Annual Report

Research and Economic Development

2008/2009

DLR

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Research and Economic Development 2008/2009

German Aerospace Center (DLR)

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Preface

The future feeds on curiosity, thirst for knowledge drives us forward. This maxim helps us to focus on the goals that we wish to achieve in the main interest areas at the German Aerospace Center (DLR), namely aeronautics, space, transport, energy and security, as well as on the goals for our management activities in our capacity as the national space agency for Germany and the country's largest project management agency.

With this in mind, during the past year we initiated a strategy process at DLR to define and describe in concrete terms the direction of the organisation over the medium and long term. Building on the outstanding status of DLR, this process specifies the goals to be reached and the paths that will be followed to them as we continue to shape our future. I personally believe it is especially important that all employees have the opportunity to participate actively in this alignment process, so that each may contribute their own unique perspective to the scientific excellence and appeal of the DLR. In parallel to this, measures have already been put in place to support the internal development and management of the Center, including among others a harmonised programmatic planning system covering all main interest areas and an intensification of innovative thinking through the initiation of "cross transfer" activities. This work has put us well on the way to defining the future direction of our research centre.

Taking an energetic approach to the future of research and society requires appropriate financing. Thanks to the special financing provided by the German Federal Ministry of Economics and Technology (BMWi) and the federal states in which the DLR facilities are located, combined with our success in attracting funding from economic stimulus programmes, we have been and remain able to focus on projects that go beyond our regular, ongoing research activities.

At this point I would like to draw your attention to a few highlights from our research programme over the past year, to give a quick taste of what you can expect from the science-related section of the report. The CoRoT space telescope has discovered a rocky planet beyond our solar system. The ESA research satellites Herschel and Planck have started their missions to expand our knowledge of the origins of the universe and the German Earth observation satellite, Terra-SAR-X, is exceeding all expectations. We continue to explore the secrets of life with a series of astrobiological and radiological experiments on the International Space Station, ISS. The 105-day space flight simulation experiment, Mars500, also proved very successful and included one German participant, Oliver Knickel.

The systematic development and testing of simulation techniques in the fields of fluid mechanics, aeroacoustics, structural mechanics and flight manoeuvres also delivered a veritable raft of successes. Using these techniques, DLR is developing a diverse range of applications, including reduction of noise emissions, handling of difficult flight situations – such as aircraft exposed to squall – and improvement of passenger comfort in the cabin.

In the future we will travel at 400 kilometres per hour in the quiet, double-decker Next Generation train, while at the same time using 50 percent less energy. Through efficient use of energy and a targeted approach to increasing the utilisation of renewable energy, it will be possible to achieve drastic reductions in global CO_2 emissions. One impressive demonstration of the technical possibilities, made possible thanks to a collaboration encompassing numerous sectors of industry, was the maiden flight of Antares DLR-H2, a fuel cell-powered motor glider capable of take off.

Although the German Aerospace Day 2009 took place outside the reporting period, I would still like to mention here that this event at DLR in Cologne on September 20, 2009 was attended by over 100,000 visitors.

In the second section of our annual report, Economic Development, we demonstrate how our work to develop a comprehensive infrastructure also extends to our third-party business activities, the personnel structure, the development of young talent, the quality assurance system, and the management team.

DLR now employs over 6,000 dedicated staff, and it is thanks to their contribution that we can look back on the 2008/2009 reporting year as a successful one, and can approach present and future challenges with energy and determination – driven by curiosity and thirst for knowledge. I hope that we have now aroused your curiosity so that you will want to learn more about the highlights of our fascinating research programmes and the other activities of the organisation – and that you find our annual report to be an exciting read.

Cologne, Germany, December 2009

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

RESEARCH RESULTS

Aeronautics

Taking as a basis the evaluation of the Aerospace programme carried out by the Hermann von Helmholtz Association of National Research Centres (HGF) in 2008, a new medium-term plan has been defined for the five-year period from 2009 to 2013, around which civil research activities will be orientated. Within this context, the way the Aerospace business division is structured has been modified slightly compared to previous years, so that it now includes the four research fields/HGF programme topics of fixed-wing aircraft, rotary-wing aircraft, propulsion systems, air traffic management and flight operations.

A range of "virtually integrated products" have also been defined in relation to the new HGF medium-term plan, which are, in particular, intended to provide an orientation framework for projects with an interdisciplinary basis. Currently 10 four of these VIPs are planned, namely "Quiet Short Take-Off and Landing", "Advanced Long Range Transport System", "Low-noise, All-weather Helicopter Operation" and "Business Travel". In essence, the aims of the national and European strategy papers, with their vision for 2020, remain largely well-aligned to those of the Aerospace programme.

The Aerospace division of DLR once again made successful contributions to national and European research programmes during this reporting period. The division concentrated particularly on the national Aeronautics Research Programme IV and the 7th European Union (EU) Framework Programme, including the Joint Technology Initiative "Clean Sky", as well as the SESAR programme (Single European Sky ATM Research).

In terms of its internal research work, DLR remains committed to maintaining and expanding the unique breadth of work in which it is involved. This diversity is especially important as it allows DLR to address all major elements of the air transport system and therefore to also pursue interdisciplinary research projects that address the system as a whole.

MiTraPor

Wind tunnel testing and simulation of air dropping loads by parachute

Set against the background of the procurement of the A400M, the evaluation of military transport aircraft is a very topical issue. The "MiTraPor – Military Transport Aircraft" project was instigated under the leadership of the Institute of Flight Systems for just this reason, with the goal of developing techniques for the evaluation of new technologies and capabilities for military transport aircraft; the project was completed in June 2009 with very successful results.

One major aspect of this project, alongside the development of techniques for the evaluation of military aircraft, was the realistic simulation of parachute drops from an open tail ramp. The aim here was to provide a multidisciplinary simulation environment capable of considering the dynamic interaction between an aircraft and its payload by simulating the behaviour of simple loads. The technique was successfully validated by means of experiments in the low-speed wind tunnel (NWB) at German-Dutch Wind Tunnels (DNW) in Braunschweig.

Results from aerodynamic simulations were further used to generate a flight dynamic model of aircraft and payload. Various air drop scenarios can be simulated in real time using this model, thereby allowing pilots to experience and evaluate how an aircraft behaves during "flight" as various types of load are dropped.

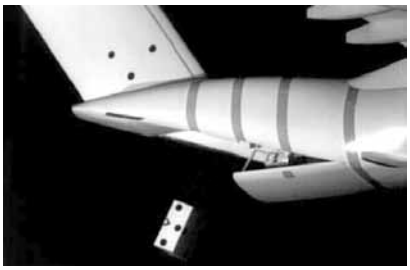
AVANTGARDE

High-accuracy numerical techniques for fluid mechanics, aeroacoustics and structural mechanics

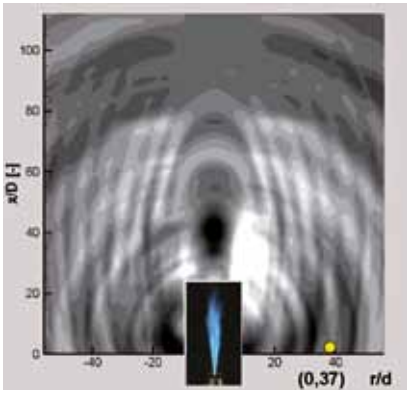
Noise emissions are produced by various types of technical equipment as a result of turbulent flow effects. The reduction of this noise is a major issue for the development of new applications involving turbulent flows. Examples of this type of application include high-lift systems and flows inside turbines. By using "rapid" simulation techniques for turbulence caused noise, it is possible to reduce the design time needed to develop such applications, because a significantly higher number of variants can be investigated during development than is possible with the purely experimental methods currently used. This means that potential noise reductions can be better utilised, ultimately leading to a quieter final product.

The DLR project "AVANTGARDE – Advanced Numerical Tools Graduation by Application in Aeronautical Research and Development" is developing high-accuracy numerical techniques for applications in the field of fluid mechanics, aeroacoustics and structural mechanics that will be sufficiently fast to allow their deployment during the early stages of the design process.

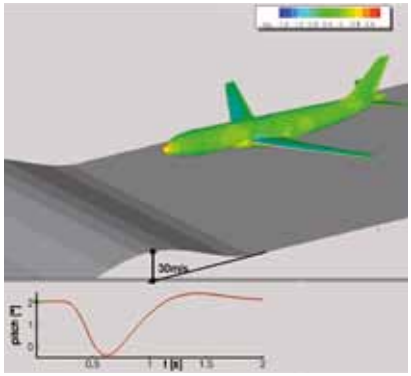
A good example of this work is the technique developed by two DLR institutes for the rapid simulation of combustion noise, which has been validated against the DLR-A flame, an internationally recognised reference flame. The simulation and experimental results are very well aligned, with the simulation only taking a few hours to run. The technique is therefore suitable for use during the development process. It is hoped that in future it will be possible to reduce the noise emissions of gas turbine combustion chambers through application of this technique.



Wind tunnel testing of air drop scenarios



Sound field emitted by DLR-A flame



Interaction of an aircraft with a generic squall (30 m/s amplitude, 60 m wavelength) and plot over time of the pitch angle of the aircraft

IMPULSE

Simulation of commercial aircraft encountering a squall

A major aim of the DLR project "IMPULSE – Innovative Methods for Prediction of Unsteady Aerodynamic Data for Loads, Stability and Control for Complete Flight Envelope" is the development of a software system that allows the simulation of aircraft manoeuvres/flight situations for a free-flying aircraft, even under conditions of extreme load in partially separated flows. To achieve this, important aspects from a number of disciplines must be taken into account, including aerodynamics, structural engineering and flight mechanics.

An example of the type of flight situation encountered is the interaction of a commercial aircraft with atmospheric disturbances such as squalls and wake turbulence. In order to simulate such disturbances, a concept for the software system was developed and implemented as part of project IMPULSE. The concept has already been successfully demonstrated for a commercial aircraft encountering a squall during a passenger flight. This required a coupling of the disciplines of aerodynamics and flight mechanics.

The squall was specified in accordance with the relevant FAR (Federal Aviation Regulations) guideline, FAR Part 25.341. The amplitude of the vertical velocity was set at 30 metres per second with a wavelength of 60 metres. The basis for the simulation was an undisturbed passenger flight (trimmed state). Executing such a temporally precise simulation in an efficient manner has only become possible thanks to supercomputers like the C2A2S2E cluster, which uses 512 processor cores.

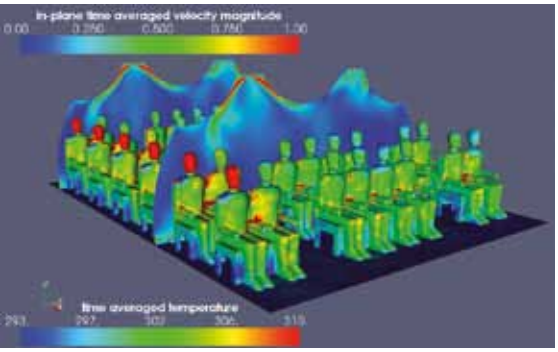
CoSiCab+

Simulation of passenger comfort in the aircraft cabin

The DLR "CoSiCab+ – Comfortable and Silent Cabin +" project is pursuing the aim of creating numerical tools for the evaluation and improvement of passenger comfort in aircraft cabins, in order to reduce the time taken for the design process through avoidance of large amounts of experimental development work. In parallel to this, the experimental simulation capabilities using the modified Do728 cabin have been significantly extended. New measuring techniques have also been developed for validation of the numerical tools, allowing highly accurate data sets to be obtained for the purpose of characterising the cabin atmosphere and cabin air flow.

Numerical simulation of air flow in the cabin is an invaluable tool when designing its layout. The THETA (Turbulent Heat Release Extension of the TAU Code) code was developed by DLR for this purpose. This code fulfils the stringent demands with regard to flexibility, accuracy and efficiency that are required for it to be integrated into the design process.

For the CoSiCab+ project, THETA has been successfully extended with a high-accuracy, high-efficiency method for simulation of heat transfer through radiation from surface to surface. Thanks to the efficient implementation, simulation of heat transfer can be carried out for every time step and for a very high number of discrete directions in space. This means that the precision of the thermal flows calculated is enormously increased. In turn, this allows for very accurate solutions given the highly transient nature of flows in the cabin. It has even been possible to implement the option to simulate sunlight through a cabin window and to increase the long-term stability of the code specifically for realistic grids. In addition to this, the turbulence models were greatly improved through implementation of wall functions.



Flow in an upper deck cabin (measurement in two planes) and passenger surface temperatures

As a result of these combined measures, it is now possible to run efficient, stable simulations of flow solutions including thermal radiation and sunlight penetration in aircraft cabins on large simulation grids on massively parallel architectures. In order to validate these types of volumetric flows, the CoSicCab+ project developed the tomographic particle image velocimetry (PIV) measurement technique and applied this to the measurement of very large volumes.

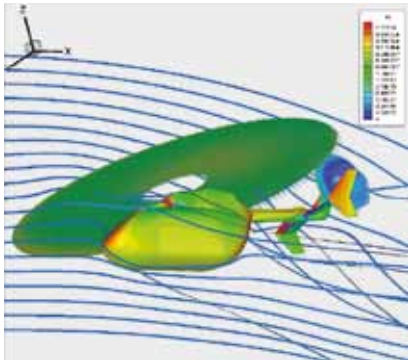
FRIENDCOPTER

Low-noise landing procedures

One of the major factors limiting the use of rotary-wing aircraft in civil and, to a certain extent, in military applications is the noise produced by rotary wings. The external noise produced by aircraft on approach to helipads at hospitals in densely populated districts is perceived with particular sensitivity and may lead to landing restrictions or even an outright ban.

It was with this situation in mind that the EU specified the "FRIENDCOPTER – The Passenger and Environmentally Friendly Helicopter" project. Alongside a wide range of other targets, the FRIENDCOPTER is intended to demonstrate that significant noise reductions are possible with standard production helicopters if landing procedures are optimised for noise. Building on data from flight tests, DLR has developed a semi-empirical prediction model that allows classical optimisers to be applied to the definition of noise-optimised approach procedures. Results obtained in this manner were flight tested and shown to achieve noise reduction at ground level of up to 10 dB. Based on these results it can be shown that there is a relationship between airspeed, torque at the rotor mast, and the noise on ground. This permits low-noise approaches to be performed by utilising the torque indicator present in every helicopter. This method has been patented and will make a noticeable contribution in future to mitigation of the noise nuisance experienced by populations around hospitals.

EC135-FHS performing a low-noise approach



Quasi-stationary flow simulation using TAU for the EC145 whole-helicopter configuration

SHANEL

Computational Fluid Dynamics (CFD) for rotary-wing aircraft using DLR's unstructured TAU method

The FLOWer structured CFD method was validated for rotor applications as part of the German-French CHANCE (Complete Helicopter AdvaNced Computational Environment) project, but when applied to helicopter fuselages and rotor heads it became apparent that creating structured grids for these complex geometries was too resource intensive for it to be a practical option as part of future projects. The use of unstructured grids may offer a way around this problem.

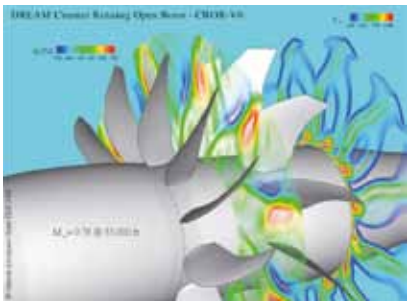
For this reason, work was started within the scope of the "SHANEL – Simulation of Helicopter Aerodynamics, Noise and Elasticity" project to qualify the unstructured DLR CFD method, TAU (flow solution software), for rotary wing applications. This initially involved re-simulating the aerodynamics of the fuselages in isolation, before extending TAU using the actuator disc method to produce quasi-stationary flow simulations for whole-helicopter configurations. Moreover, it was also possible to show that TAU is able to simulate unsteady flows about a rotor during forward flight with the same level of precision as FLOWer. Work continues with the aim of extending the TAU code to enable it to combine the efficiency of a structured technique with the flexibility of an unstructured solver for unsteady flow applications.

DREAM

Open rotor optimisation with AutoOpti

In comparison to all other future propulsion technologies, open rotors promise the greatest reductions in specific fuel consumption. Apart from optimisation of aerodynamics, research in this field is focussing on reducing the noise emissions produced by open rotors, as these can be significantly higher than those from enclosed engines at take off and for the same airspeed in flight. This is the context of the ongoing work on counter-rotating open rotors at the Institute of Propulsion Technology.

Under the direction of Snecma, these future propulsion concepts are being investigated using both numerical and experimental methods within the framework of the European project "DREAM – vali-Dation of Radical Engine Architecture systeMs". The numerical work is making use of the "AutoOpti" automatic optimiser developed by the Fan and Compressor department. Through use of an evolution strategy, the aim here is to make further significant improvements to the aerodynamics of the reference configuration by means of targeted, yet random, variation of the three-dimensional blade geometry.



Results of unsteady flow TRACE simulations of an open rotor using Snecma reference geometry

Various criteria for simplifying the estimation of noise emissions were also integrated into the automatic optimisation process.

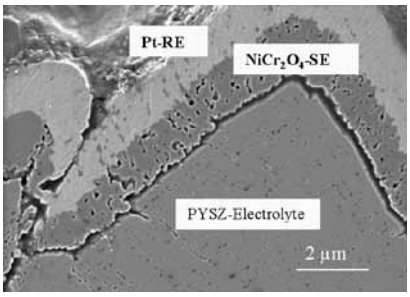
Analysis of the aerodynamics is performed using the 3D Navier-Stokes based TRACE (Turbomachinery Research Aerodynamics Computational Environment) method developed at the Institute of Propulsion Technology. The initial optimisation using a large number of geometry variants was completed in February 2009 and shows some significant potential for improvement over the initial geometry provided by Snecma.

Design Integration of Planar Sensors

Detection of pollutants in combustion atmospheres

In order to achieve further reductions in the emission of pollutants from internal combustion engines, such as used in aircraft propulsion systems, it is necessary to be able to precisely control the combustion process. This demands precise knowledge of pollutant concentrations at locations as close as possible to, or ideally inside, the combustion chamber. Sensors are therefore required that can operate at high temperatures in oxidising atmospheres. On top of this, the installation space is severely restricted, meaning that the use of separate, bulky measuring systems is seldom an option. The aim of this project is therefore to integrate sensors at the design stage that can operate reliably in the combustion atmosphere to deliver data on the concentrations of pollutants such as NOx.

The solution developed was an impedance sensor integrated into the design of a turbine blade that already featured a thermal insulation layer. Using a combination of technologies from the new Coating Technology Centre, including electron beam evaporation and magnetron sputtering, the teams successfully produced a planar, multi-layer sensor system. The sensor has already been successfully tested under a combustion gas atmosphere and has been characterised in terms of signal consistency and response characteristics. Thanks to increased selectivity and sensitivity, the sensor can detect NOx even in oxygen-rich atmospheres and at elevated temperatures. Further development of the sensor is necessary to allow wireless data transmission, which will allow it to be used directly in the combustion gases produced by aircraft and gas turbines (and also conventional engines), delivering reliable measurements of NOx and CO for direct control of the combustion process. This would represent an important contribution to further reducing the pollutant emissions of these systems, in addition to secondary measures such as catalytic converters.



Sensor integrated into the design to allow measurement of pollutant concentrations during operation

Jet engine components for component testing

Structural Load-Bearing Guide Vanes

Successful development of construction techniques in EU project VITAL

In light of the goals set by the Advisory Council for Aeronautical Research in Europe (ACARE), the EU project "VITAL – Environmentally Friendly Aero Engines" has succeeded in making major advances towards implementing lightweight structures in jet engines. Working in collaboration with various European companies and institutions, DLR has been able to develop construction techniques, structures and manufacturing technologies for a structural load-bearing guide vane lattice. The aim here was to integrate both aerodynamic and structural functionality into a single component for the purpose of reducing structural mass, installation space and production costs.

Through a direct collaboration with engine manufacturer Rolls-Royce Germany, DLR created a construction technique based on thermoplastics, which has successfully passed a profitability analysis conducted by the industrial partner. Rolls-Royce in the United Kingdom carried out a component test incorporating the structure developed at DLR, which was also completed successfully. On the basis of the results achieved, work will now continue at national level to find a specific application for the technology in an engine at Rolls-Royce Germany.

The OPTITHECK project, part of the German National Aeronautics Research Programme (LuFo), is now concerned with expanding the data base, which is urgently required for the approvals process. The Institute of Structures and Design is involved in this project as a sub-contractor and is therefore able to continue to contribute its expertise. Beyond this, other DLR projects are currently looking at additional approaches to utilising this construction technique and the manufacturing technologies that it has generated.

Because automation problems will also become an issue as the engine structures move into production, the construction of the Centre for Lightweight Construction and Production Technology in Augsburg currently planned by DLR has taken on new importance. This new centre will allow research and development activities to consider issues relating to manufacturing technologies and their implementation at an early stage in order to match the requirements of standard production.

Innovative Taxiway Management

EU project EMMA2 successfully completed

The airport is increasingly becoming the cause of delays. Expansion of infrastructure, for example through the construction of new runways, is rarely an option. DLR researchers have now successfully implemented an environmentally-friendly solution through the development of new traffic management procedures, as part of the EU's EMMA2 (European Airport Movement Management by A-SMGCS, Part 2) project. This was demonstrated to an assembly of the public and around 120 experts at Malpensa Airport, Milan.

Air traffic controllers are heavily reliant on visual contact with aircraft. Pilots use paper-based maps for orientation. Communications are handled exclusively over voice radio and logs are usually handwritten by air traffic controllers on paper control strips. The new taxiway management system gives air traffic controllers an electronic overview of taxiing aircraft, provides support to pilots in the form of a navigation system and partially replaces voice communications with an electronic data link. On the air traffic control side, this new form of communication will take the form of electronic flight strips, with additional support being provided through taxi path planning and scheduling of time slots when aircraft are cleared for taxiing.

In addition to relieving the pressure on voice frequencies, which at times become overloaded, this can also lead to significant fuel savings. According to a study by EUROCONTROL, a five percent reduction in taxiing times at an airport with 350,000 taxiing movements per year would save around 1,470 tonnes of fuel, with a corresponding reduction in carbon dioxide emissions of 4,630 tonnes. EMMA2 has successfully shown the way towards this.

Air traffic controller in a simulation exercise

Traffic guidance in ATTAS cockpit

Experimental GBAS station at Braunschweig Research Airport

Satellite-Aided Blind Landings

Experimental next-generation Ground Based Augmentation System for precision landings

Adverse weather conditions are a major cause of delays in aviation. Today's blind landing systems make it possible to continue operating runways in poor conditions, even with extremely restricted visibility, however, there is a heavy penalty to pay in order to ensure safety is guaranteed: the number of landings per hour and per runway must be cut by as much as 70 percent compared to normal conditions. The result is delayed and cancelled flights.

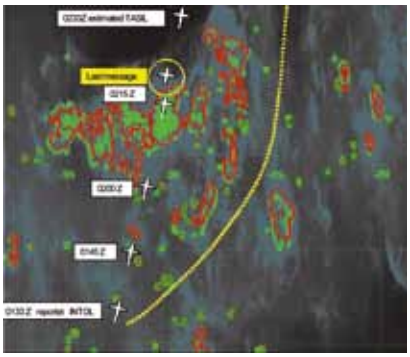
The FAGI (Future Air Ground Integration) project at DLR has made important contributions towards the introduction of novel satellite-aided blind landing systems, known as Ground Based Augmentation Systems (GBAS) for precision landings, which allow this penalty to be considerably reduced. To this end, researchers at DLR developed a GBAS station equivalent to precision landing category CAT-I standards. This was put into operation at Braunschweig Research Airport, where trials of the new technology were successfully completed during flight campaigns. These trials saw aircraft guided accurately to the runway through use of satellite navigation and ground-based assistance.

The experimental station developed in this project is the only platform of its type in Europe and in the near future will have its capabilities extended to the highest precision landing category, CAT-III, to cover situations with close to zero visibility. These developments are proceeding in close cooperation with major partners from the aircraft and equipment manufacturing industries, as well as national and European air traffic control organisations, and it is intended to submit for standardisation in future.

Weather and Flying

Improved safety and greater efficiency in adverse weather conditions

In order to limit the effects of the weather on air traffic, all aviation decision makers need to be provided with the same consistent information about adverse weather. For this reason it is necessary to develop an improved, accurate weather forecasting system that is tailored to the needs of pilots, air traffic controllers and airport operators as well as optimise the behaviour of the aircraft during bad weather. This is being done by building an Integrated Terminal Weather System (ITWS), which not only delivers specific information about thunderstorms, snowfall and wake turbulence, but also aids pilots when flying through squalls and wake turbulence by means of automatic aircraft control interventions.



Example of a flight path change: red contours indicate the thunderstorm cells, the yellow line indicates an alternative route bypassing the storm

The first phase of the project included the development of a system to allow pilots to precisely locate not only those thunderstorm cells visible on the cockpit radar, and therefore in the near vicinity, but also storm activity further from the aircraft. This will allow the crew to avoid hazardous areas in good time and, where necessary, by a wide margin. This significant improvement in situational awareness will hopefully contribute to the avoidance of accidents that would be caused by flying in areas with active thunderstorm cells.

People and Safety in Aviation

Investigation of workload on pilots working for a low-cost carrier on short-haul routes

Flying and related activities on short-haul routes demand a high degree of concentration and awareness due to the high number of take-offs and landings each day. The organisation on the ground and the associated time pressures have just as much effect as long and/or irregular flying hours on the workload and fatigue levels of cockpit staff.

Work was therefore carried out as part of a project to establish the workload and stress experienced by pilots both objectively (ECG) and subjectively (questionnaire), with the aim of determining whether there are any negative effects relating to fatigue and performance (reaction test time) during the course of a flight sequence. Factors studied included evaluating if there was any effect relating to the number of flights per day, the number of consecutive days on duty or the time at which the duty period started, as well as establishing the relationship between workload and fatigue.

Study of workload on pilots working for a low-cost carrier on short-haul routes

Space Agency and Space R&D

The German Aerospace Center (DLR) is where Germany's national and international space flight activities converge. Research work is carried out by the DLR Space Research institutes, whereas policy issues are the remit of the DLR Space Agency, which is responsible for pursuing national and international space-related activities on behalf of the Federal Government of Germany. DLR's own research institutions make contributions to scientific, technological and operational activities. The integrated German space programme combines German participation in the European Space Agency (ESA) programmes, the EUMETSAT organisation, the national space programme, the DLR R&D programme "Space" and additional space activities on behalf of science and industry. Through these activities, DLR is in a prominent position to demonstrate its ability and efficiency as a partner in national and international space flight missions and research projects. The following examples provide a brief overview of successes and events during the past year in these areas.

