Annual Report

Research and Corporate Results

2005/2006

DLR

Research and Corporate Results 2005/2006

German Aerospace Center (DLR)

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Preface

Dear readers,

Next year, the German Aerospace Center (DLR) will be able to look back on a tradition that spans an entire century. And indeed, the level of importance and performance reached by the aerospace sector in that time is fascinating to contemplate, a fact that is eloquently documented by our annual report entitled "Research and Corporate Results". A century ago, who would have expected research to make such progress in the service of science, the society, and the economy? Who could have foreseen DLR occupying top positions in Europe and even in the entire world with such assurance?

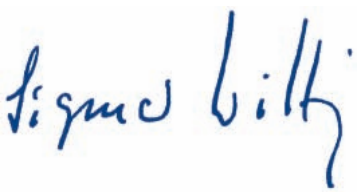
Just take the leading position in the field of Earth observation which Germany claimed and was granted at the Ministerial Conference of the European Space Agency ESA in December 2005. It not only emphasises Germany's excellence in instrument development but also promotes the use of Earth observation in numerous applications of political and societal importance. Then, there is the acquisition of two new leading-edge research aircraft last year, a Gulfstream G550 and an Airbus A320. This addition to DLR's fleet of aircraft offers extraordinary opportunities to address multi-faceted questions in aeronautical and atmospheric research at the highest level. Thus, besides clearly demonstrating its excellence and innovative strength, DLR sustainably consolidated its leadership in European aeronautical research.

The same is true for two other DLR business areas, transport and energy, which share synergies with the aerospace area. In the transport area, a climate-controlled roller test bench for passenger cars was commissioned which is equipped with systems for exhaust-gas analysis and – a the worldwide first – explosion protection. This large-scale facility permits testing even vehicles powered by hydrogen and natural gas to assist in the development of new propulsion concepts. As regards to energy, the work of the business area on solar hydrogen production, which was awarded a number of international prizes, deserves particular mention as it places hydrogen more firmly on track towards becoming the fuel of the future.

Entitled "Research Results", the first part of our annual report graphically describes all these as well as many other highlights. Together, they form an important contribution towards securing the future of our society and our economy. However, we are only able to fulfil our mission so effectively because the state accords great strategic importance to the aerospace as well as to the transport and energy sectors and regards DLR as a crucial force in this area. The truth of this was brought home to us once again when responsibility for DLR was transferred from the Federal Ministry of Education and Research to the Federal Ministry of Economics and Technology. In the future, DLR will similarly be able to rely on this high esteem, which also puts us under a corresponding obligation. The Federal Ministry of Economics and Technology set a number of positive highlights from the very start, particularly at the ESA Ministerial Conference mentioned above. The same holds true for the other ministries and state governments which are DLR's partners. They all show similar commitment to supporting DLR, and we try to give them the best possible returns. The way in which DLR produces its services is described in the second part of the annual report entitled "Corporate Results". It displays the characteristic configuration of the "DLR Research Enterprise" as well as its manifold national and international relations, thus corroborating DLR's claim to being a research institution that uses the very latest methodology in its operations. At the same time, it invites benchmarking by quoting a number of selected performance indicators. But the reason for DLR´s leading position is not only its research portfolio. It is also the combination of its functions as a research institution, a space agency, and Germany´s biggest project management organisation which provides the opportunity to open up new dimensions for the future.

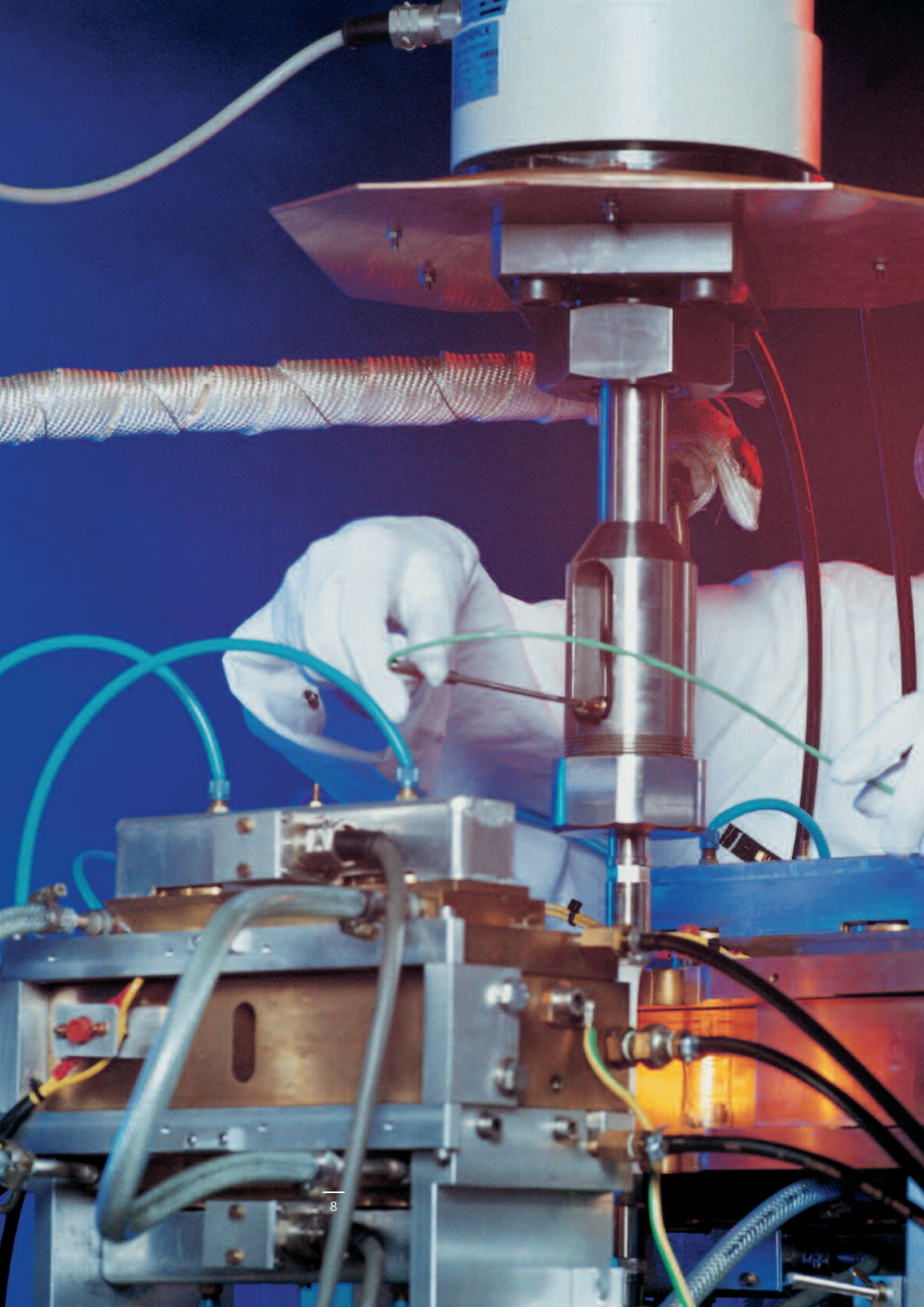
One hundred years of aerospace research, from 1907 to 2007, did nothing to lessen our dynamism, on the contrary: DLR is more dynamic than it ever was before. New challenges, new tools, new methods – not only are all these things expected of us, but we actively push them on ourselves. As you read this report on our "Research and Corporate Results", I should be glad if you could feel some of the drive which our more than 5,000 employees generate so inimitably.

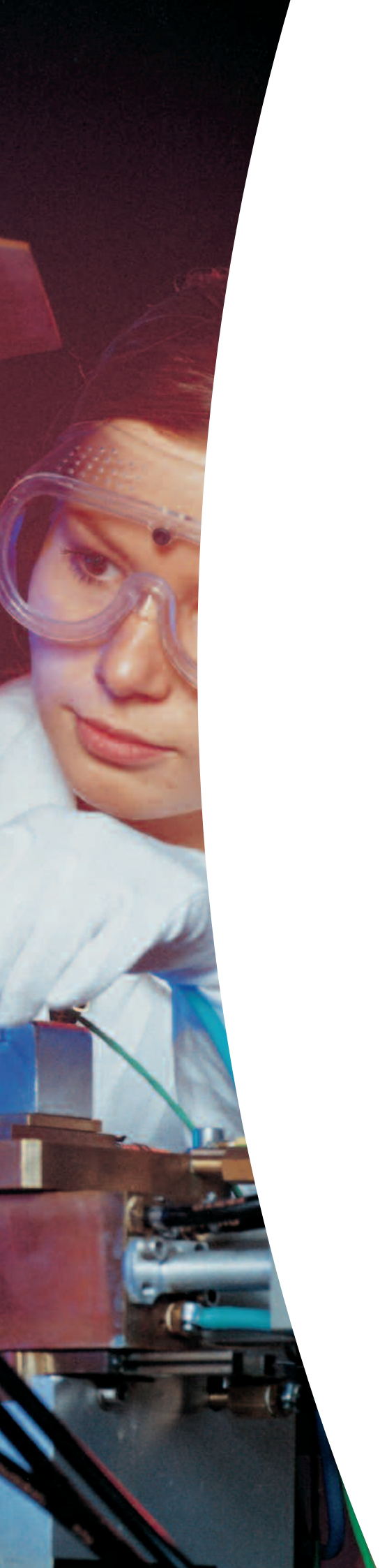
Koeln-Porz, December 2006



Prof. Dr.-Ing. Dr.-Ing. E.h. Dr. h.c. mult.
Sigmar Wittig

Chairman of the Executive Board





RESEARCH RESULTS

Aeronautics

Addressing nearly all essential aspects of today's air transport system, the research programme of the aeronautics business area covers fixed-wing aircraft, helicopters, propulsion technologies, air traffic management, and the environmental aspects of air transport. Wherever it appears feasible and sensible, defence technology problems will be investigated in close connection with technologies for civilian applications although, because of their nature, they sometimes form the subject of dedicated research projects.

In civil aviation, research is largely guided by the general objectives of the European research agenda. As before, the period covered by this report was characterised by increasingly profound cooperation with aeronautical research institutions elsewhere in Europe, particularly ONERA in France and NLR in the Netherlands. Similarly close contacts were maintained with the industry to ensure the relevance of DLR's work in practical applications.

The current aeronautics research programme of the Federal Government (LUFO IV) is expected to make a major contribution towards enhancing the network that exists between research and the industry in Germany. The scope of DLR's participation in the recent first call for joint project tenders was correspondingly large. On the European plane, it is expected that the seventh research framework programme will be launched in 2007. Here again, DLR is preparing to make its own contributions towards aeronautical issues.

New research aircraft in a flying change

HALO for atmospheric research, a converted A320 for flight system development

For DLR's aeronautics area, taking delivery of two new research aircraft within a few weeks forms an special highlight in the period covered by this report. A Gulfstream G550 was acquired under a joint investment programme involving the Federal Ministry of Education and Research, the Max Planck Society, the Helmholtz Association, and DLR. Replacing a Falcon that is now more than thirty years old, it will be employed by DLR mainly in atmospheric research under the name of HALO (high altitude long endurance). Serving as a flying platform for aircraft technology research, an Airbus A320 will replace a VFW614, also aged about thirty and still used by DLR for similar missions today as the only still-flying machine of its type. In the next two years, the two machines will undergo an extensive retrofitting programme to equip them for their proper duties as research airplanes.

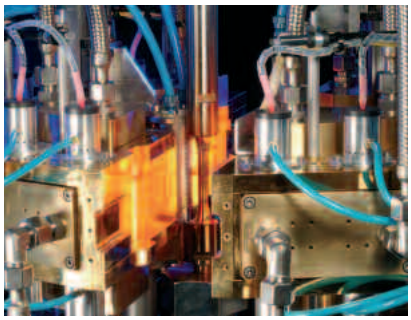
DLR's recently-acquired research aircraft, A320 (left) and HALO (right) (© Gulfstream Aerospace Corporation)

These acquisitions underline DLR's unique role as operator of the largest fleet of civil research aircraft in Europe, which currently comprises 13 serviceable planes and helicopters. Besides serving to support in-house research programmes, the machines are available to external partners, like all the other large-scale experimental facilities of DLR.

New test facility for engine components

Testing heat insulation coatings for highly loaded turbine blades

In most modern high-performance engines, ceramic heat insulation coatings are used to protect components exposed to extremely high temperatures from overheating. Demonstrating the reliability of such coatings in an engine calls for realistic test methods. The essential point is that the damage mechanisms that control the service life of a component in laboratory experiments should be the same as those in real-life engines.



Open radiation furnace with an internally-cooled cylindrical specimen at the Center

At the Institute of Materials Research, an innovative test facility was developed and built to simulate the operating conditions of the blades in the first stage of an engine turbine, which are exposed to the severest stress. Specimens are cylindrical and fitted with an inner bore. While the ceramic surface is heated by concentrated radiation, the inner bore is cooled with compressed air, so that the resultant steep temperature gradient between the outer and inner surface resembles that of an internally-cooled turbine blade. Ceramic surfaces may reach a maximum test temperature of 1,200 °C. High-density radiation for heating and an additional air blast for cooling keep heating and cooling times down to less than 30 seconds. In this way, the thermal and mechanical fatigue stress of an entire flight, including take-off, cruising, landing, and engine shutdown may be applied to laboratory specimens within 3 minutes in a time-compressed test. Because the temperature gradient is controlled, the test is called "thermal gradient mechanical fatigue" or TGMF.

One major failure mode in operation involves coatings flaking off at the interface between the ceramic topcoat and the metal substrate. Under the quasi-operational conditions of a TGMF test, fatigue cracks will form in parallel with the interface between the metal and the ceramic material, causing the coating to flake off more quickly than in straightforward thermal-fatigue tests. Any resultant microstructural and chemical changes and/or injuries are investigated by microscopy and microanalysis, while numerical methods are used to simulate stress and damage processes so as to clarify damage mechanisms.

Heating resin by microwave radiation

A new process for the aviation industry

Resins used in so-called injection processes are frequently preconditioned for injection. Preconditioning involves minimising the viscosity of the matrix which, in the case of those resins that are relevant in aircraft engineering, is done by increasing the temperature of the matrix in a container.

Microwave resin heater for process acceleration

At the moment, the standard process established in the industry is heating by convection, although the need for heat transition and the bad thermal conductivity of resin constitute a severe drawback affecting the homogeneity of the temperature distribution within the resin itself.

The current process permits heating a volume of resin to a target temperature of 80°C within c. 4 hours, although temperature distribution will become homogeneous only after c. 8 hours. This affects the processing time of the resin as well as the flexibility of the manufacturing chain. Preconditioning resin by microwave heating constitutes an innovative approach. Based on the dielectric heating of dipole molecules in a high-frequency electromagnetic field, this selective inertialess heating mechanism ensures energy-efficient resin processing. The resin is penetrated by the microwave radiation to a depth sufficient to permit volumetric heating, thus avoiding undesirable temperature gradients within the resin body. Compared to conventional heating, the microwave process is capable of reducing the time required to reach homogeneous temperature distribution by a significant margin.

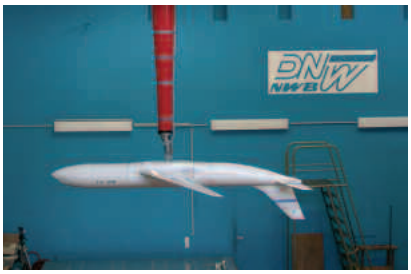
This effect may be reinforced by rotating the container mechanically. In preliminary tests already conducted, process time was cut down by 90%. The temperature distribution within the resin container reached during these tests proved absolutely homogeneous, converging very well with the steady state after conventional heating by convection. Because of the numerous advantages it offers, the microwave heating process was qualified for the aircraft industry and integrated in the serial production of Airbus Deutschland GmbH.

Improved simulation system

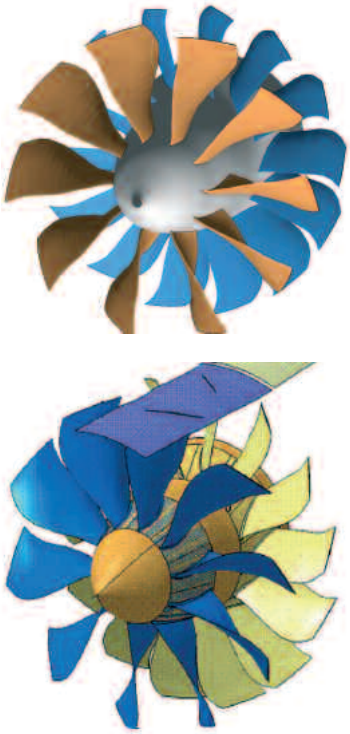
Analysing non-stationary pressure distributions at wing and tail assembly sections

For the further refinement of experimental and numerical methods to determine dynamic derivatives, DLR has its own lightweight-construction model (DLR-F12) which goes beyond conventional capabilities in that it permits determining not only transient forces and moments but also transient pressure distributions along wing as well as vertical and horizontal tailplane sections. In experimental investigations, the model is mounted on the model positioning mechanism (MPM) developed jointly by the Low-speed Windtunnel Project (DNW-NWB) and DLR.

Measurement results are then used to verify and validate the numerical algorithm employed so as to improve the simulation of flows around complex configurations subject to quasi-stationary and instationary harmonic movements. A proprietary numerical code for unstructured hybrid meshes called TAU is used to solve the Eulerian and Navier-Stokes equations involved. Depending on the complexity of the model, this mathematical process may be used to determine instationary flow fields (see Figure) and dynamic coefficients, the results obtained by this process converging very well with those obtained experimentally.



The system is capable of simulating with a high degree of precision not only all rotation movements of the model around its axes but also lifting and flapping motions



Fan designs by SNECMA (bottom) and DLR (top)

The VITAL EU project

Designing a counter-rotating fan for noise reduction

Based on the development of the silencer fan and the knowhow gained in setting up DLR's own UHBR rig, an efficient, noise-optimised counter-rotating fan is being designed and tested experimentally under the VITAL EU project. The companies and/or research institutions SNECMA, COMOTI, CIAM, and DLR are working jointly on the project. A first draft of such a fan has been completed, which will be optimised aerodynamically with the aid of an optimisation algorithm developed by DLR. On the left, the Figure shows the first model to be investigated experimentally. Executed by SNECMA, this fan design features back-swept rotor blades. Our own design research indicates that a fan featuring forward-swept blades on the outer casing offers superior efficiency and partial-load behaviour (right).

The detail studies, parameter variations, and particularly the instationary flow simulations that are currently under way will, together with the aero-acoustic evaluation that is to follow, form the basis for the ultimate decision about which configuration will serve as the basis for the second model to be built and investigated experimentally.

The WHIPOX ceramic matrix composite

A new material for engine components conducting hot gas

Oxidic fibre-reinforced ceramic materials (CMCs) are temperature and oxidation-resistant as well as tolerant towards thermal shocks and mechanical overloads. At DLR's Institute of Materials Research, a CMC material called WHIPOX® was developed in the course of the last few years that is remarkable for the economy of its production and the adaptability of its properties. WHIPOX CMCs consist of Al2O3 or Al2O3/mullite fibres and a variety of suitably formulated porous aluminium-silicate matrices.

For gas turbine applications, the composite must be coated on the hot-gas side. At high temperatures, such a coating offers protection from water vapour corrosion and, if required, additional thermal insulation. At the present stage of development, a two-layer system of Al2O3 and ZrO2 appears to serve the purpose particularly well. Current development activities aim to improve the long-term stability of coated CMCs that will be used as combustion-chamber walls in future engines. Under the "Combustion Chamber 2000" project, various DLR institutes work together on the development of combustion-chamber walls made of WHIPOX. The Institute cooperated closely with the Institute of Structures and Design on engineering, designing, and developing an attachment concept that is now patent-protected. DLR Institutes of Propulsion Technology and Combustion Technology are engaged in developing cooling concepts suitable for ceramic materials and testing ceramic combustion-chamber walls under as-installed conditions.

Numerous new uses for WHIPOX CMCs have been developed in addition to gas turbine applications, the most prominent among them being industrial furnaces and pore burners, heat shields for space vehicles, and radar-transparent components (radomes) for ultrafast missiles.

