. Prof. Henke was therefore also unable to extend his tenure as vice chairman of the governing board by a further year. DLR was however granted observer status on the governing board as a co-leader of the Technology Evaluator, so DLR will continue to be represented on all the relevant boards of the JTI Clean Sky.

As a member of the executive board of N.ERGHY (New European Research Grouping on Fuel Cells and Hydrogen AISBL), the association of European research institutions in the Fuel Cells and Hydrogen JTI (FCH JTI), DLR remains significantly involved in the execution and strategic alignment of the association. Particularly with regard to a possible continuation of the JTI in Horizon2020, the N.ERGHY board is currently focusing its efforts on actively representing scientific interests in the upcoming revision and coordination processes.

The participation of DLR researchers in four successfully submitted proposals to the FCH JU call for proposals 2011 shows that DLR as a popular and competent project partner also contributes significantly to the success of the FCH JTI in terms of research.

As demanded by the European Parliament, a significant focus of the Commission's proposal for Horizon2020 is on outsourcing administration (up to 70% of the budget) from the Commission. The Commission therefore intends to continue the corresponding instruments (PPP, JTI) from FP7 in Horizon2020 and adapt them as required. For this reason, the existing JTIs (Clean Sky, FCH JTI) are working on shaping these instruments for Horizon2020. Its membership in Clean Sky and the New European Research Grouping on Fuel Cells and Hydrogen AISBL (N.ERGHY) enables DLR to actively position its topics and interests in the successor organisations.

Moreover, preparations for Joint Technology Initiatives (JTI)
- of the automotive industry for the European Green Cars Initiative (EGCI), and
- for the rail vehicle industry (Shift2Rail)

are currently underway, and DLR is actively contributing to these in the same fashion as to the existing JTIs.

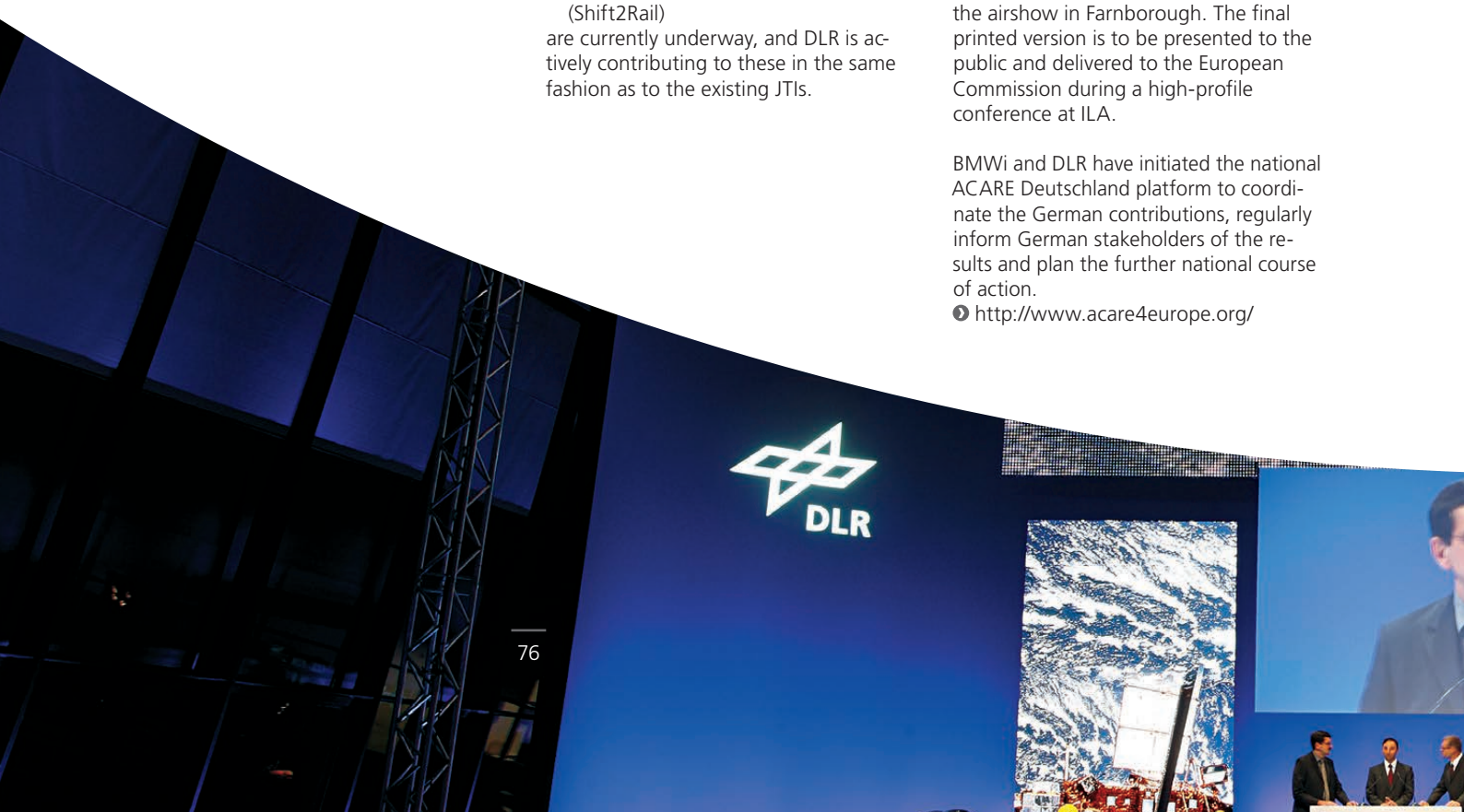
Similarly to ACARE's role in preparing Clean Sky in the 7th Framework Programme, the European Rail Research Advisory Council (ERRAC) will play an important part in the rail segment. Prof. Lemmer is involved in ERRAC as a national representative, enabling DLR to actively position its interests in the preparations for such a rail JTI.
http://www.nerghy.eu/index.php

ACARE/Flightpath 2050

Following publication of the new Vision for Aviation (Flightpath 2050) during the Aerodays 2011 in Madrid, the new Advisory Council for Aviation Research and Innovation in Europe (ACARE) is tasked with preparing a new Strategic Research and Innovation Agenda for European Aviation (SRIA).

With active involvement of DLR representatives (among them Prof. Henke as head of the working group "Prioritizing research, testing capabilities and education"), the various working groups compiled the first items for the SRIA by late March 2012, which were integrated into an overall draft. The contents of the SRIA were approved by ACARE during an ACARE General Assembly meeting at the airshow in Farnborough. The final printed version is to be presented to the public and delivered to the European Commission during a high-profile conference at ILA.

BMWi and DLR have initiated the national ACARE Deutschland platform to coordinate the German contributions, regularly inform German stakeholders of the results and plan the further national course of action.
http://www.acare4europe.org/



EREA – Association of European Research Establishments in Aeronautics

During the 2011 airshow in Le Bourget, the board of the Association of European Research Establishments in Aeronautics (EREA) met with representatives of the European Defence Agency to discuss the potential for future collaboration particularly in the field of unmanned aerial vehicles. To this end, the EREA working group compiled a study titled EREA for UAS (E4U) and submitted it to the EDA in late 2011.

On December 20, 2011, EREA Chairman M. Peters welcomed around 100 guests from the European Parliament, the European Commission, industry, research and member states at the annual EREA reception. Together with Director-General Robert-Jan Smits of the DG for Research and Innovation, he presented the EREA Best Paper Award 2011 to a VKI team whose publication unequivocally received the best evaluation.

On the following day, the results of the second phase of the study "Air Transport System of the Future" were presented and discussed. After approval by the EREA board, the results will be submitted to various groupings (ACARE, European Commission, industry). In addition to adopting the plans and annual budget for 2012, Prof. Henke was elected new EREA chairman for the next two years. M. Peters (NLR) as vice chairman and P. Eijssen (NLR) as new EREA secretary will support him in his duties.
› http://erea.org/

EERA – European Energy Research Alliance

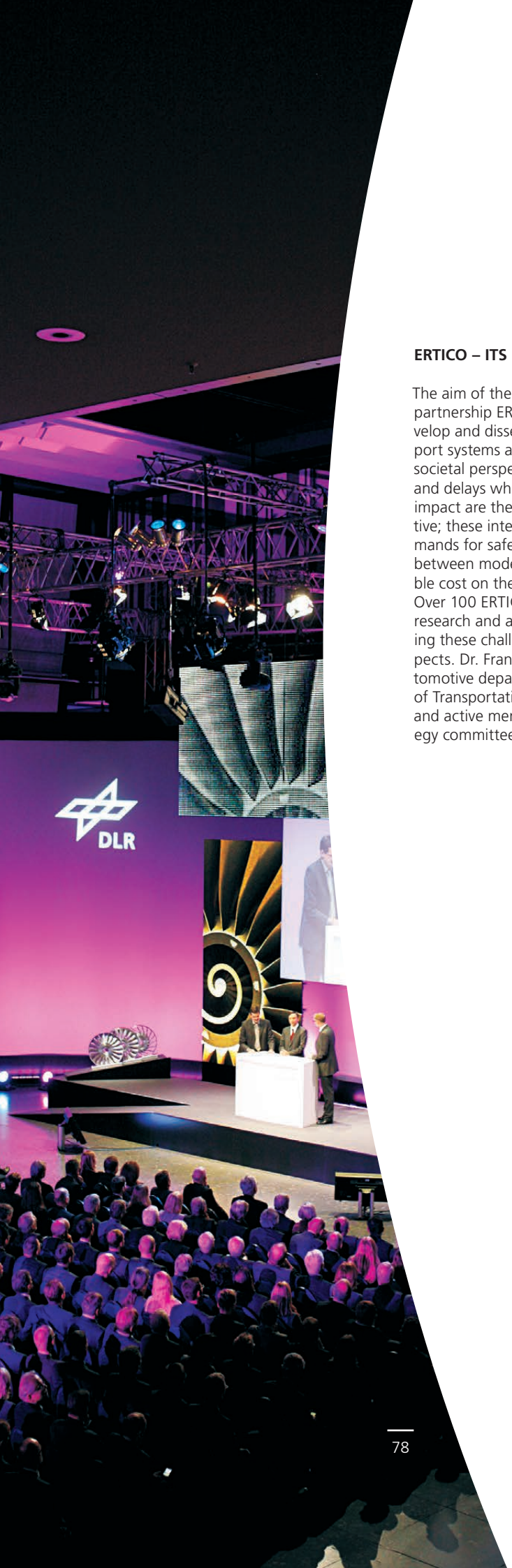
EERA now comprises 13 Joint Programmes (JP) that concentrate and strengthen the representation of European research in the various SET plan technology key areas (e.g. Energy Storage, CSP etc.).