Highlights from the Space Agency

ESA Council at Ministerial Level

Conference very successful for Germany

The ESA Council of Ministers met from November 25–26, 2009 in The Hague, Netherlands, to conclude the decision-making process on policy and programmatic decisions affecting the joint space policy for the years ahead. Ministers and delegates from the 18 member states of the ESA (the newest member, the Czech Republic, joined on January 01, 2009) and Canada (an associated country) took part in the conference. Representatives of the EU commission and observers from other EU countries were also present.

The main aim of the conference was the continuation of the ESA programmes at a high level. Since the 2005 meeting of the Council of Ministers, Germany has had the largest stake in the programmes, and as such has a significant role to play in ensuring the continuity of the European space agenda. With the German contributions (around 2.2 billion euros plus contributions by the Federal Ministry of Transport, Building and Urban Development, BMVBS, amounting to approximately 570 million euros and a first-time contribution of about 2 million euros from the German Federal Ministry of Defence, BMVg), the Federal Government has focussed on fields in which Germany has the appropriate expertise and that offer particularly good opportunities for German industry in future.

The outcome of the conference was a clear success from the German perspective. Germany was able to push through some major demands:

- The ESA is to take on important work in the field of climate change, with Germany playing a leading role
- Germany's stake in space applications and services that are close to market was substantially increased
- Together with France, the European partners were persuaded to continue to make full use of the ISS in its capacity as humankind's greatest communal project in the fields of science and technology
- New subsidies for the marketing of the Ariane carrier rocket were prevented

RapidEye

German satellite constellation launched

On August 29, 2008, the RapidEye satellite constellation was successfully launched from Baikonur Cosmodrome in Kazakhstan. The five identical Earth observation satellites provide data from space for civilian use. They can observe a region of the Earth with a resolution of 6.5 metres each day.

Since March 18, 2009, RapidEye AG has been delivering high-resolution optical satellite data products from the new German Earth observation satellite constellation to the RapidEye Science Archive (RESA), which are free of charge for research purposes. The data is being archived and distributed by the German Remote Sensing Data Centre.

RapidEye is primarily geared towards commercial applications for the agriculture, insurance and food industries, as well as use in disaster relief efforts. Future products include thematic maps for harvest planning, identification of crop damage, digital elevation models and damage assessment. Information will also be made available to various national and international institutions. Use of the data for research will be coordinated by DLR.

Researchers have access to images covering a total area of 29.4 million square metres. This corresponds to an area roughly three times larger than Europe.

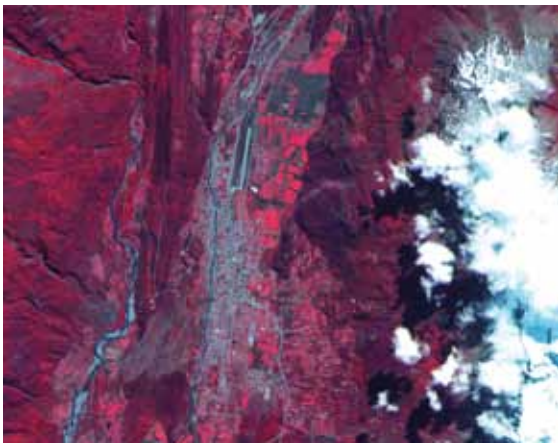
The RapidEye project is a public-private partnership supported by the DLR Space Agency on behalf of the Federal Ministry of Economics and Technology (BMWi).

Herschel and Planck

High-tech German research on-board both infrared telescopes

On May 14, 2009, the Herschel and Planck space telescopes were successfully launched from Europe's space centre near Kourou in French Guiana, South America. On board both infrared telescopes is German high-technology research, financed by DLR through BMWi funding. Herschel will explore extremely cold objects in distant galaxies, while Planck will investigate light from the early universe for cosmic microwave background radiation. German scientists are heavily involved in these ambitious European Space Agency (ESA) missions.

Herschel produced its first image of an object in space on June 14, 2009. Scientists report that the quality of the image taken by Herschel's PACS camera is comparatively high. Although not all of the telescope's settings have been optimised, it is already exceeding expectations.



Argentina, El Bolsón, RapidEye, October 21, 2008

Herschel's first image: Galaxy M51

The Sunrise telescope gondola prior to the test flight

The Max Planck Institute for Extraterrestrial Physics (MPE) in Garching, Germany, is involved in the development of PACS (Photodetector Array Camera and Spectrometer), one of the three main instruments carried by Herschel. Herschel is the first space observatory to cover the complete range of far infrared wavelengths down to sub-millimetre level (60 to 670 micrometres).

Because Herschel is investigating parts of this spectrum for the first time, astronomers expect a raft of new discoveries. Scientists will be able to explore the formation and development of galaxies since the dawn of the universe. Herschel will also assist in the search to understand the composition of comets, planetary atmospheres and the surface of planets in our own Solar System.

Planck will considerably improve the way in which cosmic background radiation is measured and will map the whole sky with an angular resolution better than ten arcminutes. On-board instruments are designed to be able to record temperature variations of around one millionth of a degree. Researchers anticipate that Planck will make fundamental contributions to the current issues concerning cosmologists: What did our universe look like in its early stages? How did it form into its current state? What form will future developments take?

Planck is carrying a telescope with a mirror surface area of 1.50 metres by 1.75 metres, plus two further instruments to measure microwave radiation in different frequency bands. Germany is represented by the Max Planck Institute for Astrophysics (MPA) in Garching. Researchers at the MPA developed the software for processing the data and for information exchange during the construction of the instruments, wrote the simulation programs needed to test the data processing routines and analyse the observation data, and built a database to store the processed measurements.

Sunrise

Ascent by balloon – German telescope observes solar atmosphere

The German Sunrise telescope was launched on June 08, 2009 from the Esrange Space Centre in Kiruna, northern Sweden, for a five-day mission. Sunrise was built by DLR with assistance from BMWi at the Max Planck Institute for Solar System Research (MPS) in Katlenburg-Lindau. Sunrise observes the Sun from a great height with a level of accuracy never before achieved by either a ground-based telescope or a space probe. Structures on the Sun as small as 35 kilometres can be seen. The initial goal is to analyse the movement and magnetic orientation of fine structures in hot plasma, that is the ionised gas in the solar atmosphere. Through observation of these dynamic processes, scientists hope to learn how to better understand the fundamental physical forces and the behaviour of the Sun as a complete system. This is important, since even small fluctuations in solar radiation have an effect on the sensitive balance between weather, climate, and the Earth.

Sunrise also serves as a preparatory venture in the context of the "Solar Orbiter" space mission from the European Space Agency (ESA), which is planned for launch in 2017.

The solar telescope was raised by a giant American balloon. With a volume of approximately one million cubic metres it is the largest high-altitude balloon ever launched in Europe. Inflated, the total diameter of the balloon is over 100 metres.

ATV "Jules Verne"

ISS attitude control and collision avoidance successful

The European space transport vehicle ATV (Automated Transfer Vehicle) "Jules Verne" completed its mission of almost 7 months with a controlled re-entry into Earth's atmosphere on September 29, 2008. The ATV was launched from Kourou on an Ariane 5 ES launch vehicle on March 09, 2008 and on April 03, 2008 became the first European space vehicle to dock fully-automatically with the International Space Station (ISS). On-board were five tonnes of supplies for the space station, including foodstuffs, breathing air, drinking water and fuels. In addition to this, the ATV re-boosted the International Space Station to a higher altitude a total of four times, a procedure necessary to correct the orbit of the ISS that could previously only be carried out by the Russian cargo spacecraft Progress and the American Space Shuttle. The ATV also completed smaller ISS attitude control manoeuvres and a manoeuvre to avoid a collision between the ISS and space debris before undocking on September 05, 2008 and being burnt up according to plan upon atmospheric re-entry.

Joint projects from the Space Agency and Space R&D

TerraSAR-X and TanDEM-X

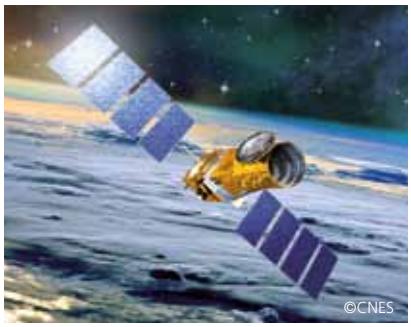
TerraSAR-X exceeds expectations

On June 15, 2007, the German Earth observation satellite TerraSAR-X was launched on what was to become a uniquely successful mission. Since its launch, the DLR mission control centre has produced around 35,000 radar images of the Earth's surface and used these to create around 50,000 high-quality products for scientific and commercial users.

The results presented here demonstrate the high quality of the products from the TerraSAR-X satellite, which are still surpassing requirements in many areas. High-accuracy geolocation with better than half-metre resolution makes it possible to fully-automatically overlay two images of a scene taken at different times with pixel-accurate precision. The high radiometric accuracy and the very good stability of the radar instrument are also noteworthy.

The two additional payloads on TerraSAR-X, the Laser Communication Terminal (LCT) built by TESAT and the TOR (Tracking, Occultation and Ranging) experiment supplied by the Helmholtz Centre Potsdam – Research Centre for Geosciences (GFZ), are also operating without problems. The LCT is a technology demonstrator financed by the DLR Space Agency

Egypt, pyramids of Giza – radar data for archaeology showing structures below the sand



CoRoT

that is being used for verification of a system for high-speed optical data transmission in space. Initial trials of the LCT succeeded in establishing reproducible data transmission between the two low-flying satellites, TerraSAR-X and NFIRE, with a transfer rate of 5.5 gigabits per second.

The second, almost identical, German radar satellite, TanDEM-X (TerraSAR-X add-on for Digital Elevation Measurement) is expected to launch in 2010 from Russia's Baikonur Cosmodrome. The two satellites will fly in close formation at separations ranging from a few kilometres down to 200 metres and will record data for a global digital elevation model of all land masses on the Earth's surface with a hitherto unprecedented degree of accuracy.

CoRoT

Discovering planets beyond our Solar System

The CoRoT (Convection, Rotation and Planetary Transits) satellite has discovered its first rocky planet beyond our solar system. The planet, the smallest known extra-solar planet discovered to date, has been named CoRoT-Exo-7b and is approximately twice as large as Earth. It orbits a central solar-type star in just 20 hours.

CoRoT launched on December 27, 2006 from Baikonur Cosmodrome in Kazakhstan and is the first satellite mission tasked with the search for extrasolar rocky planets. CoRoT carries a telescope with a 27 centimetre aperture and is in polar orbit about the Earth at an altitude of approximately 900 kilometres. CoRoT's measuring equipment can not only be used in the search for extrasolar planets using the transit method, but is also suitable for recording and examining the oscillation of stars.

The mission is led by the French space agency CNES. Researchers on the project are drawn from the ESA and other research institutes in Belgium, Brazil, Germany, Austria and Spain. The DLR Institute of Planetary Research in Berlin developed and tested the on-board software in less than five years on behalf of the German Federal Government and with financial support from the DLR Space Agency. The German team also includes members from the Thuringia State Observatory in Tautenburg and the Rhine Institute for Environmental Research at the University of Cologne.

Ten Years of DLR Parabolic Flights

227 experiments in freefall

From February 02-14, 2009, DLR conducted its 13th parabolic flight campaign with the Airbus A300 ZERO-G. Taking off from Bordeaux Airport, the largest flying laboratory in the world undertook a total of four flights for the purpose of research in weightlessness. These were used by researchers for 16 experiments in the fields of biology, human physiology, physics, materials research and technology.

The DLR Space Agency has been conducting parabolic flights for ten years. During the 13th flight campaign, the Airbus A300 ZERO-G carried 227 experiments, with a combined weight of almost 33 tonnes,

into freefall for the DLR. The DLR Institute of Materials Physics in Space and DLR Institute of Aerospace Medicine both obtain great benefits from the opportunity to expose their experiments in the fields of materials and life sciences to around 20 weightless episodes of 20 seconds duration. School children also had the chance to participate in the biological and medical experiments. The payload even included two artistic experiments. A total of 1,425 parabolas provided a total of 8 hours 20 minutes of weightlessness.

LCT

Completion of optical data transmission campaigns

The two LCTs developed for inter-satellite links were implemented and successfully tested on the TerraSAR-X and NFIRE (Near Field Infrared Experiment) satellites.

The first inter-satellite link campaign was successfully completed in May 2008. Over a period of three months, the laser inter-satellite links were verified in operation with a data rate of 5.5 Gbits/s and for durations up to 12 minutes. The bit error rates, which give an indication of the quality of the optical connection, were better than specified. The acquisition times required to establish a link currently amount to about 20 seconds, which is a outstanding achievement. As such, this inter-satellite link technology has proven itself fully suitable for the intended task.

Direct satellite to ground laser links between NFIRE satellites and an optical ground station on Maui started in Spring 2009. Initial experiments to prove out the tracking systems have already been conducted here. The next step is direct optical data transmission of NFIRE test data, which will be recorded at the optical ground station. Initial results are expected in the near future.

REXUS

Student experiments launched aboard sounding rockets

The two-week long REXUS 5/REXUS 6 (REXUS – Rocket Experiments for University Students) research campaign started on March 02, 2009. These experiments, conducted by DLR in collaboration with the Swedish National Space Board (SNSB) and the European Space Agency (ESA), offered students their first chance to carry out their own experiments aboard a sounding rocket. The REXUS campaigns take place at the European launch base for sounding rockets and balloons (Esrange) close to the northern Swedish town of Kiruna.

Students were invited to submit proposals for experiments, of which five were selected for this campaign. These were concerned with geophysics, astrophysics and technology trials.

Galileo

Test areas ready for operation in Germany

With its eye on Galileo and the preparation of future applications for satellite-aided navigation, DLR has constructed various test areas in Germany to meet the requirements of different contracts and investments. These are intended to offer innovative companies and institutions the unique opportunity within Europe of being able to test and develop their ideas for new products and services under real-world conditions.

REXUS 6 is lifted onto a trolley to move it into the engine hall

The Mars500 team half way through the experiment, top right is Oliver Knickel, Germany

The various test environments are designed to satisfy the specific requirements of the following developmental areas: receiver development (GATE – GAlileo Test and development Environment, in operation since July 2008), maritime applications (SEA GATE, test operation since May 2008), aviation applications (aviationGATE, under construction), road-going applications (automotiveGATE, under construction), and rail applications (railGATE, under construction).

Ariane and Future Launch Vehicles

Good market position for Ariane – First firing of Europe's staged combustion engine

The Ariane 5 programme ran without any incident using the ECA (Etage Superieur Cryotechnique) version of the Ariane 5, with six launches taking place between mid-2008 and mid-2009. This is close to the maximum possible launch rate of seven flights per year. The commercial market position of Arianespace is currently very strong compared to its main competitors, Proton and Sea Launch/Zenith.

ESA's Future Launcher Preparatory Programme (FLPP) saw the first firing in Europe of a propulsion system using the "staged combustion" of hydrogen and oxygen on a test bed at DLR Lampholdshausen, Germany. This class of propulsion system (as currently used on the US Space Shuttle) is highly likely to be employed at some point in future as the main propulsion unit on the possible successor to Ariane 5.

Mars500

German participates in 105-day simulation of space flight to Mars

The 105-day space flight simulation experiment, Mars500, in Moscow was completed with German participation. A module system at the Institute of Biomedical Problems (IBMP) of the Russian Academy of Sciences had been home to the team. The six test subjects – including a member of the German Armed Forces, Oliver Knickel – were subjected to extensive tests before returning to their loved ones. The main question underpinning the Mars500 was this: How can the physical and psychological performance of humans be maintained under the extreme conditions of a long space mission? DLR, the IBMP and the European Space Agency, ESA, all made substantial contributions to Mars500. DLR research institutes carried out several experiments into both physiological and psychological issues. In addition to this, DLR provided financial support for the project in its role as national space agency on behalf of the German Federal Government.

The Mars500 container is a cylindrical module system with a living and working space of 180 square metres. There are also cooling cells for foodstuffs, the majority of which were provided by German suppliers, and a quarantine station. The gravitational field and air pressure were unmodified, with oxygen content harmonised at regular intervals. Radio communications to the "ground station" and back incurred a delay of up to 40 minutes.

The experiment is planned to enter the second phase in March 2010, with a realistic flight and habitation period of 520 days. A virtual Martian surface will be constructed specifically for this project, which will then become home to the three "cosmonauts" for 20 days.

Robotics

First national conference on space robotics cements new research focus

Under the patronage of the German Federal Minister of Economics and Technology, Dr. Freiherr zu Guttenberg, DLR hosted the "First National Conference on Space Robotics" from May 13–14, 2009 in Berlin. A collaboration between the Federal Ministry of Economics and Technology (BMWi) and DLR, this conference represents the launch of a new research focus area, "Robotics for Space Application".

This first national conference on space robotics saw presentations on recent successes and projects from the DLR Centre of Robotics, Mechatronics and Automation and other German research institutes and companies. These gave an overview of the current state of space robotics in Germany and revealed numerous synergies with terrestrial applications and developments.

Podium discussions were held with representatives from the fields of research, industry and politics addressing the new research focus area of Space Robotics and the relationship between space developments and industrial sectors, as well as investigating possible approaches to implementing a knowledge and technology transfer framework. The latest developments in robotics were on display in the accompanying exhibition, "Space Robotics and Applications for the Earth", with exhibits including rendezvous and docking sensors from JenaOptonik, a moonlander from EADS and Rollin' Justin from DLR.

Highlights from Space R&D

Satellite-Aided Disaster Information

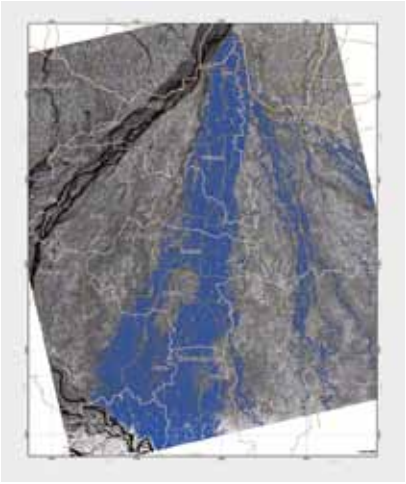
Rapid assistance with TerraSAR-X during floods in North India and Nepal

Widespread flooding following the bursting of a dam on the Koshi river in eastern Nepal on August 18, 2008 eventually affected over three million people from more than 250,000 homes in 1,600 locations. Destruction of roads and flooded railways severely handicapped the ongoing relief efforts.

DLR used radar images from space to provide highly accurate mapping of the flooded areas in order to rapidly get assistance to where it was needed and to keep rescue teams up-to-date with information about affected areas and remaining intact infrastructure. The Centre for Satellite Based Crisis Information (ZKI) at DLR Oberpfaffenhofen, Germany, used data from the German TerraSAR-X radar satellite, launched in 2007.

The analysis was based on data from the TerraSAR-X satellite captured on August 30, 2008 and September 01, 2008. The intervening period until the second data capture on September 01, 2009 was significantly reduced thanks the unique left-looking mode provided by TerraSAR-X. In normal mode, the satellite looks to the right-hand side of the flight path; looking to the left (left-looking mode) requires special programming.

Key visual for the First National Conference on Space Robotics



Overview map of flooding in India and Nepal

The Centre for Satellite Based Crisis Information (ZKI) is a service provided by the German Remote Sensing Data Centre (DFD) at DLR. Its task is the rapid acquisition, processing and analysis of satellite data of natural and environmental disasters for humanitarian activities and civil security purposes. Evaluations are carried out in accordance with special requirements from national and international political agencies and relief organisations.

DLR Experiments on the ISS

Searching for the secrets of life

During a 4-hour and 49-minutes lasting extravehicular activity (EVA) on March 10th, 2009 the astrobiological exposure facility EXPOSE-R was mounted to the Zvesda modul outside the Russian segment of the International Space Station (ISS).

EXPOSE-R with its 8 experiments and approximately 1200 individual samples shall contribute to the question of life's origin on Earth. Lead-managed by the radiobiology division of the DLR – Institute of Aerospace Medicine and in close cooperation with the Rheinisch – Westfälische Technischen Hochschule Aachen (RWTH Aachen) and the Technical University Munich (TUM) the experiment "Spores – Spores in artificial Meteorites" is operated. This is one of the 6 astrobiological experiments on the ISS of the "ROSE-Consortiums" (Response of Organisms to Space Environment) coordinated by DLR. Additionally integrated into the EXPOSE-R facility are several dosimeters monitoring the ionising and the solar UV-radiation during the mission to deliver useful information to complement the sample analysis.

The involved scientists investigate the question whether life in the form of microorganisms may have been transported embedded in meteorites from one planet to another and if life necessarily originated on Earth. Each tray is loaded with a variety of biological samples including plant seeds and spores of bacteria, fungi and ferns that will be over layered or mixed with meteorite material. Outside Earth's protective atmosphere, the organisms will be exposed to solar ultraviolet (UV) radiation, vacuum, cosmic rays and extreme temperature variations as the ISS repeatedly passes between areas of direct sunlight and the cold darkness of Earth's shadow. Afterwards the investigators determine the survival rate of the organisms.

In parallel to the mission in space, exactly similar samples contained in an almost identical EXPOSE-R package on the ground are being exposed to simulated space conditions (vacuum, temperature and ultraviolet radiation) matched to measurements taken by the EXPOSE-R on the ISS and transmitted to Earth. This part of the experiment is taking place at the Planetary and Space Simulations Facilities (PSI), DLR Cologne, Germany.

The radiation measuring devices and all the chemical and biological samples will be returned to Earth after their stay in space, when they will be distributed among the laboratories of the relevant research groups for analysis.

All pre-flight preparation and integration of the samples was carried out at the DLR Microgravity User Support Centre (MUSC). DLR also provided operational support for the mission once EXPOSE-R was installed and activated in its final position outside the ISS.

Mapheus

Three minutes for material physics in weightlessness

DLR launched the Mapheus (German acronym for "material physics under weightlessness") sounding rocket on Friday May 22, 2009 from the Esrange Space Centre in Kiruna in northern Sweden. Researchers from the Cologne-based DLR Institute of Materials Physics in Space wanted to use this flight to investigate how liquids would behave during the period of weightlessness lasting around three minutes. This focussed mainly on the properties of liquids, particularly on solidification and demixing. The absence of any buoyant force in weightlessness enables precise measurements to be taken under controlled and defined test conditions that cannot be achieved in ground-based tests.

The Mapheus rocket was developed and built with this purpose in mind by the scientists in Cologne and engineers from DLR Space Operations' MORABA mobile rocket base in Oberpfaffenhofen. Project management was provided by the DLR Institute of Space Systems in Bremen. The 113 kilogram scientific payload on the inaugural flight of Mapheus comprised three experiment modules and one battery module, developed and built by DLR Cologne. Added to this was a measuring platform supplied by Aachen University of Applied Sciences, Department of Aerospace Engineering, and the DLR Microgravity User Support Centre (MUSC) in Cologne.

The Mapheus sounding rocket is financed by the DLR research and development programme "Space" and, following the success of the inaugural flight, is now expected to launch on an annual basis to facilitate systematic investigations in the field of material physics.

CFRP for Solar Sails

Lightweight and rollable – new mast for solar sails tested in weightlessness

In order for a solar sail to move a probe through space it must be extremely large. Unfortunately, there is no such sail that will fit in a rocket launched into space from Earth. At the start of February 2009, DLR researchers demonstrated during a parabolic flight that a mast held together by extremely thin threads for use with sun sails can be successfully unfolded. The researchers from the DLR Institute of Composite Structures and Adaptive Systems focussed for this experiment on extremely lightweight, rollable masts built from carbon fibre reinforced plastic (CFRP). Despite their low mass, these masts are extremely stiff and could be used in future space missions for the basic supporting structures of large systems such as solar sails, solar collectors and antennas. The test in the parabolic flight aircraft, which had to be completely emptied out specifically for the purpose, was successful and reproducible.

DLR scientists at work on Mapheus

Transport

The transport sector is a major cornerstone of our society, shaped as it is by industrial activity. It satisfies individual needs for mobility, generates employment, and represents a major part of economic value added. However, transport also has negative consequences. Noise and exhaust emissions harm humans and the environment, countless people become the victims of accidents. These conflicting aspects of transport have led to the necessity for intensive debate and action on the current and future problems of the transport sector. The Transport programme at DLR aims to live up to this challenge. On the following pages, we present a selection of the diverse results of our research work during the 2008–2009 period.

Looking beyond specific areas of research, over the past year we have further expanded involvement in external committees and organisations. As a result, we can speak on behalf of the Mobility network at the German Academy of Science and Engineering, we are shaping policy at board level in the Rhineland branch of the German Association of Transport Sciences (DVWG) and we are taking part in discussions on the future of rail transport research as part of the Federal Ministry of Economics' expert forum, Bahn 2025+. We are represented in numerous steering groups in the German Transport Industry Forum (Deutsches Verkehrsforum) and participate actively in the work of the Association of German Engineers (VDI), the German Institute for Standardisation (DIN), and various other professional bodies. We have also increased our portfolio of contacts at the international level. The director of the Transport programme at DLR also serves as secretary of the European Conference of Transport Research Institutes. We are very active in Europe's ERTRAC and ERRAC technology platforms. We support ERTICO – ITS Europe as a partner. At the invitation of the US Transportation Research Board, we also participate on the Conduct of Research Committee and the International Committee.

NEMESIS

On the road with hydrogen

In order to use hydrogen as an alternative energy source to ensure long-term mobility, reliable and economic solutions must be found to the problems of distribution and refuelling infrastructure and conversion to electrical energy by means of fuel cells. Alternatively, hydrogen in combination with a combustion engine can be used as a range-extender. DLR has played a major role in the development of a prototype for the efficient production of hydrogen from diesel at filling stations as part of an EU project, NEMESIS (New Method for Superior Integrated Hydrogen Generation System). This modular system was used to develop methods for the desulphurisation and non-coking operation of a steam reformer, which were validated in over 200 hours of testing.

We are addressing the question of onboard storage for the hydrogen produced through the development of solid storage systems. These have great potential with respect to their volumetric storage density, however, there are still problems to solve with regard to fuelling dynamics and mass-specific storage capacity. We have proposed promising concepts for convectively cooled storage and proven these experimentally. The coupling of this type of storage unit with a high-temperature fuel cell/battery combination will be a major focus area for DLR's Vehicle Energy Systems project in future. We are building up a fundamental understanding of how these components interact through simulation of the detailed processes in the storage unit and the fuel cell. This will be followed by experiments and simulations at vehicle level to explore the implementation of suitable operational strategies that take into account heat and energy management requirements.