Flight test programme for heavy transport helicopters

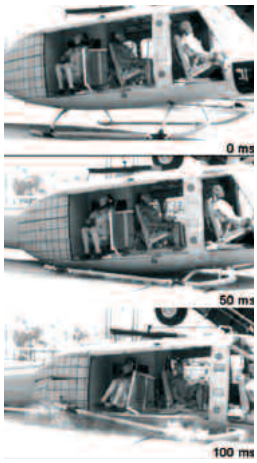
Striving for easy flyability in flight maneuver

For future projects, the scope of the requirements that apply to the flying qualities of military helicopters will have to be expanded to include heavy transport helicopters. The criteria defined in the ADS-33 aeronautical design standard guarantee aerodynamical safety and the properties required by users, which ensure that certain missions can be flown without undue pilot workload.

A Federal Army helicopter of the CH-53 G type was equipped with measuring systems at the WTD61 military establishment. Having years of experience in this field, DLR developed a flight test programme in consultation with the US Army that included a variety of maneuver and mission elements relating to the duties of transport helicopters. In addition to hovering and vertical flight maneuver, slalom-flight elements involving high-altitude rolls, lateral moves, landings on inclined surfaces, and flights with underslung loads were investigated. Flight tasks were evaluated by four experienced test pilots from Germany and the USA using standardised methods. Together with objective measurement data, these pilot judgments form the basis for formulating generalised flight-property criteria.

The programme was concluded successfully after more than 20 flight hours; the large volume of data gathered will now be analysed and compressed jointly by DLR and the US Army, the objective being to include new criteria defining the safety and simplicity of flying heavy transport helicopters in the ADS-33 aeronautical design standard, which will then serve as a guideline for evaluation and design.

CH-53 G transport helicopter being tested with 4 tons of underslung load; Bo 105 light helicopter of the Federal Army



HeliSafe TA: Simulation of a helicopter crash test using DLR hybrid computational model

The HeliSafe EU project

More safety for helicopters – even in a crash

Within the framework of the European Union's HeliSafe TA specific targeted research project (STREP), technologies are being developed to enhance occupant safety in the event of a helicopter crash. DLR's contribution focuses on modelling crash behaviour as a basis for evaluating the effectiveness of safety components, such as airbags or new restraint systems.

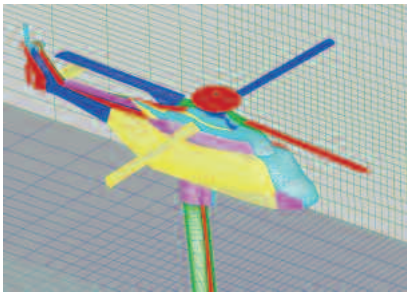
A Bell UH-1D was crash-tested at the Italian research center CIRA. Provided by the Federal Army, the helicopter was equipped with three instrumented crash dummies simulating a pilot and two passengers as well as with standard safety equipment. The scenario was selected and realised on the basis of DLR simulations of impacts on concrete. Because of a defect in the initiation mechanism of the crash system, loads were higher than expected, including peak accelerations of up to 30g which the occupants could not have survived.

Although the conditions of the crash were changed, the data gathered will play a major role in validating the computer codes and preparing another test scheduled for this year, which will serve to understand the influence of crash dynamics on occupant injuries and to develop new systems to mitigate the consequences of a crash.

The GOAHEAD EU project

Data to validate numerical methods for simulating flows around helicopters

In the context of the Franco-German cooperation CHANCE (Complete Helicopter Advanced Computational Environment), it was found that the experimental data available are not sufficient for evaluating the quality of the latest numerical methods for computing entire flows around helicopters. For this reason, DLR joined forces with ONERA, Eurocopter, and another 12 European partners to define the EU project GOAHEAD (Generation of Advanced Helicopter Experimental Aerodynamic Database for CFD code validation), which was successfully submitted to the EU.



GOAHEAD mesh

The kick-off meeting took place at DLR's Braunschweig site in July 2005. The project aims to generate a comprehensive set of high-precision data for validating numerical methods (CFD methods) by taking the Reynolds mean of Navier-Stokes equations. A configuration comprising a main rotor, a fuselage, and a tail rotor will be analysed in a variety of flight modes, from low-speed and high-speed flight to a state that corresponds to high-stress banking. The model has been defined, and work on model integration has begun. Numerical simulation meshes have been generated (see Figure), so that computing runs may be started now. They will cover the fluid-structure interaction of the main rotor as well as an approximate trim for the entire helicopter.

Helicopters – low noise, low vibration

Rotor blades become active

The noise emissions, vibrations, and flight qualities of helicopters may be improved significantly by introducing rotor blades that can be adjusted individually and adapted to local flow conditions. DLR is pursuing two approaches to achieve this:

- Actively controllable flaps at the trailing edges of the rotor blades, and
- active control of blade twist.

Designed and built jointly by DLR and ONERA, a model rotor 4m across featuring piezo-electric flap actuators was tested in ONERA's S1MA wind tunnel. An airworthy rotor corresponding to the model was developed by Eurocopter Deutschland and tested in flight in co-operation with DLR. Both wind-tunnel and flight tests confirmed that vibrations were indeed reduced by c. 90%, as calculated before. Further flight tests and wind-tunnel measurements are scheduled for this year to verify the expected noise reduction.

Under DLR's "active twist blade" project (ATB), a rotor blade demonstrator was designed and built that permits actively controlling and modifying the twist of the rotor blade. Piezo-ceramic materials integrated in the skin of the rotor blade generate a distributed twist by ± 1.5 degrees, thus enabling the rotating blade to adapt actively to local conditions. Within the framework of another DLR project (ATB II), the first project's highly promising results will be applied to a model rotor which will then be tested in a wind tunnel.

Active rotor blades featuring trailing-edge flaps or, in the future, direct twist control will make a major contribution towards enhancing the safety, comfort, and environment-friendliness of helicopter missions. Together with ONERA and the industry, the work done by DLR provides important information on which the realisation of this technology may be based.

Active twist blade – artist's view

The B-VHF EU project

A new concept for communication of air traffic controllers and pilots

Led by Frequentis GmbH, 11 partners from 5 European countries joined hands in the B-VHF EU project (broadband VHF aeronautical communications system based on MC-CDMA) to develop a new communication concept for air traffic management (ATM) communication between traffic controllers and pilots. Because of the continually increasing volume of the air traffic and related communications, it will be necessary to introduce new communication methods in aviation in the medium term to obviate bottlenecks. Launched on January 1, 2004, B-VHF ended on September 30, 2006. It aims to develop and validate the concept of an overlay system for ATM communication on the VHF band. Based on two multi-carrier technologies, namely orthogonal frequency-division multiplexing (OFDM) and multi-carrier code-division multiple access (MC-CDMA), the B-VHF system uses frequency gaps that occur on the VHF band whenever a channel is either not used or occupied by a far-distant VHF system.

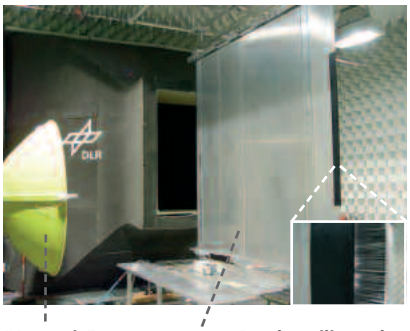
The Figure shows the method employed by B-VHF to use the VHF band as an overlay system. Using frequency gaps for transmission, B-VHF avoids transmitting on VHF channels used by VHF systems in the neighbourhood. To validate B-VHF, software simulation will be employed, and a first B-VHF demonstrator will be built and measured. Within B-VHF, DLR has assumed responsibility for the development process, the implementation of the software, and the implementation of the demonstrator for the entire physical layer. The feasibility of the B-VHF concept developed has been confirmed by the results of the simulation and the measurements of the B-VHF demonstrator at the laboratory of the DFS (Deutsche Flugsicherung GmbH).

In spring 2006, the B-VHF project was presented at the ATC in Maastricht and at the Aeronautics Days in Vienna. The future communications study jointly conducted by the FAA and Eurocontrol places B-VHF on the shortlist of promising technologies for future aeronautical communication methods.

Silent air traffic II

Successful reduction of flow noise around lift surfaces

To cope with the growing volume of air traffic in the most environmentally-friendly way possible, minimising noise is of essential importance.



Using an interdisciplinary approach, the project aims to develop concrete and realistic proposals about reducing noise in the vicinity of airports. Noise abatement through technical innovations at the source (engines and airflows) offers the best potential in this context. Numerical calculations indicate that a modern UHBR (ultra-high bypass ratio) fan may potentially bring down the sound level by 16 dB, while brush-like trailing edges may reduce the noise of airflows around lift surfaces by as much as 6 dB. In addition, operational methods (i.e. approach and take-off procedures) may be optimised as well. Greater precision in flight-path and speed guidance may serve to reduce noise levels in the vicinity of airports to a marked extent.

Next to refining a model to compute flight noise immission, it is probably one of the most important tasks of the project to develop robust criteria for assessing the effects of nocturnal noise, especially the cumulative effect of road, rail, and air-traffic noise. Two sleep laboratory studies have meanwhile been completed for this purpose.

Low-noise flight procedures

Flight captains and first officers test low-noise flight procedure in full-flight simulators

Low-noise flight procedures may influence pilot performance. Compounded by low acceptance, this might impair flight safety. Before such procedures are introduced, therefore, the extent to which they lead to higher stress than conventional procedures should be investigated. For this reason, the responses of 40 pilots in conventional standard and low-noise approaches were tested under medical supervision in A320 and A330 simulators in cooperation with Lufthansa and the Technical University of Berlin.

Examined by DLR medical staff, 20 captains and 20 first officers tested a modified (low-noise) flight procedure in full-flight simulators

Under the conditions prevailing in the test, no differences were detected between the two approach procedures as far as physiological findings are concerned (ECG, blood pressure, blink rate, stress hormones). The pilots' subjective evaluations revealed that the low-noise procedure was somewhat more difficult because of its nature, so that acceptance was lower compared to the conventional method. It appears apposite to investigate personnel stress and acceptance under real-life conditions, and to initiate further technical developments and tests to support the pilots.

Waiting for permission to take off – rush hour on the tarmac

The EMMA EU project

Implementing a taxi guidance system at European airports

Under the EMMA EU project (European airport movement management by A-SMGCS), a level 1&2 A-SMGCS system based on the operational concept was implemented at the European airports of Prague (Ruzyne), Milan (Malpensa), and Toulouse (Blagnac) by 24 international partners from 10 countries under DLR coordination. After preparatory simulation runs, the concept was validated in extensive tests at each of the airports concerned.

In its first phase, EMMA set a milestone in the implementation of A-SMGCS systems at airports by systematically following the loop from concept formulation via implementation to validation, and by demonstrating its technical utility through its mature operational concept. Under EMMA, A-SMGCS performance data from different system implementations were automatically evaluated in long-term measurements. In addition, the Ruzyne airport in Prague used insights from EMMA to improve the conflict detection and warning system operated during the test, which is now released for operation. On March 21 and 22, 2006, the EMMA project was demonstrated at an event that attracted much public attention. On April 20, 2006, the follow-up project, EMMA2, was presented to the public at the Malpensa airport in Milan. EMMA2 serves to develop and define the operational applications of higher-order taxi guidance functionalities that have not been adequately standardised so far.

The results from EMMA and EMMA2 will be amalgamated in the SESAR project (Single European Sky ATM Research). They constitute milestones on the way towards the Europe-wide introduction of the taxi guidance system with regard to safety, aircraft throughput, efficiency, and the reduction of both environmental stress and the number of delays, harmonising with the goals of EUROCONTROL, Vision 2020, and global ICAO standardisation.

Airport management

From a development environment to a suitable experimental environment

The diverse assistance and planning systems that will form part of a total airport-management concept but still exist in isolation today will be transplanted from their development environments to a suitable experimental environment to explore possibilities of bringing the partially competing interests of airport users (stakeholders) into line with the aid of CDM concepts (Collaborative Decision Making).

As a first step, the tactical systems for planning approaches (AMAN) and departures (DMAN) were integrated in the control center of the Institute of Flight Guidance (ACCES, airport and control center simulator) together with a pre-tactical planning system. Both were demonstrated successfully at the R&D symposium of the flight guidance institute as well as at the ATC in Maastricht before an audience of international ATM experts.

The solution thus realised forms a proven foundation for the further development of a total airport-management concept. Furthermore, it provides the basis for the planned in-house project FAMOS (future airport management operation system) as well as for the total airport management concept developed in cooperation with EUROCONTROL.

Because of the large amount of coordination work involved, the project was subdivided into 6 sub-projects, with DLR in charge of sub-project 5, which investigates critical ambient conditions in different flight phases and includes the planning and implementation of flight tests.

As the project is still at a relatively early stage, it is only natural that the development of devices has not yet begun. Major activities in the first year of the project included compiling requirements, investigating the interaction between aircraft type and device selection and installation (especially antennas), investigating ambient conditions prevailing in a variety of flight scenarios, and defining several variants of the architecture of the devices to be used later on.

The ANASTASIA EU project

Avionics devices for navigation and communication in civil aviation

As a project integrated in the EU's 6th framework programme, ANASTASIA (airborne communication and navigation satellite technologies and techniques in a system-integrated approach) aims to develop prototypes of future avionics devices for civil aviation. Activities focus on the development of devices for positioning (navigation component) and for communicating information from and to the cockpit and the aircraft cabin (communication component), with particular emphasis on using satellite-based systems. The target horizon envisaged is the air traffic situation from 2010 onwards. Launched on April 1, 2005, the programme is designed to extend over 4 years. Coordinated by THALES Avionics, work is shared out among 30 partners.

Space Management and Space

In the field of astronautics, DLR performs two functions simultaneously: In addition to its space R&D business area, DLR is responsible for planning and implementation of Germany space activities and representing the country's interests on the international plane in its capacity as space agency for the Federal Government.

In the period covered by this report, the work of the Space Agency and DLR's research institutes was profoundly influenced by two factors. First among these is the outcome of the conference of the European Council of Ministers, where Germany succeeded in taking the lead in the field of Earth observation. Second, it benefited from the positive development in space funding initiated by the new Federal Government. It is now possible to launch new programmes and initiate new projects. The projects that are already in operation have produced some remarkable successes, most prominent among them the series of successful Ariane launches, a splendid achievement and an important pillar for the future of German astronautics. At the same time, the expansion of activities relating to Earth observation, disaster management, and exploration enables DLR to demonstrate its growing competence in these fields. As far as the outlook for this and next year is concerned, interest certainly focusses on the space missions of Thomas Reiter and Hans Schlegel, curtain-raisers for the long-term presence of European astronauts on the ISS.

The results of the 2005 conference of the Council of Ministers

On December 5 and 6, 2005, the ESA Council of Ministers met in Berlin to decide on the ESA's space policies as well as on the continuation of existing and the launch of new programmes. The ESA's member countries, together with Canada as an associated member and the EU Commission, decided that European space activities should focus even more than before on research as well as on enhancing the competitiveness of Europe's industry. For the years to come, Germany committed itself to the payment of about Euro 1.8 bn, c. 20% of the entire subscription volume, retaining its position as Europe's second most important space nation after France. Germany's contributions towards the ESA's budget highlight the areas of German competence and offer outstanding opportunities for Germany's industry in the future.

Building the ISS

The optional ESA programmes that were confirmed include upgrading the International Space Station (ISS) and launching the European Columbus laboratory module. As the leading member country, Germany contributes Euro 220.1 million to the total programme volume of Euro 650 million.

Earth exploration – EOEP-3 and GMES

Germany's share in the Earth-observation framework programme (EOEP-3) and the global monitoring for environment and security programme (GMES) amounts to Euro 311 million (20.9%) and Euro 62 million (31%), respectively. Similarly, Germany is now committed to paying a relatively high share funded by the BMVBS in the phase 2 of GMES that will follow after 2009.

Because of its share, Germany has now assumed the lead in both programmes and, consequently, in the field of scientific and applied Earth observation, such as land observation, disaster prevention, and security issues.

Satellite communication

Germany subscribed Euro 45.5 million for ongoing programmes to support the competitiveness of Europe's industry in the field of satellite communication. What is more, Germany succeeded in initiating a new ESA programme, ARTES 11, in the emerging market for small geostationary satellites. Its share of Euro 32 million (32%) gave Germany the lead in this programme.

Space transport

To secure Europe's independent access to space as well as its core competences in space transport, Germany subscribed a total of Euro 108 million (about 15%) to the Ariane 5 support programmes ARTA and ACEP. However, because of the long lead times required for developing launcher systems, it is necessary to think about the next generation even now. To participate in this forward-looking project, Germany subscribed Euro 42.9 million (13.0%) to the Future Launcher Preparatory Programme (FLPP-2) in order to maintain and apply its development competence.

The Aurora space exploration programme

Within the Aurora programme, Germany's share in the first European exploration mission, ExoMars, amounts to Euro 86 million (14.5%), securing Germany's SMEs a variety of opportunities for involvement in the scientific payload and the lander. The budget includes an annual minimum contribution of Euro 5 million towards technology development (General Support Technology Programme, GSTP). Germany's share underlines its call for enhancing the promotion of basic technologies. After the successful conference of the ESA council of Ministers on

2005 conference of the ESA Council of Minister in Berlin

December 5/6, 2005 in Berlin, it is now imperative to assign its decisions into programmes and processes, focussing on obtaining an adequate role for Germany in each of the new programmes through intensive negotiations with the ESA's executive and the ESA member states. A point of particular importance will be to secure a leading role for Germany in the GMES land-coverage and humanitarian-aid services together with system leadership in essential components of the GMES space segment. Other goals of similar importance include reaching agreement on essential work packages and payload contributions for the ExoMars exploration mission. The chances of securing an adequate position for Germany's competences (thrust chambers, upper stage) in the development of future launchers were improved by a pending increase in Germany's subscription for FLPP-2 from Euro 23.9 million to Euro 66.8 million.

To strengthen Germany's leading role in ARTES 11, DLR Space Agency hosted a workshop on small geostationary satellites from June 28 to June 30, 2006. Industrial companies and partner agencies used this forum to refine the technical design of this new satellite platform and to identify optional payloads.

Ariane 5 integration

Ariane 5 on the road to success

13 successful starts in a row

In an unbroken series of 13 successful starts since April 2003, different versions of Ariane 5 proved the reliability of this European launcher. Thus, for instance, the European weather satellite MSG-2 was launched on an Ariane 5 GS on December 21, 2005. This satellite, number two in the Meteosat second-generation family (MSG), transmits a wide range of weather data that are used in weather forecasts, climate monitoring, and environmental surveillance. On the same flight, Ariane 5 carried an Indian telecommunication satellite (INSAT 4A) to its target orbit.

Progressive developments of the generic version resulted in Ariane 5 ECA, the rocket with the highest level of technical sophistication and performance ever built for ESA. This launcher is capable of simultaneously transporting two satellites with a total mass of almost ten tons into a geostationary transfer orbit.

On May 27, 2006, Ariane 5 ECA completed its most recent flight without problems, setting a world record by transporting a total payload mass of more than 8,200kg into a geostationary transfer orbit. Not only is the upper stage of the Ariane 5 ECA assembled in Bremen, Germany also supplies a number of other essential components before Ariane 5 is finally assembled at the range in French Guyana under the direction of EADS Space Transportation. In the last two years, DLR played a major role in the qualification of the new European heavy-lift rocket, Ariane 5 ECA.

Research under space conditions

DLR Space Agency supports German scientists in basic as well as in application-oriented research under space conditions. The Agency promotes researchers in biology, medicine, physics, and materials science from universities, Max Planck institutes, and other research institutions, providing – together with ESA – the equipment and flight opportunities they need for their experiments. Besides the International Space Station, which is used for long-term experiments, the Bremen drop tower as well as parabolic and rocket flights are available for short-term experiments.

Plasma physics on the ISS

Successful German-Russian cooperation continues

The science complex plasmas – ionised gases enriched with micro-particles – is a prominent field of research which DLR Space Agency promotes as part of its programme for research under space conditions. The first scientific experiment ever conducted on the ISS, the PKE-Nefedov experimental rig, has been used by the Max Planck Institute for Extraterrestrial Physics in Garching in cooperation with the Institute for High Energy Densities at the Russian Academy of Science in Moscow ever since March 2001.

These studies have yielded more than 30 scientific publications so far. In December 2005, the rack was exchanged for a new plasma-crystal apparatus called PK-3 Plus. By mid-January 2006, the apparatus was ready for cosmonaut Valeri I. Tokarev to continue the experiments. The German astronaut Thomas Reiter will be using PK-3 Plus from July 2006 onwards to conduct an experimental programme during the ESA-ASTROLAB mission.