DLR is already participating in five JPs and thus actively helping to shape and execute the ambitious goals of the individual program areas. In April 2012, Prof. Wagner was appointed German representative to the EERA Executive Committee. EERA's focus for 2012 is on further developing its internal structures and strongly positioning the association vis-a-vis the European Commission. The aim of these measures is to establish EERA as a key figure in shaping and aligning basic research in the Energy program area of Horizon2020.
› http://www.eera-set.eu/

ECTRI – European Conference of Transport Research Institutes

Under the presidency of Dr.-Ing. Christian Piehler, head of the DLR Transport program, ECTRI is heavily involved in developing the European Research Area. As an active representation of the interests of currently 26 leading European transport research institutions with multi-modal orientation, its main focus is on the preparations for the Horizon2020 framework program for research and innovation and for the Strategic Transport Technology Plan.

ECTRI's internal strategy process, aimed mainly at establishing an even more strongly integrating and moderating role for ECTRI in the European transport research landscape, has been concluded and specific measures to implement the revised strategy have begun. Intensive negotiations with leading European research organisations on establishing a European Transport Research Alliance (ETRA) similar to the existing European Energy Research Alliance (EERA) have been ongoing for several months.
› http://www.ectri.org/



ERTICO – ITS Europe

The aim of the European public private partnership ERTICO – ITS Europe is to develop and disseminate intelligent transport systems and services (ITS). From a societal perspective, preventing accidents and delays while reducing environmental impact are the keywords of this objective; these interests are pitted against demands for safety and smooth transitions between modes of transport at acceptable cost on the part of transport users. Over 100 ERTICO partners from industry, research and administration are addressing these challenges jointly under ITS aspects. Dr. Frank Köster, head of the Automotive department at the DLR Institute of Transportation Systems, is an elected and active member of the ERTICO strategy committee.

AET – Association for European Transport

As the organiser of the multi-modal European Transport Conference (ETC), the Association for European Transport has nominated Dr. Peter Wagner of the DLR Institute of Transportation Systems, Dr. Dirk Heinrichs of the DLR Institute of Transport Research, and Dr. Janina Scheelhaase and Ralf Berghof, both of the DLR Institute of Air Transport and Airport Research, as members of the Programme Committee. The Programme Committee is responsible for defining the thematic focus and structure of the conference and for ensuring the high quality of the scientific contributions.

TRA – Transport Research Arena

"Sustainable Mobility through Innovation" was the motto of the Transport Research Arena in April 2012. On behalf of the European Commission, this annual conference brought together leading scientists and research managers with representatives of industry, administration and politics in order to discuss the predominant lines of research in terrestrial transport in the coming years. As a member of the Programme Committee, Dr.-Ing. Christian Piehler, Director of the DLR Transport program, helped prepare the conference. He is also involved in a reform that aims to establish the TRA as a European counterpart to the American TRB Annual Convention. Sten Ruppe, Marek Junghans, Mathias Haberjahn and Christian Troppenz of the DLR Institute of Transportation Systems received the ELTIS Award at TRA 2012 for their contribution "Augmenting the Floating Car Data Approach by Dynamic Indirect Traffic Detection".

International Cooperation

Brazil

2011 saw the 40th anniversary of the historic date of November 19, 1971, when the then German Aerospace Research and Testing Establishment signed a contract with the Centro Técnico Aerospacial as an individual agreement on scientific collaboration.

The anniversary was marked with a ceremony in Sao Jose dos Campos. A high-ranking DLR delegation met with directors and scientists from DCTA, IAE, INPE and the Brazilian space agency AEB. Over the past four decades, numerous bilateral projects have been established and intensive collaborations in the fields of basic and applied research carried out with these institutions. In addition to many scientific efforts and successes accompanied by intense discussions and lively exchange, the cooperation gave rise to numerous personal relationships between German and Brazilian employees that endured beyond the respective project periods. All the participating partners agreed that this fruitful partnership in aeronautics, space and energy research should continue and be expanded.

China

On November 1, 2011, Shenzhou VIII was launched in Jiuquan. On board the return capsule was the experiment container Biobox with 17 biological experiments that had been prepared by German and Chinese researchers. Biobox is the first ever western scientific payload on a manned Chinese space mission. At the invitation of the Chinese Manned Space Engineering Office, member of the Executive Board Dr. Gruppe attended the launch together with a delegation from the Space Administration. The experiment was successful.

The 25th Joint Committee Meeting with the Chinese Aeronautical Establishment took place from November 8–11, 2011, at the DLR location Cologne. Topics included the cooperations with DNW and ETW, the progress made in developing the intermediate-range passenger aircraft COMAC 919, the results of Prof. Rossow's 2011 visit to China with a delegation from the Institute of Aerodynamics and Flow Technology, the development of the European Framework Programmes towards cooperation with China, the latest trends at IFAR (International Forum for Aviation Research) and the challenges in air transport development with regard to emission trading. After the meeting, the delegation headed by Professor Hua Jun visited DLR facilities in Braunschweig and Berlin-Charlottenburg.

A delegation from the taikonaut training center Tangjialing in Beijing visited DLR on March 15 and 16, 2012. The visit took place in accordance with the framework agreement on developing the cooperation between the Chinese Manned Space Engineering Office (CMSEO) and DLR in the field of manned space travel. The delegation visited the Institute of Aerospace Medicine in Cologne and met with Dr. Gruppe at the Space Administration in Bonn.

Between April 18 and 23, 2012, a high-ranking delegation of the Aviation Industry of China (AVIC) visited DLR in Göttingen and Braunschweig. Professor Lin Zuoming, Director General of AVIC, is an expert in engine acoustics and showed great interest in DLR's work in this field. Subsequently, the delegation visited AneCom Aero Test GmbH in Wildau.

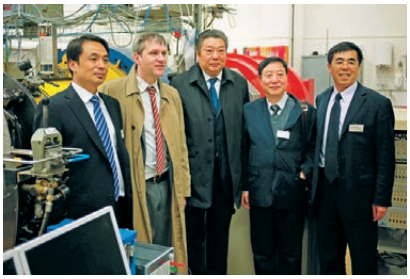
Europe, Union for the Mediterranean and Africa

Relations with numerous countries from this region are developing steadily and positively. In addition to scientific exchange, high-ranking representatives of foreign ministries, space agencies and research institutions visited DLR during the reporting period; we welcomed guests from the Czech Republic, South Africa and Nigeria, among other places.

Israel

On November 27, 2011, the DLR exhibition "A new perspective on Mars" opened at the Israel National Museum of Science in Haifa in the presence of high-ranking guests. The exhibition, which was funded by DLR's Corporate Communications department and organised in cooperation with MadaTech and the German Embassy in Tel Aviv, presents unique three-dimensional images of the surface of Mars which are the product of research by the DLR Institute of Planetary Research in Berlin. The accompanying texts were translated into Hebrew for the exhibition in Israel. DLR's Department of International Cooperation took this op-

40th anniversary of collaboration between DLR and DCTA



Prof. Lin (third from left) and his delegation visit the engine test beds at DLR in Göttingen

DLR representatives at the opening of the Mars exhibition at Technion in Haifa

portunity to foster its bilateral relationships in talks with representatives from science, industry and politics. Due to high visitor numbers, MadaTech has extended the exhibition until May 2012. In all, over 90,000 visitors attended the exhibition.

Japan

The annual strategy meeting between the Japanese space agency JAXA and DLR took place in September 2011 in Cologne. During the one-day meeting, the parties discussed and advanced their current and planned cooperations on ISS use/zero-gravity research, Earth observation – particularly disaster monitoring – and exploration, space transport systems, and administrative topics such as promoting personnel exchange.

The collaboration between DLR and JAXA on the Japanese asteroid mission "Hayabusa 2" is currently the largest cooperation project between the two space agencies. An initial cooperation agreement to intensify their collaboration was signed in November 2011.

The annual trilateral meeting between DLR and JAXA/ONERA at executive level took place at DLR Braunschweig in November 2011. The purpose of this meeting is to present and further develop bi- and trilateral cooperation projects, especially in aeronautics.

In late November 2011, a DLR-JAXA workshop on disaster monitoring was held in Tokyo. During the workshop, the significant potential for cooperation in the field of radar data analysis (use of X- and L-band data) was again highlighted and a long-term expansion of the collaboration agreed.

In a meeting in June 2012, the DLR Executive Board decided to open a new DLR bureau in Japan (Tokyo) with the aim of expanding the numerous cooperations with Japan and specifically JAXA within a strategic partnership. In addition to supporting cooperation with Japan, the bureau will also maintain and expand relations to other Asian cooperation partners such as China and South Korea.

Canada

The 21st German-Canadian STC meeting took place in September 2011 in Ottawa. It was held under the banner of the STC's 40th anniversary. At the meeting, DLR presented its bilateral cooperation projects e.g. with the Canadian Space Agency (CSA) and the Canada Center for Remote Sensing (CCRS). A milestone of this cooperation is the DLR satellite receiver in Inuvik, which also forms the nucleus for further cooperations in the field of remote data sensing.

During the IAC in South Africa, the chairman of the Executive Board, Prof. Dr. Johann-Dietrich Wörner, met with the vice president of the Canadian Space Agency CSA. To further support and simplify the already excellent cooperation, they agreed to draft a framework agreement between CSA and DLR.

Kazakhstan

The annual meeting of the KazCosmos – DLR steering committee took place in Astana from September 19–23, 2011. The DLR delegation was led by Dr. Schmidt-Tedd. After the meeting, the delegation travelled to Almaty for talks with the State Center for Space Research and Technology. The talks in Astana and Almaty focused on the cooperation between DLR and KazCosmos in the field of Earth observation and the technologies it requires.

Russia

The 2011 International Aviation and Space Salon MAKS took place from August 16–21, 2011, in Zhukovsky near Moscow. As part of the conference series "Aviation Technologies of the XXI Century", DLR and the Central Aerohydrodynamic Institute (TsAGI) held the bilateral workshop "TsAGI-DLR: advanced trends in aeronautical research" on the eve of the salon. One of the aims of the workshop was to further expand the DLR-TsAGI network of young researchers.

DLR had a booth at MAKS 2011. On August 17, 2011, Prof. Wörner had the pleasure of welcoming the prime minister of the Russian Federation, Vladimir Putin, to the DLR booth for the second time. The most important results of the meetings and talks held during the Salon in the field of space exploration were the signing of the agreement on Foton M – joint research on materials under space conditions on Russian re-entry satellites – and a supplementary agreement between DLR and Roskosmos on the project "More efficient energy supply for Russian carrier rockets and upper stages" between German company EnerSys Hawker GmbH and the Russian companies GRZ Chrunischew and Alternative Energies (AltEn). In the field of aeronautics, the main result was the signing of a cooperation agreement between the Berlin-Brandenburg Aerospace Alliance (BBAA), TsAGI, CIAM (Central Institute of Aviation Motors), AneCom Aero Test GmbH Wildau and DLR on joint research into compressors for aviation engines. German-Russian cooperation in aeronautics and space exploration was advanced in a large number of talks. Two members of the DLR Executive Board, Prof. Wörner and Dr. Gruppe, presented programs of their own at MAKS.