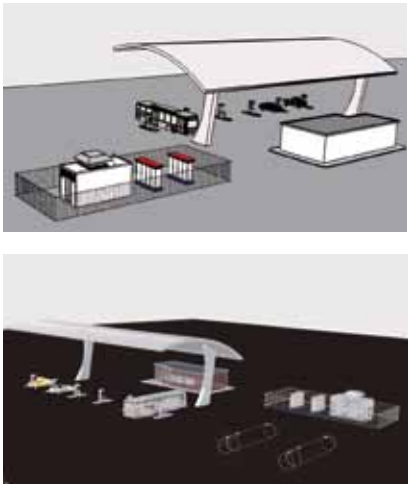
DESCAS

Driver assistance – safely

Driver assistance systems can make transport safer. Emergency braking assistance, lane-holding assistance, and the Electronic Stability Programme (ESP) can intervene if a driver becomes distracted or lacks the ability to avoid an imminent accident. Since 2007, a collaboration between DLR, the University of Oldenburg and Technische Universität Braunschweig has been engaged in a human-centered, safety-oriented development process under the auspices of the DESCAS (Design of Safety Critical Automotive Systems) Virtual Institute to improve the design of this type of active safety system with respect to reliability and error tolerance.

The application of this process is expected to help with the early identification of possible failure scenarios such as system crashes or faults with sensors and electronics. This ensures that potential faults are considered during the development phase and leads to a minimisation of risk. Possible precautions for fault reduction could include, for example, the use of redundant sensors for safety-critical functions or use of alternative ways of acquiring information. Systematic emergency strategies are being developed to handle situations where an active safety system fails despite the use of redundancy or other technical precautions. Provision of intuitive information and alerts will allow the driver to retain control of the vehicle in such situations. DESCAS is therefore also investigating driver behaviour and possible failure modes both in driving simulators and on the test track.

DESCAS is one of only ten Virtual Institutes approved by the Helmholtz Association in 2007. Virtual Institutes serve to bring together cross-disciplinary, inter-establishment expertise from higher-education institutions and the Helmholtz Centres and are untouched by geographic restrictions; they also work to support the next generation of researchers in gaining qualifications.



Fuelling station with on-site hydrogen production unit and underground storage (sketch)

Next Generation Train (artist's impression)

Silver objects: Wind tunnel model used to investigate side-wind stability and optimise resistance Light-coloured framework: Design model for topology optimisation

Next Generation Train

A step into the future of rail

The demand for rail transport to overcome large distances is growing around the world. This is founded on both a general increase in the demand for transport and the desire to replace short-haul flights with high-speed rail transport. The challenge of developing an innovative high-speed train is one that DLR is well equipped to take on thanks to its array of expertise and potential for synergies.

Ambitious goals have been defined for the concept that is to be developed for the Next Generation Train (NGT), with the German high-speed train ICE 3 serving as the benchmark. The NGT is expected to be a double-decker, high-speed, multiple-unit train capable of scheduled speeds up to 400 km/h. It is characterised by greatly reduced energy consumption, low noise operation, high levels of passenger comfort, optimised passenger flow and low-wear at the wheel to rail interface.

The multiple-unit concept will allow a hybrid form combining integral and modular product architectures. Joining technologies and lightweight construction will be of prime importance. The side-wind susceptibility of the train will be reduced through use of active control surfaces on the leading car.

A novel feature is the supply of energy through the rails. This has the positive effect of cutting out not only the need for high-maintenance overhead lines, but also the noise associated with pantographs, which are also susceptible to wear. The overall concept also embraces quick changes of passengers. Passenger flow and luggage concepts have already been created that will provide a basis for determining the position and number of doors and the design of steps. There is another innovative feature too: passengers will be able to enter the train on both decks.

Thanks to close cooperation with the rail industry and rail operators, we are able to ensure that the project remains realistically aligned to the demands and possibilities of the existing railway system.

RenewBility

Reduced greenhouse gas emissions from transport by 2030 – how it can work

Against a background of advancing global climate change, rapid and significant reduction of greenhouse gas emissions has become one of the central aims of environmental policy. Achieving this demands great effort from the transport industry. DLR's RenewBility project was established on behalf of the German Federal Ministry for the Environment to conduct research into the potential for and barriers to greenhouse gas reductions in the transport sector by 2030. The material flow-based emissions calculations being performed rely on modelling future vehicle buying behaviour and the demand for passenger and goods transport.

Results indicate that despite the expected significant increase in transport services, particularly goods traffic, substantial reductions in greenhouse gas emissions can be achieved. The project stakeholders, who are drawn from the fields of economics and politics, as well as various organisations, have agreed on a joint climate protection scenario that incorporates a large number of ambitious measures, mainly of a technological nature. The simulations clearly indicate that, through application of the suggested measures, greenhouse gas emissions from transport can be reduced by up to a quarter by 2030 from 2005 levels. The increased use of solely or partly electrically powered vehicles is expected to make a substantial contribution to this figure. It can be seen then that we are not simply relying on estimates of how high the potential is for the use of these new technologies. As a logical consequence of the above exercise, the amount of electrical energy that must be generated from renewable sources to provide future electromobility was also quantified.

ORINOKO

Better quality in traffic management

Many of the methods that are used in traffic management today are not sufficiently well tested to prove their effectiveness. In order to realise the urgently needed efficiency improvements in traffic management today and in future, new methods and procedures must be developed. It is important that these make it possible to evaluate under realistic scenarios which benefits each of the methods will bring. Working at the behest of the Federal Ministry of Economics and using a simulation-based method, DLR was able to demonstrate that planned modifications to some existing traffic lights forming part of a traffic control network in Nuremberg would have had a negative effect on the overall traffic situation. At the same time, it was possible to provide advice on how the switching arrangement could be optimised thanks to a technique developed as part of the ORINOKO project (German acronym for Operative Regional Integrated and Optimised Corridor Control). Project partner Siemens therefore produced a modified version of the system that actually realised an improvement over the control measures currently in use. The basis for this work was a traffic simulation program developed by DLR that can simulate a whole day's traffic in just a few minutes.

Top: Overview of traffic network Bottom: Utilisation of the network The colours represent traffic speeds (red = slow, green = fast); traffic density is indicated by the thickness of the line

There are many ways to the harbour – what can rail deliver?

Goods Traffic in the Port Hinterland

Escaping the threat of rail gridlock

The amount of rail goods traffic servicing the northern German ports of Hamburg, Bremerhaven and the JadeWeserPort under construction in Wilhelmshaven is set to practically double within the next ten years. The existing transport infrastructure does not, however, meet the medium- and long-term needs of the expected volume of goods. Solutions to the impending gridlock on the rails have been highlighted by a DLR study.

The study evaluated data on specific rail routes and proposed measures and then analysed these in combination with information from the rail operators using a consistent appraisal system. The results and corresponding recommendations were presented as an integrated concept for port hinterland traffic in Lower Saxony. According to the study, the main bottlenecks for rail transport are the nodal points in Hamburg and Bremen, the Hamburg-Hannover route via Uelzen and the Bremen-Hannover route via Nienburg. In addition to the long-term measures included in the Federal Transport Network Plan, there are also steps that can be implemented in the shorter-term to provide some relief. These could, for example, take some of the pressure off sections of the Bremen-Hannover route and the Bremen nodal point. This would be possible by rerouting trains coming out of Bremerhaven. Additional staged expansion of the routes will also allow higher numbers of trains to use them. This would also support the aim of transferring goods traffic from road to rail.

Optical Communication

Rapid data transmission through the air

Aircraft-based acquisition of traffic data over large areas is a very important element in traffic management and decision support for public mass events and disasters. The main problem in this respect is transferring high resolution image data from the aircraft to the ground. DLR has demonstrated for the first time the transmission of data in real time from an aircraft to a ground station using "optical communication". The major advantages

of this method, also referred to as optical free-space communication, are the compact terminals, the high data rates and a transmission technology that is not subject to official radio frequency approval.

Using the new laser-based transmission system, images can be made immediately available to a ground station or situation room. Optical free-space communication offers many advantages over conventional microwave directional radio for real-time data connections. The system does, however, place heavy demands on the communications equipment. The challenge lies in directing the narrowly focused laser beam carrying the modulated data signal at the ground station. In particular, the system must compensate for vibration, atmospheric turbulence and spontaneous movement of the aircraft, none of which can be predicted in advance. In its first test aboard the DLR's Dornier 228 research aircraft, the scanner in the beam alignment unit was able to successfully locate the position of the ground station and then steadily track it. The terminal is already capable of keeping the laser beam locked onto the ground station from a distance of over 90 kilometres.

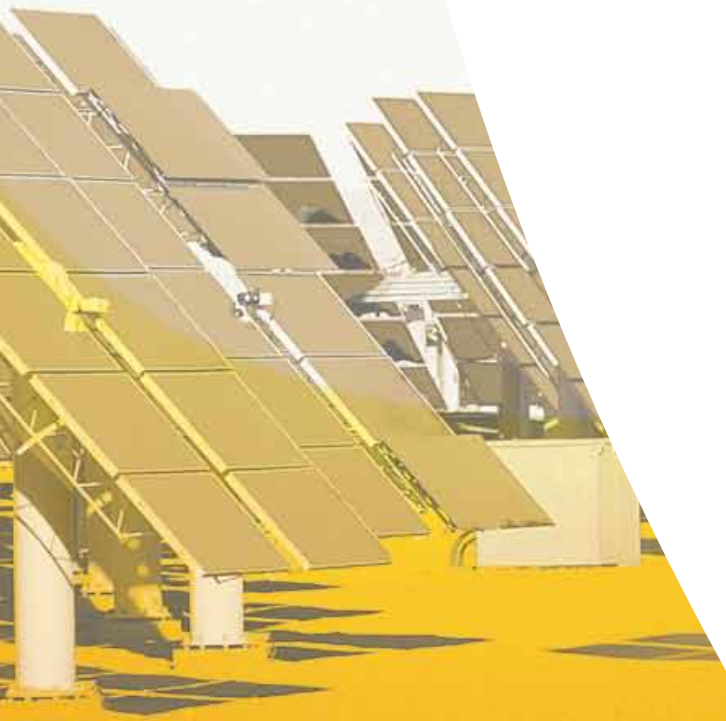
Data transmission by laser and optical terminal on aircraft (top) Optical ground station with a diameter of just 40 centimetres (bottom)

Energy

Energy conversion and use play a key role in virtually all technical systems. The efficient handling of energy is therefore an important issue in all of DLR's fields of activity. Power plants, aircraft and vehicles all need to be optimised in terms of their energy usage. An efficient power supply is also of utmost importance in space applications. Energy research at DLR is dedicated specifically to efficient and environmentally-friendly energy supply and concentrates its activities on stationary applications for the provision of electricity and heat at scales relevant to the energy industry. In doing so, diverse synergies are exploited using skills from the other programme areas and through shared use of test facilities.

The optimisation of stationary gas and steam turbines is one of the main focus areas for DLR Energy Research. Experimental work and numerical simulations carried out by DLR in the fields of compressors, combustion chambers and turbines, combined with its systems expertise, is making a significant contribution to increasing electricity generation efficiency. The use of alternative fuels is also being investigated and prepared for.

Research into fuel cell systems serves to ensure that they are reliable and long-lasting when they find application in future energy supply systems. Linking gas turbines and high temperature fuel cells to a hybrid power plant leads to an increase in electricity generation efficiency of approximately 10 percent compared with the components used individually. Concentrated solar technologies present the option of generating electricity in a highly economical and environmentally-friendly manner on a large scale, as well as the potential to provide hydrogen in the longer term. The development of high-temperature heat accumulators promises a wide range of applications in solar-thermal processes and energy intensive industries. Cross-disciplinary systems analysis work aids the provision of policy advisory services and underpins the thematic orientation of energy research in DLR and in the Helmholtz Association.



Plataforma Solar de Almería (PSA)

Collaboration with CIEMAT on Plataforma Solar extended until 2011

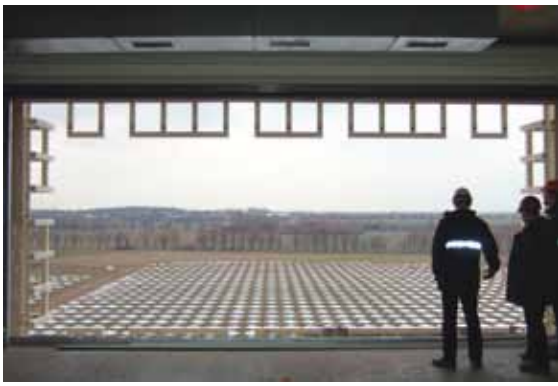
A new collaboration agreement with the Spanish research partner CIEMAT was concluded during the reporting period, guaranteeing continued access to the Plataforma Solar, the most important concentrating solar power (CSP) research plant in Europe, for a further three years until the end of 2011. This contract also provides the basis for greater independence than previously in the work carried out in Almeria by the roughly fifteen-strong Solar Research group, whose members will continue to have free access to PSA to conduct their unique R & D work. In addition to this, since 2009 researchers have had a new base at the Almeria centre in the shape of a large (300 m^2) office complex from which to conduct their ever-increasing number of projects. These notably include activities relating to demonstration projects and to commercial solar-thermal power plants at various sites in Spain and numerous other countries including Egypt, Algeria and Morocco. The strong global interest in these activities should also be seen as a significant success for the strategic work carried out over the last few years to develop our expertise in the qualifying of solar-thermal power plant components. In this respect, the new offices will provide an important focal point for the continued close collaboration with CSP Services, a company founded by members of the Solar Research team for the specific purpose of commercially exploiting this qualification expertise. Part of the new office facilities is let to CSP Services. The new facility was officially opened on March 20, 2009.

Research Platform at Jülich Solar Tower Power Plant

Experiments now possible with thermal outputs up to 500 kW

In December 2008, Kraftanlagen München (KAM), the prime contractor on the Jülich tower power plant, declared the system ready to deliver electricity to the grid.

This solar-thermal test plant is intended as a pre-commercial demonstrator for the high-temperature open volumetric receiver (HiTRec™) technology developed by DLR, with which KAM as licensee hopes to win market share in the young, growing market for solar-thermal power. The plant was financed through funding from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Ministry for Economic Affairs and Energy of the State of North Rhine-Westphalia (MWME) and the Bavarian State Ministry of Economics, Infrastructure, Transport, and Technology (STMWIVT) and is owned and operated by Stadtwerke Jülich GmbH, the local utility company. Scientific services during construction and operation of the power plant are provided by DLR and Aachen University of Applied Sciences/Solar Institute Jülich, who have also secured exclusive access and scientific usage rights through their financial investments. Official commissioning of the 1.5 MWe power plant is scheduled for the third quarter of 2009.



View from the research platform of Heliostat Array 2

A research platform has been created in the plant under the direction of DLR with funding from the Ministry for Innovation, Science, Research and Technology (MIWFT). This platform provides the research partners with testing facilities that are unique in Germany. An otherwise unused floor half way up the tower was utilised for the research platform, which includes an opening onto the heliostat array that is fitted with radiation protection and a roller door. A partial heliostat array is allocated to the research platform, which allows use of concentrated solar radiation on this second focal plane for experiments with a thermal output of up to 500 kW. This makes it the ideal target platform for scaling up developments from the 20 kW high flow density solar oven in Cologne, and is an appropriate size for pre-commercial demonstrations.

Energy [R]evolution 2008

Drastic reductions in global CO_2 emissions are possible

The Energy [R]evolution Scenario – A Sustainable Global Energy Outlook (2008) shows how global CO_2 emissions can be reduced from the current level of 30 billion tonnes per year to around 10 billion tonnes per year by the second half of the century. This drastic reduction in greenhouse gases is necessary to limit the increase in the average global temperature to 2 degrees Celsius over the pre-industrial level. The study provides evidence that, provided we make systematic use of the opportunities available for efficient energy usage and increased expansion of renewable energies, this goal is indeed consistent with delivering global access to electricity for the world population, maintaining secure and affordable energy supplies and allowing worldwide economic growth.

Even taking into account the continued rapid rise in energy consumption in countries such as China, India and Brazil, implementing efficiency measures can achieve substantial reductions in the total global energy demand. The scenario shows that the growing demand for energy can be halted at about 120 percent of today's level by 2030, after which a reduction in global energy requirements should be possible. In 2050 renewable energy sources will supply more than half the world's primary energy requirements. Electricity production has a leading role to play here: by 2050 close to 80 percent of all electricity will be generated from renewable resources, while the proportion of heating provided from renewable sources could be around 70 percent. According to the study, in the transport sector biofuels will initially be the main contributor to reducing fossil fuel dependence, with electromobility playing an increasing role from 2020 onwards.

Aerodynamics in Compressors

Significant reduction in aerodynamic losses through use of non-rotationally symmetrical side wall contours

Secondary flow effects in edge zones around the blade rows of modern axial compressors are a limiting factor on efficiency. In order to reduce losses, an evolutionary optimisation technique has been used to develop a novel non-rotationally symmetrical side wall contour. This acts as an aerodynamic separator and deflects the cross flow towards the side wall, meaning that it cannot interact with the blade boundary layer.

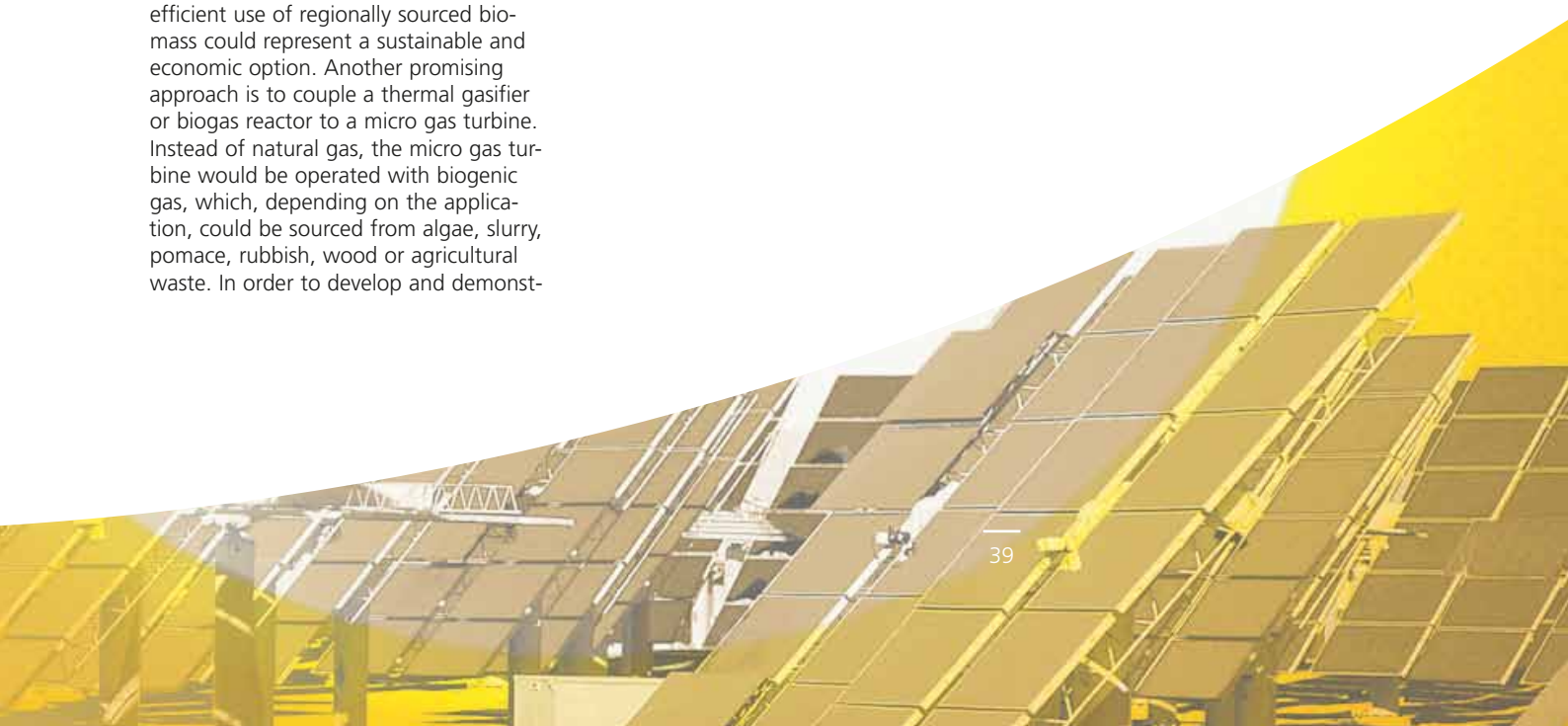
Measurements in the transonic cascade tunnel at the DLR Institute of Propulsion Technology were able to demonstrate a 20 percent reduction in aerodynamic losses in the design point of the compressor cascade through use of the new side wall contour. In the region around the pump limit, the losses have been reduced by as much as 30 percent, which has also led to an increased operating range. In addition to a global reduction in losses, the use of the contoured side wall has allowed the pressure conversion ratio in the cascade to be increased and the radial distribution of the deflection to be homogenised. This leads to improved inflow conditions for the downstream blade row.

Air-flow visualisation of a compressor cascade with non-rotationally symmetrical side wall contouring

Research Platform for Decentralised Energy

Electricity and heat from decentralised power plants

Decentralised power plants are set to be an important component in the future provision of electricity and heat. This includes plants for supplying urban districts with heat and electricity, but could also conceivably include microgeneration for individual agricultural or industrial operations. In particular, an increase in the efficient use of regionally sourced biomass could represent a sustainable and economic option. Another promising approach is to couple a thermal gasifier or biogas reactor to a micro gas turbine. Instead of natural gas, the micro gas turbine would be operated with biogenic gas, which, depending on the application, could be sourced from algae, slurry, pomace, rubbish, wood or agricultural waste. In order to develop and demonstrate these new, sustainable concepts, DLR has established a "Research Platform for Decentralised Energy" in collaboration with energy utility Energie Baden-Württemberg AG (EnBW). The DLR Institute of Combustion Technology in Stuttgart, Germany, is contributing to the project by conducting fundamental research into generating plant components and concepts based on conventional and alternative fuels, including biomass. To this end they are developing new design and simulation tools for use in the design of plant and operating concepts, as well as investigating the combustion properties of the new fuels. Beyond this, scientists at DLR are also in the process of developing novel low-pollutant, flexible-fuel combustion chamber systems for micro gas turbines. Characterisation and optimisation of the components and plant concepts are being carried out on the micro gas turbine test bed at the Stuttgart-based DLR Institute of Combustion Technology. Technology transfer is being facilitated by project partner EnBW. Working together with the DLR researchers, EnBW implements the newly developed concepts as pilot plants so they can be tested. The potential of the new generating systems is demonstrated through operating these plants. This allows important technical and commercial parameters to be evaluated with a view to subsequent deployment at a customer site.



BIGH2

Gasification products from biomass

Gasification products from biomass have become the focus of great interest in light of the problems associated with the CO_2 produced by combustion processes. Depending on the type of biomass and gasifier used, the gas obtained will vary in the proportion of hydrogen, carbon monoxide, methane, carbon dioxide and water that it contains. Hydrogen-rich gas mixtures are also generated by numerous processes found in the chemical industry, and more use will be made of these for energy generation in future too.

The hydrogen products from these two classes of process are characterised by high flame velocity, a wide flammability range and high flame temperature. As a result, the ignition delay time of natural gas/hydrogen blends varies in a highly non-linear fashion according to pressure and temperature, a factor which must be taken into account in the design of combustion chambers for gas turbines.

The BIGH2 project, a collaboration with SINTEF Energy Research (Norway) and ALSTOM Power (Switzerland), aims to establish the operating conditions that will allow safe and efficient operation of gas turbines with hydrogen-rich fuel gas.

Developments in Polymer Fuel Cells

In-situ integration of spectroscopic methods in fuel cells

Making useful advances in the development of fuel cells relies heavily on the understanding of microscopic processes at cell level. Analytical, in-situ methods and spectroscopic analysis are therefore of great importance. The number of applicable in-situ methods is, however, limited by the fact that the active layers in the cells are inaccessible to many spectroscopic methods. In a cooperative project with the Working Group for Liquid-phase Laser Spectroscopy at the University of Düsseldorf, headed by Prof. Bettermann, DLR has successfully developed an effective measuring cell that integrates Raman spectroscopy for the purpose of studying processes in polymer fuel cells. Numerous series of tests using various cell concepts were required before success was achieved. Using the successful configuration, it is now possible to record parallel spectra at seven different positions on the active surface of the cell. The results of the investigations can now be compared directly with the localised current density distribution, which is recorded using segmented bipolar plates developed at DLR. The laser beam can also be used to study the reactant distribution in the gas diffusion layer. It is anticipated that this will provide important new information on the water budget of the cell and the concentration distribution of the reactants and products in the cells, thereby making a significant contribution to improving the reliability and lifetime of fuel cells. Similar developments looking at the integration of spectroscopic methods in high-temperature solid ceramic fuel cells are already being pursued within the scope of internal DLR projects.

QUARZ

Test and Qualification Centre for Concentrating Solar Power Technologies now open

On June 09, 2009 DLR inaugurated its new Test and Qualification Centre for Concentrating Solar Power Technologies (QUARZ) in the presence of Dr. Urban Rid, Ministerial Director of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). From this point forward, the tests beds and large-scale facilities will be available to manufacturers and customers of solar-thermal plant equipment for testing the quality of essential components such as mirrors and absorber tubes. These quality tests are also important for operators and project financiers, since non-optimised plants produce between five and ten percent less electricity.

The market for solar-thermal power plants is developing at a dynamic pace. The majority of plants are currently in planning or construction in Spain. However, the USA and other Mediterranean countries have already started to tap into the enormous potential for solar-thermal power in their territories. At the same time, operators are starting to face pressure to reduce the cost of electricity production due to increasing competition. This means that product quality and longevity are becoming ever more important as manufacturers, operators and project financiers come to expect systems to operate for decades in large solar arrays. The new Test and Qualification Centre will allow the DLR Institute of Technical Thermodynamics to provide better support than ever to help manufacturers and operators of generating plants face these challenges in the future.

The facilities and test beds at the newly enlarged premises of the Solar Research department of the DLR Institute of Technical Thermodynamics in Cologne, Germany, were constructed with financial support from the BMU. They enable DLR to test components for solar thermal power plants on behalf of manufacturers and customers. The facilities also allow current standards and test methods to be evaluated and extended. The possibilities offered by the facility range from materials testing, through prototyping and quality control for standard production, to product specification and product monitoring.