DLR parabolic flights

At Bordeaux and, for the second time, in Germany

Besides the International Space Station (ISS), alternative options to conduct research under space conditions were used as well, such as parabolic flights on the Airbus A300 ZERO-G. Each parabolic-flight campaign offers in the sum around 35 minutes of weightlessness in a series of 22-second phases. Offered by ESA and DLR, these flights were used by German scientists for a total of more than 60 experiments in the autumn of 2005 and the spring of 2006. Parabolic flights serve to prepare complex experiments for implementation on the ISS or on research rockets, and to conduct scientific experiments for which 22 seconds of weightlessness are enough.

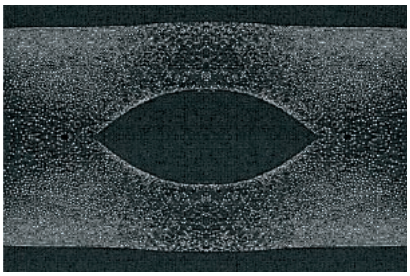
In May 2006, DLR Space Agency used Cologne-Bonn airport for the second time as a base for conducting the 8th parabolic-flight campaign since the programme was initiated in 1999. A multitude of medical, biological, physical, and materials-science experiments were run during these flights, the most prominent among them being studies of metal alloys using the TEMPUS experimental apparatus, which is unique worldwide. Research groups from various DLR institutes took part in these studies. In TEMPUS, metal samples can be levitated, melted, examined in the fluid state, and left to solidify again without coming into contact with crucible walls. In addition, pupils from the regions of Aachen and Berlin were given an opportunity to study the gravity perception of free-floating cells experimentally, in which they were supported by DLR_School_Labs.

The Graz dialogue on GMES

A market for GMES in Europe and its regions

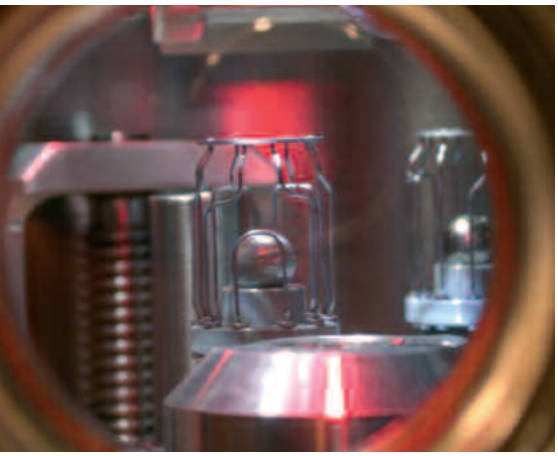
On April 19/20, 2006, during Austria's tenure of the presidency of the EU Council, a meeting on GMES was held under the motto "A market for GMES in Europe and its regions – the Graz dialogue". At the conference, high-ranking experts analysed the potential benefits of space-based services for the citizens of Europe.

The resultant "Graz declaration" defines the strategic, economic, and regional cornerstones of GMES and emphasises the indispensability of this joint monitoring programme. In addition to the ongoing GMES-related activities of DLR Space Agency, further opportunities to advance the development of GMES in a number of crucial aspects will arise during Germany's tenure of the presidency of the EU Council from January to June 2007. In that context, the Space Agency proposes making GMES a key theme during that period. Among other things, the Agency suggests holding another GMES meeting during the German presidency of the EU Council in order to enhance the political visibility of GMES and thus promote its operational implementation.

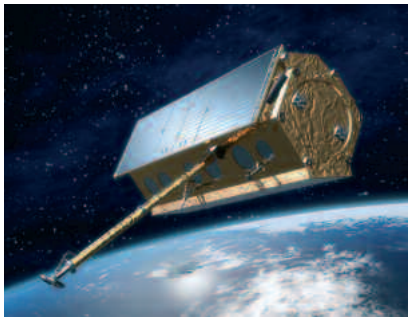


Formation of a plasma crystal under space conditions

Conducting experiments during a parabolic flight



Inside view of the TEXUS-EML apparatus



TerraSAR-X

TEXUS and MAXUS

High-altitude flights in the north of Sweden

Now in its 30th year, the sounding rocket programme for research under space conditions, which is being conducted in co-operation with ESA, was continued successfully in 2005/2006. At the ESRANGE range in the north of Sweden, ballistic rockets are used to conduct micro-gravity experiments in biology, materials science, and physics.

Commissioned by ESA and DLR Space Agency, the 42nd TEXUS mission called TEXUS-EML was launched on December 1, 2005. Reaching a peak altitude of 264km, the flight left the payload in weightlessness for about 6.5 minutes. The key item in the mission's payload was an electromagnetic levitation apparatus (EML), a new module developed from the TEMPUS levitation and melting system whose development was promoted by DLR Space Agency for many years. The design of this new equipment is based on a wealth of experience acquired during the TEMPUS Spacelab missions as well as on numerous parabolic-flight campaigns.

In May 2006, the ESA organised a twin MAXUS/TEXUS campaign. On May 2, 2006, the MAXUS 7 research rocket was launched on behalf of the ESA. 4 of 5 experiments run during this mission were designed by German scientists belonging to DLR Institute of Space Simulation, ACCESS in Aachen, and the universities of Erlangen and Tuebingen.

Next, TEXUS 43 was launched on May 11, 2006. No problems occurred during its flight and the recovery of its payload. Designed by the universities of Bonn and Erlangen, both German experiments were entirely successful. With a total of 6 out of 8 experiments conducted on these two missions, Germany once again obtained an excellent science return from the ESA's ELIPS-1 microgravitation programme.

TerraSAR-X about to take off

DLR and EADS develop radar-satellite concept

The TerraSAR-X project includes developing, building, testing, and launching an X-band SAR satellite featuring high geometric resolution and flexibility in operation. Serving to cover the federal need for scientific X-band radar data for a wide variety of applications, the satellite also represents a gateway to the commercial utilisation of Earth observation. Implemented in a public-private partnership with EADS Astrium GmbH in which several DLR institutes play a major role, the project conforms to the goal of involving national industries through such partnerships that was formulated by the Federal Government in its space concept.

The integration of the satellite has been completed, and its acceptance review was conducted successfully in May 2006. Early in June 2006, the satellite was transported to Munich for environmental tests at the IABG. The secondary LCT (laser communication terminal) payload was delivered for integration in the satellite late in June 2006. The verification and validation phase of the ground segment is scheduled to be completed in September 2006.

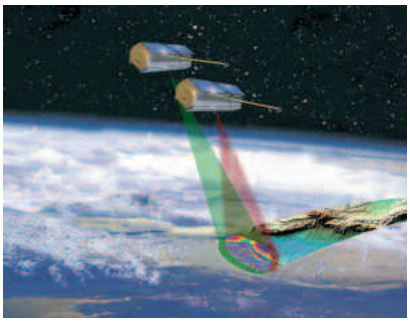
TanDEM-X and EnMAP

Successful applications in bids for future Earth-observation missions

In its evaluation of the proposals submitted for future Earth-observation missions, DLR Space Agency selected EnMAP (environmental mapping and analysis programme) and TanDEM-X (TerraSAR add-on for digital elevation measurements). Both projects are of extreme relevance to the objectives of the German space programme as well as for German researchers and industrial users. This being so, DLR Space Agency is endeavouring to realise both EnMAP and TanDEM-X.

Coordinated by the GFZ in Potsdam and supported by industrial partners including Kayser-Threde, EADS Astrium, and GAF AG, the EnMAP project involves an Earth-observation satellite which will carry a hyperspectral instrument with a high spatial resolution. Using more than 180 colour channels, hyperspectral images show the Earth's surface with a high degree of spatial and, even more importantly, thematic definition. With their aid, current scientific and application-related questions concerned with the environment, agriculture, land use, water management, and geology can be addressed and resolved at the global level. While phase B is scheduled to begin in 2006, phases C and D will follow in 2007. The launch of EnMAP is planned for 2011. Generating a global elevation model of Earth from space with a precision never attained before is the objective of TanDEM-X, submitted by DLR Institute of Microwaves and Radar Systems with the support of EADS Astrium. Towards this end, two satellite-based high-definition radar sensors will be put in place, one on TanDEM-X, the other on TerraSAR-X. Flying in close formation under precise control, the two satellites together will generate stereoptic images with a relative precision of elevation measurements that will be better than 2m. Extending over 5 years, the TanDEM-X mission may be potentially used in a wide range of scientific, commercial, and security-relevant applications. Its launch is scheduled for 2009.

A contract for the development of TanDEM-X was signed with EADS Astrium GmbH on August 31, 2006. The project will be implemented in a public-private partnership between DLR and EADS Astrium.



TanDEM-X

The US space shuttle Discovery

The ESA Astrolab mission

Long-term presence of European astronauts on the ISS

In July 2006, the German ESA astronaut Thomas Reiter left the Kennedy Space Center in the US space shuttle Discovery for a stay of six to seven months on the International Space Station (ISS). On board the ISS, Reiter will work as second flight engineer. An ESA astronaut since 1992, Reiter has done long-term space flights before.

Christened "Astrolab", this ESA mission marks not only the beginning of the long-term presence of European astronauts on board the ISS but also the return to a permanent crew of three, providing more time for scientific experiments. The resumption of transfer vehicle flights is essential for continuing the assembly of the station, which is to be completed by 2010. On this flight, ESA equipment that is important for scientific research was transported to the Space Station and installed there, such as the first deep freezer capable of reaching -80°C that was developed for the long-term preservation of biological specimens, a facility for breeding plants, and a device for measuring pulmonary functions. The Astrolab mission is a European scientific programme containing projects from human physiology, plasma physics, and radiation dosimetry as well as industrial and educational experiments. Eight experiments come from Germany. The European COLUMBUS Control Center at DLR's Oberpfaffenhofen site near Munich will be active during the Astrolab mission. To prepare for the future utilisation of the COLUMBUS laboratory module, the ESA will at this time assume independent control of its activities on the ISS.

COLUMBUS

Transport to the Kennedy Space Center

On May 28, 2006, the COLUMBUS laboratory module took off in a Beluga Airbus for the Kennedy Space Center in Florida. The completion of the COLUMBUS module had been celebrated before in Bremen at an event attended by the Federal Chancellor, Mrs Merkel.

In COLUMBUS, a multipurpose laboratory for multidisciplinary research in weightlessness has been created. It measures 6.9m

in length and 4.5 m in diameter. Platforms mounted at the outside of the laboratory offer opportunities to conduct experiments exposed to space. Research will focus on materials and life sciences, the investigation of fluids, and the development of new technologies. There are plans to use the laboratory for industrial and commercial purposes in the future. European astronauts will mainly work at the laboratory. Its operation is managed by the European COLUMBUS Control Center at DLR's German Space Control Center in Oberpfaffenhofen.

According to schedule, COLUMBUS will probably be transported to the ISS in the autumn of 2007. German science has been represented on board the ISS by a total of 14 experiments since 2001. All in all, some 80 new experiments are being planned in Germany, and another 47 have been selected for further definition after the ESA's last call for submissions in the autumn of 2004.

ExoMars

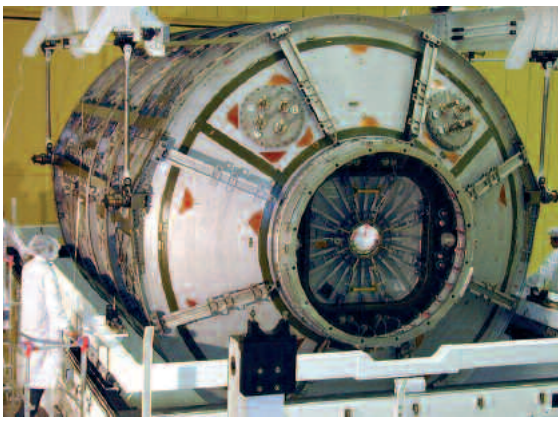
Searching for traces of life and water on our planetary neighbour

At the conference of the Council of Ministers in December 2005, Germany considerably increased its share in the ESA's AURORA exploration programme by two additional subscriptions: Euro 86 million for the ExoMars mission, which is scheduled for launching in 2011, and Euro 2 million for the core programme. AURORA aims to conduct new European missions to explore and open up the solar system, focussing on the Moon and on Mars. It includes the development of technology for robotic as well as for future astronaut missions.

ExoMars is a mission to Mars undertaken to search for traces of life and water and to investigate geological questions. Technological objectives include landing on Mars and exploring the surface with a rover robot. ExoMars comprises a service module, a landing system equipped with airbags and retro rockets, a lander station, and a rover. ExoMars will be launched on a Soyuz rocket from Kourou. Data will be communicated via the American Mars Reconnaissance Orbiter (MRO). While the rover will remain operational for about 6 months, the life of the stationary components will extend up to 6 years.

Its share of 14.5% in the ExoMars project makes Germany the fourth strongest partner after Italy (40%), Great Britain (17%), and France (16%). All in all, the project was oversubscribed by about 10%, with a total subscription of c. Euro 650 million for the period from 2006 to 2013. Germany claims visible involvement in the ExoMars development activities relating to the entry/descent/landing system, the rover, and the integration of the payload. The ExoMars phase B2/C/D is scheduled to begin in 2007 after a mission preliminary design review.

Roll-out of the European space laboratory COLUMBUS in the presence of the Federal Chancellor



The COLUMBUS module

Launch of the SHEFEX payload in a two-stage sounding research rocket in Norway

Highlights from the space R&D programme

The SHEFEX flight experiment

Testing new heat-protection concepts for reentry space vehicles

At 15:45 CEST on October 27, 2005, a two-stage sounding research rocket was successfully launched from the Andøya Rocket Range in Norway. The payload at the top of the rocket was SHEFEX (sharp edge flight experiment). Through SHEFEX, DLR aims to develop new thermal-protection concepts for reentry space vehicles, reduce the cost of their manufacture and maintenance, and test whether a sharp-edged configuration conforms to aero-thermodynamic requirements.

After the launch, SHEFEX reached an altitude of 211.5 km above the Arctic Ocean, reentering the Earth's atmosphere at almost seven times the speed of sound, with temperatures at the top of the SHEFEX payload rising to 1,600 degrees centigrade. Temperatures as high as this typically occur in space vehicles as they dive into the Earth's atmosphere. During reentry, the experimental unit remained coupled to the HAWK rocket so that its fins could be used for attitude stabilisation. After a flight duration of c. 9 minutes, SHEFEX was supposed to come down in the water about 200km away from the range. However, the parachute system was triggered by a pressure sensor when the rocket's altitude and speed were both too high, so that the parachute was destroyed. A preliminary analysis of the scientific measurements yielded surprising results. Thus, data covering the entire flight phase were recorded, a longer period than originally planned. In addition, tumbling movements of the rocket during its flight enabled data to be gathered that yield further information about the instationary phases in the flight of the payload. A preliminary analysis of the measurement results confirmed that the high manufacture, quality-control, and maintenance cost of complex components may be drastically reduced by using instead the configuration of plate-shaped panels that was examined in the test, and by cutting down on the diversity of types. Implemented in reusable launcher concepts such as the space shuttle operated by the American Space Agency, NASA, this configuration might save considerable sums in maintenance and the replacement of damaged elements.

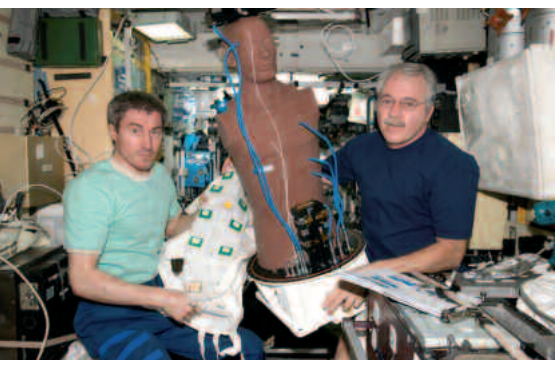
Matroshka

The space phantom returns into the station

For 18 months, a phantom called Matroshka haunted the outer wall of the International Space Station (ISS). On August 18, 2005, the crew of Expedition 11 did a space walk to fetch Matroshka back into the ISS.

Consisting of a head and a thorax, the "phantom dummy" Matroshka resembles a human torso. Inside that torso, active and passive radiation detectors are installed in more than 800 locations, including a variety of simulated human organs. The volume of useful data already supplied by these sensors has been passed on to participating scientists for analysis. To simulate the protective effect of a space suit, the dummy is encased in a carbon-fibre container. Measurements of the radiation dose to which astronauts are exposed both inside and outside the ISS permit assessing the risks of cosmic radiation for the human body. Insights from this experiment may contribute towards the development of countermeasures that offer suitable protection from cosmic radiation.

Tentative results obtained from the active sensors show that the radiation dose to which an astronaut is exposed during a space walk is higher by a factor of c. 3 than inside the shelter of the space station.



Matroshka with the ISS Expedition 11 crew: Commander Sergei Krikalev (left), Matroshka (center), flight engineer John Phillips (right)

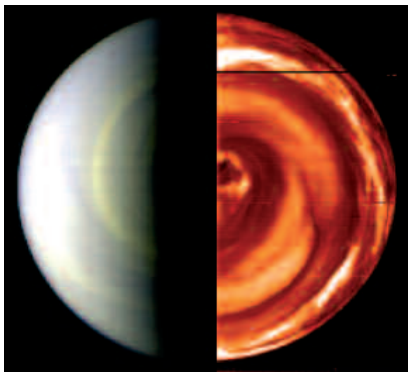
Galileo

Control center to be set up in Germany

In the negotiations between the industrial enterprises entrusted with realising the European satellite navigation system Galileo that took place in December 2005, DLR was assured that the Galileo Control Center would be established at its site in Oberpfaffenhofen, and that the operation of the 30-satellite constellation would be controlled from there for a minimum of 20 years. In 40 years of space operations, the German Space Control Center in Oberpfaffenhofen has been gathering experience in the implementation of complex commercial, scientific, and manned space missions. Control will be handled in cooperation with other European operational centers. Another control center will be established in Fucino, Italy. Satellite positioning will be handled in collaboration with the European space control center ESOC in Darmstadt and the French Center National d'Etudes Spatiales (CNES) in Toulouse.

The Galileo control centers form the heart of the entire Galileo system. By creating two control centers, the risk of failure during the positioning operation phase is kept to a minimum. Once the positioning of the constellation is complete, the satellites and their payloads will be controlled and monitored from Oberpfaffenhofen. In addition, the Control Center will process navigation data and coordinate the global ground segment together with its communications network.

The German Space Control Center and the future Galileo Control Center at Oberpfaffenhofen



Composite false-colour image of the south pole of Venus taken by the VIRTIS spectrometer on board Venus Express

Venus Express

First images of the south pole of Venus show unexpected amount of detail

Showing the south pole of the planet Venus, Venus Express has transmitted its first pictures back to Earth. Taken from a distance of 206,452 km, they show amazingly well-defined structures as well as unexpected details. The pictures were taken on April 12, 2006, after the Venus Express orbiter had successfully entered its orbit around Venus on April 11, 2006.

For the first time in the history of space flight, images showing the southern hemisphere of Venus were taken by the Venus monitoring camera (VMC) and VIRTIS (visible and infrared thermal imaging spectrometer) while the spacecraft was flying past the planet on an elliptical trajectory. Originally developed for the Rosetta comet mission at DLR's Berlin-Adlershof facility, VIRTIS will photograph Venus in the visible spectral band (0.25 to 1 micrometre) as well as in the near infrared (1 to 5 micrometers). Besides, DLR researchers are involved in the evaluation of the scientific data.

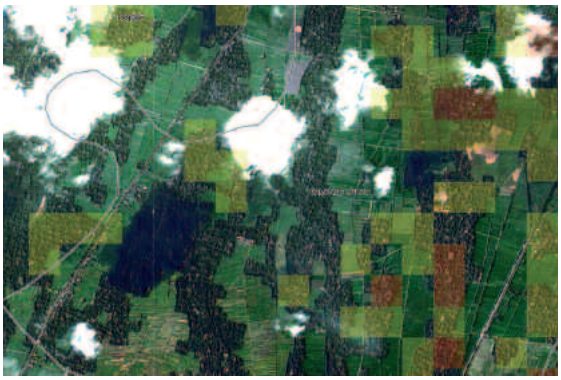
The first images show a dark vortex appearing almost directly above the south pole – a structure whose existence had been assumed for some time but not confirmed until then. This vortex corresponds to a similar cloud structure above the north pole of Venus. Although the quality of the images is poor because of the great distance of more than 200,000km, they nevertheless aroused scientific attention because the pictures taken by the VIRTIS spectrometer show surprisingly well-defined structures and an unexpected amount of detail. Image quality is expected to improve by a factor of 100 in the course of the mission.