On September 20, 2011, the MIIGAiK Extraterrestrial Laboratory (MExLab) in Moscow was officially opened in the presence of Prof. Spohn and Prof. Oberst. MIIGAiK is the Moscow State University of Geodesy and Cartography. The MExLab is a project funded by a Russian mega grant and designed to explore planetary surfaces in the solar system. The DLR Institute for Planetary Research is participating in this project. Both institutions have additionally gained multi-year project funding as part of the Helmholtz-Russia Joint Research Groups.

On February 9 and 10, 2012, the kick-off meeting for the COMBIT (Communication Blackout Mitigation for Spacecraft) project was held at the Cologne site. Participating on the German side are the Karlsruhe Institute of Technology and the Supersonic and Hypersonic Technology Department (HY) of the DLR Institute of Aerodynamics and Flow Technology, and on the Russian side the Ioffe Physical and Technical Institute of the Russian Academy of Sciences. The project will also receive funding as part of the Helmholtz-Russia Joint Research Groups.

The 4th Russian-German Conference on Electric Propulsions and their Application took place on the Volga from June 24–30, 2012, with the participation of German industry, the Space Administration and several DLR institutes. The conference presented cutting-edge solutions for propulsion problems in space probes designed for various uses.

Vladimir Putin speaks to Prof. Wörner at the DLR booth

On July 22, 2012, at 8:41:39 a.m. CEST (12:41:39 p.m. local time) the first German small satellite in the OOV program was launched on board a Russian Soyuz rocket from the spaceport in Baikonur (Kazakhstan). TET-1 is a technology testbed with eleven experiments on board which must prove their effectiveness under real space conditions for one year.

Trilateral DLR – JAXA – ONERA meeting in Braunschweig

Meeting between the chairmen of DLR and NASA at the NASA headquarters in Washington

Singapore

DLR is currently considering whether a self-supporting research bureau in Singapore would offer a suitable Asian point of contact for DLR. In addition to visibility in Asia, DLR hopes collaborating with well-trained engineers in Singapore will facilitate an eye-level exchange of knowledge. In order to assess the potential of a cooperation on aviation topics, Prof. Henke travelled to the Singapore Airshow in February 2012 to meet with partners in science and industry in accompanying talks.

South Africa

The International Astronautical Congress (IAC) took place in Cape Town from October 2–7, 2011. As usual, the Department of International Cooperation took advantage of this event to organise numerous talks both at operational and at executive level. With Prof. Wörner, Prof. Dittus and Dr. Gruppe, the entire DLR Executive Board in the field of space exploration was in attendance. This year, the Congress focused on the host country of South Africa, which had founded a space agency only a few months earlier. This South African National Space Agency (SANSA) took over significant parts of the well-established South African space infrastructure. DLR had made contact with SANSA immediately after its founding in order to intensify its existing cooperation with South Africa with the new partner. In mid-November 2011, shortly after the very constructive talks at the IAC, SANSA director Dr. Malinga visited the DLR site in Oberpfaffenhofen. During his visit, specific cooperation topics and projects e.g. from the fields of Earth observation and ground stations were discussed and a bilateral workshop was agreed. The German-South African Year of Science 2012/13, initiated by the BMBF, provides a special framework for the cooperation between DLR and SANSA. At the opening event in April 2012 in Cape Town, DLR presented several scientific lectures.

USA

In late October 2011, Prof. Rolf Henke visited the NASA Dryden Flight Test Center in California, the NASA Glenn Research Center and the Air Force Research Laboratory in Dayton, Ohio. The purpose of his visit was to hold preliminary talks with Center directors in the fields of NextGen, UAV–UAS applications and propulsion technologies. In bilateral talks between NASA and DLR with NASA Associate Administrator for Aeronautics Dr Jaiwon Shin, the parties decided to expand and intensify the bilateral cooperation in the field of ATM through a DLR/NASA cooperation agreement.

The annual DLR Holiday Reception took place in early December 2011 in Washington, D.C. Together with the program directors Dr. Hubert Reile and Christoph Hohage, Executive Board members Prof. Dittus and Dr. Gruppe and the chairman of the Executive Board, Prof. Wörner, held high-level bilateral talks with US partners such as NASA Administrator Charles Bolden, representatives of the US Congress and the German ambassador, Peter Ammon. These talks revolved mainly around the future use of the ISS, the SOFIA status report, the GRACE Follow-on Mission Status and a discussion of NASA's innovation campaign compared to that of DLR. A tour of the Goddard facility, key points of which were the James Webb Space Telescope and robotics capacities (e.g. On-Orbit-Servicing Capabilities), rounded off the program.

The National Space Symposium (NSS) took place in Colorado Springs in April 2012. With over 9,000 attendees, 165 exhibitors and almost 30 nations, the NSS is the largest and most important dual-use space trade show in the United States. DLR had a booth at the trade show and was represented by a high-ranking DLR delegation consisting of the chairman of the Executive Board, Prof. Wörner, and program director Christoph Hohage, among others.

The annual highlight of the NSS is the Space Technology Hall of Fame, an "Oscar night" for the space exploration world initiated by NASA and the Space Foundation. The Hall of Fame honours organisations and scientists who have transformed a technology originally developed for space exploration purposes into a commercial product that benefits humanity. In 2012 this event was of particular importance for DLR Public Outreach and for DLR Technology Marketing in the USA: DLR was the first German organisation to receive not one, but two awards from the American Space Foundation: DLR researchers Dr. Ekkehard Kührt, Dr. Jörg Knollenberg, Prof. Dr. Herbert Jahn and Thomas Behnke received an award for developing and successfully marketing FireWatch, an automatic early warning system for forest fires. The Space Foundation also recognised both DLR and its licensee IQ wireless GmbH as "Innovating Organizations" for the FireWatch technology.

In May 2012, NASA Administrator Charles Bolden visited Germany. On the first leg of his journey he attended the ESA ISS symposium in Berlin and met with Parliamentary State Secretary Peter Hintze and the chairman of the Executive Board, Prof. Wörner, among others. These talks focused mainly on the future of the ISS and on bilateral cooperation between Germany and the USA in space exploration. Mr Bolden's trip concluded with a visit to DLR in Oberpfaffenhofen, where he was invited to review DLR's outstanding level of radar, robotics, navigation, data remote sensing and atmospheric research and the capabilities of the German Space Operations Center (GSOC).

The Global Space Exploration Conference (GLEX) took place for the first time in late May 2012 in Washington, D.C. The aim of the conference was to bring together decision-makers from the various space agencies and from industry and research to discuss pioneering ideas, roadmaps and legal/political conditions for human and robotic space exploration. Attendees included member of the Executive Board Prof. Dittus, who held background talks with high-ranking NATO representatives. A visit to SpaceX in California and NASA Ames concluded Prof. Dittus's visit to the USA. The talks at NASA Ames in particular were highly successful, and cooperations were agreed on several projects.

2012 I 2013
Deutsch-Südafrikanisches Jahr der Wissenschaft
German-South African Year of Science

DLR and SANSA: Partners in space exploration for humanity

Germany and South Africa share a close partnership that goes far beyond the field of space exploration. In 2012/13, the Federal Government is holding a German-South African Year of Science to further strengthen joint research, in which DLR is also taking part. Our most important cooperation partner is the South African space agency SANSA, which is barely two years old. This collaboration continues a tradition spanning decades and based not least on the particular location of South Africa in the southern hemisphere. It combines experience and fresh impetus in a wide range of initiatives and projects, for example in Earth observation or missions operation, to directly benefit the people in both countries.

IFAR – International Forum for Aviation Research

IFAR is the global platform of aviation research institutions. It promotes communication and possible cooperations between the participating research institutions. 23 of the leading aviation research organisations from Europe, Asia, Australia and America today support this objective and IFAR with the overarching aim of jointly meeting their responsibility for environmentally and climate-friendly air travel across countries and continents.

At the heart of IFAR's scientific and technical work is the development of a framework document with strategies for future scientific research, focusing on technologies relating to climate effects, weather and natural phenomena, noise and local emissions, efficient flight management, flight operations and flight safety. IFAR paves the way for new partnerships and collaborations within aviation research and also externally with industry and politics. The EU supports this approach with funding through the 7th Framework Programme. The highest executive levels of IFAR members meet once a year for a summit which this year took place in Paris at the invitation of ONERA. Among other things, it ratified the IFAR Charter as a guideline for cooperation. In addition to continuing its current climate research, support for young researchers and noise were among the topics discussed. At the IFAR summit to be held in October 2012 in Nagoya and hosted by JAXA, alternative fuels will be added as a further IFAR key topic. DLR has a leading role in IFAR: Prof. Joachim Szodruch, former member of the Executive Board of DLR, is the chairman of IFAR. The IFAR secretariate and its scientific and technical management also lie with DLR. The IFAR vice chair is NASA, ensuring that two of the world's most important aviation research institutions actively further the interests of IFAR.
› www.ifar.aero

German delegates to the Space Generation Council in Cape Town with Prof. Wörner

United Nations and international organisations

DLR took part in the exhibition World Heritage in Germany, which was organised by the Federal Foreign Office to celebrate the 40th anniversary of the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage. The exhibition was opened on February 27, 2012, by Minister of State Dr. Pieper.

For the first time, over 130 young delegates from 40 countries attended the tenth Space Generation Congress ahead of the IAC in Cape Town. The purpose of the Congress was to support the United Nations Programme on Space Applica-

A future for UNESCO World Heritage Sites

The satellite images presented by DLR offer "a different view of World Heritage Sites. They are as fascinating as works of art, but at the same time they are valuable aids in, for example, monitoring World Heritage Sites. With their help, changes and developments can be detected early on and observed over time. Satellite observation is an excellent monitoring tool, and in providing it, Germany is contributing to ensuring that World Heritage Sites have a future."

Dr. Cornelia Pieper
State Secretary at the Federal Foreign Office

tions; it offered its young attendees an excellent opportunity to form international contacts and apply the specialist knowledge they had acquired at their respective home universities in numerous group projects. Thanks to various grants from DLR and the German space industry, a large number of German students were able to attend, making Germany's the largest national group.

Participants of the UN-SPIDER Workshop 2012 in Bonn

International Space University

The International Space University (ISU) in Strasbourg offers an extensive range of education and further training programs on topics relating to space exploration. Internationality, interculturality and interdisciplinarity are of great importance to ISU in all its programs. A strategic partnership exists between DLR and ISU. With seven students, Germany is far better represented in the Space Studies Program this year than it was in previous years. The nine-week summer school takes place in Florida, USA.

To add practical experience to their course content, the students of the Master of Science in Space Studies program visited the DLR site in Cologne-Porz in early February and discussed current research topics at the Institute of Aerospace Medicine.