Solar simulator in DLR test laboratory

Official opening of QUARZ, June 09, 2009

Project Management Agency

Project Management Agency for Aeronautics Research

Sustainable funding of aeronautics research

The Project Management Agency for Aeronautics Research (PT-LF) supports the Federal Ministry of Economics and Technology (BMWi) in implementing the German Federal Aeronautics Research Programme (LuFo), as well as providing support to the states of Bavaria, Hamburg, Brandenburg and Rhineland-Palatinate in running their own development programmes and projects to complement to the federal programme.

The Federal Government's engagement in civil aviation research, which has already increased significantly in recent years, is further strengthened by the implementation of the 4th Aeronautics Research Programme (LuFo IV).

With additional projected funds of 140 million euros between 2010 and 2013, LuFo IV now has a funding volume of 590 million euros and an annual funding total of 123 million euros for 2010, which will be increased by a further 10 million euros in 2011.

Through this programme, the Federal Government is delivering a stable platform for sustainable research in the aeronautics sector and is allowing industry, major research establishments and universities the opportunity to push forward with urgently necessary research work despite the difficult economic climate.

Alongside the federally funded work, the states have also broadened their efforts in the area of aeronautics research. The state of Lower Saxony has initiated its own programme in support of aeronautics and tasked the PF-LF with its implementation. This means that the PF-LF now oversees the regional aeronautics research activities of a fifth federal state in addition to the states of Bavaria, Brandenburg, Hamburg and Rhineland-Palatinate. The number of projects handled by PT-LF on behalf of the federal states in 2008 was 67.

During the reporting period, all projects submitted under the second call for proposals to LuFo IV started on schedule. In 2008, a total of 168 new federal technology projects were started in addition to the 262 ongoing projects at federal and state level.

The third call for p roposals under LuFo IV is offering 150 million euros in funding and it is expected that 158 new projects will be approved in 2009. The research activities associated with these projects must be completed during the period from 2010 to 2013.

The federal and state-based aeronautics research activities are incorporated in the European Framework Programme for Research and Technological Development. In order to ensure coordinated advancements at regional, national and European levels, the PT-LF, on behalf of the BMWi, also serves as a national contact point for the field of aeronautics research within the 7th EU Framework Programme for Research and Technological Development.

The technological skills acquired through the federal and state aeronautics research programmes have made German companies and research establishments into highly sought-after partners for the European research consortia. It was therefore possible to maintain the high return flow of funds from the European Framework Programme to Germany at a level close to 24 percent when the 7th Framework Programme for Research and Technological Development came into force.

The EU ERA-NET "AirTN-Air Transport Net" project with 27 partners from 18 European countries, which was managed by PT-LF as its coordinator, also made a contribution in this regard. During the course of this project, the partners were successful in forming the first cross-border research associations, which combined specific expertise from the different member states and utilised this for mutual benefit in the respective national programmes. The coordination of national programmes and funding mechanisms has also been met with a great deal of interest outside of AirTN. Thanks to the successful completion of AirTN, work is now underway to prepare a second phase and recruit additional members to the project consortium. According to the current planning status, AirTN2 is due to begin during the course of 2009.

In addition to the above, Germany continues its two-year spell as chair of GARTEUR (Group of Aeronautic Research Europe), the oldest research network among the leading European aeronautics nations and the core membership group within AirTN, and also assumed the chair of the GARTEUR Executive Committee for 2008-2009 on behalf of the BMWi.

As Project Management Agency for the BMWi, the PT-LF holds a central position as a service provider and source of knowledge in the field of aeronautics research at regional, national and EU levels, and is therefore in a position to effectively support the BMWi in its efforts to provide coordinated and efficient funding for aeronautics research in Germany and to avoid duplicate funding. This special position is unique among the equivalent institutions of the European partner countries. Furthermore, as the coordinator of the European ERA-NET „AirTN" project, DLR's PT-LF now also has established links with virtually all ministries and their agencies in the field of aeronautics research and has at its disposal an expanding knowledge base relating to aeronautics research in these countries.

DLR Project Management Agency

Managing almost 6,000 projects

The DLR Project Management Agency, PT-DLR for short, has positioned itself as a specialist provider of services in the areas of research and education funding and project management. In doing so, the PT-DLR operates at both national and international level. Its clients 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 EU Commission, numerous state ministries and various private entities.

At the end of 2008, PT-DLR employed 678 members of staff. In comparison with the previous year, the total funds overseen by PT-DLR for the financing of research increased by 11.7% and reached a funding volume of around 746 million euros (see Table 1). PT-DLR oversaw a total of around 5,900 projects in 2008.

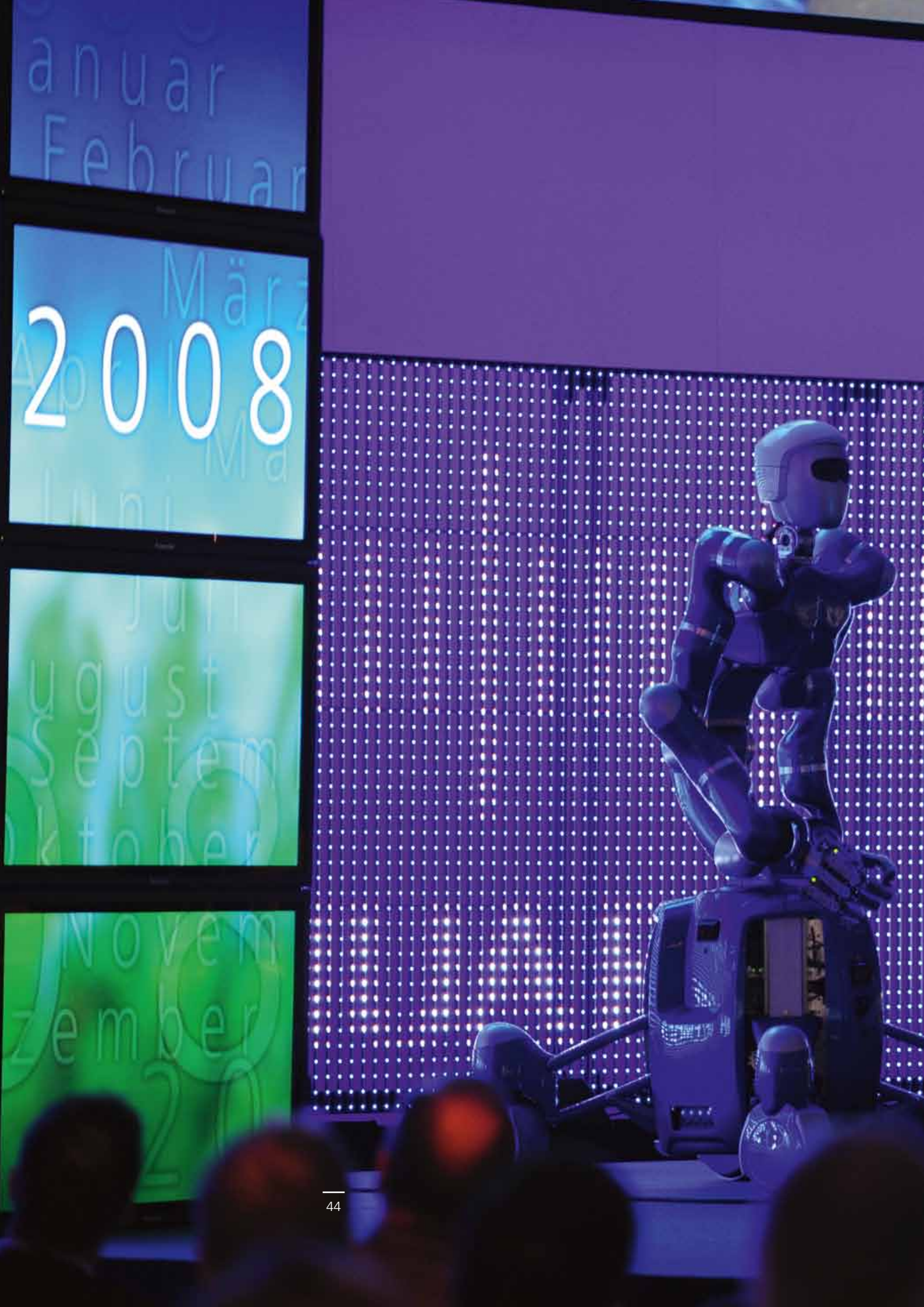
The range of subjects represented by PT-DLR's portfolio is extraordinarily broad and covers the majority of today's most important scientific and technological interest areas. Fields covered include health research, environmental research, sustainability research, information technology, new media in the economy, research into development of work and services, education research and gender research. The Project Management Agency also incorporates the national contact points for the EU programmes and the European research initiatives COST and EUREKA, as well as the EU office of the Federal Ministry for Education and Research (BMBF). The international office of the BMBF at PT-DLR oversees international cooperation in research and education in all regions of the world. Furthermore, the Public Auditors of the Federal Ministry of Education and Research for projects co-financed by the European Social Fund (ESF) can also be found at the Project Management Agency. Through its many years of experience in the areas of research and education funding and project management, PT-DLR has developed a very good network of contacts with research agencies, research establishments, expert committees and renowned experts in the national and international research community.

PT-DLR was again able in 2008 to strengthen its position as Germany's largest project management agency for research, development, education and innovation. The growth in the field of "Health Research" translated into a wide range of specific funding priorities. The area of "Development of Work and Services" experienced particular growth through the management of substantial funds from the European Social Fund. In order to better focus on the various activities dealing with the cultural and social aspects of the sustainable development of the environment, these were consolidated under the umbrella of "Humanities and social science, socio-ecological research". In addition to this, a new working group for "Empirical Education Research" was established. International topics also continue to gain in importance. The international office of the BMBF at PT-DLR was expanded through the addition of the new working group on "EU Cooperation with Third Countries". Meanwhile, the "European Programmes" department saw the establishment of the "National Contact Point of the European Research Council", which will conduct its work in collaboration with the German Research Foundation. Otherwise noteworthy is the fact that, following the the success of the "Year of Mathematics 2008", PT-DLR was once again engaged by the BMBF, this year to organise the "Year of the German Research Expedition 2009".

A detailed discussion of PT-DLR's programmes and our work during 2008 can be found in our annual report, available on the Internet under "Service & Links/Publications" at www.pt-dlr.de (German only).

Allocation of budget resources (K euros)	2007	2008
Health Research/Human Genome Research	190,100	217,300
Information Technology	192,800	196,500
Environment, Culture, Sustainability	91,000	120,100
New Media in the Economy	47,600	58,800
Development of Work and Services*	23,700	33,500
Education Research*	24,500	28,100
Humanities	22,000	26,600
Skills Agencies*	15,500	13,900
Innovation-oriented Research	14,700	12,500
New Media in Education, Higher Education Research*	21,300	12,100
International Office	11,600	10,300
Science Years Office	6,600	7,900
Equal Opportunities/Gender Research*	6,900	7,400
Empirical Education Research	0	800
Eurostars	0	200
Total:	**668,300**	**746,000**

*Co-financed with funding from ESF (European Social Fund) Socio-ecological Research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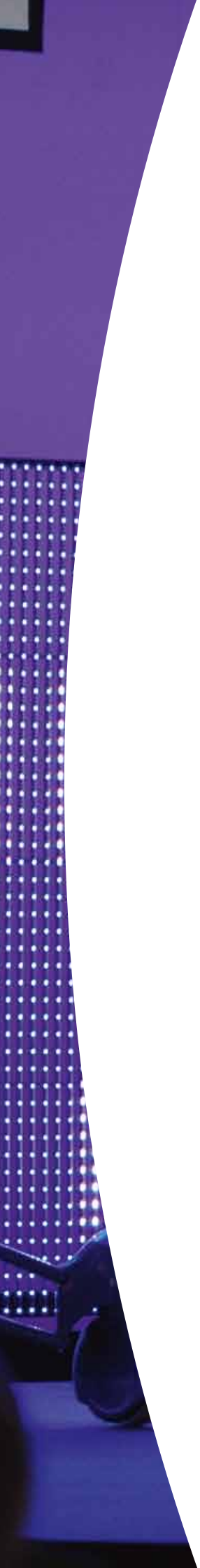


ECONOMIC DEVELOPMENT

Future Development of DLR

Current Activities

DLR's overall strategy is reviewed and revised every three to five years. The kick-off meeting for updating the DLR's company-orientated overall strategy, focussing on the next 10 to 15 years, took place in spring 2009 and was attended by members of the DLR Executive Board and directors. The guiding principles are currently being further discussed with the intensive participation of all employees of the research centre. The goal is to develop a vision and mission that is shared by all. Supported by an analysis of internal operating conditions and those of the working environment, concrete performance indicators and measures are being discussed which will help in achieving a common vision. Discussions being held throughout DLR and the opportunities that each one brings to the table create identification with the vision and mission and DLR as a jointly recognised unit.

With the updated "general focus of DLR", DLR is reacting to external developments and defining priorities for the coming three to five years. The general focus constitutes the framework for all activities and provides a basis for agreements on targets at all levels of DLR. Discussing the new general focus is an integral part of the strategic process "develop the vision, identify goals, derive measures". This process is integrated into DLR's management processes.

In order to develop DLR, Prof. Wörner initiated an internal project ZPO (Goals, Processes and Organisation) in November 2007, which implemented his ideas on governance. In October 2008, statements were made on the following topics: "From Strategy to Operational Implementation", "Management System", "Technology Marketing/Cross Transfer" and "Management of Investments and Large-Scale Facilities". Members of the Executive Board, representatives of the heads of the institutes, the Scientific-Technical Council (WTR) and programme directorates were involved in concept development and decision-making, in addition to the specialised staff and the Controlling and Strategy departments.

Implementation is currently being realised by small working groups, and decisions from the ZPO project are being approved and converted into operative processes. In the meantime, a DLR management document, the "Handbook for Programme Planning in the Planning and Management Process" has been largely revised and approved by the Energy programme directorate. Internal revenue corrections have been avoided by means of budget adjustments. Management instruments for governance of DLR are currently being drafted. This includes the creation of an institute business plan by each institute and facility, which contains the institute's ongoing and planned activities and serve as guidelines for discussions on agreeing targets. General management of this is the responsibility of the specialised aviation staff. A specific budget has been prepared for cross transfer activities, which offers enhanced incentives for technology transfer in other technology areas. A central Investment and Research Infrastructure Management department governs and accompanies the comprehensive investment measures.

Results

Third-Party Funding

In the 2008 reporting year, we were once again able to record an increase in third-party financed revenues from the core "Research and Development" process. Third-party revenues increased compared to 2007 by 14 million euros to a total of 308 million euros and account for 51 percent of DLR's overall budget. A further increase in revenue from domestic commercial enterprises was one of the contributing factors for this result. The 7.9 million euro increase results in a percentage change of 11 percent over the preceding year. In contrast, the proportion of revenue from foreign clients has decreased slightly by 1 percent compared with the preceding year. The reduction in revenues from foreign commercial enterprises amounts to 4.2 million euros. This is attributable primarily to projects at the Lampoldshausen site. On the other hand, the proportion of ESA revenues has increased.

Likewise, an increase in revenues from federal project funding of 4.1 million euros has contributed to the overall result. This is attributable primarily to large-scale BMWi projects. Revenues from BMBF project funding have decreased. This is a result of the advanced status of the large-scale Halo project. Project funding from the federal states has also decreased. This is likewise due to the standardisation of revenues from this source of financing, which had an extraordinary effect on the construction of the new institute in Bremen and the large-scale "Aeronautics Infrastructure" project in Oberpfaffenhofen in 2007. Revenue from other state or public sources of capital, such as HGF and DFG, only increased slightly and almost consistently.

Third-Party Funding	2006	2007	2008
Overall revenue from third-party funding	Euro 255 m	Euro 294 m	Euro 308 m
Proportion of overall revenue from third-party sources	49%	52%	51%
Revenue growth in comparison to preceding year, commercial revenues from domestic R & D activities	41%	26%	11%
Proportion of revenue from foreign clients (revenue volume)	29%	22%	21%
Success rate of EU proposals in the last three years (accepted/submitted)	54%	47%	46%
Revenue from EU funding	Euro 17.3 m	Euro 19.9 m	Euro 19.7 m
Ratio of EU projects as coordinator vs. all projects	16%	13%	14%

Broadly speaking, the result in the EU project sector evened out at the level of the preceding year. The success rate for EU projects has virtually remained constant at 46 percent. Approximately 250 ongoing EU projects are handled annually. The revenue volume consistently accounts for around 20 million euros per year. At the same time, a trend toward larger-scale proposals has been observed. Around 30 percent of the projects account for a full-cost volume of over 1 million euros. With a value of 14 percent and an absolute number of over 30 projects, the proportion of EU coordinator projects has likewise remained almost consistent with the preceding year.

Research-related results	2006	2007	2008
Publications in peer-reviewed journals	495	511	442
Peer-reviewed publications in proceedings, books etc.	536	568	593
Presentations for scientific conferences, workshops and lectures*)	0.85	0.76	0.55
Appointments to universities	8	13	12
Lectureships	200	204	248
Student projects	318	326	384
PhD theses	78	83	94
Postdoctoral qualifications	4	4	2

* per scientific associate engaged by the institutes and facilities

Research-Related Results

Scientific quality is one of the most important criteria in the DLR research centre. Alongside the third-party funding procured, significant indicators of this are the scientific results that are made public in publications, presentations and courses. These include variations arising from year to year, which can mainly be attributed to project work, staffing fluctuations and activities relating to proposals.

There was a slight reduction in peer-reviewed publications in comparison to the preceding year, with a total of 1,035 for the reporting period. However, the lecturing activities of DLR's scientific staff remained at around the same level as in 2007. By contrast, there was a significant increase in lectureships and once again in student projects, which have been increasing year on year.

Technology Marketing

The political, social and industrial goals of national and international innovation policies, with the associated strengthening of technology transfer from publicly-funded research and development that these promote, are increasingly considered to be a significant success factor in the competitiveness of the national economy. Shortening the time-to-market of research results to market-ready products, processes or services is a vital prerequisite here. Through its outstanding research results and technological developments, DLR is able to provide complete value-added chains that extend from fundamental research, through application-orientated research and development, to new products and services.

Technology Marketing plays an important role in putting these requirements into practice within DLR. This activity shapes the development process at DLR, starting with determining the requirements of various industrial sectors, generating ideas for related new industrial applications, implementing the ideas with best market potential by means of technology transfer projects, and turning DLR expertise into something that is commercially beneficial. The main goals here are leading DLR technologies to market readiness together with commercial partners, acquisition of new customers, management of proprietary rights and providing support for start-up companies. Once again, DLR has set these goals and improved the general conditions for achieving them by establishing attractive avenues for financing patents and carrying out technology transfer projects.

Following on from the award of DIN EN ISO 9001:2000 certification for the processes employed by Technology Marketing for the first time in autumn 2005 and the achievement of the first stage of the EFQM "Committed to Excellence" model in June 2008, Technology Marketing was recertified in accordance with DIN EN ISO 9001:2008 in April 2009.

Examples of successful Technology Marketing

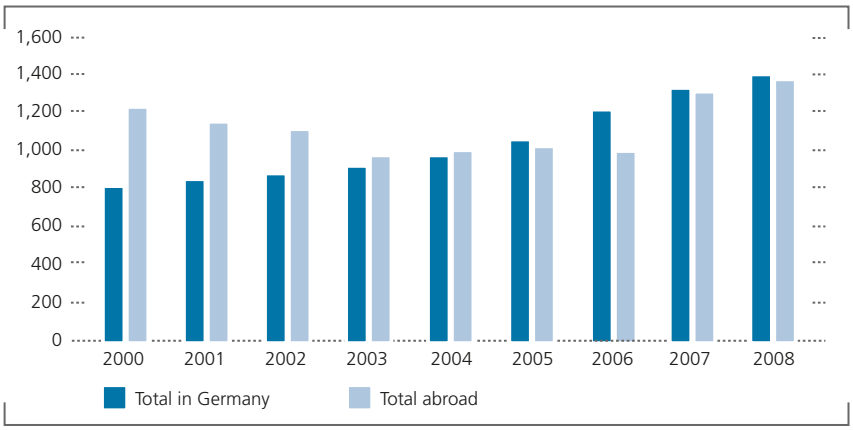
Thanks to the "Industrial Aerogel" project, new materials for casting cores have been developed. This relates to specific aerogel-related cores for engine casting as well as the addition of nano additives for foundry moulding materials. Here, aerogel granulate, as an additive for both conventional and aerogel binding agents, improves the formation of core materials, causing casting quality to increase and wastage to decrease. Furthermore, aerogel concrete demonstrators are being designed to demonstrate the outstanding characteristics of this new building material more effectively at trade fairs and to the general public.

Under the heading "DLR heart", a heart support system is being further developed in collaboration with Dualis MedTech GmbH by optimising the drive unit, pumping chamber (Ventricular Assisted Device / VAD) and wireless electrical transmission technology (Transcutaneous Energy Transfer System / TET). The applicabilities of these units are evaluated by means of continuous trials (in vitro) and acute and long-term animal trials (in vivo) as a basis for CE pre-approval studies on the animal model. The market potential for both components is immense, and DLR believes it has a very good chance of solving the problems relating to the durability and prevention of thrombogenesis associated with heart support systems currently on the market.

In collaboration with dr. wernecke Feuchtemesstechnik GmbH, DLR is developing an intelligent system for measuring gas trace humidity in extreme environments with high precision and reliability. The measurement system is to be used with technical gases in industry and in aeronautics. A transmitter for measuring gas trace humidity offers the following characteristics: it has a simple, economical and standard calibration, can be used in aggressive media (e.g. chlorine gas), has extensive cross-sensitivity compensation (temperature, pressure and flow), an extended measuring range of 0.1 ppm to 4000 ppmv and can be used in applications within a wide range of gas flow rates, gas pressure and temperature. A device with these characteristics has not come onto the market yet.

Within the context of advancing fuel cell technology, DLR is working with Otto Egelhof GmbH & Co. KG to develop highly-integrated components (structural elements and subsystem modules) for universally usable PEFC (polymer electrolyte membrane) hydrogen fuel cell systems on the basis of a cooperation/licence agreement. Egelhof is a supplier to the automotive industry, and this cooperation will enable it to supply automotive companies with the components they demand for electrical drive systems with an energy supply using fuel cells. Furthermore, Technology Marketing has supported the development of fuel cell systems for use in the aviation industry. In cooperation with Lange Aviation GmbH, BASF Fuel Cells GmbH and Serenergy, DLR has rigged up a power glider (ANTARES DLR-H2) powered by a fuel cell system. Its maiden flight took place in early summer 2009, making it the first aircraft in the world to get its take-off power from a fuel cell system.

Proprietary rights in Germany and abroad



The target of the "Innovative High Speed Laser Measurement System for Combustion Technology" project is to significantly improve combustion process diagnostics in order to reduce resultant pollutant emissions, increase the reliability of technical combustion systems and effect a fuel-flexible design of combustion chambers. To this end, a special disc laser is being developed with which two-dimensional distributions of important variables in the combustion processes are dynamically captured as snapshots (single laser pulse technology), using image generating techniques based on Laser-Induced Fluorescence (LIF) or Particle Image Velocimetry (PIV). The interaction between the flame front and the flow field in turbulent flames, which is responsible for many combustion phenomena, is examined in this way through the simultaneous use of two or more methods.

Proprietary rights

One important activity is the management of proprietary rights and licenses, which includes responsibility for building and maintaining the DLR proprietary rights portfolio. This comprises the supervising all marketing contracts with commercial entities, including the issue of licenses. The inventory of proprietary rights held by DLR now amounts to over 2,700 domestic and foreign patent registrations and patents, including EP and PCT registrations. In 2008, a total of 182 invention disclosures were submitted, several more than during the previous year.

The illustration shows that the number of domestic proprietary rights has been continually increasing over the years and now amounts to approximately 1,400 proprietary rights (patents, utility models and their registrations). Each year, the German Patent and Trade Mark Office publishes a list of the 50 most active patent applicants in Germany. In 2008, DLR occupied 28th place with 176 patent applications (see DPMA 2008 annual report at www.dpma.de). The only other research institution to be represented on the list is the Fraunhofer Society in Munich (14th place). The most active patent applicants are Robert Bosch GmbH in 1st place (with 2,645 patent applications) and Siemens AG in 2nd place (with 1,741 patent applications). However, looking at these figures in terms of the number of people employed by the aforementioned facilities, the ranking would be completely different: In 2008, DLR (approx. 6,000 employees) filed one patent application for every 34 employees, the Fraunhofer Society (approx. 15,000 employees) filed one for every 39 employees, Bosch (approx. 280,000 employees) one for every 105 employees and Siemens (approx. 400,000 employees) one for every 229 employees. This ratio must surely count as evidence that DLR has the ability to significantly advance the state of technology in its research areas.

Licenses

A turnover of approximately 4 million euros was achieved from licensing in 2008. License revenues are therefore at the average level of previous years.

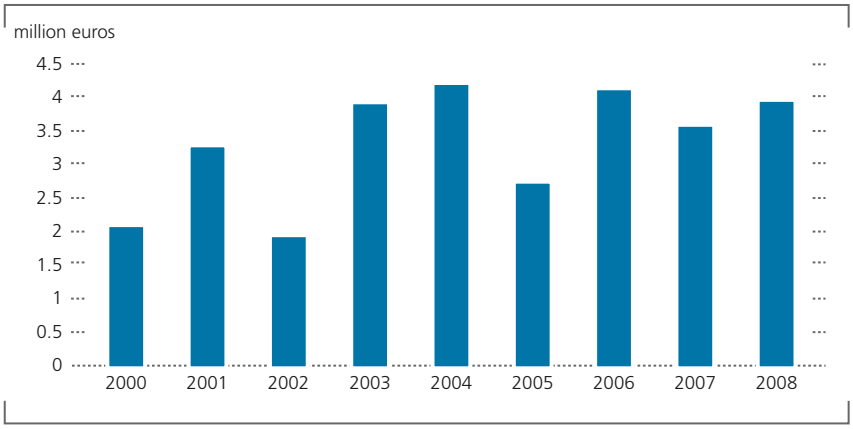
Start-up companies

Technology Marketing supports spin-off companies originating from DLR institutes and departments. Employees who are keen to establish a start-up are prepared for their independence with appropriate advice on selecting and maturing the technology, partly via technology transfer projects, and receive help in developing their business plan. DLR provides these young companies with a "Road to Market" for the technology from DLR. The companies are equipped with licenses to utilise DLR technologies and turn these into value-added applications. These in turn provide not only the expectation of license income in the long term, but also third-party revenues for the institutes in the short term via placing of development contracts between spin-off companies and DLR.