Satellite-based crisis information

Humanitarian relief in the earthquake areas of Java

In May 2006, DLR Center for Satellite-based Crisis Information (ZKI) was involved in generating an emergency map of the earthquake region on the island of Java (Indonesia). From high-resolution images taken by the satellites IKONOS, SPOT, ENVISAT, and Quickbird, ZKI employees generated satellite-image maps which the relief teams that were active in the crisis region around Bantul used as an important resource in their assistance efforts.

In addition, the ZKI processed basic geological data for use by the helpers on the spot. Among other things, they prepared elevation models that helped the rescuers to get through more quickly to people that were injured or needed help. As far as we know now, the earthquake on the island of Java killed more than 5,000 people, 20,000 were injured and 200,000 made homeless.



Damage map generated from Quickbird data showing Bantul, Indonesia, after the earthquake of May 2006

ZKI is a service provided by DLR's German Remote Sensing Data Center (DFD). Its function is to provide, process, and analyse satellite data swiftly for relief in the event of natural or environmental disasters, for humanitarian aid, and for civil security. Data evaluation is tailored to the specific needs of national and international aid organisations and political agencies. Other occasions on which the ZKI was highly helpful recently include the devastating earthquake in Pakistan in October last year and the Elbe and Danube floods of April 2006.

Optical free-space communication

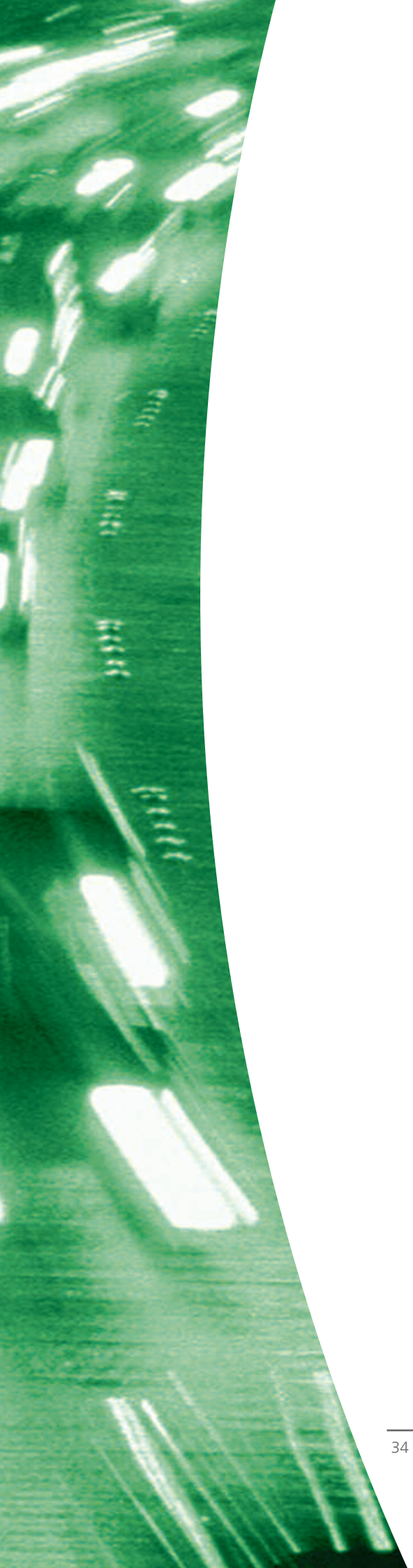
First successful reception of laser-transmitted data

Under the KIODO project, scientists of DLR Institute of Communication and Navigation in Oberpfaffenhofen succeeded for the first time in "capturing" a laser beam emitted by a satellite with a mobile ground station, receiving data at a rate of 50 megabits per second. The experiment also aimed at measuring the optical communication channel between the satellite and the ground station as well as investigating the degree to which transmission was impaired by the atmosphere. Scientists expect to be able to increase the data rate into the gigabit range in future experiments.

This so-called "optical downlink experiment" was repeated on eight nights in June 2006 at Oberpfaffenhofen. In a cooperative venture, the Japan Aerospace Exploration Agency (JAXA) provided the use of its OICETS satellite (optical inter-orbit communications engineering test satellite), while DLR supplied its mobile station for optical free-space communication.

The success of DLR's scientists proves that optical free-space communication may be used for transmissions from space. Further tests planned for the future will make use of the German Earth-exploration satellite TerraSAR-X, which will carry a high-rate optical communication terminal.

The mobile optical free-space communication station at Oberpfaffenhofen during the first successful reception



Transport

The DLR's transport business area continued its positive development in the year covered by this report in a very dynamic way. To quote a few facts, research activities were completed successfully, new research cooperations were started with science, business, and government agencies, and projects funded by third parties attracted public attention. In their interim evaluation of 2005, the review panel of the Helmholtz Association as well acknowledged the results of the last few years' development activities. In addition, co-options into high-ranking national and international bodies indicate how highly the DLR's transport research is appreciated. By deciding to enhance the DLR's commitment in the transport business area considerably within the next few years, the DLR Executive Board met a growing societal demand, clearly strengthening at the same time the DLR's position in European competition. Therefore the DLR uses its transport-related expert knowledge to make aerospace know-how available specifically for transport applications. Unique in Germany, this symbiosis ensures research results that are oriented towards solving problems while using innovative high technologies.

Clearing house

Offering information about transport data

The "clearing house for transport data and transport models" is essentially concerned with improving the information available about transport data in order to promote the secondary use of valuable research results. The institution views itself as a bipartisan service interface between providers and seekers of information in the areas of transport research, planning, and politics. At the moment, its activities focus on those data sources which are financed by public funds but do not belong to official statistics, such as the nationwide mobility surveys of the Federal Ministry of Transport, Building and Urban Affairs. While information (mainly in meta-data format) is essentially supplied by the clearing house through an internet portal, data are mostly sent by post (for security reasons etc.).

Since the autumn of 2003, c. 260 inquiries about specific data records were submitted by some 160 customers from 125 institutions. In addition, there is a constant stream of inquiries that do not relate directly to data included in the offering of the clearing house. Most of the unit's users are universities, extramural research institutions, and engineering firms. However, the group also includes transport networks, providers of transport-related services, and public agencies. Besides meta-information and data, the clearing house team also provides consultation in technical and methodological matters. By performing these functions, the clearing house goes far towards implementing the intention of the "Berlin declaration' on unhindered access to research results.

An optical reference system featuring a high-definition digital camera determines the time required to pass through a traffic jam. In addition, methods to detect and measure vehicles by radar have been developed to a level which permits ascertaining travel times from aircraft radar data.

Terminal simulation

Traffic relief at peak hours

In cooperation with Frankfurt airport, the DLR conducted a number of terminal simulations to investigate whether the shuttle buses running between terminals 1 and 2 are capable of meeting the quantitative and qualitative requirements of future traffic peaks associated with the Airbus A380. It was demonstrated that the current system reserves enough capacity to handle the expected volume of passengers at the same high level of comfort. In collaboration with Hamburg airport, an environment for simulating different airport configurations was developed to identify and evaluate bottlenecks at the terminals.

In order to estimate the financial impact of an extra pair of slots per hour on ground- and air-side turnover, the DLR looked into a number of international airports to determine the financial implications of marginal capacity modifications. Frankfurt airport was used as a test case for examining the results in three concrete scenarios. Each of these mutually independent scenarios showed a turnover gain of c. Euro 28 million for two additional slots (take-off and landing) per hour.

All-wheel rolling test bench

Inauguration and commissioning

After two years of construction, the Institute of Vehicle Concepts moved into its new building at the DLR's Stuttgart site. Subsidised with Euro 3.4 million each by the Federal and Land governments, the laboratory and office complex was officially inaugurated on February 9, 2006. At the same time, a newly-built all-wheel rolling test bench featuring air conditioning and exhaust gas analysis systems was commissioned. It is designed for passenger cars of all categories as well as for vans and light commercial vehicles. Capable of accommodating vehicles with conventional as well as hydrogen or natural gas drives, the test bench serves to test and develop new power train concepts, focussing on their energy efficiency and their emissions in operation.

This test bench is the first worldwide that is explosion-protected and laid out for the test of all-wheel drive vehicles. It is equipped with systems for analysing exhaust emissions, measuring the consumption of liquid or gaseous fuels, and climate control. It is capable of simulating the driving terms on front draughts, rear draughts or four-wheel drive draughts as well as on hybrid vehicles. Being explosion-protected, the dynamometer may be used to test vehicles running on gaseous fuels (such as hydrogen or natural gas). The air conditioning permits testing vehicles at constant temperatures ranging between -25 °C and +50 °C. The exhaust-emission analyser measures raw exhaust emissions at two points with a precision conforming to Euro 5 requirements. Finally, an integrated Matlab/Simulink interface permits coupling vehicle models into the test bench.

A fuel-cell concept vehicle being tested at the all-wheel rolling test bench with exhaust gas analysis and climate control at the Institute of Vehicle Concepts, DLR Stuttgart

Traffic jam on the A99 motorway

Tramrad and TerraSAR-X

Satellites in traffic applications

The Tramrad project evolves and investigates concepts and methods for air- and space-borne radar traffic surveillance. Basic knowledge that is essential for the detection of moving targets was developed and discussed in a review. Related studies showed that the quality of methods to detect moving targets cannot be ranked in general terms, since they depend on given application and system constraints.

The concept of an air-surveillance system, which still remains to be processed, will be based on the experimental F-SAR. An operational air-borne system featuring real-time data processing may well be developed and implemented in the medium term. Preferably operating at high altitudes, its platforms might be UAVs, airships, or balloons.

The TerraSAR-X Traffic Products project investigates the feasibility of a space-borne traffic surveillance system in practical terms. The performance prediction recently completed has shown that it will probably be possible to identify trucks without any constraints. As the TerraSAR-X earth-observation satellite was not optimised for traffic surveillance, a measurement of passenger-car traffic parameters could be limited to roads where framework conditions are favourable. Once a vehicle has been detected, its speed can be measured very precisely in most cases.

WiVSim

Simulating the demand for freight transport services

A quantitative survey conducted among about 900 business enterprises and 100 haulage companies under the WiVSim project (demand simulation for business and freight transport services) yielded important basic data required for mapping the decision-making patterns of the players on Germany's freight-transport market in a model. Subdivided into sectors and regions, the model permits mapping the causes of changes in the demand for freight-transport services among business enterprises. Ultimately, the empirical data thus obtained are used in a microscopic model approach to simulate behavioural changes in the traffic-related decisions of the players. Among other things, this will yield information about the influence of changing traffic framework conditions on individual players.

Freight traffic will go on expanding in the next few years. The model that has now been created will, for example, serve as a basis for investigating what concrete steps will serve to enhance efficiency or reduce traffic-related emissions. Commissioned by the Federal Ministry for Environment, Conservation and Reactor Safety, a first project was launched along these lines in cooperation with the Eco Institute.

Soccer

Traffic surveillance from the air

Used successfully for the first time during the World Youth Day 2005 in Cologne, the DLR's aircraft-assisted traffic surveillance system was in operation once again during the 2006 FIFA World Cup. The project "Soccer" is funded by the Federal Ministry of Education and Research and provides detailed traffic data from the air for police and traffic-management authorities deployed at critical locations where matches were being played.

Cameras and computer technology were installed in a police helicopter in Stuttgart, a small aircraft in Berlin, and a Zeppelin NT in Cologne. Traffic data were recorded, processed in real time using software developed for the purpose, and made available to traffic management in the form of traffic-situation snapshots. Large-area traffic surveys and 30-minute traffic forecasts generated by simulation runs enabled police and traffic-management authorities to take appropriate steps early enough to avoid bottlenecks and guide the traffic into less congested routes.

The same methods that were used during the 2006 FIFA World Cup may be similarly employed in handling comparably large events and extreme situations. Together with positive appraisals, the widespread interest in the system shows that there is indeed a demand for it.

The ECHAM/MADE climate model

Simulating the global spread of road traffic soot

The ECHAM climate model has been supplemented by an aerosol dynamics module called MADE. Now it is possible to simulate the micro-physical development of aerosol particles or, in other words, their entire life cycle from emission via the physical and chemical changes that the particles undergo in the atmosphere to their removal through, for instance, sedimentation or precipitation. ECHAM/MADE was used to simulate the global spread of soot generated by traffic. Particles emitted in Aitken mode (below 0.1 mm) are to be found primarily in the vicinity of the source regions; maps clearly show that concentrations are higher above Europe and Asia and lower above North America because of the smaller proportion of diesel-powered vehicles there.

Very small particles either coagulate into or attach themselves to larger particles which remain longer in the atmosphere and may be transported over very great distances; thus, for instance, part of the soot emitted in North America travels as far as Europe. Not only do soot particles directly influence human health, they also affect precipitation and the formation of clouds and, consequently, the climate as such. Among others, the European integrated project QUANTIFY investigates these influences.

Police helicopter mission in Stuttgart during the 2006 FIFAWorld Cup

Energy

Increasing energy prices and growing climate problems raised the subject of energy supply to the very top of the political agenda. Because of this, energy research is now in a correspondingly dynamic phase. There is widespread agreement that high priority should be accorded to the development of technological options. Next to issues relating to efficient and sustainable power generation, the intelligent distribution and use of electricity as well as the heat sector are moving more into focus.

The development of stationary gas turbines is a major issue on DLR's agenda. Through its focus on compressors, combustion chambers, and turbines, DLR contributes towards maximising the efficiency of power generation independently of the kind of fuel to be used in the future. Concentrating solar technologies offer the option of supplying electricity sustainably generated on a large scale on highly attractive terms and even of producing hydrogen in the more distant future. Similarly, solar process heat is a technology with a high potential. In future, sensor technologies will permit automating the operation of fuel cell systems to a large extent. Recent research results facilitate the development of innovative highly-specialised functional coatings for a multitude of applications, from fuel cells to heat exchangers. The business area's interdisciplinary systems analysis activities serve in political consultation as well as in support the subject-related orientation of energy research within DLR and the Helmholtz Association.

Activities focus on selected technologies where its particular competences enable DLR to make crucial contributions and exploit synergies with its other business areas.

Solar gas turbine

Market opportunities for solar-hybrid microturbine systems

A volumetric pressurized receiver using solar energy to heat the air for gas-turbine systems is a component with a high development potential for future solar-thermal power stations. Such components may push the efficiency of solar energy systems up to more than 30%, which is very high score for solar energy generation. In cooperation with an industrial partner, this development reached a very advanced stage of maturity at DLR in recent years. The execution of a licensing agreement with the Italian company SHAP late in 2005 marked a major step forward in marketing this technology. The company's exclusive licence for Italy includes systems up to 500 kWth. SHAP plans to launch pressurized volumetric receivers on the market as components for solar-hybrid microturbine cogeneration systems. Market opportunities appear good particularly when such systems are combined with climate-control applications.

Secondary concentrator

SOLLAB

European networking and junior scientist promotion

In 2004, Europe's leading research institutions in the field of concentrating solar technology (DLR, Germany; CIEMAT, Spain; CNRS, France; ETH Zurich, Switzerland; and as of 2006, PSI, Switzerland) joined forces to form the Alliance of European Laboratories on Solar Thermal Concentrating Systems (SOLLAB) in order to strengthen scientific collaboration and advance research on the European plane. On June 14, 2005, the Alliance held its first joint event at Koeln-Porz, the SOLLAB Symposium on Solar Thermal Hydrogen and Fuel Production. Opportunities for intense debates and ideas about exchanges at the European level gave junior scientist promotion a marked impetus at the SOLLAB Colloquium of doctorate candidates held on October 2005 in Koeln-Porz, where 27 participants from all partner institutions gave presentations.

Fuel cell optimisation

First integration and tests of segmented bipolar plates in a commercial stack

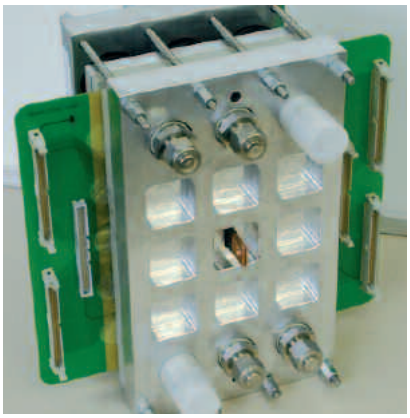
For some years, DLR has been developing segmented bipolar plates based on PC boards for use in fuel cells, aiming to study the spatially-resolved temperature and current distribution in these energy converters. These studies yield insights which are important for optimising the operation of fuel cells (improved reliability and reduced degradation) as well as for improving stack design.

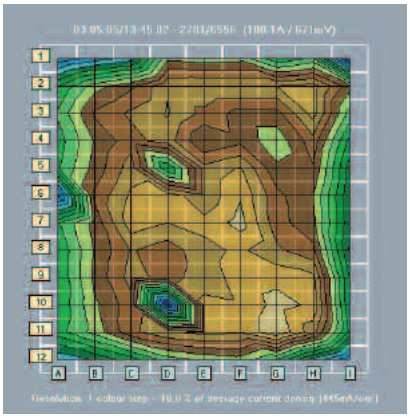
In the medium term, moreover, the same method may be used to control the operation of fuel-cell stacks. Within an EU project, a segmented cell was integrated for the first time in a commercial stack with an active surface of 220 cm^2 and tested under various conditions. The results now form the basis for using segmented bipolar plates in stacks produced by a variety of manufacturers. The first orders from users are now being processed.

Power-optimised aircraft

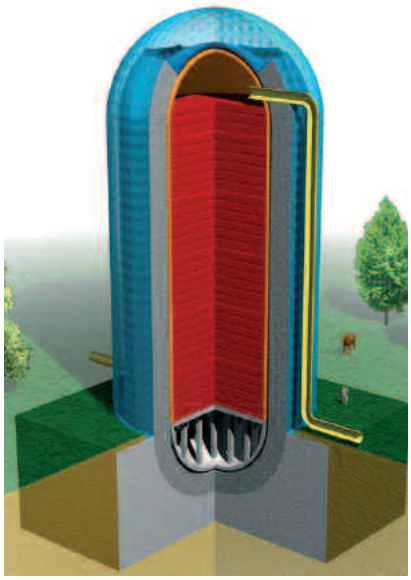
First-ever operation of a lightweight oxide-ceramic fuel cell with a kerosene reformer

Within an EU project called POA (power-optimised aircraft), a lightweight oxide-ceramic fuel cell (solid oxide fuel cell, SOFC) was operated for the first time in conjunction with a kerosene reformer. The successful coupling of a reformer with an SOFC stack is the result of a cooperation between DLR Stuttgart, FhG-ISE in Freiburg, and the Liebherr GmbH. Developed in Freiburg, the kerosene reformer was assembled to the 14-cell SOFC stack in Stuttgart. It was shown that stable and dependable operation is feasible, and that the anode exhaust from the SOFC may be fed into a burner and used to meet the system's heating demand. These measurements form the basis for further investigations into the application of fuel cells in aircraft. What is more, comparisons of different operating modes supplied knowledge relevant to the stationary operation of SOFCs.





Segmented measuring cells in the commercial stack; measured current-density distribution



Master concept of a pressurised solid-medium energy store

Modern gas turbines

Low-pollution combustion in high-efficient gas turbines

Modern gas turbines reach very low nitrogen oxide emissions thanks to the lean-premix combustion concept which, however, tends to induce undesirable combustion pulsations. While these may be effectively suppressed by fuel staging, this remedy may have a negative effect on emissions. To optimise operation, an industrial gas turbine combustor was studied with optical measuring technology in cooperation with the Alstom Company under the EU FUELCHIEF project (demonstration of a low NOx fuel-staged combustor in a high efficiency gas turbine). Based on the measurements taken, flame behaviour could be analysed precisely and the PC-assisted combustion simulation process reviewed critically. All in all, the progress achieved towards reliable low-emission combustion in gas turbine combustors was considerable.