OECD Global Forum on Space Economics

DLR has been a member of the OECD Global Forum on Space Economics since 2012. The OECD Global Forum on Space Economics is an (informal) OECD group comprised of public space exploration stakeholders. Through its applications, space exploration's societal impact is increasing. The aim of the Global Forum is to facilitate the presentation of the effects of space exploration, in particular on industry, via suitable models and establish these as "key indicators". DLR as a main space actor in Europe has the opportunity to contribute to and actively shape these efforts. In 2012, the OECD International Futures Programme is conducting the study "Role of Space Technologies and ICT in the Surveillance of Global Threats", which examines the use of space technologies in various industry sectors with regard to global threats. DLR took part in the relevant workshops and held presentations on selected topics.

UNCOPUOS

In February 2012, the annual session of the Scientific and Technical Subcommittee of UNCOPUOS (United Nations Committee on the Peaceful Use of Outer Space) was held in Vienna. In addition to established topics such as avoiding space debris, use of nuclear propulsion technologies, Earth observation, or disaster management, the sustainable use of outer space was for the first time also included on the agenda in order to enable an analysis of the diverse aspects of this extensive topic. A German space industry evening was also held again during this UN session.

The UNCOPUOS Main Committee session 2012 took place in June. "Long-term sustainability of outer space activities" was one of the central topics. By 2014/2015, guidelines are to be drawn up which Germany, supported by the technical experts in DLR, hopes to shape in accordance with its own interests. Active reduction of space debris by appropriate measures is emerging as an important issue for the future. This topic is of great interest to Germany, as the DEOS mission is intended to demonstrate important technologies required for the active retrieval of objects. Prof. Schrogl was confirmed as the German chairman of the Legal Subcommittee for 2014/2015.

In late July 2012, Ambassador Konrad Max Scharinger replaced Ambassador Rüdiger Lüdeking as Permanent Representative of the Federal Republic of Germany and thus head of the German delegation to UNCOPUOS in Vienna. DLR will provide expertise and organisational support to Mr Scharinger in Vienna.

UN-SPIDER

The 5th International UN-SPIDER Workshop on Disaster Management and Space Technology took place in late April. 45 participants from 14 countries discussed aspects of the topic "Strengthening global synergies through knowledge management, portals and networks". Dr Gruppe welcomed the participants on behalf of DLR.

People

Gender Equality and Work-Life Balance

Activities in this area again focused on providing a better balance between work and family life. DLR has been offering its employees a wide range of family-friendly measures for many years. Increasing numbers of DLR employees are making active use of the services of our internal family advisory center, the free advisory services offered by external contractor ElternService AWO, or the option of alternating telework. More and more men are also sharing family responsibilities with their partners after the birth of a baby by also applying for parental leave for several months. We saw an astonishing increase of 100% in this area between 2010 and 2011.

DLR is among twelve employers in the certification year 2011 to receive the beruf**und**familie (work and family) audit certificate for the fourth time. The certificate issued by the non-profit organisation beruf**und**familie gGmbH was presented to DLR at a ceremony in Berlin. The 371 employers to receive an award included 202 businesses, 120 institutions and 49 universities. By submitting to this external audit, which is undergone every three years and represents an initiative by the Non-profit Hertie Foundation, DLR has now been proving its family-friendly policies for a full ten years.

DLR's firm commitment to family-friendly personnel policies was also recognised by the Federal Minister for Family, Senior Citizens, Women and Youth, Kristina Schröder, with a certificate for our participation in the company competition "Erfolgsfaktor Familie 2012" (Success factor family 2012).

Among the services most in demand is assistance for employees searching for suitable childcare solutions. Almost all DLR sites now have reserved places at childcare facilities for employees' children under the age of three. Our employees are also very happy with the services provided by ElternService AWO, who were newly contracted in 2011: the annual evaluation showed satisfaction levels of over 80% in almost all areas, and satisfaction levels with ElternService AWO's core business, arranging childcare places, were as high as 84%.

Zertifikatsverleihung audit beruf**und**familie**: v.l.n.r.: Dr. John Feldmann, Peter Georgino, Peter Hinze**

Human Resources Development

Based on a strategic requirements analysis, the qualification and training measures offered by the Human Resources Development department are planned according to demand. In 2011, 610 basic and further training events were held for employees, managers and management trainees. This represents an increase of 9% compared to the previous year. The dropout rate in the training programs remained constant at 17%, while the number of additionally offered events has increased to 133, reflecting the high levels of flexibility and demand orientation of the Human Resources Development department.

Acceptance of the Human Resources Development staff by internal customers both at management and employee level remained stable, as indicated by a renewed increase in the number of team workshops, of which 131 were held during the reporting period (previous year: 125). This figure also underlines the increasingly close relationship between the Human Resources Development department and the Organisational Development department.

In 2011, 68% of employees took part in at least one training program, Human Resources Development offering for managers or team workshop. On average, each employee spent two days this year on development measures (further training courses or team workshops). This figure has declined slightly compared to the previous year due to the elimination of the mandatory training courses on performance-related pay.

Employees	**2009**	**2010**	**2011**
Employees	6,490	6,835	7,046
Total scientific staff	3,677	3,913	4,080
Scientific staff at institutes and facilities	3,076	3,140	3,569
Permanent/fixed-term contracts	3,228/3,262	3,321/3,514	3,534/3,512
Proportion of women			
– in total	30%	30%	31%
– in management positions	14%	14%	14%
– scientific staff	17%	13%	18%
Junior researchers	63	55	47
Doctoral candidates (internal/external)	734	763	879
Trainees	252	247	244

Project management forms a key area of DLR's training program, as it is one of the most important competencies of a DLR employee. The range of project management seminars is therefore being continuously expanded and professionalised: for example, the department organised special seminars on risk management; 106 employees took part in the four-day compact courses in 2011. Training courses to prepare for PMP® certification were attended by 13 participants.

An important aim of Human Resources Development is to nurture the next scientific generation. High-ranking managers and members of the Executive Board have supported 11 young employees taking on a new task or their first management position in one-year mentoring relationships. A moderated dialogue between young managers and the Executive Board of DLR took place for the eighth time, offering 75 employees with potential the opportunity to exchange opinions with the highest levels of management and discuss important strategic developments and decisions. These meetings remove hierarchical barriers and promote corporate identity.

Education and Outreach

DLR is particularly committed to supporting the younger generation. Its individual measures – from primary schools to supervising doctoral candidates – are part of a strategic concept entitled "DLR_Campus".

The **DLR_School_Labs** aim to acquaint school-age children and youths with the fascination of research. In 2011, over 25,000 youngsters attended a total of nine such pupil labs, where they were introduced to the most exciting aspects of aeronautics and space exploration, energy and transport research in the form of hands-on experiments. DLR also offered numerous work experience placements at DLR institutes and facilities, as well as events such as a Girls' Day, Children's Universities, and more. On the Internet, which is now the most important medium for young people, the DLR youth portal DLR_next is very popular. The web site presents a wide range of information in an age-appropriate fashion – including numerous multimedia features. It allows its young visitors to take a virtual trip through the solar system, construct the car of the future, or play games that test their abilities as air traffic controllers or energy experts.

At an academic level, DLR_Campus comprises a wide range of offerings for students and DLR employees completing their doctorates. All DLR institutes support students on internships and in writing theses. Complementing this high standard are various highlight offerings – from the "flying lecture theatre", which offers aeronautics students practical experience, to Space Administration projects such as STERN, which introduces students to rocketry. Based on the blueprint of the DLR_Summer_School Neustrelitz, which saw its third successful year in 2011, the first "DLR_Summer_School Raumfahrtantriebe" on space propulsion was held in Lampoldshausen – and received enthusiastic feedback from students.

Over 400 doctoral candidates have registered for the DLR_Graduate_Program, DLR's program for researchers aiming to complete a PhD, since its inception in July 2009. The program covers essential methodological, management and social skills that benefit graduates

Pilot project DLR Talent Management

"A pilot group is currently enrolled in the Talent Management program, which is part of the vice chairman of the Executive Board's portfolio and designed to promote and retain internal high-potential employees. Based on individual development plans, the seven participants are taught the main methodological, management and social competencies relevant to taking on key roles in the short to medium term."

Dr. Karsten Roth,
Head of Human Resources Development in DLR

writing their PhD theses, engaging in scientific activity within DLR, and in their future careers. The qualification program offered 83 cross-institute training courses and workshops in 2011. Two candidates have completed the program, and a further 40 are about to. This summer, previous national winners of the Young Researchers' Competition Jugend Forscht (top three and special prize winners) were for the first time able to apply to take part in the DLR_Graduate_Program. This cooperation will be continued in the coming years. Since the summer of 2012, the first external graduates from the University of Stuttgart have been participating in the program under the umbrella of the DLR@Uni initiative.

HR Development and Mobility	2009	2010	2011
Training days per employee	2.1	2.2	2.0
Mentoring pairs	8	11	10
Postings abroad (months)	487	531	518

German Staff at ESA

To support the career entry and career opportunities of young German scientists at the European Space Agency ESA, DLR has created the German Trainee Programme (GTP). This new personnel development tool is intended to contribute to increasing the proportion of German employees at ESA, where they are underrepresented, in the medium to long term. The GTP is sponsored by the BMWi and funded by the DLR Space Administration via the National Space Program.

German staff at ESA – a comparison

Member states	Number of employees	Employees [%]	Financial contribution [%]
Germany	381	19.1	24.7
France	431	21.6	20.2
Italy	384	19.2	13.6
UK	217	10.9	10.0
Spain	178	8.9	6.9

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

The GTP enables approximately 10 trainees each year to undergo on-the-job training for up to two years in fields and program areas that are important to Germany. With their team-mates and tutors from other ESA member states, they predominantly work in engineering and scientific areas.

As of the end of 2011, the employee situation at ESA was as follows: 1,995 employees are in ESA salary brackets corresponding to higher-level civil service. Compared to the previous year, the total number of employees has declined slightly. In detail, the proportion of employees from Germany, France and the UK has declined, while Italy and Spain saw a slight increase which however is not reflected in their contribution to funding. In this respect, Germany, Italy and the UK were able to contribute slightly less; only France's share has increased.

The proportion of German employees relative to Germany's share of funding has therefore not changed. It must even be pointed out that only approximately 6% of external applications come from Germany. Nonetheless Germany leads in new hires, which in addition to DLR's promotional activities is also due to strict adherence to the principle of preferentially recruiting candidates from underrepresented member states.

Future Development of DLR

DLR had already reformulated its long-term General Objectives in 2012. They include the current and future objective of being a globally recognised, well-known and leading center in its key program areas. DLR also acts as a point of contact for its societally relevant research in aeronautics, space exploration, energy, transport, the horizontal theme of security, for our research funding in aeronautics and space exploration and for other aspects of the Project Management Agency's work.

The framework for the DLR General Objectives and our daily activities in DLR is provided by the updated DLR Guidelines, which are divided into self-evident, general and specific guidelines. They reflect general societal values as well as ideals and standards that are especially relevant to DLR.