Alongside their purely commercial effect on the business activities at DLR, these support initiatives also offer an attractive prospect for interested employees and their career perspectives. Both the experience of commercial practice and the chance to join a young company built on DLR technologies can provide the basis for a professional future, particularly for staff working on temporary contracts.

Companies have the option of obtaining financing from the German High-Tech Gründerfonds, which acts as a financial partner and was set up to finance start-up companies by the Federal Ministry of Economics and Technology and notable companies. The Kreditanstalt für Wiederaufbau (Reconstruction Loan Bank) and state banks (regional funds) also maintain financing options for these companies.

License revenues



Technology Marketing supports DLR institutes and facilities in the preparation of proposals and, together with the Legal department, the structuring of contracts with these companies covering collaborative work and licensing issues. In the future, DLR will continue to act as a shareholder in commercial enterprises that aim to put technologies from DLR at the heart of their business activities. New concepts and models are currently being developed for equity holding by DLR.

Structure and Organisation

Development of the Research Centre

Administrative infrastructure

DLR achieved success within the context of the Economic Stimulus Package I with five measures in the total sum of 15.9 million euros. Administrative Infrastructure required professional support during the purchasing process for implementing these complex investment measures. As the projects are to be implemented in 2009, tight time constraints apply to those involved in implementation. For this reason, all measures from the economic stimulus package are implemented in project form. Project management for the administrative support of measures has been handed over to an experienced employee from the purchasing process. A reporting system has been designed which is suitable for the project. However, the overall team composition has proved to be more difficult, as day-to-day business in the purchasing process must not fall behind when implementing significant measures from the economic stimulus package. Purchasing, the leading organisational unit, has a problem with recruitment in that not all advertised positions are currently being filled by appropriately qualified staff. DLR is calling on the assistance of a temporary employment agency in order to solve its staffing issue.

DLR's Administrative and Technical Infrastructure (ATI) is subject to evaluation by external and internal advisers (heads of institutes) every five years. The next evaluation is planned for November 2009. Preparations for this have begun. The outstanding evaluations will focus on the following:

- Implementing targets and strategies
- Increasing the efficiency of business process management
- Appropriately matching commercial information systems to internal customer requirements (institutes/facilities)

Construction management

Following the completion of the Construction Management (CM) reorganisation and the incorporation of the CM West Region (Cologne site), additional potential for optimisation has been identified alongside newly obtained experience when addressing construction activities. This resulted in necessary changes within the framework of continuous process improvement (CPI), which have been incorporated into the flow and organisation of core processes. This includes reviewing the requirement plan in consultation with the institutes and facilities, as well as modifying the process steps when addressing "unscheduled construction activities". As a result, the adjustment necessary to meet individual user requirements as well as the processes involved can be optimised in terms of efficiency.

The positive results of the construction monitor that have already been achieved in the practical testing phase will lead to the preparation of document management, proposal guidelines and cost monitoring during the next development phase. Integration into DLR's existing IT infrastructure is a priority when further developing the construction monitor.

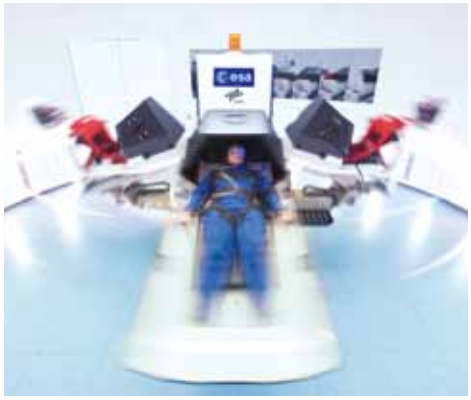
In spring 2009, within the context of the Economic Stimulus Package II set up by the Federal Government, DLR submitted 17 proposals for promoting construction and reconstruction activities amounting to 40 million euros.

Military science research

In November 2008, the DLR Executive Board resolved to set up the organisational unit "Programme Coordination for Security Research", which reports directly the Chairman of the Board. The Executive Board assigned this organisational unit the task of coordinating DLR's defence research and representing DLR, both internally and externally, in matters relating to defence technology and security research in consultation with the Executive Board. Coordination is subject to the programme guidelines agreed with the Federal Ministry of Defence (BMVg):

- Airborne platforms
- Satellite and sensor technology
- Impact, protection and materials
- Safety and dual use

Topics and detailed content-related planning for the programme guidelines are determined between the Federal Ministry of Defence's relevant organisational unit



Scientific competitions at DLR. Left: DLR Centre of Excellence, Space Life Sciences with its short-arm centrifuge Right: Executive Board, scientists, representatives of the programme directorates and representatives of the Strategy department during the final round of the "Visionary Projects Competition 2009/2010" in January 2009

and DLR's Program Coordinator for Security. "Programme Coordination for Security Research" is the central contact for the Federal Ministry of Defence, the industry and other research institutes with a defence or security focus. The vacancy for Programme Coordinator for Security Research is currently being advertised.

Construction of the organisational unit will be implemented shortly after the appointment is made. After this, the Federal Ministry of Defence and the Programme Coordinator for Security Research will determine the future topics and detailed content-related planning for the programme guidelines.

The Executive Boards of the Research Establishment for Applied Science (FGAN) and the Fraunhofer Society signed a merger agreement in Munich on June 24, 2009, in which the Fraunhofer Society assumed all the rights and duties of the FGAN under the principles of universal succession. Previously, under the leadership of the BMVg in collaboration with the FGAN, a strategic partnership position paper was drawn up between the FhG-FHR (Fraunhofer Institute for High Frequency Physics and Radar Techniques) and DLR-HR (DLR Microwaves and Radar Institute).

Scientific competitions at DLR

The technological studies for the third round of the "Visionary Projects Competition" are in full swing. The Executive Board advertised the competition in November 2008, encouraging mainly young researchers to submit their innovative and creative ideas for future technologies. On the basis of predetermined criteria, an internal jury selected the 10 best from more than 50 submitted ideas and, in January 2009, the Executive Board made a decision regarding funding. The 10 research groups competed for the award by contributing to a series of short and concise presentations. The technological ideas had to be both visionary and, at the same time, realisable. The Executive Board selected the Energy topic "Fuel from the Sun", the Materials topic "Agents in Resin" and the Drive topic "Laser Drives in Space" for 90,000 euros of funding per year for two years. The topics "CFRP with super coating", "EDDY" for early detection of hurricanes and "Urban 3D Mapping" will receive a lower level of funding of 10,000 euros per year for two years. After the assistance, the researchers will conclude their studies and present their findings to the Executive Board.

Once again, the selection process in the institute-orientated competition "DLR Centre of Excellence 2009 to 2011" (DLR-CoE) was a head-to-head race. The Executive Board rewarded two topics: "CAESAR Centre of Advanced Experimental Simulation Tools for Aerodynamic Research" and "Space Life Sciences". The DLR-CoEs commenced activities in 2009. Each of the two DLR-CoEs will receive 500,000 euros in funding, split over three years, in order to further develop their expertise.

Quality Management, Standardisation, and Environmental Protection

Quality management	2006	2007	2008
Existing certifications & accreditations	16	19	25
Number of DLR auditors	14	15	15
Implementation of audit	24%	29%	32%

Quality Management

Excellent scientific advisors, high third-party revenues and our growing number of employees are just some of the indicators for the success of DLR's customer relations in the public and private sector. DLR operates a sustainable quality management system designed to support the DLR managers and to maintain successful customer relationships through outstanding research results and high-quality scientific and technical services and products.

The management process designed by the Executive Board's Quality Board provides the framework for our institutes and facilities that enables them to establish and operate their management systems independently. This management process has been certified in accordance with DIN EN ISO 9001 since 2003 and was successfully recertified for the second time in March 2009. At the same time, the external auditors acknowledged DLR as having a high level of professional competence in this area.

With its Quality Management department, DLR has been pursuing the objectives of not only maintaining its competitiveness but also increasing it, stabilising legal security and providing integrated management support.

DLR's quality policy combines quality, safety, environmental protection, and sustainability. It provides the basis and initial point for an integrated management system. The DLR Code of Conduct constitutes the directives of ethical behaviour concerning DLR and its partners. In the Code of Conduct, DLR creates and enhances the ethics in scientific work, the maintenance of corporate regulations and values according to the United Nations Global Compact, e.g. work life balance, employees' career advancement, health and safety for all staff, as well as accountability for the environment and DLR's regional and international social relations.

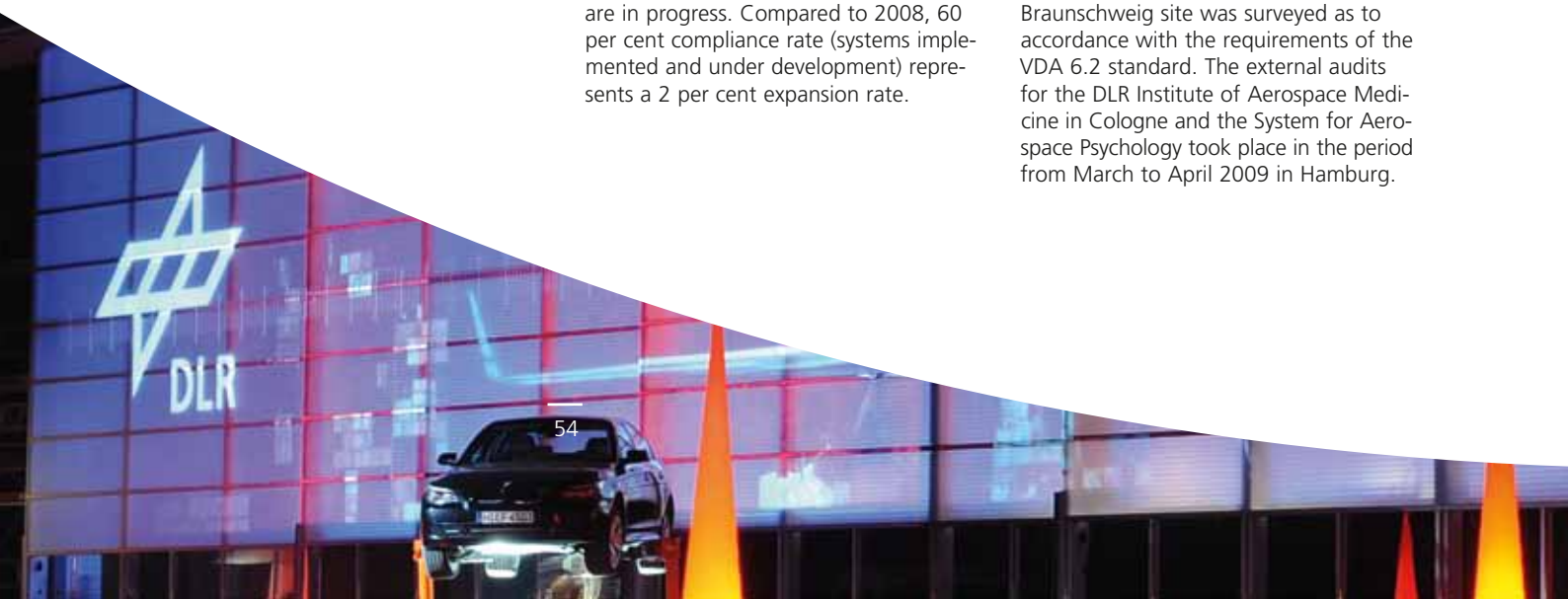
Within the Helmholtz Association of German Research Centres, our integrated quality management system is one of DLR's unique selling propositions.

In 2008, quality management systems were implemented and certified in 19 institutes, facilities, and organisational units; additional twelve institutes and facilities are in progress. Compared to 2008, 60 per cent compliance rate (systems implemented and under development) represents a 2 per cent expansion rate.

The development core focussed on the extension of existing systems by coverage enhancement. Additional performance processes have been implemented as well as management system requirements augmented. The trend toward integrated management systems is continuing. The quality management process turns out to be the mainspring of the system establishment by integrating safety at work as well as environmental aspects.

Certification qualification for the Institute of Composite Structures and Adaptive Systems was approved in autumn. The test laboratory of the Institute for Space Systems was reaccredited in November 2008. At the same time, the Administrative Infrastructure successfully completed the external surveillance audit. The external audit of the Applied Remote Sensing Cluster approved the successful assimilation of additional operational units into the management system.

The Space Agency, the DLR Institute of Flight Guidance and Technology Marketing were successfully recertified in December 2008, January 2009 and March 2009 respectively. In January, the DLR Institute of Transportation Systems was monitored at both sites as to compliance with DIN EN ISO 9001. Additionally, the Braunschweig site was surveyed as to accordance with the requirements of the VDA 6.2 standard. The external audits for the DLR Institute of Aerospace Medicine in Cologne and the System for Aerospace Psychology took place in the period from March to April 2009 in Hamburg.



The surveillance audits for the Integrated Management System of Space Operations and for Technical Services (including the industrial training division) took place in April 2009. The Materials Testing Laboratory for Fire Behaviour (MTB, Trauen) at the Institute of Propulsion Technology was also assessed for certification qualification in April 2009. The first external audit of the management system of the Programme Directorate Transport as well as the audit of the Centre for Combustion Technology in May 2009 resulted in successful certification in accordance with DIN EN ISO 9001. Qualification for certification of the Internal Auditing and Joint Venture Management department's system as well as qualification for accreditation of the Simulation and Software Technology facility's software engineering laboratory in Braunschweig was determined in June 2009.

DLR is a member of the European Foundation for Quality Management (EFQM). During the reporting year, DLR employees continued taking advantage of the EFQM assessor training offered in DLR's training programme. Once again, DLR took part in selecting the winners of the 2009 Ludwig-Erhard Prize with one assessor.

According to the EFQM model, an external evaluation was performed in the Administrative Infrastructure in December 2008, the first self evaluation of the Technical Services in spring 2009. Technology Marketing commenced preparations for achieving the "Recognised for Excellence" level.

On the occasion of the 2008 annual general meeting in Oberpfaffenhofen, the DLR Quality Prize was awarded for the sixth time. The award went to the Quality Representative of Space Operations and an external service provider.

Regarding DLR's supplier part, our customers' and partners' demands to assess DLR in all and / or the individual institutes and facilities by means of audits or by requiring a certificate still remain at a high level.

Several requirements already exceed the ISO 9001, e.g. Airbus and Rolls-Royce demands EN 9100, EADS ISO 14001.

Since September 2004, employees being able to certify sufficient expertise and an effective knowledge of DLR applicable processes have been appointed DLR Auditor. During the reporting period, these 15 auditors performed 32 per cent of planned system audits. By reason of enabling mutual monitoring across all DLR facilities, we aim for a significant increase of DLR auditors.

The directives in terms of investment protection in software development have been integrated into the management system and currently pass through the introduction phase. Early in 2009, safety standards appointed by the Central Safety division were published using the integrated system. The inventory and surveillance of all product-relevant measurement and test equipment used in DLR have begun. Appropriate software support has been successfully established. The inventory should be completed by middle of 2010.

Reviewing the process of evaluating the internal and external customer satisfaction as well as creating recommendations for the project management with facility-spanning cooperations are essential tasks at hand. Currently, the entrenchment of the safety concept in DLR's management system is in progress. The working group of quality representatives recommended the entrenchment of the scientific results assurance process in the management system as well. This has now been assigned and is in progress.

Standardisation

Expertise in standardisation as a strategic management instrument provides competitive advantages and benefits, based on the associated leap forward in knowledge and corresponding head start. In Germany, the economic advantages due to standardisation are determined as being around 16 billion euros per year.

Standards facilitate global trade and international cooperation. They conduce to rationalisation, quality assurance, environmental protection, and safety. They contribute to deregulation by exonerating the state from technically detailed regulations. Standards play a major role in deciding the opportunities for market access of new product development and its positioning against European and international competition. They guide the transfer of knowledge and promote innovative potential and technology convergence.

DLR actively cooperates with the leading standard organisations on a national, European, and international level, e.g. DIN, CEN/CENELEC, and ISO. Together with the other European space agencies and European aerospace industry partners, DLR is working on developing consistent standards for aerospace projects in the European and international associations ECSS, CCSDS and ESCC. More than 300 standards and over 1,000 specifications have already been developed.

In 2006, the Federal Ministry of Economics and Technology began a long-term project initiative "Innovation with Norms and Standards", which is being coordinated by DIN. In 2007, DLR successfully completed a "Technology Readiness Level" standardisation project as part of this initiative in cooperation with EADS Space Transportation and the DIN Aerospace Standards Committee. The result is proposed as an ISO standard. Standardisation of research results within DLR is implemented accompanying research and development at the various institutes and facilities coordinated and supported by the standardisation section being part of standardisation and EEE-parts division of the quality and product assurance department.

For the 2009 project year, DLR received an award for three standardisation projects:

- Force Limited Vibration Testing (FLVT)
- Wind tunnel experiments for EN 14067-6 on evaluating the effect of side winds on rail vehicles
- Dependability of traffic situation illustrations.

For the 2010 project year, eight proposals for standardisation projects concerning the DLR Aeronautics, Space, Transport, and Energy segments have been submitted.

Environmental protection and safety

Along with the numerous and varied research activities and developments in the fields of environmental protection, conservation of resources and emissions reduction, operational environmental protection and the health of employees are firmly anchored in the organisational policy as goals of equal importance to the success of the business and other social aspects. This intention is highlighted in DLR's Code of Conduct.

The management activities should be deepened once Technical Services has become an infrastructure service provider for technical issues. The status of the proprietary system in accordance with ISO standards 9001 and 14001 has been strengthened through activities based on the European Foundation for Quality Management (EFQM) and Balanced Scorecard (BSC) models. With the EFQM model, additional aspects such as an integrated strategy, market observation, the image of the organisation, social impacts and sustainable economic activity are incorporated in a structured manner. An annual report based on nine internationally recognised criteria highlights the cooperation, evaluates the management system and also presents the developments quantitatively. At the same time, strengths and weaknesses are systematically carved out and key optimisation opportunity areas are determined. The latter are also incorporated into the catalogues of measures or agreements on targets. The BSC keenly promotes target determination within the facility with annual agreements in the line organisation, as well as the generation of adequate operating figures. It is this alone that makes well-founded comparisons with excellent infrastructure service providers in research, administration and economics possible and provides an opportunity to learn from the best. During the last audit in March 2009, the certifying body acknowledged Technical Services' high level of professionalism, which was attributed to this approach.

DLR's quality framework system is continually being extended in terms of environmental protection and safety. The relevant standards, such as ISO 14001 and OHSAS 18001, already have significant importance for the certification activities undertaken in the various institutes and facilities run by DLR. A working group was established to facilitate the harmonious integration of the systems. The entire Lampoldshausen site with its integrated management system was successfully audited once again. DLR's safety and environmental protection standards have been further supplemented. One example of this is the CE (Conformité Européenne) certification of machines designed and constructed in-house.

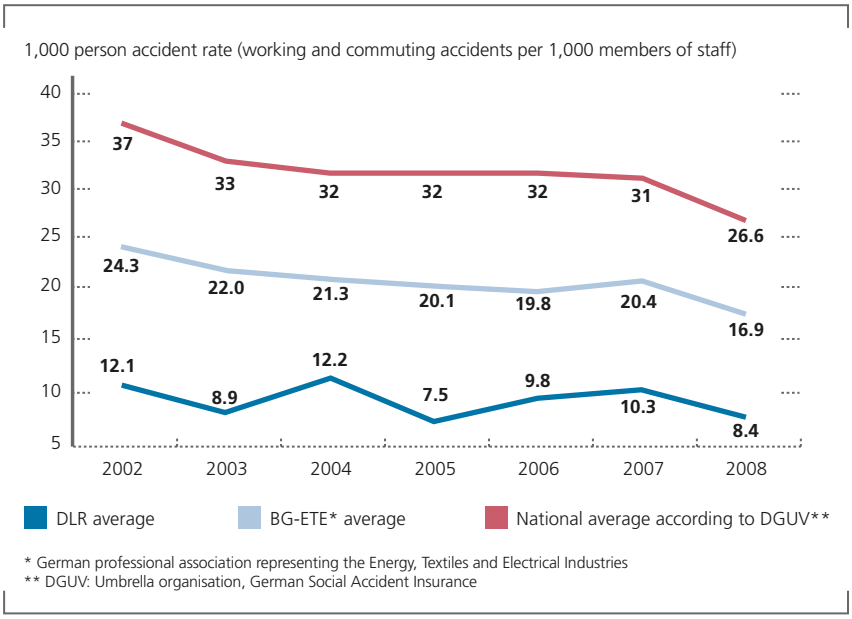
There is a focus area in the field of energy efficiency and thermal insulation as a consequence of an increasing requirement for buildings and facilities for developing research. Various federal programmes are incorporated here in over 15 projects. When it comes to construction and reconstruction activities, DLR is committed to complying with the "Sustainable Construction" guidelines issued by the Federal Ministry of Transport, Building and Urban Affairs (BMVBS). All phases of a building or facility cycle are taken into consideration in order, for example, to reduce the requirement for energy and materials, to minimise waste and to lengthen the lifecycle. Suppliers, service providers and users are also included in this. On the subject of "Green IT", activities in the field of waste heat recovery have also been initiated. In the field of energy production and use, the focus is on technologies for reducing CO_2 such as environmentally friendly heat pumps and waste water treatment systems using sunlight.

DLR is also obliged to address the issue of legacy waste. For example, extended ground and groundwater cleansing with filter systems is carried out by remediating excavated material. Even pipework had to be cleansed due to contaminants.

A particular focus area for safety and environmental protection was internal communication, which was further improved through ongoing development of the Internet application (www.umwelt.dlr.de) and further training of selected target groups, such as the next generation of managers. Information events for employees, such as an Environment, Health and Safety day in Stuttgart, have also been provided. Additionally, personal health checks, fitness and nutrition consultations and flu jabs are offered. Travel medicine and workstation ergonomics are also popular topics. Provisions for a pandemic constituted a focus area within the field of risk communication. Numerous activities were introduced such as establishing a crisis management group, creating a pandemic handbook with references on the intranet and holding emergency funds in readiness at DLR. In this way, employees receive relevant information regarding prevention and on how to behave in the case of such an event.

The number of accidents at DLR was significantly lower than the national average as a result of the comprehensive preventative measures (see illustration). With an incident rate of 8.4 accidents per 1,000 employees during 2008, DLR was well below the national average of 26.6 and had only half the average number reported by the employers' liability insurance associations of 16.9. Structured operating figures in the large research institutions have been generated and compared within the Helmholtz Association since 2008. Here, the per 1,000 person rate of 7.5 falls just below our DLR values. DLR recorded 51 notifiable accidents, of which almost half occurred away from the workplace, either while travelling on business or commuting between home and work.

Accident trends at DLR



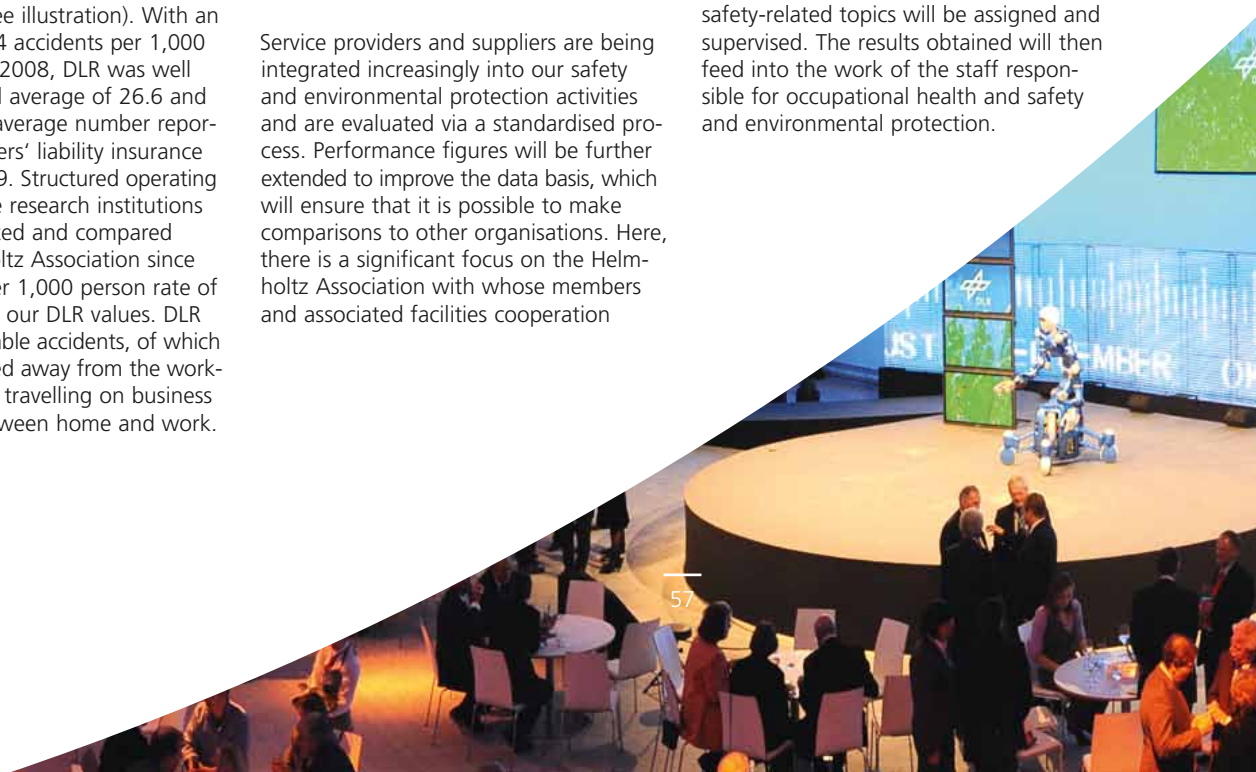
* German professional association representing the Energy, Textiles and Electrical Industries
** DGUV: Umbrella organisation, German Social Accident Insurance

The majority of workplace accidents fell neatly into the categories of falls, trips, sprains, cuts and skin-penetrating injuries.

No fatal accidents occurred in the year under review. Although this relative figure has decreased, the days lost and associated costs have increased by almost 15 percent. This amounts to increased accident severity.

Service providers and suppliers are being integrated increasingly into our safety and environmental protection activities and are evaluated via a standardised process. Performance figures will be further extended to improve the data basis, which will ensure that it is possible to make comparisons to other organisations. Here, there is a significant focus on the Helmholtz Association with whose members and associated facilities cooperation already exists. This optimisation process will continue to be accompanied by regular, integrated audits, for which special DLR auditors are being trained.