Adiabatic compressed air energy storage

A new concept permits storing energy efficiently without local emissions

Compatibly integrating the energy which, according to plans for the period up to 2020, will be generated by wind power and other renewable energies calls for modifications of the German grid and power-station systems. The resultant need for action was last quantified in the "dena Grid Study" especially for those regions where offshore wind energy will be fed into the grid in the future. Large-scale energy storage in adiabatic compressed air stores is a new technology which may potentially make substantial contributions in this regard. The concept now being pursued permits storing energy efficiently and without local emissions by compressing and/or expanding air in turbo machines, a key element being the idea of separately storing the heat generated by the compression process until needed. Under the adiabatic compressed-air energy storage project, a master concept of a pressurised heat store was developed which complies with applicable efficiency and cost requirements, setting an important milestone for the development of a 300-MW overall concept.

TRACE

Enhanced method for analysing multistage turbo-machine components

The TRACE CFD method for mathematically analysing multistage turbo-machine components under stationary and unsteady conditions was successfully updated to cover real gases as well as multiphase flows. Given the pressures (up to 45bar) and temperatures (up to 1,800K) currently reached in gas turbines, the behaviour of air and exhaust gases can no longer be analysed exactly when an ideal gas is assumed. Consequently, a real-gas model was added to the TRACE CFD programme which now permits simulating gases with caloric and/or thermal imperfections. Taking real gases into account is even more important in power-station processes featuring steam circuits because steam cannot be regarded as an ideal gas in the circuits commonly used today.In particular so, when the process enters the two-phase zone of water in the low-pressure section of the turbine. Here water condenses and falls out in the form of droplets. Droplet formation is one of the crucial factors influencing losses in low-pressure turbines, another factor being erosion of the blades in the last rows. TRACE is now capable of predicting this phenomenon as well.

To this end, an Euler-Langrange algorithm was implemented in TRACE so that the movements of water droplets can now be traced by particle tracking after computing their formation and growth with the aid of a newly-integrated nucleus formation and condensation model. Enhanced by numerous new models, TRACE was validated by, among other things, computing a previously-measured turbine grid under the influence of condensation.

Environmentally compatible fuel supply

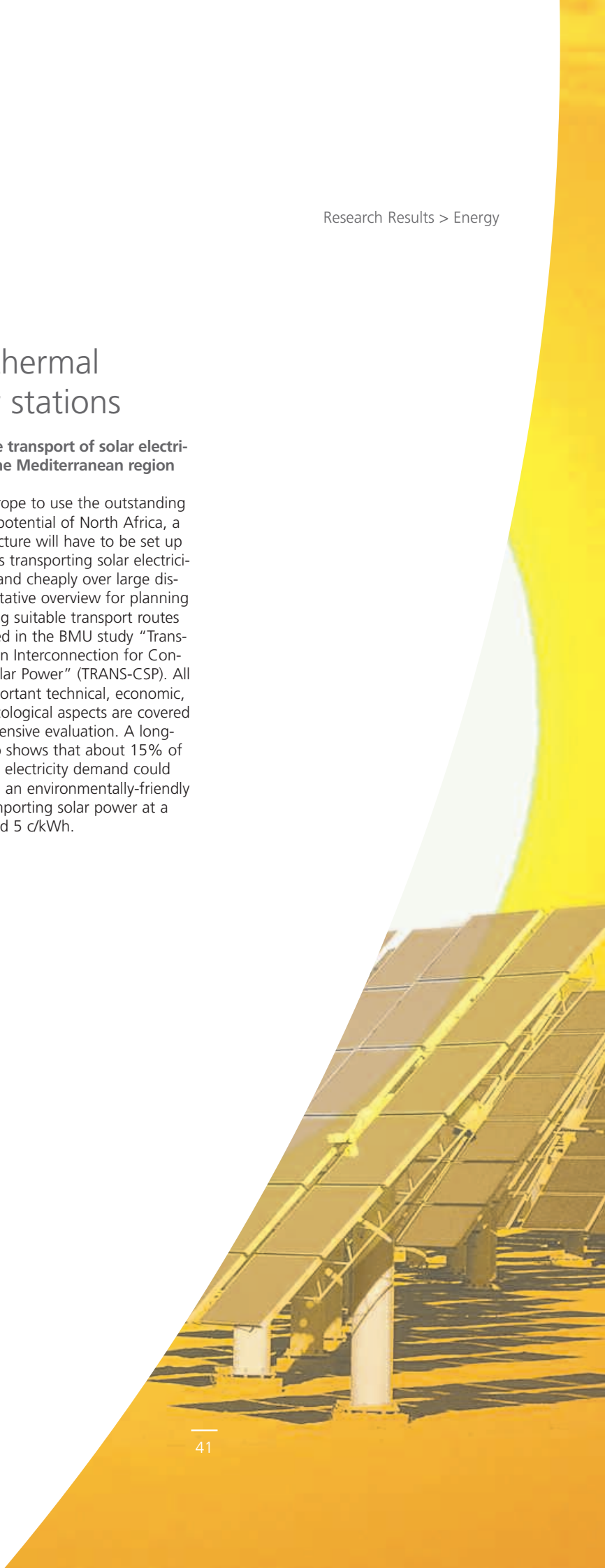
The Federal Environment Agency supports study of an overall strategy for the introduction of alternative fuels

Any strategy for supplying environmentally compatible fuel for the transport sector must take into consideration the close interactions with the expansion of renewable energies on the power and heat market. Supported by the Federal Environment Agency and conducted by DLR together with the Wuppertal Institute and the IFEU, a study entitled "Development of an Overall Strategy to Introduce Alternative Fuels" showed that using renewable energies to generate electricity and utility heat will have the greatest positive impact on climate protection in the short and medium term. Among the biofuel approaches, using the potential of energy crops in the production of gaseous fuels contributes most towards climate protection because of the high area-specific energy yield. Especially after 2050, producing hydrogen by electrolysis using electricity from renewable energy sources will be the option offering the greatest technical potential.

Solar-thermal power stations

Study on the transport of solar electricity across the Mediterranean region

To enable Europe to use the outstanding solar-energy potential of North Africa, a grid infrastructure will have to be set up which permits transporting solar electricity efficiently and cheaply over large distances. A tentative overview for planning and evaluating suitable transport routes was developed in the BMU study "Trans-Mediterranean Interconnection for Concentrating Solar Power" (TRANS-CSP). All the most important technical, economic, social, and ecological aspects are covered in a comprehensive evaluation. A long-term scenario shows that about 15% of the European electricity demand could be covered in an environmentally-friendly manner by importing solar power at a cost of around 5 c/kWh.



Project Management Agencies

Project Management Agency for Aeronautics Research and Technology

Activities focus on preparing the new aeronautics research programme (LUFO IV) and DLR's leading role in AirTN

The Project Management Agency for Aeronautics Research (PT-LF) supports the Federal Ministry of Economics and Technology (BMWi) in implementing the Federal aeronautics research programme (LUFO) as well as the governments of the Federal States Bavaria, Hamburg, Brandenburg, and Rhineland-Palatinate, which have their own funded programmes and projects supplementing the Federal programme. Apart from implementing the Federal aeronautics research programme and the Federal States promotion activities, which together incorporate more than 250 projects in the period from 2003 to 2007, activities are focused on preparing the new aeronautics research programme for 2007-2012 by issuing a call for projects for the period up to 2010. At the same time, the agency had to arrange the launch of the second aeronautics research programme of the city of Hamburg, which also covers the period from 2007 to 2010. When they were announced, these two new programmes met with great interest in industry and science. Both calls for submissions were considerably oversubscribed, and the unexpectedly large number of application outlines received had to be screened in a labour-intensive process.

Together with the other extensive activities listed here, this work had to be handled by a team of 12 employees. To ensure that the new programmes, which will incorporate more than 400 sponsored projects, can be implemented properly, it is planned to increase the project staff.

Beyond the core duties named above, the PT-LF performs a variety of special or supporting functions on behalf of the BMWi including, for instance, handling preparations for the ILA 2006 and processing development loans or WTO inspection reports. In support of the EU aeronautics research programme, the PT-LF assists and advises the BMWi by preparing and attending meetings of EU committees and bodies as well as by editing and publishing information.

In addition, the PT-LF continues to work for the BMWi in its capacity as "information and consultation unit on EU aeronautics research", in which it was recognised by the EU Commission as an "aeronautics national contact" and integrated in the overall structure of the EU framework programme.

GARTEUR is the oldest research network of Europe's leading aeronautical nations; PT-LF speaks for the BMWi in the GARTEUR Executive Committee and represents it on the GARTEUR Council. Within the EU's AirTN ERANet project, which was launched by GARTEUR at the initiative of Germany and involves 27 partners from 17 European countries, the PT-LF is responsible for the management of the network and the coordination of the project on behalf of the BMWi. The project essentially aims at supporting the future development of Europe's aeronautics research strategy, thereby ensuring the EU Commission's future commitment to a European aeronautics research programme. Another objective is to provide technical support for the SESAR programme initiated by the EU and EUROCONTROL.

Based on the role of key project management agency in aeronautics, in which it has already established itself on the national and regional plane, its coordinating role in AirTN presents DLR with an opportunity to position and qualify itself as an organisation on which, if the need should arise, an international agency to manage publicly-sponsored aeronautics research in Europe could be based.

DLR Project Management Agency

The successful "Einstein Year" is now followed by the "IT Year 2006"

Led by Dr. Siegfried Schneider since November 1, 2005, DLR Project Management Agency (PT-DLR) handles scientific, organisational, and administrative management functions within the promotion programmes of the Federal Ministry for Education and Research (BMBF), the Federal Ministry for Economics and Technology (BMWi), the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (BMFSFJ), and the Federal Ministry of Health (BMG). In addition, it works on orders from Land ministries and private clients.

At the end of 2005, the PT-DLR employed a staff of 505, handling public funds amounting to a total of around Euro 559 million (see Table), a result that is practically identical with that of the previous year. All in all, it supervised around 3,900 projects in 2005.

The most important subjects of the PT-DLR's work include health and environmental research, information technology, new media in the economy and education, research on the shaping of the world of work, as well as education research, humanities, and equal opportunities.

Allocation of budget funds

in 1,000 Euro	2004	2005
Information technology	168,027	178,864
Health research/Human genome research	165,548	166,423
Environmental research and technology	59,898	59,899
New media in the economy	29,921	35,324
Education research*	40,157	33,417
New media in education and technical information**	35,314	29,838
Work structuring and services	26,983	25,770
International office	10,330	12,134
Equal opportunity/Gender research***	6,595	6,241
Helmholtz Association Strategy Fund	11,389	4,828
Büro Einsteinjahr 2005	1,929	3,137
Humanities	2,234	2,743
European programmes	106	58
Total:	**558,431**	**558,676**

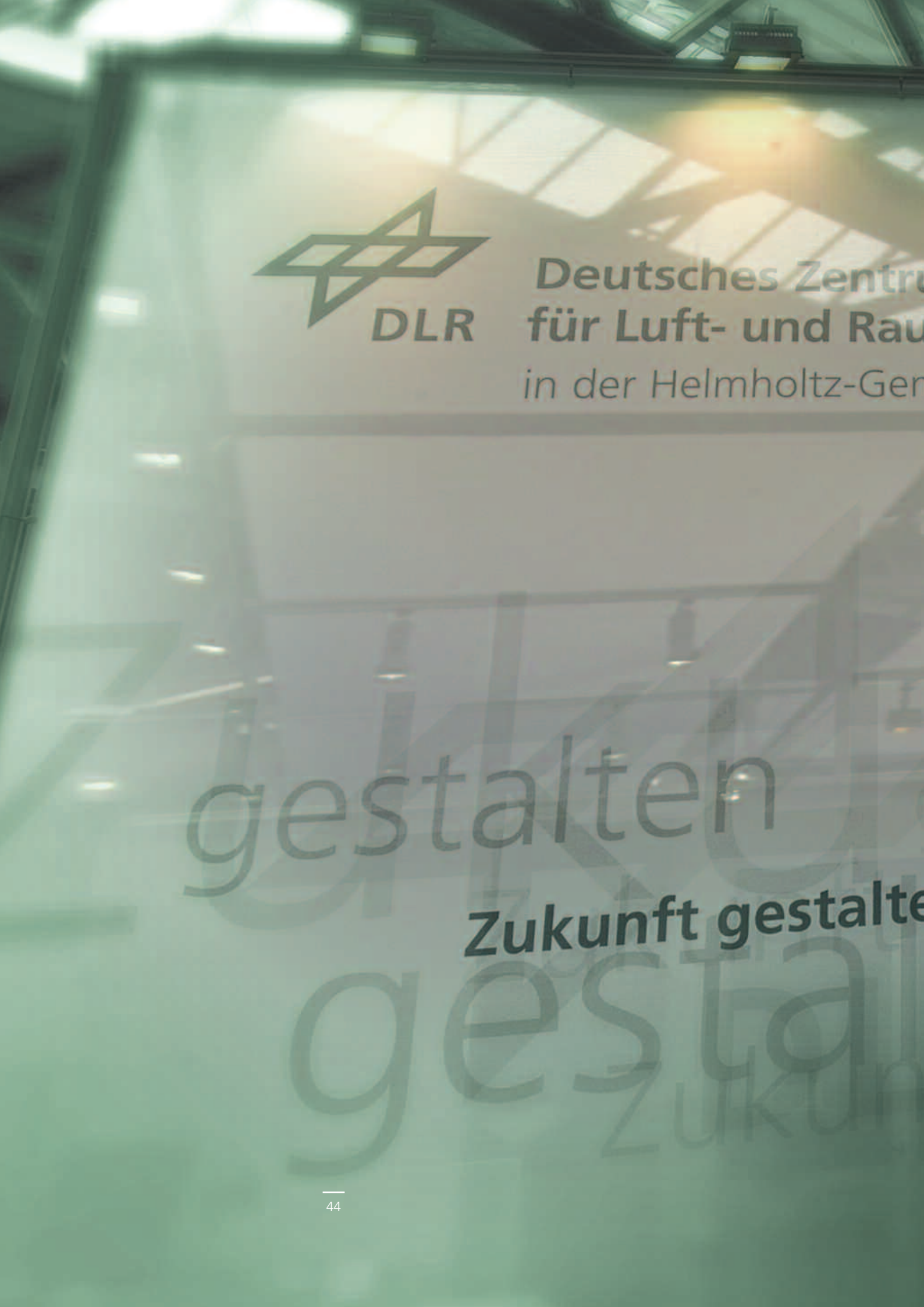
* Cofinanced by the European Social Fund (ESF) with Euro 16.8 million in 2005
** Cofinanced by the ESF with Euro 4.2 million in 2005
*** Cofinanced by the ESF with Euro 1.4 million in 2005

Following the "Einstein Year" which it organised with great success, the Agency now manages the "IT Year 2006" for the BMBF.

Because of its many years of experience in the promotion of research and education as well as in the management of projects, the PT-DLR maintains excellent contacts with research agencies and institutions, technical bodies, and established experts in the national and international world of research which, among other things, permit extensive activities aiming at Europe. Increasing at a pace that deserves mention, the consequences of these activities not only include the extension of the "European programmes" organisational unit but also affect those technical departments of the PT-DLR which manage projects of the ERA (European Research Area) network.

This promotion instrument creates an opportunity of networking national promotion programmes in the EU member states with those of the European Commission. Its objectives include opening research programmes for mutual access and developing and implementing joint measures. Last year, the PT-DLR once again successfully contributed towards applications for a number of ERA network projects, acting as coordinator in some and as a partner in others.

You will find detailed descriptions of all activities and programmes in the PT-DLR's business report for 2005 (www.pt-dlr.de/pt/service/publikationen).


DLR
Deutsches Zentru
für Luft- und Rau
in der Helmholtz-Gem
gestalten
Zukunft gestalte

CORPORATE RESULTS

Corporate Strategy

The research enterprise

As a research enterprise, DLR combines top-flight research with the entrepreneurial goal of working efficiently and effectively. To reach that goal, and to optimise its work, DLR practices a consistent system of strategy, business, and quality management in its discipline-oriented institutes and facilities, its governmental business areas, space and project management agencies, and in its administrative and technical infrastructure.

This document spells out DLR's essential goals and strategies for the next three years

At three-year intervals, DLR reviews its corporate strategy in a comprehensive process to meet current challenges. Developed from this new orientation, the technical strategies of the business areas – aeronautics, astronautics (in close cooperation with the Space Agency which is responsible for the integrated German space programme), transport, and energy – form the basis for the business plans of DLR's 27 institutes and facilities.

DLR's corporate strategy is underpinned by the process orientation of its administrative and technical infrastructure which, among other things, provides support in legal issues relating to projects involving third-party funds. Furthermore, DLR is supported in its practice by a job-tailored system of personnel management as well as by systematic employee development. To motivate its employees, DLR implements gender mainstreaming and strives for compatibility of career and family/ private life.

New corporate strategy

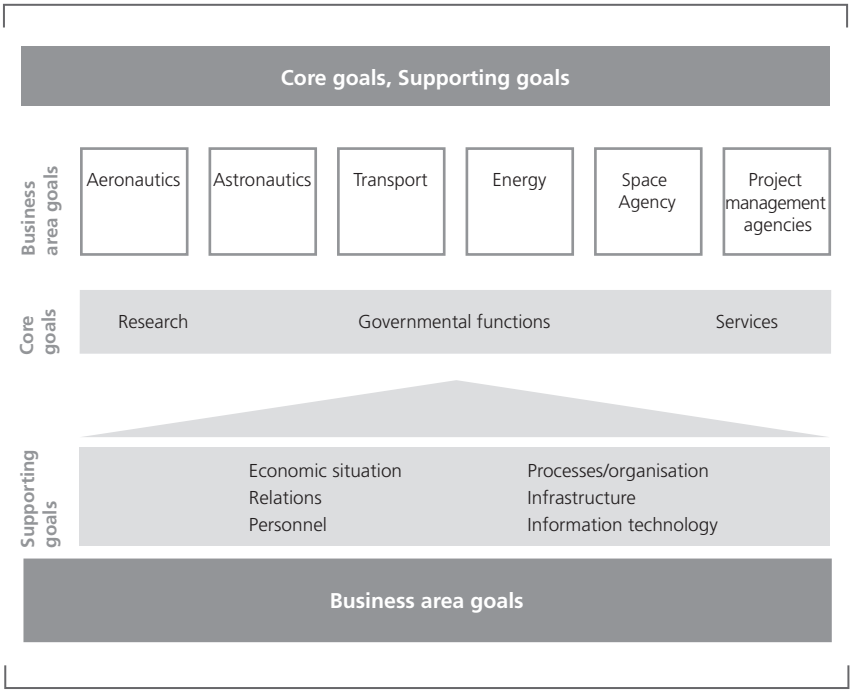
Following a proposal by the Executive Board, DLR's supervisory board, the Senate, adopted an updated corporate strategy entitled "DLR – A Research Enterprise – Goals and Strategies 2006-2009" in the spring of 2006. Even in its predecessor document of 2003, DLR left the beaten track in the management of public research institutions. The current corporate strategy, "Goals and Strategies 2006-2009", specifies guidelines for DLR's work in the next three years. Furthermore, it contains a suitably modified vision and an updated description of DLR's business areas.

On the one hand, these are the research and development goals of the four business areas, aeronautics, astronautics, transport, and energy. On the other hand, the "Goals and Strategies 2006-2009" specify the goals of the two governmental business areas of DLR, the national Space Agency and the largest project management agency in Germany. Derived from these, the document defines not only scientific but also business goals regarding the economic situation, relations, personnel, processes, organisation, infrastructure, and information technology.

The corporate strategy is oriented towards four goals. The first is pursuit of European leadership by assuming the role of architect while emphasising autonomy and maintaining a reserved attitude towards concepts of overarching institutional integration within the European framework. The second is powerful growth in the transport and energy business areas in response to political and societal demand. Further goals include enlarging the scope of the two interdisciplinary fields of defence technology and security research and emphasising those of DLR's activities in its four R&D business areas which are of importance to Germany as a business location without, however, making any fundamental change in its portfolio of basic research, application-related activities, and the application-oriented operation of its large facilities.

The "Goals and Strategies 2006-2009" acquire particular importance against the background of the transfer of responsibility for DLR from the Federal Ministry for Education and Research to the Federal Ministry for Economics and Technology. Through its new corporate strategy, DLR emphasises its claim to sole leadership in German aerospace research, at the same time making a bid for leadership in Europe.