The introduction of comprehensive strategic projects pertaining to DLR as a whole and across program areas has helped DLR make good progress during the reporting year towards achieving the goals it has set itself in the General Objectives. Initial projects have been completed: the visibility of DLR at higher education institutions has been improved, preparations for the innovation campaign have been completed, and internal transparency has been achieved regarding DLR's policy-making role in European and international networks. Further projects are currently in the final phase, all others are on schedule.

A central aim of the General Objectives is to better position DLR as a source of technologies and ideas in order to strengthen the flow of knowledge from DLR to industry. To meet this goal, DLR plans to focus more strongly on innovations while also working to further increase its inventions; measures include optimising internal and external networks. These efforts are supported by the launch of the project "Vorbereitung Normungsoffensive" (Preparations for the standardisation campaign) which aims to transfer expertise generated at DLR to industry in a more targeted fashion through membership in standardisation boards.

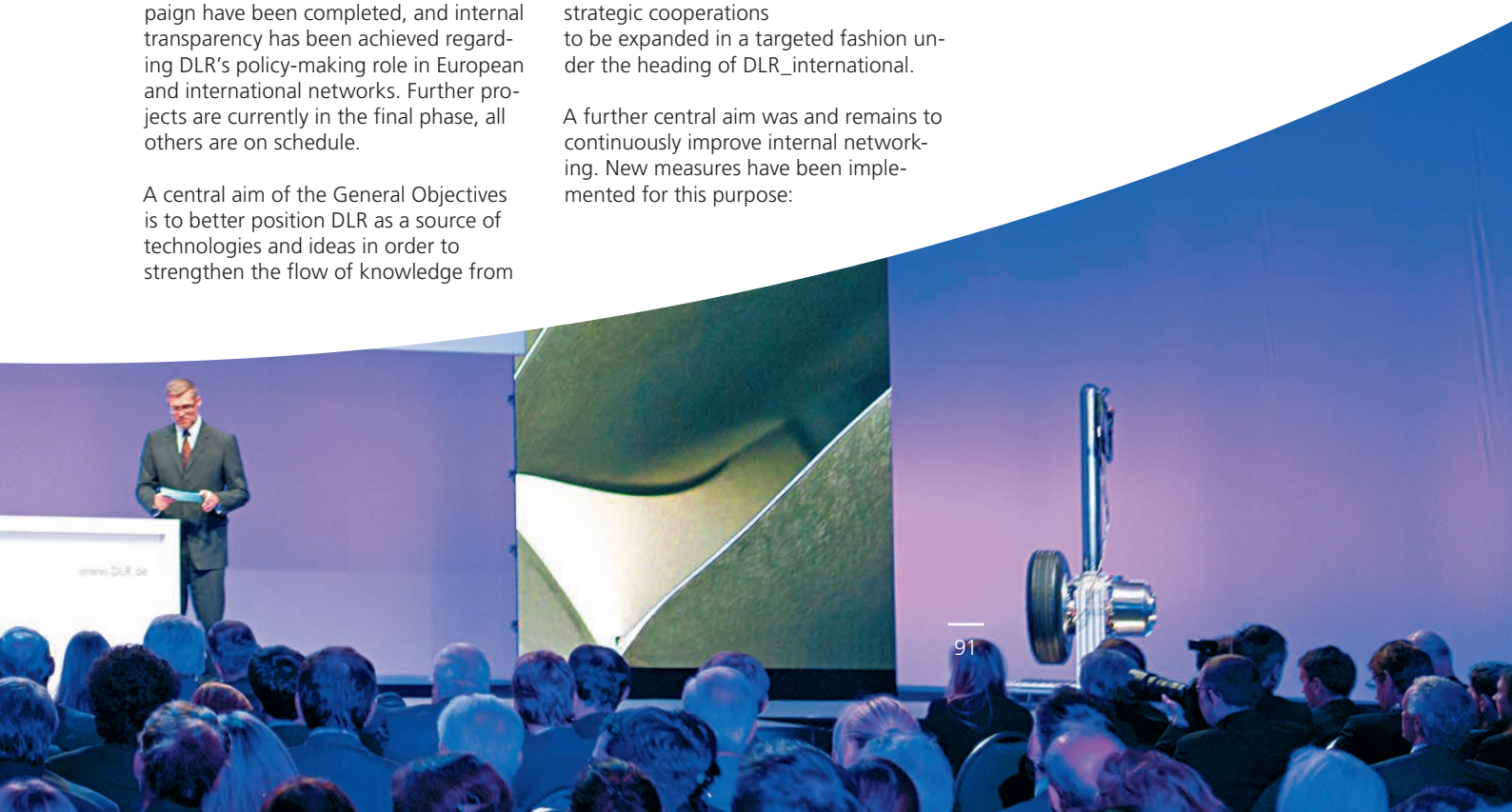
Furthermore, DLR intends to establish a network to enable both current and former employees to continue to contribute to DLR if they wish. This would increase the probability of former employees remaining in contact with DLR and passing on the knowledge they created at DLR to younger people. DLR also aims to become even more visible to pupils, students and postdocs. To this end, the recruitment process and public outreach activities are being revised in their entirety and the internal procedures for appointing DLR heads of department to universities are being improved.

At an international level, objectives have been formulated which will serve as guidelines for our activities. They require strategic cooperations to be expanded in a targeted fashion under the heading of DLR_international.

A further central aim was and remains to continuously improve internal networking. New measures have been implemented for this purpose:

- A central e-mail contact: ein@dlr.de
- Internal Communications office
- Continuation of the chairman of the Executive Board's Tour20xx@DLR at all sites

In addition to networking, DLR also aims to further promote the exchange of knowledge among its employees. This purpose is served by the comprehensive strategic project "Etablierung eines integrierten Wissensmanagementsystems im DLR" (Establishing an integrated knowledge management system in DLR, EIWis), which identifies ways of collaborating internally and accessing knowledge that exists within DLR. Analysis measures included for example a DLR internal online survey in which over 20% of employees took part. After evaluating the survey results and further input, the implementation phase will form the next step. A final point that was central to the internal optimisation process was improving transparency and streamlining internal information flow, for which the management processes "Managing and Controlling R&T Infrastructure" and "Developing Sites" were optimised.

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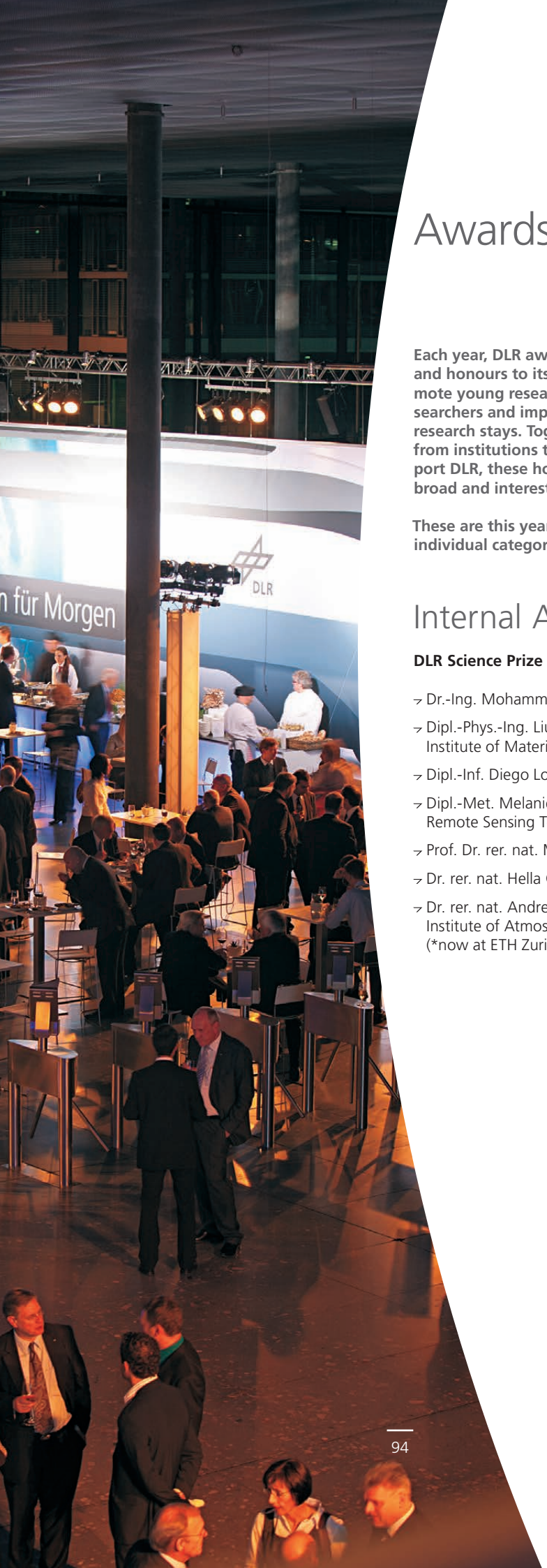


Awards and Commendations

Each year, DLR awards various prizes and honours to its employees to promote young researchers, senior researchers and important external research stays. Together with awards from institutions that wish to support DLR, these honours cover a broad and interesting range.

These are this year's winners in the individual categories.

Internal Awards

DLR Science Prize

- Dr.-Ing. Mohammad Rizviul Kabir
- Dipl.-Phys.-Ing. Liudmila Chernova
  Institute of Materials Research
- Dipl.-Inf. Diego Loyola
- Dipl.-Met. Melanie Coldewey-Egbers
  Remote Sensing Technology Institute
- Prof. Dr. rer. nat. Martin Dameris
- Dr. rer. nat. Hella Garny
- Dr. rer. nat. Andrea Stenke*
  Institute of Atmospheric Physics
  (*now at ETH Zurich)

DLR Senior Scientists

- Prof. Dr.-Ing. Jörg Melcher
  Institute of Composite Structures and Adaptive Systems
- Dr.-Techn. Konstantinos P. Papathanassiou
  Microwaves and Radar Institute
- Dr.-Ing. Berend G. van der Wall, M. Sc.
  Institute of Flight Systems
- Dipl.-Ing. Klaus Landzettel
  Institute of Robotics and Mechatronics

DLR Research Semester

- Dr. rer. nat. Volker Grewe
  Institute of Atmospheric Physics
- Dr.-Ing. Alexander Kling
  Institute of Composite Structures and Adaptive Systems
- Dr.-Ing. Patrick Le Clercq
  Institute of Combustion Technology
- Dr.-Ing. Robert Meyer
  Institute of Propulsion Technology
- Dr.-Ing. Josef Mittermaier
  Microwaves and Radar Institute
- Dr.-Ing. Christoph Möhlenbrink
  Institute of Flight Guidance
- Christina Rico Garcia, M. Sc.
  Institute of Communications and Navigation
- Dipl.-Ing. Marco Straubel
  Institute of Composite Structures and Adaptive Systems
- Prof. Dr.-Ing. Günter Strunz
  German Remote Sensing Data Center
- Dipl.-Inf. Jürgen Wohlfeil
  Institute of Robotics and Mechatronics