Prominence will also be given to the field of environmental protection and safety in the programmes we offer to support the next generation of academics and specialist networks. Student projects on safety-related topics will be assigned and supervised. The results obtained will then feed into the work of the staff responsible for occupational health and safety and environmental protection.



Relations

Helmholtz Association of National Research Centres (HGF)

Programme development

By means of the appraisals within the Energy research area, DLR was able to associate itself with the outstanding evaluation results of the previous round of programme-orientated funding. The future positioning of the research activities in the three energy programmes with DLR participation, "Rational Conversion and Use of Energy", "Renewable Energies" and "Technology, Innovation and Society" has been assigned to the international top flight by the assessors in each case. The second funding period has begun in the Aeronautics, Space and Transport research division. The activities agreed according to the evaluation will be expanded due to the construction of the DLR Centre of Robotics, Mechatronics and Automation using additional funding from the state of Bavaria and the Federal Ministry of Economics and Technology.

Initiative and networking fund

The Space Life Sciences Research School (SpaceLife) is being supported by the fund for six years. This course of lectures enables young researchers to engage in interdisciplinary research topics, such as radiation biology, gravitation biology, astrobiology or space physiology and psychology. The programme is being supplemented by national and international conferences, as well as scientific seminars and personal development courses. Three advanced training positions in HGF's Management Academy have been filled by DLR. The training course covers management and leadership skills.

National and European Networks

Collaborations with universities

Cooperation with universities and colleges is one of the strategic goals of DLR's organisational policy. Joint projects in practically every sector of industry ensure optimum utilisation of existing resources in programmatic research. At the level of the individual, these collaborations provide a boost to the training of highly-qualified young talent for industry and research. Similarly, both DLR and the higher education institutions benefit from working together. For the educational establishments, the scientific and technical infrastructure available at DLR is indispensable for numerous fields of research. For DLR, these schemes ensure access to young scientific talent and new topics of research.

Each year DLR oversees almost 700 postgraduate students working on their PhD theses, with approximately 400 more students completing their final year master's projects. The number of DLR scientists with lectureships has increased significantly in the last few years. In 2008, around 250 scientists were tasked with delivering lectures, tutorials, seminars etc. at universities and colleges.

Joint appointments form a central element of the links that individual employees have to higher education. All heads of DLR institutes must also accept an appointment to a position in higher education, meaning that alongside their positions in the institutes, the DLR heads of institutes take on a university professorship with all the rights and duties to the university that this entails. Combined appointments based on the qualification criteria of both partners ensure that positions are filled by the best candidate and give the scientist appointed increased potential for research and teaching.

Participation in DFG programmes

DLR has observed a significant increase in inclusion in the German Research Foundation's programmes over the preceding year. The coordinated programmes of the German Research Foundation (DFG) provide support for numerous networks of researchers who apply themselves as interdisciplinary teams to a large group of topics. The Foundation supports Collaborative Research Centres that focus on excellence in research, priority programmes designed to develop pools of expertise, and research training groups for training high-calibre young scientists. During the reporting period, DLR participated in Collaborative Research Centres fifteen times, Priority Programmes fifteen times and Research Training Groups three times. Participation in Collaborative Research Centres has significantly increased compared with the previous year: In 2007, there were only seven participations.

National and European networks	2006	2007	2008
DFG participations	27	27	33
Sponsorship agreements	54*	45*	49

* In "Research report and economic development 2007/2008", the figures 53 sponsorship agreements in 2006 and 44 in 2007 were published. A recount resulted in the corrected values, which are indicated here.

Sponsorships

Sponsorships are a successful instrument for rapid technology transfer through individuals and also enable highly qualified young talent to be secured for research and development in science and economics. This involves companies taking on half the costs of training young scientists, who are engaged by DLR for a period of between three and four years to work in areas of equal interest to DLR and the company. A portion of this time is spent at the company. In 2008, a total of 49 sponsorships were overseen at DLR, which represented a slight increase in comparison to the previous year.

Collaboration with ACARE / EREA

Due to the current developments in aeronautics, ACARE has reviewed its existing Strategic Research Agenda (SRA-2) and almost completed the content for a supplement to it. During this process, aspects which were not yet known or considered when the SRA was drafted, such as the high oil price and the incorporation of air traffic into the Emission Trading System, were analysed and adjustments to the strategy were formulated. Via EREA, DLR was instrumental in developing the SRA addendum that was officially made public in November 2008 at the EU Aviation Summit in Bordeaux. Now almost half the time has passed between the publication of Vision 2020 and the target year 2020, and ACARE and EREA are concentrating their efforts on drafting an interim summary. DLR is working together with experts on the EU projects, AGAPE and MEFISTO, which were set up for this purpose. On the one hand, these projects aim to accomplish the technical ACARE goals and, on the other hand, to determine the influence of the research projects in the 5th and 6th EU framework programme on innovation and products. The project results are to be taken into account in ACARE's strategic deliberations for the period after 2020.

During a small celebration on September 29, 2008 in Brussels attended by EU Research Commissioner Mr. Potocnik, the EREA Board signed a declaration in which EREA members explained the principles of the European Charter for researchers to follow. Many aspects of this Charter have already been implemented at DLR for many years.

At its annual event on December 09, 2008, the EREA Board was able to welcome once again around 80 representatives from Parliament, the Commission, regional and national ministries as well as from the industrial and research sectors. As guest of honour, Mr. Jacob, Vice Director General for the Directorate-General for Research and responsible, amongst other things, for Priority Transport, provided information on the Commission's activities for further developing the European Research Area. After that, Mr. Maugars (president of ONERA and chairman of EREA) presented the EREA Best Paper Award to Dr. Ewert (DLR Braunschweig) for his article entitled "Broadband slat noise prediction based on CAA and stochastic sound sources from a fast random particle-mesh (RPM) method" in the "Computers & Fluids" journal (Elsevier). The EREA Award for the Best Innovative Idea was given to Mr. Paniagua, VKI, for his study proposal "Turbine modulation shocks with plasma actuators (TUSMOPLA)". The feasibility study financed by this is being conducted in cooperation with INTA and ONERA and the results are to be presented at the 2009 annual meeting of EREA.

After the DLR institutes participated once again in the past year in the 2nd call for Transportation and Aeronautics proposals in the 7th framework programme with a success rate above EU's average. As there was no call for proposals for 2009 contract negotiations for the successful projects could be driven forward. With regard to the 3rd call for proposals in the theme Transport (incl. Aeronautics) planned for Summer 2010, DLR had put its ideas forward directly via BMWi, ACARE and EREA in an early stage of the preparation process.

Collaboration with the EU

With regard to the 7th framework programme, it is generally reported that the Commission has, on the one hand, changed over to annual calls for proposals and, on the other hand, is attempting to issue all calls for proposals in parallel. Furthermore, contrary to the Commission's announcement to increase simplification, contract negotiations are taking significantly longer than within the 6th framework programme. Under these general conditions, the fear is that in the future researchers will be continually weighed down by applications and contract negotiations.

Successful examples of the administration of research programmes from national calls for proposals (e.g. LuFo) should consulted during preparations for the 8th framework programme, which are starting now.

After lengthy contract negotiations, DLR commenced work on the Clean Sky Joint Technology Initiative at the end of 2008. DLR is involved in the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) via the N.ERGHY association. By heading a dedicated working group DLR gained influence in the preparation of the work programme and thus of contents of calls for proposals. On that basis DLR institutes have participated successfully in several project proposals.

DLR's New Year reception on February 02, 2009 at the Representation of Lower Saxony at the EU in Brussels was held under the slogan "Smart Mobility for Europe". Through a series of presentations, discussions and talks, DLR presented itself as one of Europe's leading research centres to approximately 120 representatives from the European Commission, the European Parliament, permanent representation, regional and national ministries, as well as representatives of the member states represented in Brussels and the industrial and research sectors.

In parallel to this, Prof. Wörner used his presence in Brussels to discuss the topics like European space policy, the EU recovery package, the Green Car initiative and DLR participation with the directors of the European Commission Mr. Weißenberg (Directorate-General for Enterprise and Industry), Mr. von Bose and Mr. Siegler (both Directorate-General for Research).

The fact that Dr. Piehler, DLR Program Director Transport, has assumed the role of Secretary General in the European Conference of Transport Research Institutes (ECTRI) since the beginning of the year has been directly advantageous as regards DLR participation in the Green Car initiative. DLR aspects are able to carry more weight due to the joint development of positions by the major European traffic research facilities.

Collaboration with NLR

After the possibility of associate membership was approved in principle in the last meeting of the Admin Board of SESAR Joint Undertaking, preparations were made for the participation of the joint subsidiary of DLR and NLR, AT-One, as an associate member. Since this process will presumably continue until 2010, both partners are successfully striving to obtain sub-contracts from SESAR members. However, the individual SESAR members have less funds available to them for sub-contracts than anticipated. Work package reductions have been necessary due to the high level of over-bookings.

In addition, the SESAR Joint Undertaking's strategies were further substantiated with regard to long-term ATM research. Interested research organisations, universities and the industry should be able to bid for thematic networks and small research projects (maximum EU contribution of 600,000 euros) during the course of 2009, or by the start of 2010 at the latest. DLR and NLR are actively participating in the SESAR Joint Undertaking's calls for proposals on long-term ATM research with their joint subsidiary, AT-One.

Collaboration with ONERA

For many years, DLR has cooperated especially closely with ONERA, the French large-scale aerospace research establishment, particularly in the field of helicopters and civilian transport aircraft. In the system operation sector, this is strengthened by the cooperation between DNW (German-Dutch Wind Tunnels) and ONERA within the context of the Aero Testing Alliance (ATA).

Since 2000, DLR and ONERA's research in the field of rotary-wing aircraft, i.e. helicopters and tilt-rotor aircraft, has been integrated into a joint research programme. The DLR/ONERA management organisation, PCMT (Permanent Common Management Team), coordinates and harmonises all activities of both research centres that relate to rotary-wing aircraft and supports the DLR institutes and the ONERA departments in marketing the results. One of the PCMT's main tasks is to promote and manage multi-disciplinary projects and activities that make optimum use of the experience, skills and resources available to DLR and ONERA.

In addition, implementation of the DLR/ONERA cooperation agreement in the field of transport aircraft technologies and the network of DLR and ONERA objectives in this research field are continually being further advanced. At the same time, gradual implementation is occurring by means of the successive introduction of joint projects with ONERA (Common Research Projects, CRP).

Collaboration with CNES

The coordination processes and established exchange between DLR and CNES on a variety of specialist topics have been continually advanced. On a political level, France has recommended the initiation of a joint, visible project on climate-related space exploration in order to strengthen the cooperation between Germany and France. A working group has been set up between DLR and CNES, in order to develop proposals.

International Collaboration

USA

The change of office at the White House saw the end of Mr. Griffin's tenure as NASA administrator. Under the new government and on behalf of the Office of Science Technology Policy (OSTP), Mr. Obama has initially appointed a committee to amend the NASA programme for crewed space exploration and with it for the future of the shuttle fleet and US flights to the International Space Station (ISS). The committee held a meeting headed by the former Vice Chairman of Lockheed Martin, Mr. Augustine, and carried out its duties in parallel with the nomination procedures for the new NASA administrator, Mr. Bolden. Mr. Bolden himself participated in four missions as an astronaut.

With the change at the summit of NASA in mind, a NASA delegation at board level visited DLR at the beginning of March 2009, primarily to explore opportunities for future collaborative projects between DLR and NASA. Other US delegations also visited various DLR sites, in particular in order to identify potential for cooperation in exploration. Amongst other things, the basis for this is the Statement of Intent for the foundation of the International Lunar Network (ILN), signed in July 2008 in the NASA AMES Centre. The aim of this agreement is to achieve concerted action on lunar research projects in order to examine the surface and structure of the moon. In addition, a NASA specialist group gathered information on European carrier skills in Bremen and Lampoldhausen.

In December 2008, Prof. Wörner and Mr. Reiter visited current and potential research facilities and collaboration partners in the USA. Following DLR's traditional Christmas reception in Washington, discussions took place with the NASA Jet Propulsion Laboratory (JPL) regarding possible scientific projects in the fields of remote sensing and climate research, space research and applications for robotics. A tour of the largest joint project between DLR and NASA, the Stratospheric Observatory for Infrared Astronomy (SOFIA), also proved possible. The infrared observatory in a Boeing 747 adapted for research purposes should deliver its first scientific data in 2010.

The Paris Air Show in Le Bourget in June 2009 was cause for renewed bilateral contact in aeronautics research between Prof. Szodruch and Dr. Shin, the NASA Associate Administrator for Aeronautics Research. Since the International Aerospace Exhibition (ILA) 2008, DLR has been strengthening its contacts with the US Air Force Research Laboratory (AFRL) by means of several reciprocal visits. At the end of June 2009, this prompted the visit by a DLR delegation headed by Prof. Wörner to AFRL in Dayton, Ohio, during which the collaborative relationship between DLR and AFRL was further developed.

Canada

At the beginning of March 2009, DLR welcomed the newly appointed president of the Canadian Space Agency (CSA), Dr. MacLean, to the DLR site in Oberpfaffenhofen. The main theme of discussions was the ground station in Inuvik planned by DLR in Canada, which represents an important building block in the ground segment for the TanDEM-X mission. The sup-

port of the CSA and CCRS for a receiving station on Canadian soil is therefore fundamental to DLR. The potential for cooperation in the fields of robotics, radar, satellite operation and Earth observation was also discussed.

In July 2008, Dr. Baumgarten attended the 50th COSPAR conference in Montreal and utilised this stay in Canada for a meeting with the partner organisation, the Canadian Space Agency (CSA). A delegation from the Hanseatic city under the leadership of privy counsellor Mr. Heseler took control as the next venue responsible for organising the 51st COSPAR conference in Bremen.

Japan

This year's trilateral meeting between DLR, ONERA and JAXA took place at the Paris Airshow in Le Bourget in June 2009. Once again, these discussions on aeronautics research were used successfully to evaluate ongoing projects and to define new joint research projects (see illustration).

On a bilateral basis, JAXA and DLR used discussions in July 2008 to coordinate potential joint research projects. Most notably, it was agreed that the bilateral cooperation in the field of hypersonic transport would be extended. In spring 2009, a JAXA delegation visited the Cologne site, with the aim of preparing for the DLR/JAXA strategy dialogue on space travel planned for August 2009 in Tokyo (amongst other things).

Russia

At the end of November 2008, the festivities for the 90th anniversary of N. J. Schukowski's Central Aerohydrodynamics Institute (ZAGI/TsAGi) provided the occasion for a DLR delegation, headed by Prof. Szodruch, to visit Moscow. In March 2009, a new collaboration agreement with ZAGI/TsAGi in the field of aeronautics

Trilateral meeting between DLR, ONERA and JAXA

research was produced based on these talks, which puts the traditionally good relationships on a new footing. The agreement was signed on March 26, 2009 at ZAGI/TsAGi in the presence of Prof. Pinkwart (Minister for Innovation, Science, Research and Technology for North Rhine-Westphalia). Before the agreement was signed, the first joint ZAGI/DLR seminar on "Trends of Cooperation in Aeronautical Research TsAGi & DLR" took place in order to define promising fields of collaboration on both sides. In the future, these seminars will constitute an integral part of the cooperation between ZAGI/TsAGi and DLR, and it has already been possible to use them to initialise a number of collaborative projects.

March 2009 saw the commencement of Mars500, the 105-day space flight simulation experiment, with German contributions at the Institute of Biomedical Problems (IBMP) at the Russian Academy of Sciences in Moscow. Prof. Wörner bid farewell to the crew, which included a German participant, on their 105-day simulated space flight. DLR is instrumental in Mars500, alongside the IBMP and the ESA.

Ukraine

Within the framework of the European Neighbourhood Policy, DLR, under the leadership of the French Space Agency CNES (Centre National d'Etudes Spatiales) and together with the German Federal Ministry of Economics and Technology (BMWi), is participating in a twinning programme with Ukraine entitled "Boosting Ukrainian Space Cooperation with the European Union". Within the context of this programme, numerous individual measures have been conducted to inform Ukraine about the European aerospace structures and programmes. Workshops and seminars in Ukraine followed a study tour through the ESA centres in Germany and the Netherlands, as well as different space-related venues throughout DLR and the industry. On April 23, 2009, within the framework of the mid-term event, a consistently positive balance was drawn up in the presence of the German, French and EU ambassadors.

Brazil

At the end of August 2008, a technical delegation visited Brazil for talks with the partner organisations CTA (Aerospace Technical Centre), INPE (Brazilian National Institute for Space Research) and the AEB (Brazilian Space Agency). The central theme of this visit was the procurement of rocket motors for the DLR MORABA High Altitude Research programme, which is being implemented within the framework of the German national programme and the European EASP agreement. Potential collaborative projects in Earth observation and robotics were also discussed with the INPE.

India

In January 2009, a Space Agency delegation, headed by project director Mr. Hohage, visited India (Bangalore) and the Indian Space Research Organisation (ISRO). During their stay, they were able to visit the rocket launch facilities in Sriharikota (near to Chennai), the ISRO's central facilities for the Indian Earth observation programme, satellite integration and the Indian scientific programme. The renewal of dialogue with ISRO involves the examination of all potential fields of collaboration, in particular with a view to possible launch services, Earth observation and research under space conditions. These topics were taken up and discussed in more detail when Mr. Nair (chairman, ISRO) paid a visit to Prof. Wörner at DLR on May 28, 2009 in Cologne.

China

DLR signed a framework agreement with the China Manned Space Engineering Office (CMSEO) in December 2008 within the context of a visit to Germany by leading representatives of Chinese manned space flight. This followed a 3-day visit by the Chinese delegation to various DLR facilities.

Australia

In February 2009, Prof. Szodruch travelled to Australia for, amongst other things, a joint workshop by the Cooperative Research Centre for Advanced Composite Structures with the DLR Institute of Composite Structures and Adaptive Systems. In doing so, both facilities deepened their bilateral cooperation, which is also furthered within the context of the EU COCOMAT project. The itinerary included discussions with representatives of the Federal Government in Canberra on DLR topics.

Algeria

At the request of the Algerian Space Agency ASAL, the first discussion on potential collaborative topics took place in July 2008 with the involvement of the German aerospace industry. DLR is considering the Algerian desire for a collaborative agreement against the background of the successful visit by the chancellor to Algeria and DLR's existing research cooperation with the Algerian energy agency NEAL.

Arabian Peninsula

Earth observation connects the German aerospace industry and research with partner facilities in the United Arab Emirates. A second field of collaboration exists within the context of DLR energy research, prompting the DLR Institute of Technical Thermodynamics to take charge of developing a solar-hybrid gas turbine system with combined heat and power generation for Abu Dhabi. A feasibility study was developed during the first phase of the joint project USHYNE (Upscaling of Solar-Hybrid Gas Turbine Cogeneration Units) with the Masdar Research Network in Abu Dhabi. This serves as a basis for a 5 megawatt demonstration facility where not only electricity but also cooling energy for building air conditioning are generated by means of solar energy and gas firing. The objective of the EIMS (Environment Information Management System) project with Saudi Arabia is to develop a comprehensive environmental surveillance system (land, water and air). The project is being carried out with a German-Italian consortium, whereby DLR (DFD) is charged with developing a prototype for air quality control. Against this background, DLR Executive Board member Mr. Reiter accompanied the German Federal Minister for Economic Affairs, Dr. Freiherr zu Guttenberg, on his journey to the United Arab Emirates and Saudi Arabia in May 2009.

United Nations and international organisations

In accordance with the global slogan "The universe, yours to discover!" Germany, with the support of DLR, inaugurated the International Year of Astronomy 2009, as it was proclaimed by the United Nations, in the Museum of Telecommunications in Berlin on the evening of January 20, 2009.

On March 02, 2009, the chairman of the United Nations Committee on the Peaceful Use of Outer Space (UNCOPUOS), ambassador Dr. Arévalo (Columbia), also visited DLR. Dr. Arévalo put forward his work programme in the UNCOPUOS and solicited strengthened cooperation with the up-and-coming space nations of Latin America. The director of the UN Office for Outer Space Affairs (UNOOSA), Prof. Othman, had already visited DLR in December 2008. In October 2008, the

Left: Mr. Matsuura, Director General of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and Prof. Wörner (Chairman of DLR) at the official opening of the joint exhibition "What a Sight: Space Looking Out for World Heritage", UNESCO Paris, April 01, 2009; centre: Signing at the WMO; right: Participants in the UN-SPIDER – DLR stakeholder workshop in Windhoek, Namibia, January 29, 2009

second UN-SPIDER workshop took place on the UN campus in Bonn, which gained wide-ranging support from more than 130 participants in 45 countries. This emphasises the leadership role the UN-SPIDER is now playing with regard to networking disaster management and service providers from the field of satellite-based crisis information. The close collaboration of UN-SPIDER and the Centre for Satellite Based Crisis Information (ZKI) within the context of numerous disasters (including the flood events in Namibia, Myanmar, Bangladesh and West Africa and the earthquake in China) was found to be very successful in terms of the rapid and efficient mobilisation of international support. Alongside ad-hoc crisis mapping, ZKI engaged in a UN-SPIDER technical advisory mission in Namibia, for example, with a training programme focussed on floodwater mapping and participated in the UN Regional Cartographic Conference for the Americas in New York. As the example of Namibia shows, this intensive exchange with UN organisations can also facilitate new project initiatives and plays an important role in implementing sustained crisis management.

Furthermore, in cooperation with UNESCO in spring 2009, the successful exhibition "What a Sight: Space Looking Out for World Heritage" in Paris was officially opened by Mr. Matsuura, Director General of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and Prof. Wörner. Large-scale satellite images of world cultural heritage sites and landscapes were displayed.

Furthermore, on July 22, 2009, a Memorandum of Understanding was ceremonially signed between the World Meteorological Organisation (WMO) and DLR, which henceforth established the World Data Centre for Remote Sensing of the Atmosphere (WDC-RSAT), residing in the German Remote Sensing Data Centre (DFD), as an official WMO world data centre. The signing at the WMO in Geneva was carried out by Dr. Jarraud, general secretary of the WMO, Prof. Wörner and Prof. Dech, in the presence of the president of the German meteorological service, Mr. Kusch, who represents Germany's interests at the WMO, a UN technical organisation.

Above: End of the first phase of the Mars500 isolation study in Moscow. Far right: the German participant Mr. Knickel; centre: "Out of this World – Wonders of the Solar System" exhibition in the Oberhausen gasometer; below: Mr. Reiter chatting to the 250,000 exhibition visitors

Communications

DLR Communication is responsible for all aspects of DLR's external communication: press relations, online communication (DLR web portal), trade fairs, exhibitions and other events, publications (for example DLR News, real time), audio-visual media and visitor relations. With the introduction of clear management structures, it was possible to increase communication efficiency for improved reaction to continually increasing changes and challenges posed by, amongst other things, the national and international media landscape. DLR has increasingly been able to position itself as a determining element in the formation of opinions on general scientific and political issues and on the topics covered by its own research departments.

The primary effects of DLR Communication, that is to say the direct consequences of DLR's own communicative activities, were accompanied last year by additional secondary effects. The expressions of opinions by DLR scientists meant that coverage of aerospace issues was more objective and media discussion of problems was more matter-of-fact, a particular consequence of continual harmonisation between all aspects of DLR communication. By the same token, close collaboration with the institutes, facilities and sites in implementing tangible measures such as press conferences and other events as well as visits and presentations also made a positive impact.

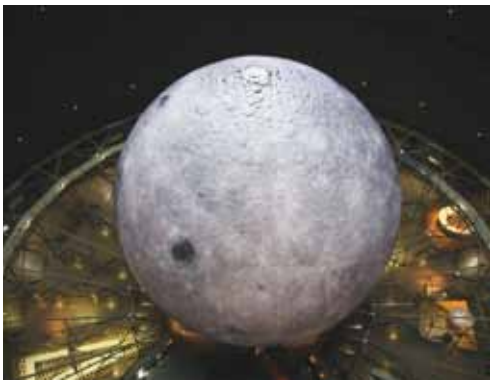
DLR was also a sought-after partner on occasions such as the selection of the German Alexander Gerst as a member of the European team of astronauts, the 40th anniversary of the moon landing and for all rocket and shuttle launches with German and European participation. DLR also became increasingly attractive as a media contact point due to its successful use of online communications, such as webcasts, and its coverage and series, such as Astronomy Question of the Week. Furthermore, DLR Communication proved itself to be a reliable partner for external institutions and facilities from industry and politics.

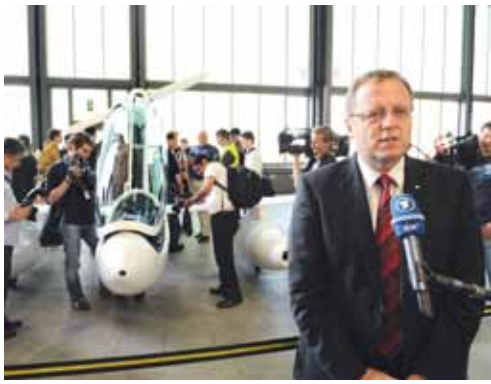
Selected highlights:

- The new member of DLR's research fleet, Halo (High Altitude and Long Range Research Aircraft), landed at the DLR research airport in Oberpfaffenhofen on January 24, 2009. With more than 200 feature stories, coverage extended far beyond the region and ensured national and international interest for DLR.
- The Mars500 isolation experiment began on March 31, 2009 in Moscow (see also page 26). The simulated "flight" ended successfully after 105 days. German Federal Armed Forces officer Mr. Knickel was among the international team. In close collaboration with Russian colleagues and the ESA, media measures were organised and implemented in Germany and Moscow, which generated a massive amount of media interest in this mission, with more than 1,000 feature stories.
- A project in which DLR participated with extraordinary commitment, the new "Out of this World – Wonders of the Solar System" exhibition, opened in the Oberhausen gasometer on April 02, 2009. The exhibits include spectacular reproductions of the planetary system, fascinating images of alien worlds, valuable historic instruments and modern technology for space research.

"Out of this World" is the largest European exhibition for the International Year of Astronomy and managed to attract 250,000 visitors in just four months.

- UNESCO in Paris gave an insight into the scientific work of DLR in the form of an exhibition of Earth observation images. The exposition continues to be used, as a result of its success.
- The maiden flight of the fuel cell aircraft, Antares, enjoyed extraordinary lively coverage, which was accompanied on the part of DLR Communication by various types of publicity including a press conference, web article and an interview in DLR News.