Strategy system structure



Presentation of results

This chapter on corporate strategy introduces the "Corporate Results" part of this annual report. This part describes the progress made by the business areas in implementing the corporate strategy together with their most important activities. By way of documentation, selected performance figures are presented to underpin DLR's claim to being a "research enterprise". In a way that is outstanding in the system of science and research, these performance figures, together with the scientific results presented, document DLR's scientific excellence and business success, proving the eminence of, and the demand for, its research services. However, this presentation is intended not only to demonstrate the level of our own performance but also to offer an opportunity for benchmarking to our partners and competitors.

Results

Third-party funds

In the reporting year of 2005, revenues from projects involving third-party funds increased once again, so that they now contribute Euro 275 million or 52% to DLR's economic performance. This corresponds to a 3% increase in the share of third-party funds in DLR's total revenue. This increase is mainly due to subsidies, where a large-scale project in the aeronautics business area led to considerably higher revenues from direct BMBF project funding. However, direct project support from the Land governments (Berlin alone excepted) as well as from the BMWi increased as well. In the case of Berlin, direct project subsidies declined because of the expiry of the government's funding plan to finance the creation of a transport institute at the Berlin-Adlershof location. Thus, the declining trend in project-funding revenues that prevailed in the years before has now been halted at least temporarily.

After the considerable increase of 2004, revenues from the domestic economy not only remained at the high level of the previous year but even grew slightly by 1%. Revenues from projects involving foreign clients expanded once again. At 31% of DLR's revenues from third-party funds, their share has remained above 30% for five consecutive years.

Compared to the previous year, revenues from EU subsidies increased by Euro 3.1 million, reaching a record high now when the 6th EU Research Framework Programme is nearing its end. 40% of all EU applications were successful. Similarly, the ratio between those EU projects in which DLR is merely involved in research and those which it coordinates under the 6th EU Research Framework Programme improved once again. By now, DLR is entrusted with coordinating the research network of 21% of all EU projects in which it is involved.

Given the fact that DLR's revenues were boosted once again by a number of large-scale projects, we may say by way of conclusion that revenues from third-party funds will stabilise at the level of the last few years in the medium term.

Third-party funds

	2003	2004	2005
Total third-party funds	Euro 240 m	Euro 242 m	Euro 275 m
Total revenue share of third-party funds	49%	49%	52%
Growth of domestic R&D revenues	-11%	+18%	+1%
Share of revenues from foreign clients (revenue volume)	39%	35%	31%
Rate of success of EU applications in the last thee years (granted/submitted)	33%	42%	40%
Coordinator/total ratio (ongoing EU projects)	14%	18%	21%
Revenues from EU subsidies according to annual statements	Euro 13.1 m	Euro 12.5 m	Euro 15.6 m

Numerical data according to annual financial statements

Research-related results

DLR regards itself as a research enterprise with a claim to outstanding scientific quality. This being so, scientific results are just as crucial as the acquisition of third-party funds, which is important to ensure the industrial orientation of DLR's research activities As indicators of scientific quality and productivity, publications, presentations, and teaching posts are recorded continuously. Variations are mainly due to project work, personnel fluctuation, or application submissions. We are happy to state that, at a total of 561, the number of publications in peer-

reviewed journals increased again compared to the previous year (450). If we add to this peer-reviewed publications in proceedings, books, etc., we arrive at 1,127 publications that were reviewed by experts in one form or another before they were published.

As far as presentations are concerned, DLR's scientists were not quite as active in the period covered by this report as in the two preceding years. In this case, the figure declined approximately to the level of 2002. On the other hand, the number of teaching posts filled at universities as well as that of completed diploma papers continues to increase as swiftly as in the years before.

Product-related results

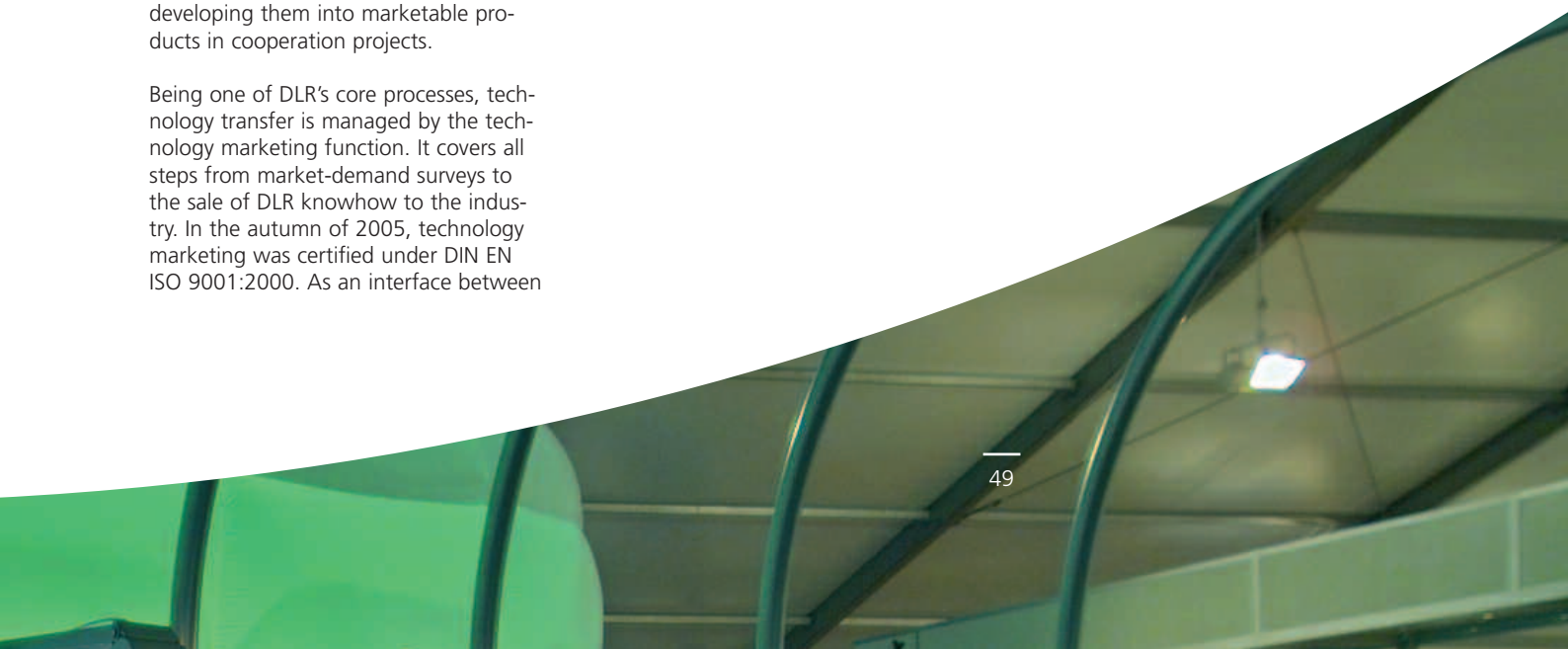
	2003	2004	2005
Publications in peer-reviewed journals	524	450	561
Peer-reviewed publications in proceedings, books, etc.	not surveyed	500	566
Presentations at scientific conferences, workshops, readings	1,438	1,620	1,387
Calls to universities	11	12	9
Teaching posts	137	159	177
Diploma papers	199	235	264
Dissertations	77	86	71
Habilitations	4	5	5

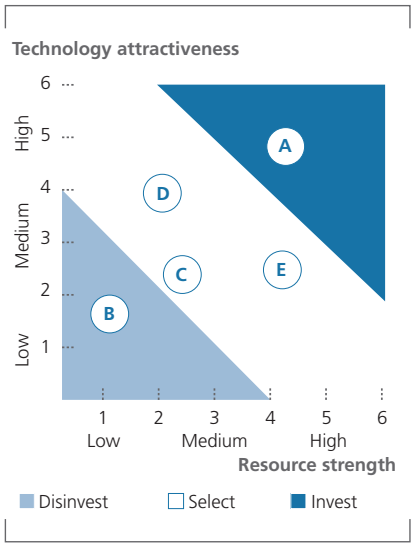
Technology marketing

The research and development results achieved by DLR in its aerospace, energy, and transport business areas will continue gaining in importance on the national and international plane. Not only are they used in landmark space missions and innovative air-transport systems, they also pave the way for innovations in all walks of life. In this field, DLR cooperates with companies from all sectors of the economy to translate research results into marketable new products and services. Technology marketing assists companies in identifying relevant DLR technologies, evaluating them, and developing them into marketable products in cooperation projects.

Being one of DLR's core processes, technology transfer is managed by the technology marketing function. It covers all steps from market-demand surveys to the sale of DLR knowhow to the industry. In the autumn of 2005, technology marketing was certified under DIN EN ISO 9001:2000. As an interface between research and industry, between ideas, innovations, and the market, its key concern is customer benefit. Lived by the entire staff, quality management forms an excellent basis for trustful and long-standing cooperation with our customers.

To support this process, technology marketing has developed Road to Market®. On the one hand, Road to Market® uses a systematic and segment-oriented approach to identify potential sources of third-party funds in the economy for DLR's institutes, followed by the development of a marketing plan (technology push).





Institute competences A through E

On the other hand, the same method may be used to identify the demand profile of a company or market segment and to create a roadmap for DLR to develop the requisite technology (market pull). Following the methodology of strategic corporate management, Road to Market® may include any of the steps enumerated below, depending on the problem in hand:

- Target-oriented inventory of competences and/or technologies
- Market and competition research
- Portfolio analysis to evaluate DLR competences and/or technologies under the aspects of market-oriented attractiveness and resource strength
- Interdisciplinary technology roadmap or concrete marketing plan

In 2005/2006, Road to Market® was successfully implemented in a variety of projects including, for example, the satellite-based fire detection system FIRES, the titanium matrix composite material, and system conditioning competences.

The main objectives of technology marketing include conditioning DLR technologies in line with the demand so that products can be realised in cooperation with partners from the economy, acquiring new customers, protecting business areas by intellectual property rights, and supporting the establishment of new companies.

Examples of successful technology marketing

Developed in cooperation with the Kinoton company, the HDTV scanner scans analogue film material at high speed and resolution and translates this information into a transmission format that conforms to the HDTV standard. The pilot-production model will be presented at industrial fairs in 2006 and launched on the market in 2007.

The 'modular air-cooled low-temperature fuel cell system' was integrated in an automatically guided vehicle and, in cooperation with CARDEC, in an airport apron vehicle. At the Hannover Fair of 2006 as well as at the 2006 ILA, the vehicle met with lively interest from the industry. FRAPORT will test it in operation.

Executed cooperation and licensing agreements form the basis for the partnership of Hydro Aluminium and Metallguss Herpers in the "aerogel binder" transfer project which involves developing aerogel sand cores for aluminium precision castings such as cylinder heads. In cooperation with PANCO, DLR developed a "potential and Seebeck thermoelectric microdetector for semiconductor characterisation". Several prototype units have been completed and forwarded for evaluation to research laboratories at universities as well as to the industry (Beta tester).

In cooperation with Kayser-Threde, a camera system was developed for monitoring the separation of rocket stages. Having received a development order from ARIANESPACE, Kayser-Threde expects to sell no less than 5 camera systems per year.

After a run-up of more than eighteen months, a technology transfer and licensing agreement was concluded in the middle of 2005 with the Norwegian company NAMMO AS. The technology transfer project aims to transfer the liquid silicating process for manufacturing fibre-reinforced ceramic components that was developed and patented by DLR.

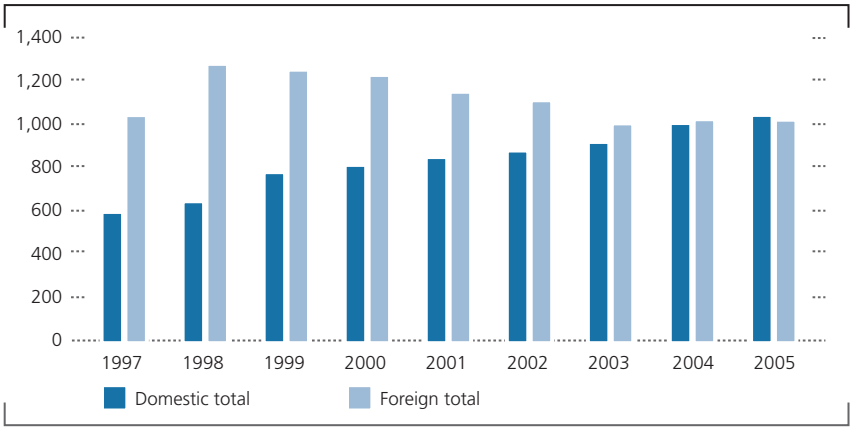
To produce rocket-engine components in series, NAMMO AS will build dedicated production facilities. DLR will advise and support NAMMO AS in acquiring and commissioning the equipment as well as in the ramp-up to serial production. The technology-transfer order is valued at more than Euro 750,000. In addition, DLR stands to receive royalties in the amount of more than Euro 200,000. The first physical components will be so-called jet vanes that are placed in the exhaust jet of a rocket motor to control the thrust vector.

With the IMAR company, a licensing agreement was concluded for a "load stabilisation system for helicopters" that was developed at DLR Institute of Flight Systems. It consists of a software package which uses the gyro-horizon to suggest flight manoeuvres to the pilot that help the helicopter to regain its flight stability quickly and prevent the buildup of pendulum motions in the underslung load. Flight stability is particularly vulnerable in helicopters whenever underslung loads are transported. Swinging underslung loads are frequently dropped blindly and may even cause helicopters to crash, which is why there is such a lively interest in the new pilot-assistance system. The system software is currently being developed further under a follow-up project to assist in depositing loads precisely on the spot.

Intellectual property rights

Having increased to 216 in 2005, the number of inventions registered was higher by c. 20% than in the hitherto most successful year of 2004 (176 registrations). This development continued into 2006, when the number of inventions registered was 117 by the end of June. In 2004, the number of German patents held by DLR was up by around 10% compared to the previous year, and by the end of 2005, DLR held 1,063 national patent applications and/or patents. The number of foreign patents remained at the level of 2004.

DLR patents in Germany



Technology marketing

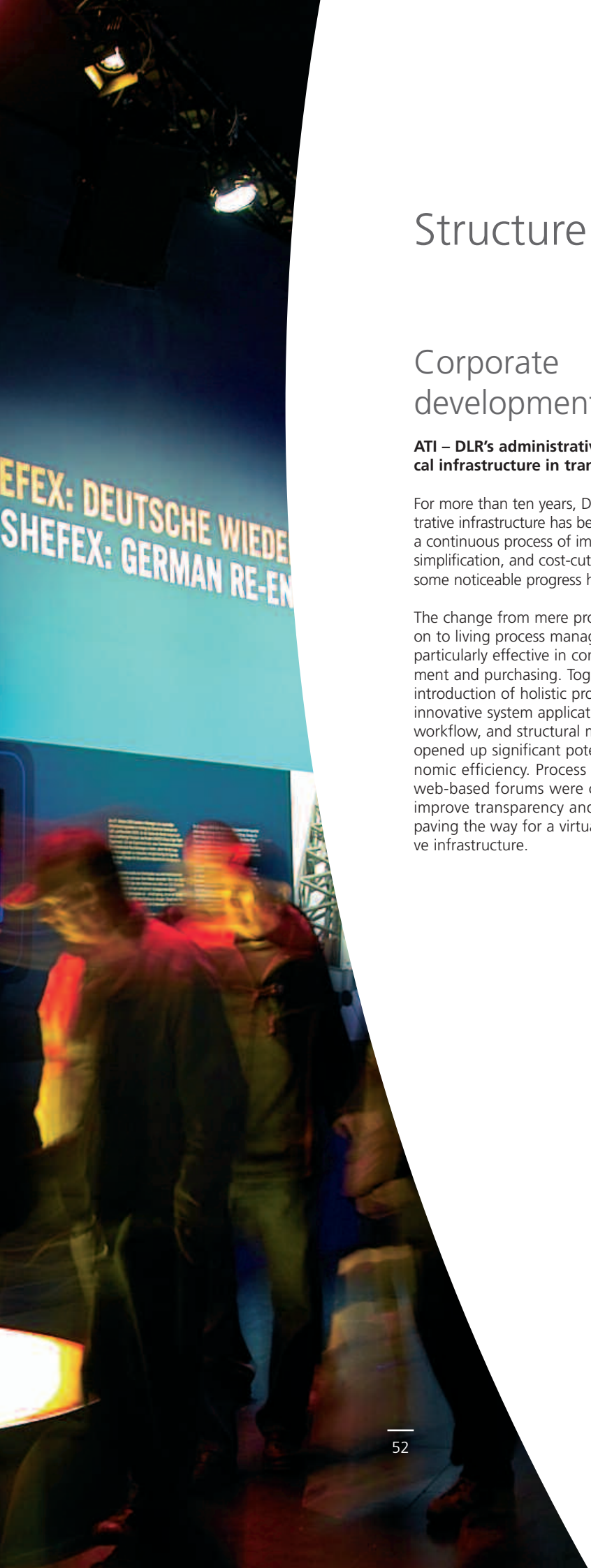
	2003	2004	2005
Revenues from licences	Euro 3.9 m	Euro 4.2 m	Euro 2.7 m
Company hive-offs	1	1	1
New DLR technology-transfer projects	10	12	15
Investments in technology-transfer projects	Euro 2.2 m	Euro 2.4 m	Euro 3.5 m

Licences

With Euro 2.7 million, DLR's revenues from licences did not match the level of the previous year. The reason for this lies in the fact that the sales of two important licensed products slumped steeply: One of these products belongs to the energy sector and depends to a large extent on the soaring price of oil, while the other belongs to a segment of the computer market where alternative problem solutions that increasingly replace DLR's product have been developed in the meantime.

Company launches

Four projects to launch new companies were put on track, for which funds from the HGF impulse and networking fund (EEF II) were acquired successfully.



Structure

Corporate development

ATI – DLR's administrative and technical infrastructure in transformation

For more than ten years, DLR's administrative infrastructure has been undergoing a continuous process of improvement, simplification, and cost-cutting in which some noticeable progress has been made.

The change from mere process orientation to living process management was particularly effective in contact management and purchasing. Together with the introduction of holistic processes and innovative system applications, strategy, workflow, and structural modifications opened up significant potentials in economic efficiency. Process portals and web-based forums were created to improve transparency and orientation, paving the way for a virtual administrative infrastructure.

Thus, DLR's administrative infrastructure won the 7th International Speyer Quality Award for "Quality in Administration", and its strategic purchasing concept was nominated for the BME's innovation prize next to that of DaimlerChrysler and T-Mobile. In a special issue of the journal "Wissenschaftsmanagement" which appeared in 2005, DLR presented and put up for discussion its practical experience as well as its exemplary approaches to process management, which had been evaluated previously by an external agency. Twice a year, DLR as a best practice enterprise offers interested companies an opportunity to benefit from its experiences and successes at the TOP meeting on "Focus on the Costumer: Changes in Administrative Business Processes", an initiative of the FAZ Institute. This successful and innovative approach to business-process management will be pursued consistently in the future. Besides, it will be oriented towards the model of the European Foundation for Quality Management (EFQM).

As part of the redesign effort under the project "System House Technology (SHT)", the "engineering and precision manufacturing" business process was modelled which is now applied in pilot projects at all locations. The experience gained during this pilot phase will be assessed in a self-evaluation from August 1, 2006 onwards. At the same time, preparations will begin for transforming the "System House Technology" into a profit center and creating the requisite instruments and tools.

Within the "facility management implementation" (FM) project, the costs and prices of individual service packages were analysed and compared to the services of external sources until the spring of 2006. Recommendations were derived from the results. Furthermore, the workflows involved in planning and controlling construction activities were mapped in a model that will soon be ready for implementation by the line management. This being so, it is now imperative to

continue "FM implementation" in its two downstream projects, "construction man-agement" and "building management" together with the activities under the project "pilot FM at Koeln-Porz" that were commissioned by the Executive Board.

The "building management" project involves generating product and service catalogues and modelling key processes. The "construction management" project is concerned with modelling the process of controlling construction measures and developing corresponding control tools. Lastly, the project "pilot FM Koeln-Porz" reviews the option of commissioning an external service provider to operate a location.

The results of these projects will be evaluated in November 2006.