Prizes Awarded by the Society of Friends of DLR

Otto Lilienthal Research Semester

- Dr. Jörn Helbert, Institute of Planetary Research, DLR Berlin Adlershof,

  to expand knowledge in the field of planetary research

Fritz Rudorf Prize

- Andreas Schütz, Public Relations, Cologne / Berlin Adlershof
- Jürgen Mallwitz, Program Administration, Bonn-Oberkassel

Innovation Prize

for successful teamwork on the project "Pulsed High Performance LED Illuminator"

- Dr. Boleslaw Stasicki, Dr. Jürgen Kompenhans, Institute of Aerodynamics
- Dr. Christian Willert, Institute of Propulsion Technology in Cologne-Porz

Hugo Denkmeier Prize

- Dr. Ing. Karen Mulleners (youngest doctoral candidate) with the topic "On the Coherent Structures Behind the Phenomenon of Dynamic Stall"

Chairman's Prize

- Nicolas Perlot (youngest person to register a patent in his year), Institute of Communications and Navigation, Oberpfaffenhofen

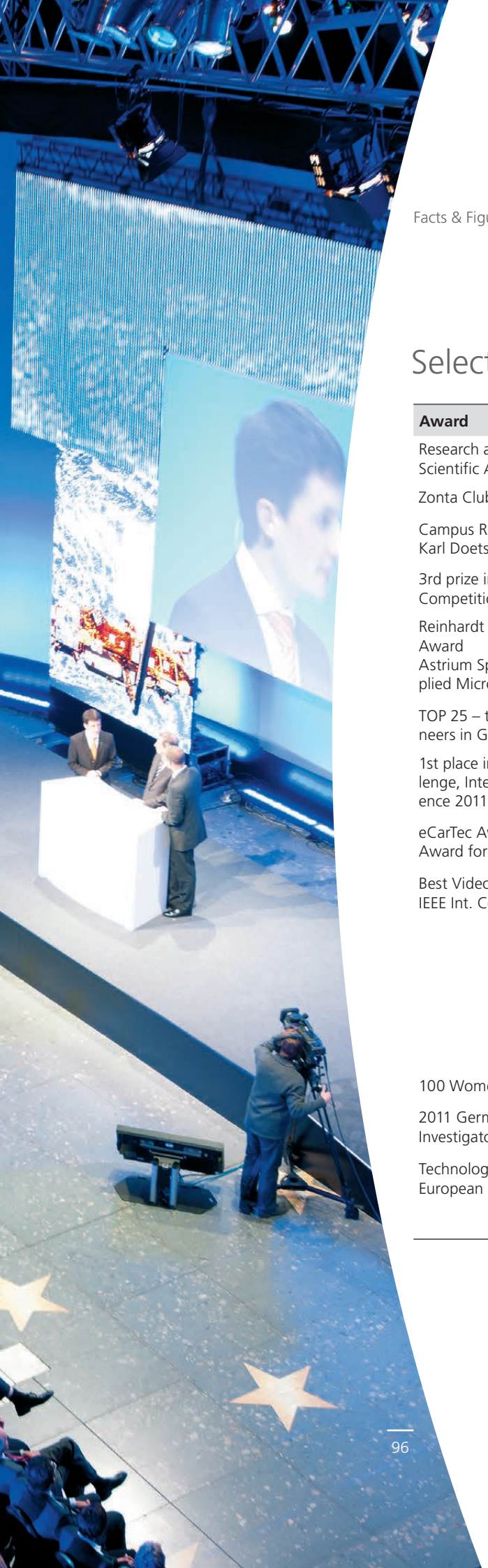
DLR_School_Lab Prize

- Käthe Kollwitz Oberschule, Berlin The Johanna Rettner group investigated the subject of "Noise sensors" with great dedication and success.

Franz Xaver Erlacher Prize

- Astor Torano Caicoya, Microwaves and Radar Institute, Oberpfaffenhofen

l.-r.: F. X. Erlacher, A. T. Caicoya, Dr. B. Stasicki, Dr J. Kompenhans, Dr. Ch. Willert, Dr. J. Helbert, K. Papathanassiou, Dr. K. Landzettel, H. Rauck, Prof. J. Melcher, K. Mulleners, N. Perlot, A. Schütz, J. Mallwitz



Selection of External Awards in 2011

Award	Prize winner
Research and Technology Organisation: Scientific Achievement Award 2011	Dr.-Ing. Robert Konrath
Zonta Club Amelia Earhart Club Award	Dipl.-Ing. Insa Pruter
Campus Research Airport Karl Doetsch Young Scientist Award	Dipl.-Ing. Christoph Deiler
3rd prize in the European Satellite Navigation Competition 2011	Dipl.-Ing. Michael Felux
Reinhardt Abraham Lufthansa Foundation Award	Dipl.-Ing. Ralf Seemann
Astrium Spacelab Prize, 1st prize in the Applied Microgravity Research category	Sascha Kopp
TOP 25 – the most influential female engineers in Germany	Dipl.-Ing. Anja Frank
1st place in the Outdoor Multiple MAV Challenge, International Micro Air Vehicle Conference 2011	Dipl.-Ing. Korbinian Schmid and Dipl.-Ing. Johann Dauer
eCarTec Award 2011, 3rd prize, Bavarian State Award for Electric Mobility	Prof. Gerd Hirzinger
Best Video Award finalist, ICRA 2011, IEEE Int. Conf. on Robotics and Automation	Dipl.-Phys. Berthold Bäuml, M. Sc. Florian Schmidt, Dipl.-Ing. Thomas Wimböck, Dipl.-Ing. Oliver Birbach, Dipl.-Ing. Alexander Dietrich, Dipl.-Ing. Matthias Fuchs, Dipl.-Ing. Werner Friedl, Prof. Udo Frese, Dipl.-Inf. Christoph Hermann Borst, Dipl.-Ing. Markus Grebenstein, Dipl.-Ing. Oliver Eiberger, Prof. Gerd Hirzinger
100 Women of Tomorrow	Dr.-Ing. Martina Neises
2011 German Thermoelectric Society Young Investigator Award	Dr. rer. nat. Johannes de Boor
Technology Transfer Award 2011, euRobotics, European Robotics Research Network	Dr. sc. techn. Ralf Koeppe and Dr.-Ing. Alin Albu-Schäffer on behalf of the KUKA and DLR team

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%

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

German-Dutch Wind Tunnels (DNW) Foundation, Noordoostpolder/Netherlands
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DLR Affiliates and Joint Ventures

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As of June 30, 2012, DLR had 46 sponsoring members in addition to honorary members, scientific members and ex officio members.

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- Prof. Dr. Manfred Aigner, Stuttgart
- Dipl.-Kfm. Uwe Baust, Düsseldorf
- Jürgen Breitkopf, Munich
- Prof. Dr. Hans-Jörg Bullinger, Munich
- Dr. Reinhold Busen, Oberpfaffenhofen
- Bernhard Conrad, Hamburg
- Prof. Dr. Hansjörg Dittus, Cologne
- Marco R. Fuchs, Bremen
- Prof. Dr. Ursula Gather, Dortmund
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- Prof. Dr. Peter Gruss, Munich
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- Dr. Reinhold Lutz, North America
- Dr. Rainer Martens, Munich
- Peter-Michael Nast, Stuttgart
- Prof. Dr. Christiane Schmullius, Jena
- Prof. Dr. Stephan Staudacher, Stuttgart
- 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 donate 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
- 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 and Research for the State of North Rhine-Westphalia, Düsseldorf

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

- Aerodata AG, Braunschweig
- AIR LIQUIDE Deutschland GmbH, Düsseldorf
- ALSTOM Power Systems 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
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- Tesat-Spacecom GmbH & Co. KG, Backnang
- Volkswagen AG, Wolfsburg
- ZF Luftfahrttechnik GmbH, Calden

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- The Honorable Daniel Saul Goldin, Washington
- Prof. Dr. rer. nat. Walter Kröll, Marburg
- Prof. Dr. rer. nat. Reimar Lüst, Hamburg
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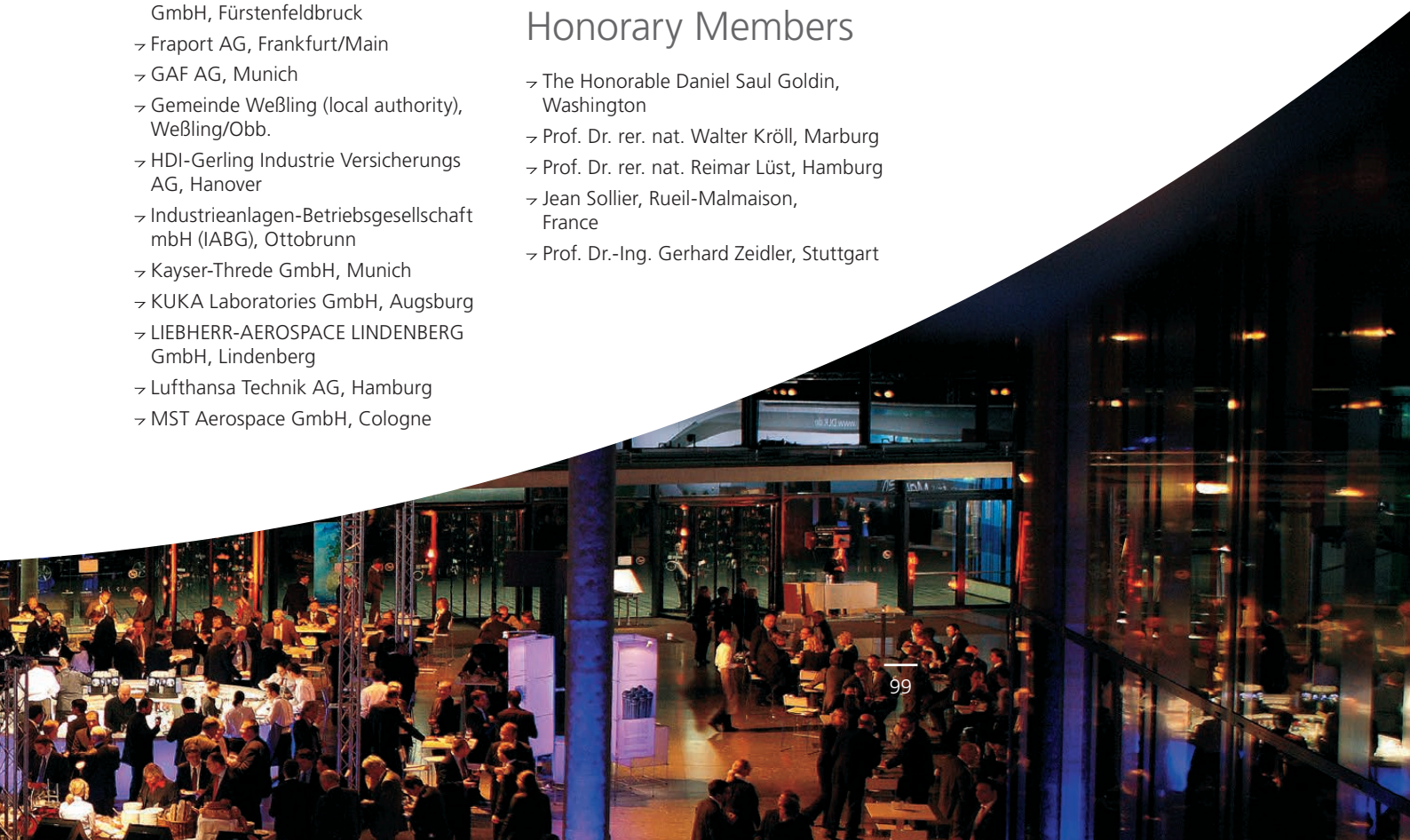
- Prof. Dr. Philipp Hartl, Munich
- Prof. Dr. Hans Hornung, Pasadena, California, USA
- Prof. Dr. Joachim E. Trümper, Garching