Left: A gigantic sculpture, with a diameter of 25 metres, of the „largest moon on Earth" can be seen in the "Out of this World – Wonders of the Solar System" exhibition in the Oberhausen gasometer; right: Interview with Prof. Wörner at the launch of Antares DLR-H2

The appreciation of DLR as a scientific authority was demonstrated by the abundance of journalist enquiries about the prospective Desertec energy project, which were answered swiftly and competently by DLR and resulted in broad media coverage.

Political and Economic Relations

As part of the restructuring of the second level of executive management, a new organisational unit has been established under the authority of the Chairman of the DLR Executive Board and is now in the set-up phase: "Political and Economic Relations".

One of the main tasks included in the remit of this department will be to further intensify communication with the political establishment, that is with parliament and government at state and national levels. Alongside the traditional political counselling activities of DLR on aerospace themes, the intention is that advisory services will now be intensified in the transport and energy research sectors as well, with stronger interaction between the various fields of action.

The construction of a network of economic leaders and key figures from professional associations will be another focus area for the new unit. It will be important in this regard to ensure that deliberate efforts be made to include small and medium-sized enterprises (SMEs). The results of activities in the field of economic relations will extend far beyond the existing contacts and collaborations with the aerospace industry – above all in the context of the work of Technology Marketing and the numerous projects that the DLR institutes and DLR Space Agency are already involved in.

The main objective of the measures introduced by the new Political and Economic Relations communications unit will be commitment to the general political goal of sustainability, that is to entrench the innovative and synergetic potential of DLR research and development and the work of the agency even more deeply into the consciousness and long-term strategic manoeuvrings of politicians and economists.

People

Gender Equality and Work Life Balance

Repeated commendations with the Total-E-Quality award and family audit (audit berufundfamilie®) are striking evidence of a family-orientated DLR with a HR policy geared towards equal opportunities. DLR has established a wide range of family-friendly practices such as flexible working hours and models of teleworking, particularly in conjunction with working part-time temporarily to facilitate the return to work after parental leave. The broad scope of the family service supports DLR employees in looking for and arranging suitable childcare and advises them when a dependant becomes in need of care. At the Bremen and Cologne sites, this has already been extended to incorporate specific childcare solutions for infants. The Equal Opportunities department has increased its staffing levels and now provides a family councelling service.

In December 2008, the Executive Board approved a catalogue of complex measures that once again emphasized the significance of "equal opportunities for everyone in DLR". Equal opportunities is considered to be a principle at all levels of DLR and intrinsic to the DLR culture alongside the former key areas of balance between work and family life, HR policy and HR development. In the future, the promotion of girls and young women will be addressed in a special way. Communication on all objectives and measures is continually being developed.

Human Resources

The further steps required for implementing DLR performance-related pay mentioned in the last report have been developed together with the Central Staff Council. All in all, over 70 full-day events for managers and two- to three-hour information events for employees have been carried out at all sites, predominantly by internal consultants. The first achievement period for assessment began on April 01, 2009 and ends on March 31, 2010.

In addition, HR activities are affected by strengthened IT penetration. The introduction of live eRecruiting is still planned for the current year. An integrated process is being established that goes from the advertisement of a job, via the management of applicants right up to the process of selecting and employing the successful applicant, including the involvement of the relevant works council, without discouraging applicants with an unnecessary number of input masks. The introduction of a Newsletter function is also planned. Interested applicants may submit their profile and are informed automatically when a suitable position becomes available. Regional limitation to particular DLR sites is possible.

A second stage of expansion has optimised the workflow in the field of travel expense accounting and designed it to be particularly customer-friendly. An additional workflow has been introduced for absence logging. Procedures that have historically developed in different ways, to some extent due to the lack or variety of electronic timekeeping systems, have been removed and the absence data for SAP (Software for Systems Analysis and Program Development) has been made available using a standardised procedure.

The intention is for the workflow for electronic employee applications (Employee Self Services) to be expanded to include additional absence records, such as illness and unpaid absence, as well as notifications of changes to the personal data of employees such as bank details, name and address.

The reporting system for the HR management process is being developed and adapted to electronic web applications with SAP connection. This means that customers are able to submit their individual reporting requirements and receive their reports electronically once they have been created in SAP HR. These value sets are governed by the functions and privileges assigned.

The administrative requirements and necessary workflows for awarding scholarships have been developed to cope even better with fulfilling the statutory tasks for qualifying the next generation of scientists. The first scholarship agreements have already been concluded.

With the spin-off of the Institute of Space Applications (GfR GmbH), a change to a company pension scheme away from the VBL (provider of supplementary pensions in Germany) was finally managed. A company pension scheme in the form of a friendly society with HDI-Gerling was realised, prompted due to the low average age of employees affected by the transfer of operations.

Personnel	2006	2007	2008
Employees	5,344	5,627	5,880
Scientific associates (total)	2,749	3,046	3,295
Permanent/fixed-term contracts	3,043/2,301	3,104/2,523	3,148/2,732
Proportion of women			
- total	29%	30%	30%
- in management positions	12%	13%	14%
- scientific associates	13%	12%	16%
Young scientists	110	93	86
Doctoral candidates (internal/external)	538	607	670
Trainees	243	247	252

Human Resources Development

The need and demand orientation of Human Resources Development (HRD) has been consistently further developed. The use of internal training programmes reached a new high in 2008: overall, 395 further education and training events took place for employees, managers and management trainees (not taking into account 70 events for performance-related pay, see Human Resources). The cancellation rate for the training programmes was effectively reduced to below 20 percent, 56 events were planned at short notice based on current customer requirements.

The number of team workshops (tailor-made events for specific organisational units) increased from 38 (2007) to 56. This is evidence of increasing interaction between HR development and organisational development. In addition, seven mentoring pairs were supported following on from the previous year and eight new tandem arrangements were formed. In 2008, 50.8 percent of employees participated in at least one training programme or took part in a management course or team workshop offered under the HR development remit. Each employee spent an average of 1.8 days per year on HR development activities (training events or team workshops) and this added up to 10,574 days in 2008 across the organisation.

HR development and mobility	2006	2007	2008
Training days per employee	1.7	1.7	1.8
Mentoring pairs	8	7	8
Assignments abroad (months)	564	568	545

HR's primary aim is to nurture the next generation of scientists. For the fifth time, there has been moderated dialogue between young management professionals and the DLR Executive Board. Over 70 emerging leaders had the opportunity to exchange ideas with management at the highest level and to stay informed about key strategic developments and decisions. This helps to break down the barriers of hierarchy and to promote the corporate identity.

A new qualification programme open to all DLR doctoral candidates, the DLR_Graduate_programme, was also launched. In addition to professional qualifications, the programme covers important methodological, management and social skills that can be used directly during the promotion period and that boost the career in the long term as key competencies. Key areas include scientific presentations and publications, project management and third-party acquisition, conflict management and conducting negotiations, team leadership and intercultural skills. In addition, participants have the opportunity to network with doctoral candidates throughout DLR, to present their topic at international conferences and publish it in professional journals. The DLR institutes also profit from the doctoral candidates' increased knowledge and abilities. Moreover, DLR presents itself as an attractive employer to the next generation of scientists.

Project management is one of the key skills possessed by employees. The number of participants in the 4-day intensive training course has increased steadily to over 80 in 2008. Introductory courses in project management have recently been incorporated, as well as training courses in preparing for PMP® certification, the most prevalent and widely accepted project management certification throughout the world. In addition, there is a plan to establish a project career path in parallel to the management career path at DLR. One of the main requirements for this is to generate a new requirement profile for DLR project leaders and to gear the qualification towards this – also in cooperation with external universities.

The concept of talent management combined with systematic succession planning, based on skills-related requirement profiles, is currently being transformed into current change processes in the technical infrastructure. The goal is to identify, support and develop employees with high potential, encourage them to remain loyal to the organisation and enable them to take on key functions.

As a key element of the project to develop the entire administrative culture within DLR, employee surveys with feedback from managers were carried out for the second time in 2008/2009 in order to check the effects of development measures. The results (for 25 managers and 232 employees) show an improvement in employee job satisfaction which, although only slight, is prevalent across all aspects and a homogenisation of the leadership behaviour over the various administrative support processes.

Human Resources Marketing

Appointing new employees for DLR is becoming increasingly difficult. In 2008, the number of vacancies for engineers was four times greater than the number of engineers seeking employment. In Germany, the number of engineering graduates is just 90 percent of the number of engineers nearing retirement age. The economic crisis accounts for these basic facts in the short term, but when the economy picks up there will once again be competition for good applicants. This makes it all the more important for DLR to position itself as an attractive employer with the relevant target groups and university graduates of the so-called "MINT" subjects of mathematics, information technology, sciences and technology: This is the goal of DLR's HR Marketing department.

Central HR Marketing was established for this reason on November 01, 2008 with the following main tasks:

- Development and successful positioning of an attractive DLR employer brand compared with competitors from research organisations, universities and industry

- Precise definition of the target groups and market research with the development of a meaningful database and basis for decision-making
- Offering support and advice to the institutes during the recruitment process (e.g. through presence at relevant trade fairs and the creation of meaningful print materials)
- Coordination and control of all relevant marketing activities

The "Profiling the DLR Employer Brand" project constitutes a strategic core element of the initial phase, during which the basis for DLR's successful positioning as an attractive employer will be formed by means of internal and external surveys, competitive analyses and econometric evaluations. The project should be completed by the end of December 2009 and operative implementation will commence in January 2010.

Presence at four trade fairs in Bremen, Darmstadt, Karlsruhe and Munich in May and June 2009 and the creation of an employer brochure were used to support and advise the institutes during the recruitment process. Feedback from the DLR institutes and trade fair visitors was consistently positive. The DLR presence at the trade fair in Karlsruhe was awarded first place in the estimation of the students, ahead of well-known competitors such as Lufthansa Technik, IBM, ESA and Siemens. Furthermore, Central HR Marketing has assumed responsibility for the content of the DLR job portal and is revising it to suit the target groups.

German staff at ESA – a comparison

Member state	Number of employees	Employees [%]	Financial contribution [%]
Germany	390	19.0	22.1
France	506	24.6	21.3
Italy	365	17.8	14.7
GB	195	9.5	12.7
Spain	151	7.4	5.9

German Staff at ESA

At the end of 2008, ESA employed a total of 2,054 people in salary brackets A1 to A6 and HC (comparable with senior public servants). The proportion of German employees is 19 percent and therefore continues to fall short of Germany's financial contribution of 22.1 percent. In contrast, France and Italy are significantly overrepresented.

In 2008, the proportion of German staff decreased from 19.2 percent to 19 percent compared with the preceding year. First and foremost, this development can be attributed to the very low German applicant rate of 8.5 percent (by comparison, approx. 1/3 of all applicants come from Italy). Overall, the German aerospace industry in particular must motivate its employees more strongly to switch over to the ESA.

Commendations and Awards

In-house awards, 2008

DLR Science Prize

- Dr. rer. nat. Sven Reutzel
  German Space Agency
- Dr. rer. nat. habil. Peter Galenko
  Dr. rer. nat. Stephan Schneider
  Institute of Materials Physics in Space
- Dr. rer. nat. Helena Hartmann
  Ruhr University of Bochum
- Dr. rer. nat. Michael Esselborn
  Dr. rer. nat. Martin Wirth
  Dr. rer. nat. Andreas Fix
  Institute of Atmospheric Physics
- Dipl. oec. troph. Petra Frings-Meuthen
  Institute of Aerospace Medicine
- Dr.-Ing. Luise Kärger
  Institute of Composite Structures and Adaptive Systems

DLR Research Semester

- Dr.-Ing. Michael Angermann
  Institute of Communications and Navigation
- Dipl.-Ing. Massimiliano Di Domenico
  Institute of Combustion Technology
- Dipl.-Ing. Jörg Nickel
  Institute of Composite Structures and Adaptive Systems
- Dr. rer. nat. Michael Rose
  Institute of Composite Structures and Adaptive Systems
- Dipl.-Ing. Sven Schmerwitz
  Institute of Flight Guidance
- Dr. rer. nat. Bernadett Weinzierl
  Institute of Atmospheric Physics

DLR Senior Scientists 2008

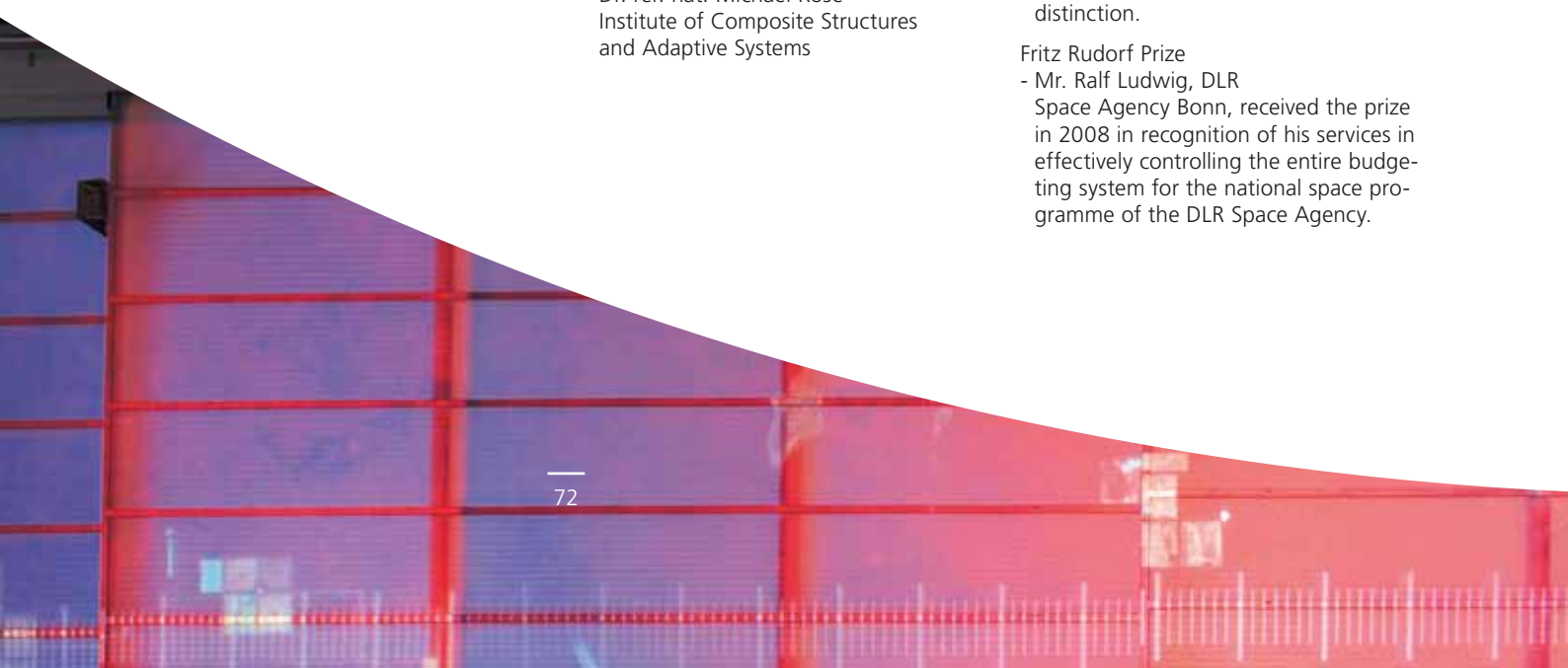
- Dr. rer. nat. Andreas Petzold
  Institute of Atmospheric Physics
- Dr.-Ing. Uwe Schulz
  Institute of Materials Research

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

Otto Lilienthal Research Semester
- This time, it was possible for the research semester prize to be awarded to two candidates thanks to a generous donation by Prof. Manfred Fuchs (OHB Bremen) and his wife Christa and, in recognition of this contribution, the prize this year has been named the "Otto Lilienthal Prize/Manfred and Christa Fuchs Prize". The research semesters went to Dr. rer. nat. Ekkehard Kührt, Institute of Planetary Research, for a research trip to the Physical Institute of the University of Bern in Switzerland, and Dr. phil. Christian Willert, Institute of Propulsion Technology, with scheduled research trips to the California Institute of Technology in the USA and to the Monash University in Melbourne, Australia.

Hugo Denkmeier Prize
- Dr.-Ing. Inga Mahle, MTU Aero Engines Munich was commended as the youngest doctoral candidate in the aerospace field to be awarded a doctorate with distinction.

Fritz Rudorf Prize
- Mr. Ralf Ludwig, DLR Space Agency Bonn, received the prize in 2008 in recognition of his services in effectively controlling the entire budgeting system for the national space programme of the DLR Space Agency.



Chairman's Prize
- Dr. phil. Andreas Baumann, Institute of Robotics and Mechatronics, in recognition of being the youngest patent applicant during the year.

Innovation Prize
- Dr. phys. Wolf Eckhard Müller, Dr. Gabriele Karpinski and Mr. Pawel Ziolkowski, Institute of Materials Research, for their successful teamwork in "Product Development for the Potential-Seebeck Microprobe (PSM)"

DLR_School_Lab Prize
- the 10-strong prize-winning team from the DLR_School_Labs in Oberpfaffenhofen. The team comprised pupils from the Hector Seminar (promotion of gifted and talented pupils) in Heidelberg, who applied themselves with great enthusiasm and success to the topic "Geophysical Remote Sensing using Satellites".

DLR Quality Prize

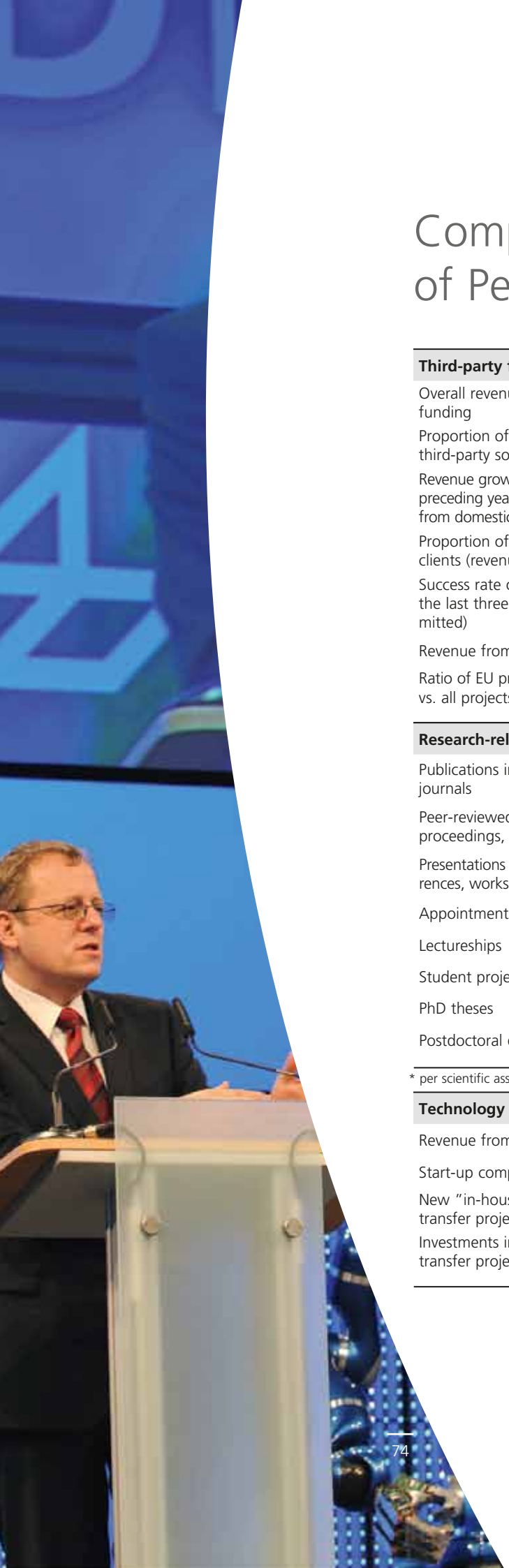
The Deputy Chairman of the Executive Board, Mr. Klaus Hamacher, and the Head of Quality Management, Ms. Marion Scheuer-Leeser, presented the 2008 Quality Prize to:

- Mr. Walter Fohrmann, Quality Representative of Space Operations and Astronaut Training and
- Mr. Marcus Myrbach, Lloyd's Register Quality Assurance GmbH, trainer and consultant in quality-related areas.

Quality Prize award ceremony, f.l.t.r.: Mr. Hamacher, Mr. Fohrmann, Mr. Myrbach

Selection of external awards in 2008

Award	Prize winner
AHS Technical Fellow Award	Bernd Gmelin
Asanuma Award	Dr. rer. nat. Jürgen Kompenhans
AVK Innovation Prize	Michael Kühn
Berblinger Prize from the German Academy of Aviation and Travel Medicine	Dr. rer. pol. Tanja Niederl
Christa and Manfred Fuchs Prize	Dr. phil. Christian Willert
Dobson Award	Dr. rer. nat. Veronika Eyring
EREA Best Paper Award 2008	Dr.-Ing.Roland Ewert
Industrial Robot Innovation Award	Martin Görner, Prof. Dr.-Ing. Gerhard Hirzinger
Innovation Prize 2008 from the Klee Foundation	Dr. Thomas Schmid
Knowledge Sharing Award	Dipl.-Ing. Elmar Beeh
Leo Brandt Prize "DGON Master of Navigation"	Jörg Brauchle
Nathaniel B. Nichols Medal 2008	Prof. Dr.-Ing. Gerhard Hirzinger
Munich Airport Environment Award	Dr.-Ing. Marco Weiss
Zeldovich Medal	Dr. Thomas Berger



Compilation of Performance Indicators

Third-party funding	2006	2007	2008
Overall revenue from third-party funding	Euro 255 m	Euro 294 m	Euro 308 m
Proportion of overall revenue from third-party sources	49%	52%	51%
Revenue growth in comparison to preceding year, commercial revenues from domestic R & D activities	41%	26%	11%
Proportion of revenue from foreign clients (revenue volume)	29%	22%	21%
Success rate of EU proposals in the last three years (accepted/submitted)	54%	47%	46%
Revenue from EU funding	Euro 17.3 m	Euro 19.9 m	Euro 19.7 m
Ratio of EU projects as coordinator vs. all projects	16%	13%	14%

Research-related results	2006	2007	2008
Publications in peer-reviewed journals	495	511	442
Peer-reviewed publications in proceedings, books etc.	536	568	593
Presentations for scientific conferences, workshops and lectures*)	0.85	0.76	0.55
Appointments to universities	8	13	12
Lectureships	200	204	248
Student projects	318	326	384
PhD theses	78	83	94
Postdoctoral qualifications	4	4	2

* per scientific associate engaged by the institutes and facilities

Technology marketing	2006	2007	2008
Revenue from licenses	Euro 4.1 m	Euro 3.6 m	Euro 3.9 m
Start-up companies	2	4	2
New "in-house" technology transfer projects	13	10	8
Investments in technology transfer projects	Euro 2.8 m	Euro 2.44 m	Euro 3.5 m

Management instruments	**2006**	**2007**	**2008**
Total project work	66%	73%	72,8%

Quality management	**2006**	**2007**	**2008**
Existing certifications & accreditations	16	19	25
Number of DLR auditors	14	15	15
Implementation of audit	24%	29%	32%

National and European networks	**2006**	**2007**	**2008**
DFG participations	27	27	33
Sponsorship agreements	54*	45*	49

* In the research report and economic development 2007/2008, the figures 53 sponsorship agreements in 2006 and 44 in 2007 were published. A recount resulted in the corrected values, which are indicated here.

International collaboration	**2006**	**2007**	**2008**
International visiting scientists (staying > 1 month) referenced to scientific assoc´s in institutes	6.6%	7.4%	7.9%

Personnel	**2006**	**2007**	**2008**
Employees	5,344	5,627	5,880
Scientific associates (total)	2,749	3,046	3,295
Permanent/fixed-term contracts	3,043/2,301	3,104/2,523	3,148/2,732
Proportion of women			
- total	29%	30%	30%
- in management positions	12%	13%	14%
- scientific associates	13%	12%	16%

New talent	**2006**	**2007**	**2008**
Young scientists	110	93	86
Doctoral candidates (internal/external)	538	607	670
Trainees	243	247	252

HR development and mobility	**2006**	**2007**	**2008**
Training days per employee	1.7	1.7	1.8
Mentoring pairs	8	7	8
Assignments abroad (months)	564	568	545

DATA & FACTS

Institutes and Facilities

- Aerodynamics and Flow Technology
- Aeroelasticity
- Aerospace Medicine
- Air Transport and Airport Research
- Atmospheric Physics
- Combustion Technology
- Communications and Navigation
- Composite Structures and Adaptive Systems
- Flight Guidance
- Flight Operations
- Flight Systems
- German Remote Sensing Data Center
- Materials Physics in Space
- Materials Research
- Microwaves and Radar
- Planetary Research
- Propulsion Technology
- Remote Sensing Technology
- Robotics and Mechatronics
- Space Operations and Astronaut Training
- Space Propulsion
- Space Systems
- Structures and Design
- Technical Physics
- Technical Thermodynamics
- Transport Research
- Transportation Systems
- Vehicle Concepts

Members and Committees

As of June 30, 2009, DLR had 47 sponsoring members in addition to honorary members, scientific members and ex officio members.