Final selection of the winners of the Vision Contest by the Executive Board

Defence technology and security research

As one of the hallmarks of the new corporate strategy, special importance will be accorded to enlarging the activities relating to the interdisciplinary subjects of defence technology and security research against the background of national and European changes. As a long-standing part of DLR's programme, research in defence technology and security forms an integral element of DLR's multidisciplinary research activities. Because of the general demand for utilising dual-use potentials more extensively, synergies between defence and civilian research are moving into the foreground. In the last few years, DLR was able to substantiate its claim to uniqueness on a number of occasions. In the aeronautics business area, examples include DLR's work on the ManPad defence system and in helicopter research. In the astronautics business area, the most important cases in point include the achievements in the field of laser communication as well as activities in Earth observation, space surveillance, and satellite-based communication. In many of the fields just named, moreover, DLR holds a leading position both in Europe and worldwide. This system competence enables it to utilise research investments to the maximum and to transfer its knowledge in a manner which, among other purposes, serves to strengthen the position of the German industry in European and international competition.

DLR´s own science contests

DLR is engaged in top-level research in selected areas of aeronautics, astronautics, transport, and energy to secure the future of our society. In pursuit of its objective of continuously enhancing excellence in research, DLR systematically promotes eminent research achievements by annually organising a contest for DLR Center of Excellence award which retroactively rewards outstanding performance not only by the right to carry the title but also by additional funding.

Another aspect of similar importance is foresight forward and addressing new trend-setting issues to ensure that DLR will remain a driving force in innovative solutions and top technologies ten years hence. For this reason, DLR's Vision Contest supports individual employees or small working groups who suggest projects with an outstanding potential of producing new applications or even new technologies in the medium term. Projects suggested should be of scientific as well as societal relevance.

Both contests were again advertised and implemented in 2005. The first project to be awarded the title DLR Center of Excellence was concentrating solar systems developed and optimised to use solar power in the production of energy, fuel, and clean water.

The second was composite structures, a project in which the development of materials was advanced which, because of their specific properties such as low weight and controllable thermal expansion, appear particularly suitable for use in aeronautics, astronautics, energy technology, and transport. The contest will be held again in July 2006.

In the Vision Contest, there were three winners from the fields of early earthquake recognition, intelligent structures, and functional materials. In these fields, feasibility studies or preliminary tests will be carried out for two years. Six other fields were awarded material resources for minor studies. The Vision Contest will probably be held again in 2007.

Scientific Technical Council

DLR's Scientific Technical Council (WTR) is a statutory body which advises the Executive Board and the Senate on important matters. It is composed of representatives of the facility directors and the workforce. At its regular meeting in 2006, the key issues discussed included AT1, the plans of the business areas, the effects of DLR's transfer to the jurisdiction of the BMWi, and HGF membership. The Council assisted the Executive Board by participating in institute audits and the appointment of institute directors. Technical issues were debated in the WTR's technical committees which it has formed for the aeronautics, astronautics, energy, and transport business areas.

German personnel with ESA

The proportion of German staff at ESA has been one of DLR's key concerns for a number of years. Activities in this regard were continued without change in either quantity or quality. As a result, DLR succeeded in stabilising the proportion of Germans in the ESA's staff at its previous level of about 19%. At the moment, 361 or 19.1% of the ESA's permanent staff of 1,891 are German nationals. Given Germany's share of 23.6% in the ESA budget, the proportion of German staff employed is still disproportionately low.

For the first time, Germany succeeded in occupying rank one in the ESA's young graduate trainee programme with a share of more than 20% among the new recruits in the 2005/2006 campaign. This positive result is due to the joint efforts of DLR, the Foreign Office, the BDLI, and ESA. Work on the ESA's exchange programmes advanced further, so that a total of five employees seconded by DLR will be working for ESA by the end of 2006. It is gratifying to note that

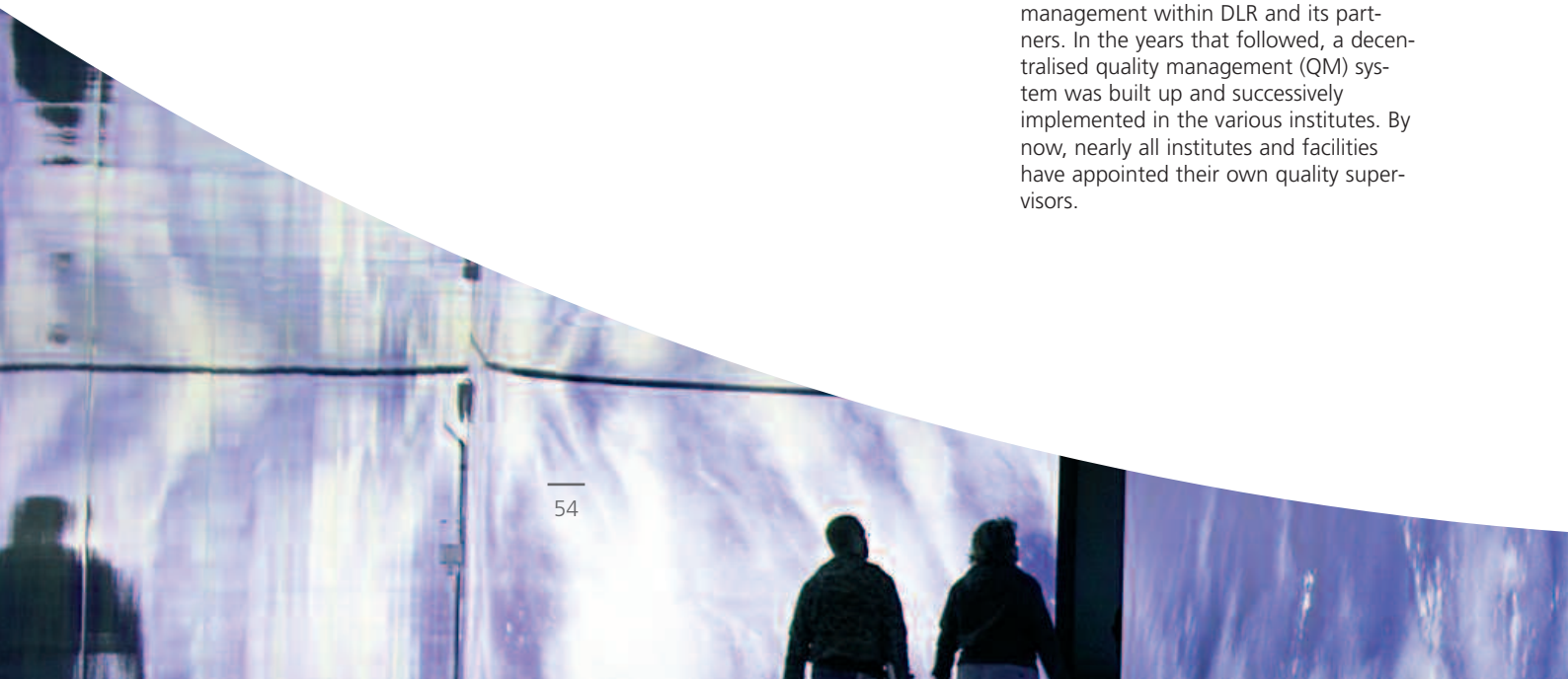
Quality management and environmental protection

DLR's performance and competitiveness are both founded on the quality of its research results, products, and services. The Center is ready to be measured by the most sophisticated standards in research, management, and infrastructure. For the greater satisfaction of its clients, partners, and employees, DLR continually improves quality and safety as well as health and environmental protection. Safety and environmental protection have been essential criteria in the work of DLR for years.

The principles and guidelines of DLR's management system were revised in the period covered by this report. Its principles form an integrated whole, combining quality management, workplace safety, and environmental protection.

Quality management

As early as 1999, DLR decided to organise R&D quality assurance in line with the ISO 9000 system. In this context, the focus is not – and never was – on complying with the standard as such but on embedding the concept of quality management within DLR and its partners. In the years that followed, a decentralised quality management (QM) system was built up and successively implemented in the various institutes. By now, nearly all institutes and facilities have appointed their own quality supervisors.



By the middle of 2006, a total of 16 institutes, facilities, and organisational units had introduced and certified their own quality management systems, a proportion of more than 30%. Similar systems are being established at another ten institutes and facilities.

Another focus in the development of quality management was on enhancing existing systems by widening their scope to include additional performance processes, and by subjecting them to more extensive demands. There is a continuing trend towards integrated management systems that comprise quality management in addition to workplace safety and environmental protection. The establishment of management systems in which workplace safety and environmental aspects are integrated is driven by the QM process.

A unified quality management for the entire enterprise is one of the characteristics that distinguish DLR from other large research institutions. In June 2006, DLR's quality management process was recertified by Bureau Veritas Quality International (BVQI). As part of that audit, the quality and product assurance system was certified under DIN EN ISO 9001.

As an interface between research and industry, between ideas, innovations and the market, DLR's technology marketing mainly focusses on customer benefit. Last year, it was successfully certified after no more than a brief preparation. The TM management system follows the criteria of excellence of the European Foundation for Quality Management (EFQM).

The Executive Board has meanwhile begun to organise its administrative activities in the form of processes. The concept as well as the results achieved so far in the various administrative processes appeared so convincing to the experts of the 7th International Speyer Quality Contest that they awarded DLR the international prize for quality in administration. DLR's third quality prize was presented at its annual general meeting. Once again, one of DLR's assessor took part in the contest for the 2005 Ludwig Erhard Prize.

Quality management

	2003	2004	2005
Current certifications and accreditations	13	13	13[1]
Number of DLR auditors		9	13
Audit implementation			60%

[1] Due to a change of the counting procedures this number will be cited as 15 in future reports

As more and more of our clients and partners are certified, there will be a growing number of cases in which either the presentation of a certificate is demanded, or it is suggested that DLR as a whole and/or individual institutes and facilities that supply goods or services should be evaluated in audits. In some of these cases, demands go beyond ISO 9001 even now, such as the demand for EN 9100 made by AIRBUS or that for ISO 14001 made by EADS. In other cases, concrete demands by clients have led to audits of DLR facilities being performed by the clients themselves. The trend is upward. In isolated cases, explicitly additional acquisition potentials could be developed, which would have been impossible if the facility in question had had no QM system.

DLR's range of products and services is as diverse as that of its clients. An analysis of DLR's customers in the period from 2001 to 2003 reveals a complex structure involving an annual total of c. 500 clients from the third-party fund sector. It is noteworthy that about 5% of the clients account for 80% of the third-party revenues. To measure the satisfaction of DLR's clients, a process is being introduced which, though decentralised, will be implemented consistently throughout DLR. A standard tool for supplier evaluation is being tested at the moment.

The quality guidelines that have been in force since 1999 are being revised at the moment and will be published soon. On the way towards an integrated management meeting the most sophisticated demands, a new quality policy has been documented in DLR's Objectives and Strategies. The training of management system auditors was standardised. Employees able to demonstrate adequate technical knowledge together with familiarity with the methods commonly used at DLR have been appointed DLR auditors. In the period covered by this report, these auditors conducted 60% of the system audits scheduled within DLR. In November 2005, the first meeting for mutual exchange was held, attended by a large number of DLR auditors.

In the future, all DLR institutes and facilities will be audited systematically to establish a solid foundation for the ongoing development of the entire QM system, which also includes taking stock of and monitoring the product-relevant measuring and testing equipment used at DLR. As regards customer satisfaction, institutes and facilities report that clients are mostly well satisfied with their performance.

Environmental protection and safety

Environmental protection and safety have been essential criteria in DLR's work for many years. Following international standards, in-house environmental protection complements DLR's manifold research activities in climate protection, resource conservation, and other objectives of sustainable development. Thus, for example, reducing aircraft noise, emissions, and fuel consumption as well as the development and use of satellites to capture environmental data have been among the key targets of DLR's scientific work. Among other things, DLR provided essential assistance during the tremendous environmental disaster triggered in the Indian Ocean by the winter tsunami of 2004/2005.

From the time when DLR's technical infrastructure at the Koeln-Porz location was certified as the first facility within the Helmholtz Association to be evaluated under the environmental management standard ISO 14001, DLR has been consistently following the path of ongoing improvement and integration with other safety and quality systems. These integrated systems define targets and regulate the identification, documentation, and publication of all relevant activities. More importantly, DLR undertakes in these systems to improve on an ongoing basis its product- and facility-related measures, minimise effects of environmental relevance, and optimise safety features that protect the staff, the environment, and the equipment. That this commitment is being fulfilled was once again confirmed by independent experts.

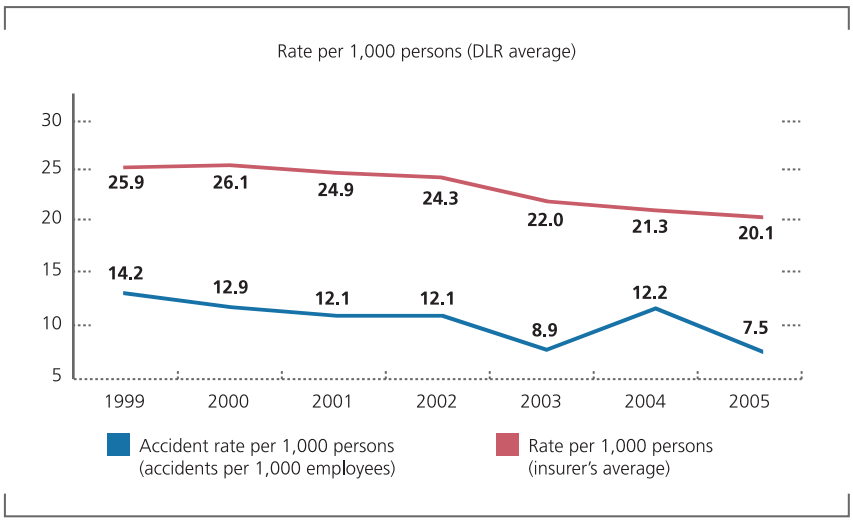
As before, the external and internal transfer of information will remain of the key items in the process of continuous improvement, risk communication included. The "environment server", an internet and intranet platform (www.umwelt.dlr.de) for communication with various target groups, is upgraded and updated constantly. Here, interested persons may discover a wide variety of important information about emergency plans, ergonomics, the management of hazardous substances, a quality assurance manual, a legal database, training courses, and environmental-protection targets. In 2005, the portal was linked to the Helmholtz Association's newly-created work and environmental protection portal (www.argus-helmholtz.de). Another of last year's focal points was fire protection, with regard to which particularly older buildings were audited and action catalogues developed to optimise fire protection in buildings.

Management training courses have been developed and are now being implemented on a supra-regional basis. In 2005, DLR produced films and animations for training purposes that aim to enhance sensitisation. Furthermore, information events for employees are offered as well. In addition, two health and environmental protection days (DLR-GUT) were held at Koeln-Porz and Bonn-Oberkassel in the period covered by this report. Issues relating to waste disposal, health care, fire protection, and energy management were addressed and graphically explained to the audience with the help of external partners. "Audience involvement" bulked particularly large this time as fire fighting drills, measurements, and fitness exercises were held. Matters relating to workplace ergonomics were discussed as well as energy-conservation issues.

Despite extensive technical and organisational precautions, accidents cannot always be avoided. 38 reportable accidents happened in 2005, of which more than one third occurred not at the workplace but in traffic, involving cars and bicycles. This year's accident rate of 7.5 per 1,000 employees is the lowest since 1993. Statistically, only somewhat less than 5 occurred at the workplace, while the remainder were traffic accidents. Once again, this rate is far below the average registered by the Federal Republic (c. 28 in 2004) and by the appropriate employers' accident insurance, where it was almost 20 in 2005. Because of the low incidence of accidents, DLR pays the lowest rates offered by the insurance company.

DLR consistently pursues the process of continuous improvement in environmental protection and safety. More and more service providers, suppliers and other partners are being included in our activities and evaluated accordingly. An evaluation of safety and environmental-protection systems conducted with competent partners for purposes of infrastructural development led to optimisations in safety management, the organisational structure, and human resources (permanent staff). In the process, the departments supervising workplace safety, environmental protection, fire protection, and security were pooled and centralised. At the same time, the internal "working group on integral security" was created, the purpose being, among other things, to facilitate the exchange of information between supervisors, set overarching standards, and establish competence centers. In many subsectors of safety technology, one or more trained experts are available today. Another constituent element of safety management is the unambiguous and transparent assignment of safety and environmental-protection duties throughout the entire line management. These optimisation processes will be further supported by the introduction of indexes to improve the database and facilitate comparisons with other institutions as well as by regular audits and team developments.

Accidents at DLR



Relations

Helmholtz Association of National Research Centers

Programme performance

DLR was able to repeat last year's success achieving the goals envisaged in the transport and astronautics research field, which is its sole preserve. DLR's fleet of aircraft was modernised by the acquisition of a high-altitude research plane, HALO, and an A320, ensuring that our clients and partners will have such large research equipment available in the future. In parallel with the existing research network on integrated Earth observation, EOS, the natural disasters networking platform was founded. Participating centers agreed to pool their scientific expertise in the field of natural disasters, to supply data, models, and scientific information products, and to process information for the press and the public.

Impulse and networking fund

DLR received funds for two new groups of young scientists from the impulse and networking fund of the Helmholtz Association. Two cooperations were supported, one with Aachen RWTH on electrolytic production routes for titanium matrix composites and another with Braunschweig TU on a new flow solver technology based on adaptive higher-order discontinuous Galerkin methods. Forming a new virtual institute for atmospheric research with the HALO research aircraft, the cooperation between DLR, seven German universities, and three centers belonging to the Helmholtz Association was supported as well. Another virtual institute formed by DLR and the University of Stuttgart addresses hybrid power stations.

National and European Networking

Networking within the aeronautics research programme

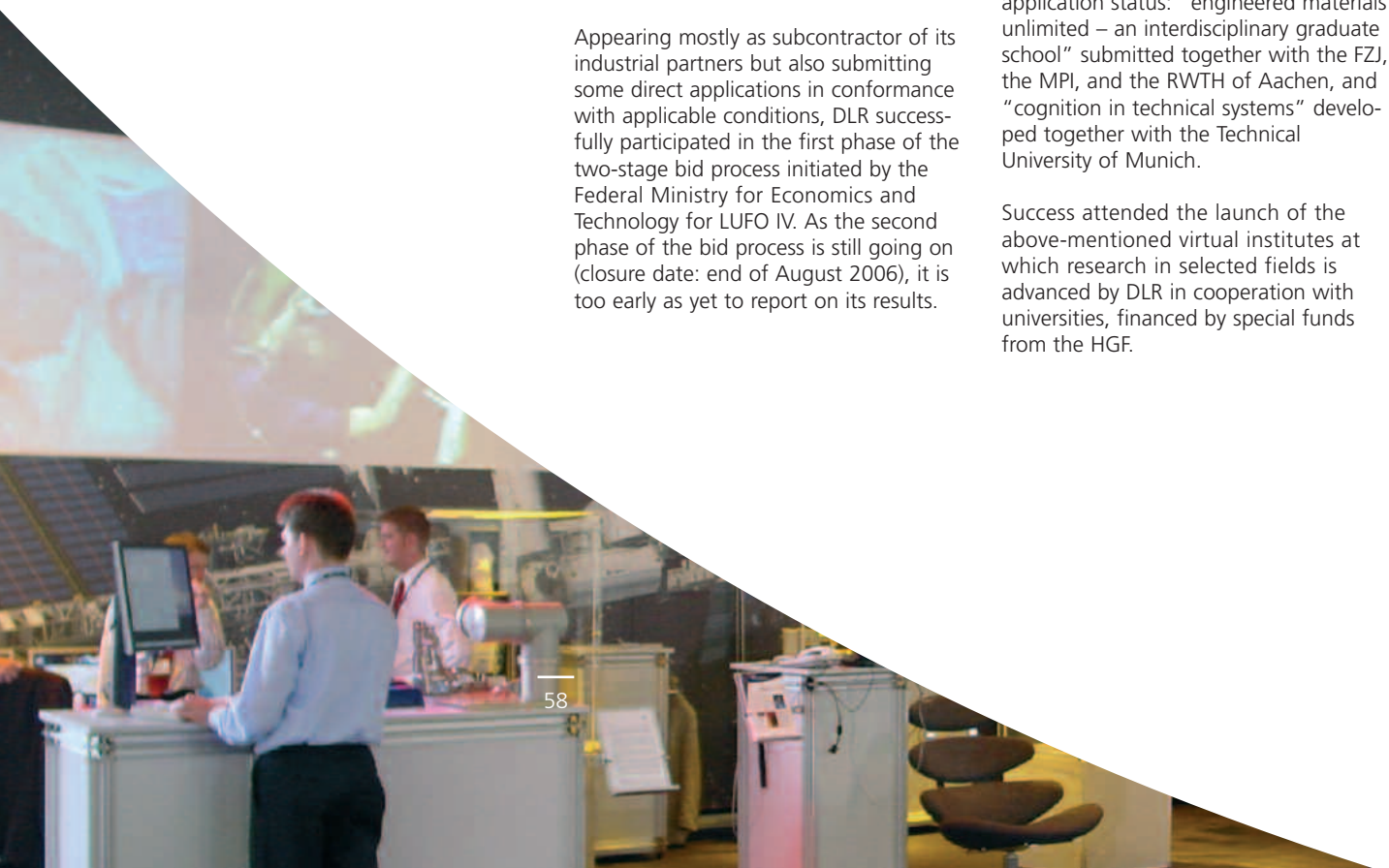
Appearing mostly as subcontractor of its industrial partners but also submitting some direct applications in conformance with applicable conditions, DLR successfully participated in the first phase of the two-stage bid process initiated by the Federal Ministry for Economics and Technology for LUFO IV. As the second phase of the bid process is still going on (closure date: end of August 2006), it is too early as yet to report on its results.