Members of the Executive Board

As of June 30, 2012

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



Senate

As of June 30, 2012, the following persons were members of the Senate:

From the scientific sector

- Prof. Dr. Manfred Aigner
- Prof. Dr. Hans-Jörg Bullinger ex officio
- Dr. Reinhold Busen
- Prof. Dr. Ursula Gather (Vice Chairwoman)
- Prof. Dr. Michael Grewing
- Prof. Dr. Peter Gruss ex officio
- Prof. Dr. Matthias Kleiner ex officio
- Prof. Dr. Uwe Klingauf
- Peter-Michael Nast
- Prof. Dr. Christiane Schmullius
- Prof. Dr. Stephan Staudacher

From the economics and industrial sector

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

From the state sector

- Under Secretary Erwin Bernhard
- Under Secretary Dr. Thomas Gerhardt
- VLR I Michael Häusler
- State Secretary Anne Ruth Herkes (Chairwoman)
- State Secretary Dr. Josef Lange
- Under Secretary Günther Leßnerkraus
- Under Secretary Dr. Ronald Mertz
- Under Secretary Gerold Reichle
- Ulrich Schüller
- Counsellor of State Dr. Joachim Schuster
- Under Secretary Dr. Beate Wieland

(without voting rights in 2012)

- Counsellor of State Nicolas Zimmer

Senate Committee

As of June 30, 2012, 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.-Ing. Martin Bruse
- Prof. Dr. Klaus Drechsler
- Prof. Dr. Reinhard Niehuis
- Prof. Dr. Christiane Schmullius (Vice Chairwoman)
- Prof. Dr. Heinz Voggenreiter
- Prof. Dr. Gebhard Wulfhorst

From the economics and industrial sector

- Christa Fuchs
- Prof. Dr. Jürgen Leohold
- Dipl.-Ing. Georg Rayczyk (Chairman)
- Dr. Artur Redeker
- Dr. Helmut Richter
- Dipl.-Phys. Berry Smutny

From the state sector (with voting rights in 2012)

- Dr. Walter Dörhage
- Deputy Assistant Under Secretary Ronald Else
- Under Secretary Helge Engelhard
- VLR I Michael Häusler
- Senate Counsellor Bernd Lietzau
- Deputy Assistant Under Secretary Norbert Michael Weber

(without voting rights in 2012)

- Deputy Assistant Under Secretary Dr. Axel Kollatschny
- Chief Deputy Assistant Under Secretary Dr. Peter Mendler
- Under Secretary Dr. Dietrich Nelle

- Dipl.-Ing. Josef Schiller
- 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
- MinR 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

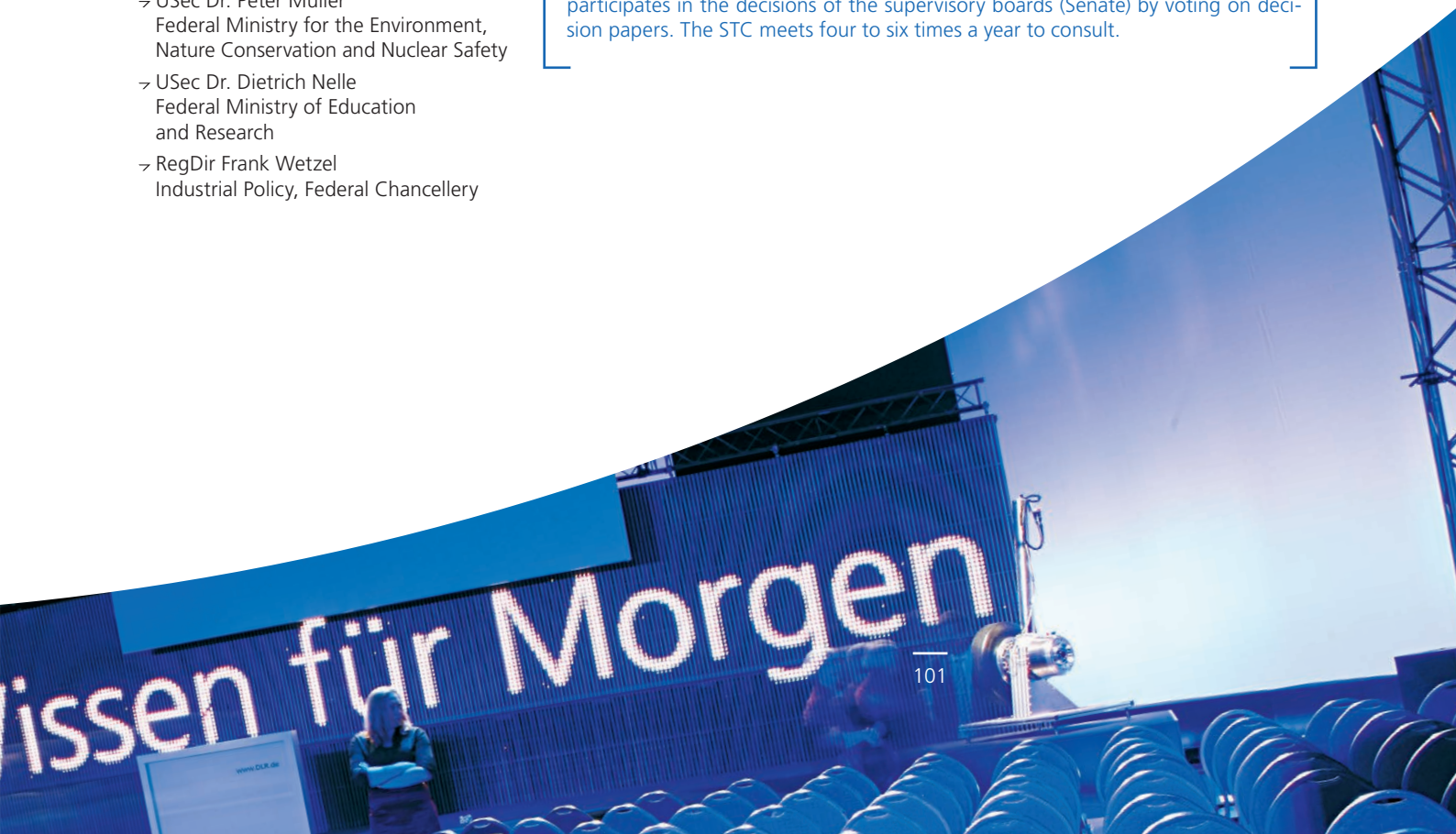
Scientific and Technical Council

Members of the STC as of 30 June 2012

- Prof. Dr. Stefan Schlechtriem
  Institute of Space Propulsion
- Prof. Dr. Felix Huber
  Institute of Space Operations and Astronaut Training
- Prof. Dr. Dirk Kügler
  Institute of Flight Guidance
- Prof. Dr. Andreas Dillmann
  Institute of Aerodynamics and Flow Technology
- Prof. Dr. Karsten Lemmer
  Institute of Transportation Systems
- Prof. Dr. Martin Wiedemann
  Institute of Composite Structures and Adaptive Systems
- Dr. Marina Braun-Unkhoff
  Institute of Combustion Technology
- Dr. Joachim Götz
  Institute of Flight Systems
- Dipl.-Ing. Firas Lethaus
  Institute of Transportation Systems
- Dipl.-Ing. Sven Kaltenhäuser
  Institute of Flight Guidance
- Dr. Thomas Holzer-Popp
  German Remote Sensing Data Center
- Dr. Stephan Ulamec
  Space Operations and Astronaut Training

Remit of the Scientific Technical Council

According to the DLR Charter, the STC is an institution of the organisation. It advises the Executive Board on all matters of scientific and technical importance and participates in the decisions of the supervisory boards (Senate) by voting on decision papers. The STC meets four to six times a year to consult.



Overview of Operating Figures

Third-party funding	2009	2010	2011
Total revenue from third-party funding	381m euros	401m euros	436m euros
Proportion of overall revenue from third-party sources	49%	54%	55%
Earnings trend in revenue from R&T activities in Germany	12%	-6%	-5%
Percentage of earnings from foreign clients (profit volume)	25%	24%	21%
Revenue from EU funding	21.7m euros	22.6m euros	26.1m euros
Success rate of EU applications (accepted/submitted)	37%	36%	31%
Coordinator rate on approved EU projects	22%	22%	18%

Research-related results	2009	2010	2011
Publications in peer-reviewed journals	577	654	721
Peer-reviewed publications in proceedings, books, etc.	460	563	491
Talks given at scientific conferences, workshops, lectures*	0.55	0.51	0.58
Appointments to universities	13	14	17
Lectureships	244	296	295
Diplom theses	396	487	542
PhD theses	105	85	105
Habilitations	4	1	6

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

Technology Marketing	2009	2010	2011
Investments in technology transfer projects	2.8m euros	4.0m euros	4.5m euros
New in-house technology transfer projects	11	14	17
Revenues from licenses	3.9m euros	4.2m euros	4.5m euros
Spin-off companies	2	2	2

Management instruments	2009	2010	2011
Total project work	73.1%	73.5%	74.8%

Quality management	2009	2010	2011
Existing certifications	28	30	30
Number of DLR auditors	10	11	11
Audits performed	38%	49%	45%

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

International cooperation	2009	2010	2011
International visiting scientists*	3.3%	3.0%	2.4%

* (stays > 1 month) referring to scientific staff in institutes

Staff	2009	2010	2011
Employees	6,490	6,835	7,046
Total scientific staff	3,677	3,913	4,080
scientific staff employed by institutes and facilities	3,076	3,140	3,569
Permanent/fixed-term contracts	3,228/3,262	3,321/3,514	3,534/3,512
Proportion of women			
- in total	30%	30%	31%
- in management positions	14%	14%	14%
- scientific staff	17%	13%	18%