Honorary Members

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

Sponsoring Members

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

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

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

- Aerodata AG, Braunschweig
- AIR LIQUIDE Deutschland GmbH, Düsseldorf
- ALSTOM Power 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
- Bundesverband der Deutschen Luft und Raumfahrtindustrie e. V. (BDLI) (German Aerospace Industries Association), Berlin
- CAE Elektronik GmbH, Stolberg
- CAM Systems GmbH, Unterföhring
- Carl-Cranz-Gesellschaft e. V., Weßling/Obb.
- Commerzbank AG, Großkundencenter Region West, Düsseldorf
- Deutsche BP Holding AG, Hamburg
- Deutsche Gesellschaft für Luft- und Raumfahrt – Lilienthal Oberth e. V. (DGLR) (German Aerospace Society), Bonn
- Deutsche Gesellschaft für Ortung und Navigation e. V. (German Institute of Navigation), Bonn
- DFS Deutsche Flugsicherung GmbH, Langen
- Diehl Aerosystems Holding GmbH, Nuremberg

- Diehl Defence Holding GmbH, Überlingen
- Dornier GmbH, Friedrichshafen
- Dresdner Bank AG, Cologne
- EADS Deutschland GmbH, Munich
- ESG Elektroniksystem- und Logistik GmbH, Fürstenfeldbruck
- Fraport AG, Frankfurt/Main
- GAF AG, Munich
- Gemeinde Weßling, Weßling/Obb.
- HDI-Gerling Industrie Versicherungs AG, Hanover
- Industrieanlagen-Betriebsgesellschaft mbH (IABG), Ottobrunn
- Kayser-Threde GmbH, Munich
- KUKA Roboter GmbH, Augsburg
- LIEBHERR-AEROSPACE LINDENBERG GmbH, Lindenberg
- Lufthansa Technik AG, Hamburg
- MST Aerospace GmbH, Cologne
- MT Aerospace AG, Augsburg
- MTU Aero Engines GmbH, Munich
- Nord-Micro Elektronik AG & Co. OHG, Frankfurt/Main
- OHB-System AG, Raumfahrt- und Umwelt-Technik, Bremen
- RheinEnergie AG, Cologne
- Rheinmetall Defence Electronics GmbH, Bremen
- Röder Präzision GmbH, Egelsbach
- Rohde & Schwarz GmbH + Co. KG, Cologne
- Rolls-Royce, Deutschland Ltd. & Co. KG, Dahlewitz
- RUAG Aerospace Deutschland GmbH, Weßling
- Siemens AG, Munich
- Snecma Groupe SAFRAN, Vernon
- Stadt Braunschweig, Braunschweig
- Tesat-Spacecom GmbH & Co. KG, Backnang
- Volkswagen AG, Wolfsburg
- ZF Luftfahrttechnik GmbH, Calden

Scientific Members

- Prof. Dr.-Ing. Philipp Hartl, Munich
- Prof. Dr. Hans Hornung, Pasadena, California, USA
- Prof. Dr.-Ing. Dr.-Ing. E. h. Erich Truckenbrodt, Grünwald
- Prof. Dr. rer. nat. Joachim E. Trümper, Garching

Ex Officio Members

- Prof. Dr.-Ing. Manfred Aigner, Stuttgart
- Dipl.-Kfm. Uwe Baust, Düsseldorf
- Jürgen Breitkopf, Munich
- Prof. Dr.-Ing. Dr. h. c. mult. Hans-Jörg Bullinger, Munich
- Marco R. Fuchs, Bremen
- Prof. Dr. rer. nat. Ursula Gather, Dortmund
- Prof. Dr. Reinhard Genzel, Garching
- Dipl.-Ing. Rainer Götting, Heidelberg
- Prof. Dr. rer. nat. Michael Grewing, France
- Prof. Dr. rer. nat. Peter Gruss, Munich
- Dipl.-Kfm. Klaus Hamacher, Cologne
- Dipl.-Ing. August Wilhelm Henningsen, Hamburg
- Prof. Dr.-Ing. Peter Horst, Braunschweig
- Prof. Dr.-Ing. Matthias Kleiner, Bonn
- Prof. Dr.-Ing. Jürgen Klenner, Bremen
- Prof. Dr.-Ing. Uwe Klingauf, Darmstadt
- Dr.-Ing. Reinhold Lutz, Munich
- Dr.-Ing. Rainer Martens, Munich
- Peter-Michael Nast, Stuttgart
- Dr.-Ing. Norbert Rüdiger Ninz, Überlingen
- Dr.-Ing. Manfred Peters, Cologne
- UndSec Gerold Reichle, Bonn
- Dipl.-Ing. Thomas Reiter, Cologne
- Dr. rer. pol. Rainer Schwarz, Berlin
- Prof. Dr.-Ing. Joachim Szodruch, Cologne
- Prof. Dr.-Ing. Johann-Dietrich Wörner, Cologne
- Prof. Dr. Gunter Zimmermeyer, Berlin

Senate

As of June 30, 2009, the following persons were members of the senate:

From the scientific sector

- Prof. Dr.-Ing. Manfred Aigner
- Prof. Dr.-Ing. Dr. h. c. mult. Hans-Jörg Bullinger, ex officio
- Prof. Dr. rer. nat. Ursula Gather (Deputy Chairman)
- Prof. Dr. rer. nat. Reinhard Genzel
- Prof. Dr. rer. nat. Michael Grewing
- Prof. Dr. rer. nat. Peter Gruss, ex officio
- Prof. Dr.-Ing. Peter Horst
- Prof. Dr.-Ing. Matthias Kleiner, ex officio
- Prof. Dr.-Ing. Uwe Klingauf
- Peter-Michael Nast
- Dr.-Ing. Manfred Peters

From the economics and industrial sector

- Dipl.-Kfm. Uwe Baust
- Jürgen Breitkopf
- Marco R. Fuchs
- Dipl.-Ing. Rainer Götting
- Dipl.-Ing. August Wilhelm Henningsen
- Prof. Dr.-Ing. Jürgen Klenner
- Dr.-Ing. Reinhold Lutz
- Dr.-Ing. Rainer Martens
- Dr.-Ing. Norbert Rüdiger Ninz (Deputy Chairman)
- Dr. rer. pol. Rainer Schwarz
- Prof. Dr. Gunter Zimmermeyer
- Under Secretary Erwin Bernhard
- Secretary of State Jochen Homann (Chairman)
- Secretary of State Dr. Hans-Gerhard Husung
- Secretary of State Dr. phil. Josef Lange
- Under Secretary Günther Leßnerkraus
- Privy Counsellor Carl Othmer
- Ministerial Director Thilo Schmidt
- Under Secretary Andreas Schneider
- Secretary of State Dr. jur. Michael Stückradt
- Ministerial Director Dr. Christian D. Uhlhorn
- VLR I Joachim Freiherr von Marschall

(without voting rights in 2009)

- Under Secretary Dr. rer. pol. Gerd Gruppe

Senate Committee

As of June 30, 2009, the senate committee comprised six members from the scientific sector, six members from the economics and industrial sector and five members from the state sector.

From the scientific sector

- Dr.-Ing. Martin Bruse
- Prof. Dr.-Ing. Klaus Drechsler
- Prof. Dr. rer. nat. Ursula Gather (Chairman)
- Prof. Dipl.-Ing. Rolf Henke
- Prof. Dr.-Ing. Reinhard Niehuis
- Prof. Dr.-Ing. Heinz Voggenreiter

From the economics and industrial sector

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

From the state sector (with voting rights in 2009)

- Under Secretary Helge Engelhard
- Deputy Assistant Under Secretary Dr. jur. Axel Kollatschny
- Dipl.-Ing. Josef Schiller
- Deputy Assistant Under Secretary Karl Schumacher
- Deputy Assistant Under Secretary Hendrik Zillinger

(without voting rights in 2009)

- Chief Deputy Assistant Under Secretary Dr. jur. Reinhard Altenmüller
- Dr. Walter Dörhage
- Senate Counsellor Bernd Lietzau
- Deputy Assistant Under Secretary Dr.-Ing. Ulrich Steger
- VLR I Joachim Freiherr von Marschall

Executive Board

(As of June 30, 2009)

- Prof. Dr.-Ing. Johann-Dietrich Wörner (Chairman)
- Dipl.-Kfm. Klaus Hamacher (Vice Chairman)
- Ministerial Director Gerold Reichle
- Dipl.-Ing. Thomas Reiter
- Prof. Dr.-Ing. Joachim Szodruch

Space Committee

(As of June 30, 2009)

- Ministerial Director Jürgen Meyer,
- Federal Ministry of Economics and Technology
- Ministerial Director Dr. C. D. Uhlhorn, Federal Ministry of Education and Research
- Joachim Freiherr von Marschall, Ministry of Foreign Affairs
- VA Wolfgang Reimer, Federal Ministry of Food, Agriculture and Consumer Protection
- Under Secretary Thilo Schmidt, Federal Ministry of Transport, Building and Urban Affairs
- Norbert Weber, Federal Ministry of Defence
- Under Secretary Dr. Rainer Sontowski, Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
- Under Secretary Dr. Gabriel Kühne, Federal Ministry of Finance
- Senior government official Frank Wetzel, Office of the Federal Chancellor

Scientific-Technical Council

Members of the Scientific-Technical Council (As of June 30, 2009)

- Prof. Dr.-Ing. Alberto Moreira (Chairman)
- Prof. Dr. rer. nat Thomas Holzer-Popp (Deputy Chairman)
- Dr. rer. nat. Reinhold Busen
- Prof. Dr. rer. nat. Hansjörg Dittus
- Prof. Dr.-Ing. Dirk Kügler
- Dipl.-Ing. Frank Kocian
- Prof. Dr.-Ing. Karsten Lemmer
- Prof. Dr. Dr.-Ing. habil. Hans Müller-Steinhagen
- Prof. Dr.-Ing. Cord-Christian Rossow
- Dipl.-Ing. Uwe Teegen
- Dr. rer. nat Stephan Ulamec
- Dr. rer. nat Marina Braun-Unkhoff

Affiliates and joint ventures

DLR Joint Ventures Gesellschaft mit beschränkter Haftung (DLR Joint Ventures Limited Liability Company), Bonn, Germany

100%

The purpose of this company is participation in European Economic Interest Groupings (EEIGs) within the framework of the statutory tasks of the German Aerospace Center. The company holds interests in the European project management agency EDCTP-EEIG and AT-One EWIV, an enterprise founded in 2007 to support and organise the collaboration between DLR and NLR in the field of air traffic management.

DLR Gesellschaft für Raumfahrtanwendungen (GfR) mbH (DLR Company of Space Applications mbH), Weßling, Germany

100%

The purpose of this company is provision of services in the area of space applications.

Stiftung Deutsch-Niederländische Windkanäle (DNW) (German-Dutch Wind Tunnels Foundation), Noordoostpolder, The Netherlands

50%

DLR established this foundation as a non-profit organisation on an equal basis together with its Dutch partner organisation, NLR. Its object is to operate, maintain and continue to develop the low-speed wind tunnel in Noordoostpolder owned by the DNW foundation as well as wind tunnels owned by DLR and NLR. (www.dnw.aero)

European Transonic Windtunnel GmbH (ETW), Cologne, Germany

31%

ETW, the European Transonic Wind Tunnel, built and operated by four nations, Germany, France, the United Kingdom and The Netherlands, is the most modern aerodynamic wind tunnel anywhere in the world. The ETW is used to test and optimise new aircraft designs and concepts using scale models under realistic flight conditions. The knowledge gained plays a decisive role in the success of an aircraft development project. (www.etw.de)

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

25%

This company was founded in collaboration with T-Systems, EADS and LfA Förderbank of Bavaria. Its object is to conduct negotiations within the framework of the GALILEO project, as may be required to participate in the construction and operation of the European satellite navigation programme, GALILEO.

Anwendungszentrum GmbH (Incubation Centre for Applications GmbH) Oberpfaffenhofen, Gilching, Germany

25%

The Incubation Centre was established as a public-private partnership and is receiving start-up funding until the end of 2009 from funds provided by High-Tech-Offensive Bavaria. Since its launch, more than fifty companies have either passed through this start-up and entrepreneurial incubation centre in the field of satellite navigation initially funded by DLR alone, or have settled permanently at the Oberpfaffenhofen site as a result of its activities. (www.anwendungszentrum.de)

Europäische Akademie zur Erforschung von Folgen wissenschaftlichtechnischer Entwicklungen Bad Neuenahr-Ahrweiler GmbH, Bad Neuenahr-Ahrweiler, Germany

25%

The European Academy deals with the scientific study and evaluation of the consequences of scientific and technological advances for individuals and society as well as for the natural environment. The main focus is on the examination of processes that are influenced by the natural and engineering sciences and medical disciplines. As an independent scientific institution, the European Academy pursues a dialogue with the world of politics and society at large. The state of Rhineland-Palatinate is the further shareholder. (www.europaeische-akademie-aw.de)

ZFB Zentrum für Flugsimulation Berlin GmbH (Centre for Flight Simulation GmbH), Berlin, Germany

16.67%

The purpose of this company is to provide flight simulators for applied research in the fields of flight control and flight management, particularly for research and education purposes, system simulation and manipulation and associated areas of technology, instruction and training for aerospace engineers and training for flight crews. (www.zfb-berlin.de)

WPX Faserkeramik GmbH (WPX Fibre Ceramics GmbH), Cologne, Germany

10%

WPX Faserkeramik GmbH is a start-up company ensuing from the DLR Institute for Materials Research, which is built upon DLR's expertise in structural materials. The purpose of the company is to provide product development, sales and service for the technical applications of WHIPOX – DLR technology. (www.whipox.com)

Dualis Medtech GmbH, Bernried, Germany

10%

Dualis MedTech develops, produces and markets novel medical implants for patients with severe heart conditions. The central product is the DUALIS-VAD implantable heart support system with the DUALIS-TET wireless energy transfer system. The technology is based upon technology from the Institute of Robotics and Mechatronics, DLR Oberpfaffenhofen. (www.dualis-medtech.de)

Zentrum für Angewandte Luftfahrtforschung GmbH (Centre for Applied Aeronautics Research GmbH), Hamburg, Germany

10%

The purpose of the company is to promote applied aeronautics research at the Hamburg site. The company is tasked to contribute to developing the research infrastructure, combining existing research skills, improving collaboration between the industrial sector, suppliers, large-scale research and the scientific community and implementing a stronger national and international network.

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

9.8%

InnoZ researches the complex interactions at the interface between mobility and social change, developing innovative solutions to new challenges arising and to be faced by players in the transport and infrastructure sector. To this end, InnoZ combines a wide range of interdisciplinary skills under one roof. Sociological, geographical and economic expertise is equally included as are the perspective of applied transport economics. (www.innoz.de)

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

6%

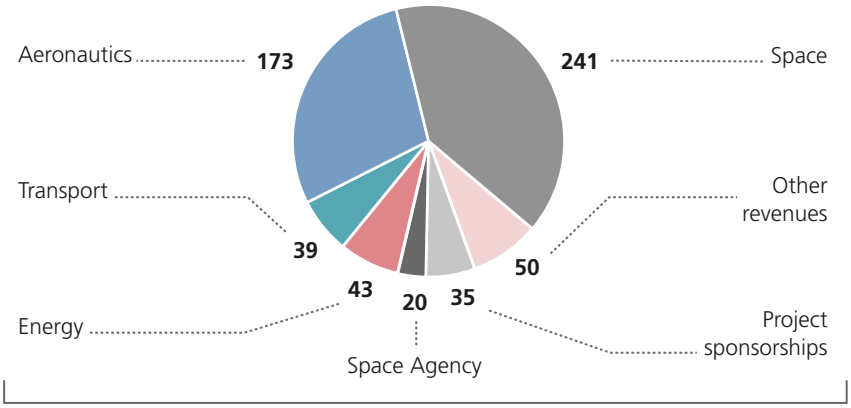
The aim of the competence centre is to introduce, develop and disseminate modern information and communications technology within the healthcare sector. Major focus areas include providing neutral advice and project management services for customers from industry and healthcare, implementing interoperable solutions to facilitate integrated provision and promoting knowledge transfer between the communities of the healthcare sector, science, politics and economics. (www.ztg-nrw.de)

Use of Funds

Overall Revenue 2008 (third-party and basic funding)

Overall revenue 2008

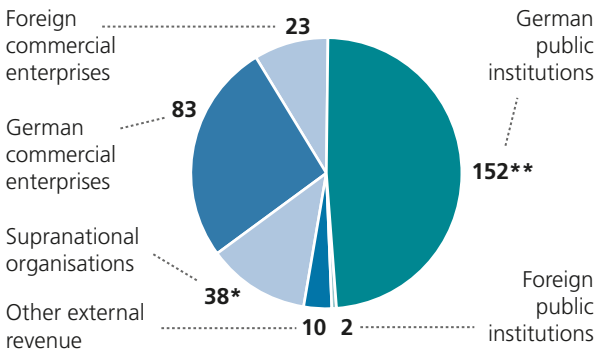
Total 601 million euros — All data in million euros



Third-Party Funding according to Origin and Institutional Funding 2008

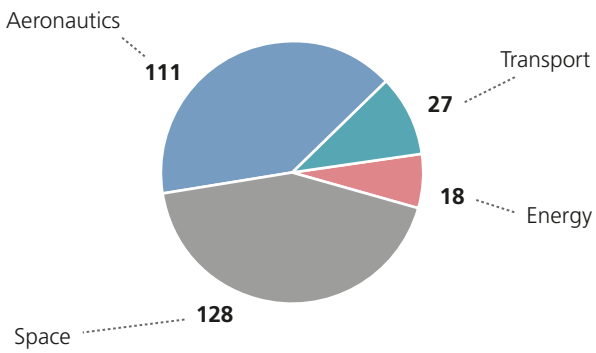
Third-party funding

Total 308 million euros — All data in million euros



Institutional funding*

Total 284 million euros — All data in million euros

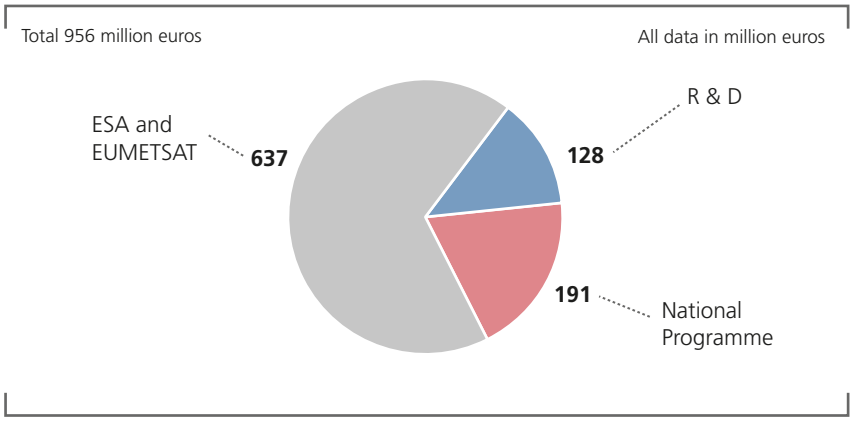


* without other revenue

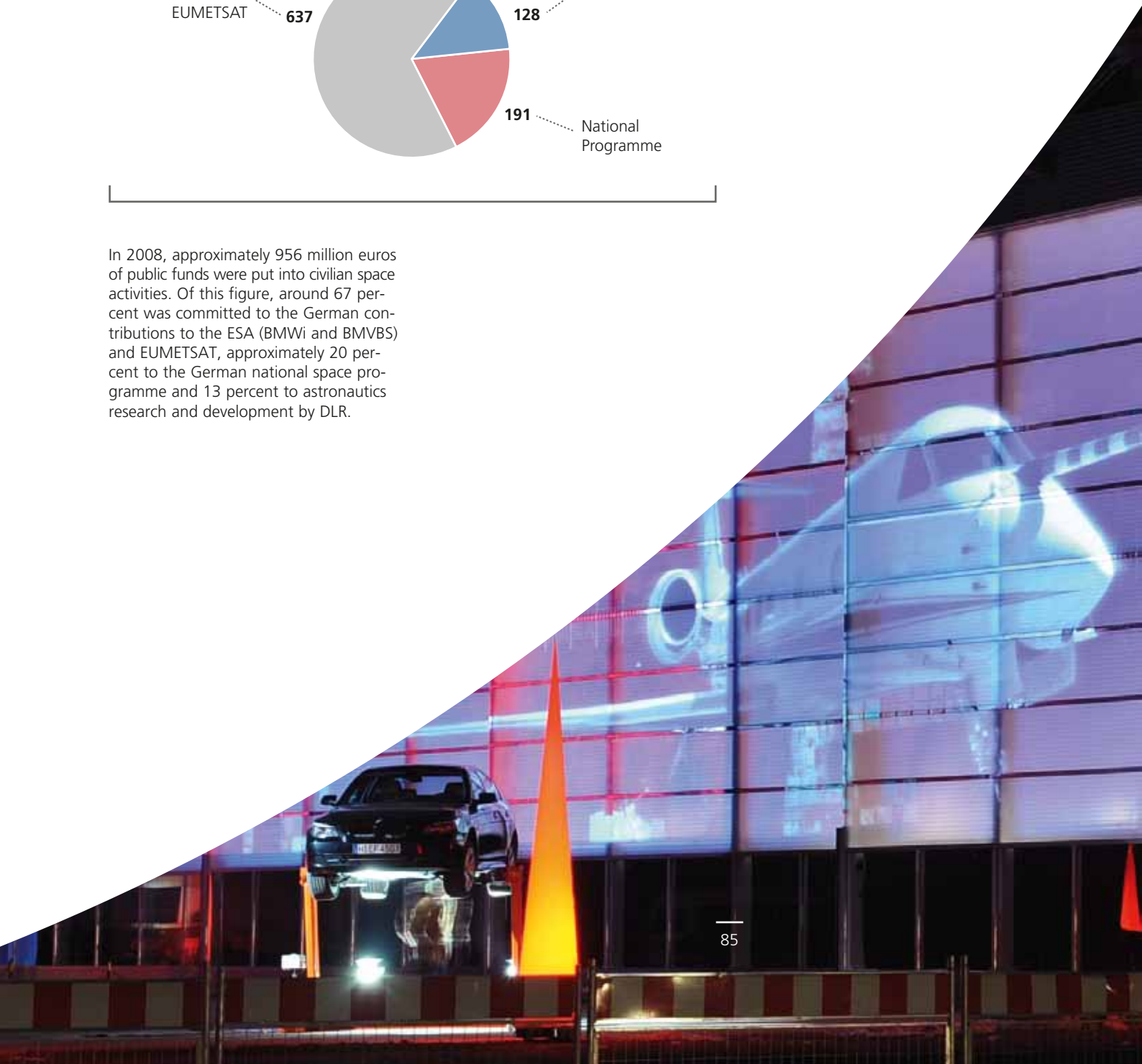
***** including: ESA **18**, EU **20**
****** including: project sponsorship **54**, national public institutions **76**, other R & D third-party funding **22**

German public funds for space activities in 2008

Public funds for space activities



In 2008, approximately 956 million euros of public funds were put into civilian space activities. Of this figure, around 67 percent was committed to the German contributions to the ESA (BMWi and BMVBS) and EUMETSAT, approximately 20 percent to the German national space programme and 13 percent to astronautics research and development by DLR.



List of Abbreviations

ACARE	Advisory Council for Aeronautical Research in Europe
AEB	Agencia Espacial Brasileira – Brazilian Space Agency
ASAL	Agence Spatiale Algérienne – Algerian Space Agency
ATA	Aero Testing Alliance
ATM	Air Traffic Management
BDLI	German Aerospace Industries Association
BG	Professional association
BMBF	Federal Ministry of Education and Research
BMFSFJ	Federal Ministry of Family, Senior Citizens, Women and Youth
BMG	Federal Ministry of Health
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMVBS	Federal Ministry of Transport, Building and Urban Affairs
BMVg	Federal Ministry of Defence
BMWi	Federal Ministry of Economics and Technology
CCSDS	Consultative Committee for Space Data Systems
CCRS	Canada Centre for Remote Sensing
CE	Communauté Européenne – European Community
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CFD	Computational Fluid Dynamics
CFK	Carbon fibre reinforced plastic
CIEMAT	Centro de Investigaciones Energéticas, Medioambietnales y Technológicas – Spanish Research Centre for Energy, the Environment and Technology
CMSEO	China Manned Space Engineering Office
CNES	French National Space Agency
CSA	Canadian Space Agency
CTA	Brazilian Aerospace Technical Centre
DFD	German Remote Sensing Data Centre
DFG	German Research Foundation
DIN	German Institute for Standardisation
DLR	German Aerospace Center
DNW	German-Dutch Wind Tunnels
EADS	European Aeronautic Defence and Space Company
ECSS	European Cooperation of Space Standardisation
ECTRI	European Conference of Transport Research Institutes
EFQM	European Foundation for Quality Management
EREA	European Research Establishments in Aviation
ESA	European Space Agency
ESCC	European Space Components Coordination
ESF	European Social Fund
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EWIV	European Economic Interest Grouping
FAR	Federal Aviation Regulations
FGAN	Research Establishment for Applied Science
FHG	Fraunhofer Society
FuE	Research and development

GAF	Society for Applied Remote Sensing
GARTEUR	Group for Aeronautical Research and Technology in Europe
GMES	Global Monitoring for Environment and Security
GNSS	Global Navigation Satellite System
HGF	Helmholtz Association of National Research Centres
IBMP	Institute of Biomedical Problems of the Russian Academy of Sciences
INPE	Instituto Nacional de Pesquisas Espaciais – Brazilian space research institute
INTA	Instituto Nacional de Técnica Aeroespacial – Spanish Space Agency
ISO	ISO
ISRO	Indian Space Research Organisation
ISS	International Space Station
JAXA	Japan Aerospace Exploration Agency
KMU	Small and medium-sized enterprises
LCT	Laser Communication Terminal
LUFO	Aeronautics research programme
MIWFT	Ministry of Innovation, Science, Research and Technology of the State of North Rhine-Westphalia
MoU	Memorandum of Understanding
MPG	Max Planck Society
MWME	Ministry of Economic Affairs and Energy of the State of North Rhine-Westphalia
NASA	National Aeronautics and Space Administration
NEAL	New Energy Algeria
N.ERGHY	New European Research Grouping on Fuel Cells and Hydrogen
NLR	National Aerospace Laboratory – Dutch aerospace research institution
NWB	Low-speed wind tunnel
ONERA	Office National d´Etudes et de Recherches Aerospatiales
PPP	Public Private Partnership
PSA	Plataforma Solar de Almeria
PT	Project Management Agency
SAR	Synthetic Aperture Radar
SESAR	Single European Sky ATM Research
SNSB	Swedish National Space Board
TU	Technical University
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNOOSA	United Nations Office for Outer Space Affairs
UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
VBL	VBL [provider of supplementary pensions in Germany]
VDI	Association of German Engineers
WMO	World Meteorological Organisation
WTR	DLR Scientific-Technical Council
ZAGI	Central Aerohydrodynamics Institute
ZKI	Centre for Satellite Based Crisis Information
ZLP	Centre for Composite Production Technology

DLR at a Glance

DLR is Germany´s national research center for aeronautics and space. Its extensive research and development work in Aeronautics, Space, Transportation and Energy 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 program 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 6,500 people are employed at thirteen locations in Germany: Koeln (headquarters), Berlin, Bonn, Braunschweig, Bremen, Goettingen, Hamburg, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Stuttgart, Trauen and Weilheim. DLR also operates offices in Brussels, Paris, and Washington D.C.

DLR's mission comprises the exploration of the Earth and the Solar System, research for protecting the environment, for environmentally-compatible technologies, and for promoting mobility, communication, and security. DLR's research portfolio ranges from basic research to innovative applications and products of tomorrow. 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 centers.

DLR

Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Strategy and networks

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