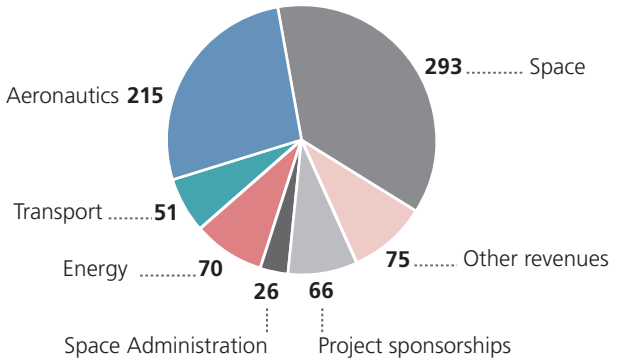
New talent	2009	2010	2011
Junior researchers	63	55	47
Doctoral candidates (internal/external)	734	763	879
Trainees	252	247	244

HR development and mobility	2009	2010	2011
Training days per employee	2.1	2.2	2.0
Mentoring pairs	8	11	10
Postings abroad (months)	487	531	518

Use of Funds

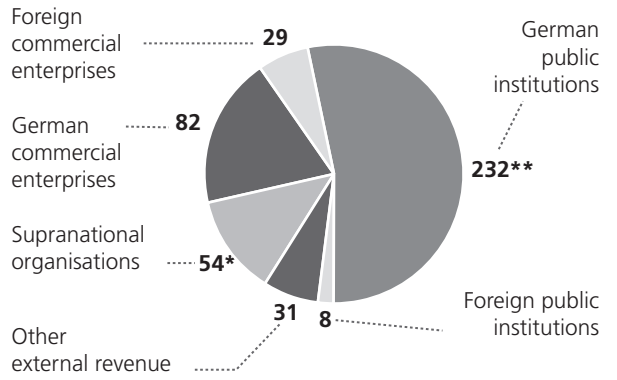
Overall revenue 2011

Total 796 million euros — All figures in million euros



Third-party funding related to origin 2011

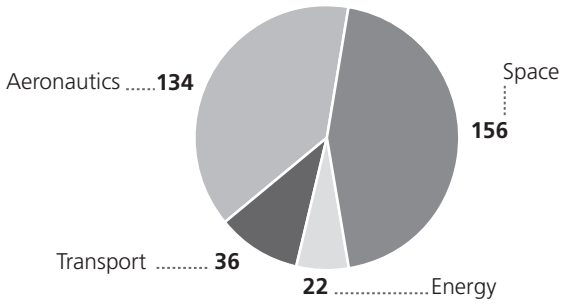
Total 436 million euros — All data in million euros



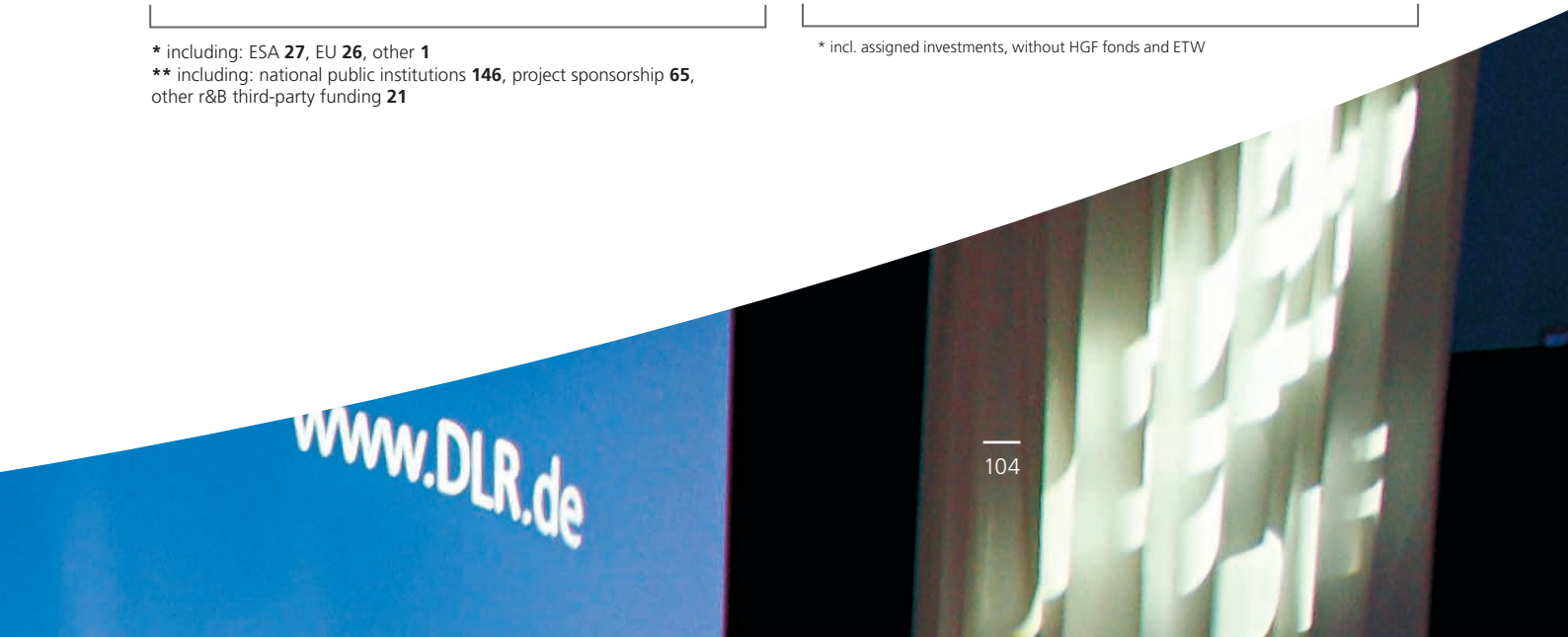
***** including: ESA **27**, EU **26**, other **1**
****** including: national public institutions **146**, project sponsorship **65**, other r&B third-party funding **21**

Institutional Funding 2011*

Total 348 million euros — All data in million euros



* incl. assigned investments, without HGF fonds and ETW



List of Abbreviations

ACARE Advisory Council for Aeronautical Research in Europe
AEB Agência Espacial Brasileira (Brazilian Space Agency)
ATM Air Traffic Management
AutoOpti Automatic Optimiser
AZVT Expansion of the Centre for Combustion Engineering
BMBF Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research)
BMVBS Bundesministerium für Verkehr, Bau und Stadtentwicklung (Federal Ministry of Transport, Building and Urban Development)
BMVg Bundesministerium für Verteidigung (Federal Ministry of Defence)
BMWi Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology)
CATS Climate compatible Air Transport System
CCRS Canada Centre for Remote Sensing
CCSDS Consultative Committee for Space Data Systems
CEN European Committee for Standardization
CENELEC European Committee for Electrotechnical Standardization
CFD Computational Fluid Dynamics
CNES Centre National d´Etudes Spatiales (French National Space Agency)
CoE Center of Excellence
COPUOS United Nations Committee on the Peaceful Uses of Outer Space
COST European Cooperation in Science and Technology
CSA Canadian Space Agency
CSP Concentrated Solar Power
DFG Deutsche Forschungsgemeinschaft (German Research Foundation)
DGUV Deutsche Gesetzliche Unfallversicherung (German Social Accident Insurance)
DIN Deutsches Institut für Normung (German Institute for Standardization)
DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. (German Aerospace Center)
DNW Deutsch-Niederländische Windkanäle (German-Dutch Wind Tunnels)
EADS European Aerospace Defence Agency
ECTRI European Conference of Transport Research Institutes
EEE Electronic, electrical and electromagnetic components
EFQM European Foundation for Quality Management
EREA Association of European Research Establishments in Aeronautics
ESA European Space Agency
ESCC European Space Components Coordination
ETW European Transonic Windtunnel GmbH
EU European Union
EUREKA European Research Coordination Agency
FAA Federal Aviation Administration
FCH JTI Fuel Cells and Hydrogen Joint Technology Initiative
FHS Flying Helicopter Simulator
GATE Galileo test and development environment
GMES Global Monitoring for Environment and Security
GPS Global Positioning System
GTP German Trainee Programme
HGF Helmholtz Association of German Research Centres
IAQG International Aerospace Quality Group
IBMP Institute for Biomedical Problems
ILA Internationale Luft- und Raumfahrtausstellung (Berlin Air Show)
INS Innovation with Norms and Standards
ISO International Organization for Standardization
JAXA Japan Aerospace Exploration Agency
KazCosmos Kasakh Space Agency
SMB Small and medium-sized businesses
LIDAR Light Detection and Ranging
LuFO Luftfahrtforschungsprogramm (German Aeronautics Research Program)
MoU Memorandum of Understanding
N.ERGHY New European Research Grouping on Fuel Cells and Hydrogen
NASA National Aeronautics and Space Administration
NGT Next Generation Train
NLR Nationaal Lucht- en Ruimtevaartlaboratorium (National Aerospace Laboratory of the Netherlands)
NREL National Renewable Energy Laboratory
ONERA Office National d'Études et de Recherches Aérospatiales (French Aerospace Lab)
PMP Project Management Professional
PT-DLR Project Management Agency in DLR
PT-LF Project Management Agency for Aeronautics Research
QM Quality management
Roskosmos Space agency of the Russian Federation
RWTH Rheinisch-Westfälische Technische Hochschule
SAR Synthetic-Aperture Radar
SHEFEX Sharp Edge Flight Experiment
SOFIA Stratospheric Observatory for Infrared Astronomy
Start SF Start solar research
TAMS Total Airport Management Suite
TanDEM-X TerraSAR-X add-on for Digital Elevation Measurement
TEXUS Technologische Experimente unter Schwerelosigkeit (Technological experiments under weightless conditions)
TNS Transfer von Forschungs- und Entwicklungsergebnissen durch Normung und Standardisierung (Transfer of Research and Development Results by Standardization)
TWG Transonic wind tunnel Göttingen
UAV Unmanned Aerial Vehicles
UNESCO United Nations Educational, Scientific and Cultural Organization
UN-SPIDER United Nations Platform for Space-based Information for Disaster Management and Emergency Response
ZKI Zentrum für satellitengestützte Kriseninformation (Center for Satellite Based Crisis Information)

DLR at a Glance

DLR is Germany's national research centre for aeronautics and space. Its extensive research and development work in Aeronautics, Space, Energy, Transport and Security is integrated into national and international cooperative ventures. As Germany's space agency, DLR has been given responsibility for the forward planning and the implementation of the German space programme by the German federal government as well as for the international representation of German interests. Furthermore, Germany's largest project management agency is also part of DLR.

Approximately 7300 people are employed 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 operates offices in Brussels, Paris, 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 the energy supply and mobility of the future, as well as for communication and security. DLR's research portfolio ranges from basic research to the development of tomorrow's products. In that way DLR contributes the scientific and technical know-how that it has gained to enhancing Germany's industrial and technological reputation. DLR operates large-scale research facilities for DLR's own projects and as a service provider for its clients and partners. It also promotes the next generation of scientists, provides competent advisory services to government, and is a driving force in the local regions of its field centres.

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

Strategy and International Relations

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www.DLR.de/en/