Cooperation with universities

In all business areas, cooperation between DLR and various universities not only ensures optimum resource use in programmatical research but also promotes the training of highly-qualified young people for industry and science. Cooperation equally benefits both DLR and the universities. For the universities, the scientific and technical infrastructure available at DLR forms an indispensable element in, and/or a prerequisite for, numerous research activities. For DLR, in turn, it opens up access to young scientists. In this regard, close integration in the personnel field has proved particularly helpful, especially the joint appointment of DLR institute directors and, more recently, other selected leading managers. A prominent example showing how closely DLR is networked with universities is joint atmospheric research with the HALO research aircraft.

DLR institutes from all locations actively participated in the excellence initiative of the Federal and Land governments, submitting project proposals together with universities. Reaching the next round, the following proposals were given full application status: "engineered materials unlimited – an interdisciplinary graduate school" submitted together with the FZJ, the MPI, and the RWTH of Aachen, and "cognition in technical systems" developed together with the Technical University of Munich.

Success attended the launch of the above-mentioned virtual institutes at which research in selected fields is advanced by DLR in cooperation with universities, financed by special funds from the HGF.



Participation in DFG programmes

The so-called coordinated programmes of the German research foundation (DFG) support extensive networks of scientists addressing major complex issues in interdisciplinary research. Special research areas emphasise excellent research, focus programmes serve to build up technical capacities, and graduate colleges train excellent young scientists. In the period covered by this report, DLR institutes were involved in 8 special research areas, 12 focus programmes (2004: 21), and 8 graduate colleges.

Sponsorships

Securing a supply of highly qualified young scientists for research and development is an essential concern for science and business. Sponsorships combine promoting young scientists with ensuring fast technology transfer through individuals. Business enterprises pay a half-share in the cost of training young scientists, who are employed by DLR for three to four years to work in fields that are of equal interest to both DLR and the companies concerned, where they spend part of their time.

In 2005, DLR sponsored a total of 54 young scientists, yet another increase over the preceding years.

Trilateral Dialogue

Trilateral Dialogue is the name of a cooperation in the aerospace sector that unites the DFG, universities, the industry (BDLI), and DLR. It aims to improve the harmonisation of research objectives and programmes among the partners, and to focus research activities on economically promising fields. Further objectives include promoting R&D capacities for education and training as well as sponsoring young scientists and engineers. The transfer of responsibility for DLR from the BMBF to the BMWi will involve adapting the orientation of the Trilateral Dialogue to the new framework conditions. In the field of aeronautics, the Trilateral Dialogue aims to coordinate and harmonise basic research. Together with the application-oriented research under LUFO, application-related and basic research will eventually merge in a common master concept.

Cooperation with ONERA and AIRBUS

Based on the cooperation framework agreement signed between DLR, the ONERA, and AIRBUS in July 2005, plans were drawn up for joint projects addressing flight physics, aircraft cabins and structures, flight systems, and aircraft noise, some of which have been launched already. Further enhancing bilateral cooperation between DLR and the ONERA, an agreement on metrology was added to the existing bilateral cooperation agreement in January 2006, addressing advanced measuring techniques, airborne optical remote sensing, and advanced radar systems and applications.

Cooperation among DLR, NLR, DNW, and ONERA: "Aero Testing Alliance"

Agreements to establish the Aero Testing Alliance EEIG (ATA) involving the DNW and the ONERA were signed in April 2006. The complete contract consists of a general cooperation agreement between all participating organisations (DNW, NLR, DLR, ONERA) in which the essential rules of cooperation are defined, and the statutes of the ATA, which is headquartered with the DNW at Noordoostpolder. The business of the ATA is to support DNW and ONERA in marketing and selling their wind tunnel services, to implement joint activities in technology development, and to realise joint investments. This cooperation marks an important step towards joint operation of the DNW and ONERA wind tunnels. The present cooperation concept is scheduled for evaluation in three years.

National and European networks

	2003	2004	2005
DFG participations	34	36	30
Sponsorship contracts	37	43	54

Cooperation within EREA

The share of the European research institutions in the 3rd call under the 6th EU framework programme amounted to 19% of the total STREP (special targeted research project) budget. The share of the EREA (Association of European Research Establishments in Aeronautics) in the total STREP budget was 12.8%, while that of DLR amounted to 5.5%. As far as the acquisition of funds for special targeted research projects (STREPs) and integrated research projects (IPs) is concerned, DLR was the most successful of the EREA partner institutions. At the same time, the EREA aeronautics research institutions actively participated in formulating the content of the coming 7th EU research framework programme to ensure adequate participation for the EREA establishments in the future.

Collaboration with CNES

Building on the success of the jointly-organised conference on launcher technologies in November 2005, the 7th International Launcher Conference to be held early in 2007 on "Advanced Concepts" will be organised jointly as well. Sponsored by Spanish institutions, it will take place in Barcelona. In February 2006, the R&D programme directors met to promote closer interconnections between the CNES and DLR on the scientific and technological plane.

The discussion revolved around joint activities to develop a new satellite platform, the exchange of scientific radar and formation-flight data, and ongoing cooperation on launchers, which is to be formalised in a letter of agreement. As a first step to merge competences in the field of small satellites (BIRD/Myriade), a DLR employee was posted to the CNES development team in Toulouse for six months.

Collaboration with CIEMAT

In the last 25 years, great efforts were made jointly by DLR and the CIEMAT to develop the technology of solar-thermal power stations to market maturity. The ultimate success of this enormous staying power is evident from the number of commercial solar power stations which are currently being built and planned in Spain. All essential components that are used today in these solar power stations were either developed or tested on the CIEMAT run Plataforma Solar de Almería (PSA) at Almería in the south of Spain, the leading test and demonstration center for solar-thermal power station technologies worldwide.

The CIEMAT and DLR are agreed that further joint research and development activities in the field of solar-thermal power stations will be needed to enhance system efficiency and reduce costs. In addition, both partners are jointly engaged in studying the option of alternative fuels or, in more concrete terms, of producing hydrogen using solar radiation. This being so, DLR and the Spanish national energy research institution CIEMAT will continue their long-standing successful cooperation in the field of concentrating solar systems for at least another 3 years. Their objective is to develop and refine key components for concentrating solar systems within the framework of joint research projects, in which DLR's access to the PSA plays a key role. Consequently, framework conditions regulating the work of the permanent DLR delegation at the PSA form an important part of the agreement. The delegation currently consists of 12 staff members.

Further important impulses for cooperation come from a large number of EU network projects. Scientific exchanges about joint seminars and publications demonstrate the intense mutual involvement of both partners which, in addition, enjoy the benefits of an outstanding global network through their membership in the European research alliance SOLLAB and the SolarPaces network of the International Energy Agency (IEA).

Participation in European technology platforms; preparations for the 7th framework programme

The Commission's proposals for the 7th framework programme (FP7) are largely based on the work and the papers of the European technology platforms (TPs). DLR takes an active part in all platforms which are of relevance to its business areas. Most prominently, these include the fuel cell/hydrogen TP and the traffic-relevant platforms ERRAC (European Railroad Research Advisory Council) and ERTRAC (European Road Transport Research Advisory Council) as well as ACARE (Advisory Council for Aeronautical Research in Europe), whose work was expressly praised by Commissioner Potocnik at the Vienna Aerodays of 2006. In November 2005, the EREA Board met informally with Commission representatives of the research, energy, and transport general directorates to discuss various EREA interests.

Next to the long-established interfaces in air-transport system/aeronautics research, ATM, and security research, relations with the research infrastructure section (ESFRI) were revived so as to enable the more application-oriented aerospace infrastructures to benefit from the new infrastructure programme under the 7th FP.

Cooperation with new EU member states

Since the enlargement of the EU, integrating the facilities and competences of the ten new EU member states has been an integral element in DLR's strategy. To reinforce and extend cooperation with this group of countries, DLR organised two international conferences in Berlin, one on applied Earth observation and GMES (September 2005), and one on cooperation in aeronautics research (May 2006). At both events, German infrastructures and industrial competences were presented and offers made to join research networks, particularly with regard to calls under the EU research framework programme. Both conferences were followed by workshops for elaboration as well as by technical round-tables on specific subjects.

Network of technical astronautics centers

At the technological level, activities to promote networking with the ESA's technology center (ESTEC) were continued. Next to enhancing the well-established cooperation on robotics, reentry, and materials, additional cooperations were initiated on navigation, concurrent engineering, and software engineering.

To promote technological competence networking, the ESTEC created a Networking Partnering Initiative to organise the exchange of personnel and finance about 20 doctorate theses per annum. Participating in the pilot phase of this initiative, DLR will co-finance 2 places for doctorate candidates together with ESTEC.

Prof. Wittig with NASA administrator, Michael Griffin

International cooperation

Cooperation with the USA

When the flights of the US space shuttles to the International Space Station (ISS) were resumed in July 2005, the event marked an important milestone in the cooperation with the USA as it was a fundamental prerequisite for the launch of the European Columbus module in the second half of 2007. At the same time, talks with NASA began to be informed by the new American space exploration strategy. Among other things, the discussion about this reorientation of NASA formed the subject of the talks of Prof. Wittig in Washington and the visit of NASA's deputy administrator, Shana Dale, to Berlin and Oberpfaffenhofen in January 2006. Since then, a close exchange with NASA's administrator, Michael Griffin, has been developing.

On the other hand, Prof. Bachem concentrated on the subject of Earth observation during his visit to the USA, focussing on contacts with NASA's JPL and on the opportunities offered by R&D cooperation in applied Earth observation between DLR and American partner institutions, such as NOAA and USGS. At the same time, the visit offered a view of America's industrial competences in the field of radar technology.

International cooperation

	2003	2004	2005
International visiting scientists (stay > 1 month) versus scientific assistants	6.1%	6.1%	7.9%

Russia

At first, collaboration with Russia revolved around the International Space Station (ISS). Launched to the ISS on a Soyuz-Progress M 51 on December 24, 2004, the German ROKVISS robotics experiment was mounted on the outside of the Russian service module after mid-January 2005. Meanwhile, its successful mission has been prolonged by another year. In mid-August 2005, the extremely successful ESA experiment MATRYOSHKA supervised by DLR was fetched back into the space station, where the passive detectors integrated in the dummy were removed for return to Earth. In December, MATRYOSHKA was fitted with new detectors to obtain data for comparing radiation exposure inside and outside the station.

In August 2005, DLR was represented for the first time at the Moscow Aerospace Show (MAKS) in Zhukovsky near Moscow, presenting its own exhibition in the German pavilion.

Members of the Executive Board took advantage of the show to conduct a multitude of talks with, among others, Anatoly Perminov (director of the Russian Federal Space Agency ROSKOSMOS) and Stanislav Konyuchov, president of the Yushnoye Corporation and representative of the NSAU, the National Space Agency of Ukraine. Later, Prof. Wittig made use of opportunities to visit industrial facilities in Samara (ZSKB PROGRESS, the manufacturer of the Soyuz launchers; SNTK Kusnetsov, the producer of aircraft and rocket engines; and Aviakor, the manufacturer of the Tu-154M and An-140 aircraft). In Ufa, the delegation met representatives of the Ufa State Aviation Technical University and the UMPO engine factory as well as the deputy prime minister of the Russian Autonomous Republic of Bashkortostan.

In November 2005, a Russian industry delegation led by the Ufa State Aviation Technical University (UGATU) paid a visit to Germany and DLR. Together with representatives of the German industry (Siemens, MTU, Rolls Royce Germany), the delegation discussed options of using aircraft-engine derivatives more extensively in energy generation and natural-gas compression applications on the European-Russian market for energy carriers. The delegation showed great interest in the numerical methods for designing high-pressure compressors developed by DLR Institute of Propulsion Technology as well as in the ceramic coating processes for engine components exposed to extremely high temperatures that were developed at DLR Institute of Materials Research.

At the request and initiative of the Russian Federal Ministry for Industry and Energetics, an EU-Russia workshop on aeronautics research was held in Brussels, demonstrating that the interest of the Russian state in the EU's aeronautics research promotion has grown, and that it is now better placed to participate in it with its own funds. The fact that Russia was made first official partner country of the International Aerospace Exhibition (ILA) in Berlin belongs in the same context, providing a suitable framework for a meeting of the German-Russian Cooperation Council and a multitude of other bilateral workshops and talks.

Japan

The Japanese Space Agency, JAXA, largely completed its process of restructuring and reorganisation in 2005/2006, so that DLR-JAXA strategy dialogue of March 2006 did indeed ring in a new phase in German-Japanese cooperation, particularly in research and development. The dialogue produced new approaches to bilateral cooperation, continuing and complementing a tradition that extends over many years in some fields, such as communication and navigation, Earth observation, parts and components, space propulsion, and planetary research. As its own contribution towards the official 'Germany in Japan' Year, DLR showed its fascinating large photographs of Mars in 3-D format at the University of Kyoto in March and April 2006. Taken by the high resolution stereo camera (HRSC) developed and operated by DLR, the images introduced the Japanese public to the results of German leading-edge research in camera development and planetary exploration.

Execution of the contract with KARI

China

On July 27, 2005, the 22nd joint committee meeting (JCM) took place between DLR and the Chinese Aeronautical Establishment (CAE) at DLR location in Oberpfaffenhofen, marking 25 years of successful cooperation between the two institutions. During a trip to China undertaken by Prof. Szodruch in October 2005, a supplementary agreement specifically regulating the involvement of partners from the aeronautics industry in research projects was signed. The trip was occasioned by the East West High Speed Flow Field Conference (EWHSFFC) as well as by visits from other Chinese research institutes and industrial enterprises, such as the First Aircraft Institute (FAI) and the China Aeronautical Radio Electronics Research Institute (CARERI) which work, among other things, on the development of the Chinese regional aircraft, ARJ 21.

Another highlight was a working visit paid by a high-ranking delegation of the Ocean Remote Sensing Institute (ORSI) at the Ocean University of China (OUC) to DLR Institute of Atmospheric Research. The delegation's visit was based on the memorandum of understanding about cooperation on the use of LIDAR technologies that was signed in February 2005. In May 2006, the president of the Academy of Science visited DLR facility at Koeln-Porz, accompanied by a delegation.

Korea

In 2006, the Korean Space Agency, KARI, commissioned a German consortium composed of industrial enterprises and DLR's R&D to manufacture essential components for the optical instrument of the Kompsat-3 satellite. This achievement of Germany as a space nation was celebrated in April 2006 in the presence of the Korean deputy prime minister and the president of KARI. Furthermore, a framework agreement was signed with KARI to intensify collaboration in consideration of the high scientific potential of bilateral research cooperation.

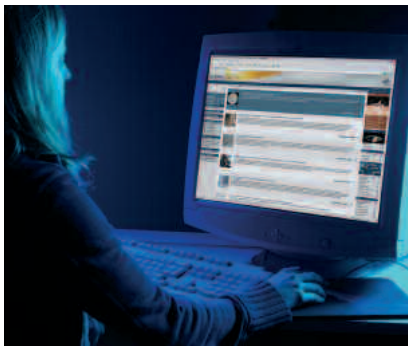
East West High Speed Flow Field Conference in China

Brazil

In 2005 and 2006, members of the new leadership of the Brazilian space establishments visited DLR for bilateral talks. The visit of the president of the Brazilian Space Agency, AEB, was mainly concerned with Earth observation and the further development of rocket engines for microgravitation research. In 2005, for example, a VS-30 rocket engine made in Brazil was used in the Shefex experiment. There are plans to upgrade cooperation between DLR-MORABA and its Brazilian partners. Prominent among the subjects discussed in talks between DLR Executive Board and the new director of INPE was a study addressing the option of launching a joint L-band satellite (MAPSAR project).

Algeria

In the field of energy research, a bilateral cooperation dialogue was established with research partners in Algeria. At a visit of the Algerian research establishment, NEAL, potential projects were discussed, and a memorandum of understanding on future collaboration was signed.



The new DLR web portal

Corporate communication

Consistent corporate communication for the research enterprise

Abandoning its classical format, DLR's press and public-relations work has recently been developing towards corporate communication. According to the generally accepted definition, corporate communication means the strategic use of all communication media by an enterprise, forming part of its corporate identity. The purpose of corporate communication is to communicate comprehensively the codified standards, values, and services of an enterprise. In its effect on the outer world, it demonstrates how the goals of a corporate culture are being lived and practiced.

Real-life zooms featuring DLR logo showing World Cup stadiums from space: The arena in Berlin

The impact of this strategy change may be illustrated by examples from the period covered by this report on DLR's research and corporate results. DLR's consistent corporate communication aims at

- branding,
- positioning DLR as a reference address within the community,
- transparently presenting DLR, its mission and results to the (general) public, and
- positioning DLR in the parliamentary sphere.

The essential instruments of corporate communication include

- classical communication through the media,
- communication through events,
- a state-of-the-art internet presence,
- cooperation with media partners and agencies, and
- parliamentary relations.

Corporate communication products

Building up DLR as a brand name is achieved by consistent communication about all its business areas. The best examples of successful branding in the period covered by this report include the book 'Mountains from Space', of which more than 60,000 copies had been sold worldwide by the copy deadline date, the 2005 Space Day when DLR alone logged more than 3 million media contacts, and the real-life zooms from space onto the arenas of the Football World Cup, the World Equestrian Games at Aachen, and the Hockey World Championship in Moenchengladbach in 2006. Next to its branding benefits, this campaign yielded a theoretical advertising benefit for DLR amounting to more than Euro 10 million.

As before, frequent parliamentary evenings feature prominently among the activities to position DLR in the parliamentary sphere. During the meeting of the ESA Ministerial Council in December 2005 in Berlin, DLR's corporate communication showed eminent efficiency in positioning the establishment with politicians from Germany and the ESA member states.

Cooperations increasingly supplement classical media communication which, however, remains indispensable in day-to-day business. DLR has been cultivating highly cooperative relations with the WDR for years, and collaboration with the Lufthansa Magazine, meanwhile institutionalised, is a cooperative venture with a profound impact on DLR's scientific community. This helps to secure for DLR a reputation as a 'reference address' that reaches far beyond the borderlines of classical scientific publishing. Published in the Lufthansa Magazine, articles signed by and interviews with Executive Board members as well as reports on excellent results achieved especially by DLR's aeronautics research locations reach decision-makers, multipliers, and interested members of the public. Further cooperations with other media partners are under preparation.

Furthermore, DLR's communication efforts through events and the classical media significantly contributed towards creating a transparent image of DLR in the period covered by this report. At the ILA 2006, the redesigned R&D stand right next to the space hall was convincing; at this major aerospace exhibition, DLR's media work resulted in more than 10 million media contacts. Together with DLR's convincing online communication, so-called crossover media approaches during parabolic flight campaigns and particularly the participation of VIPs from the space as well as the non-space community constitute the finishing touches to the image of DLR's corporate communication on the way towards a consistent presentation of DLR as a research enterprise.

Preparations for the centenary of aerospace research in Germany

DLR's oldest precursor organisation was established in Goettingen in 1907. Accordingly, 2007 will be a year marked by the centenary of this event. Preparations to make 2007 a year distinguished by this jubilee with its numerous events and activities have already begun. DLR will take advantage of the opportunity to present its competences and the benefits of its work for science, the economy, and the society to a broad national and international public.

DLR's appearance at the ILA 2006

People

Equal opportunities; work-life balance

That DLR is a family-oriented enterprise that aims for equal opportunities is witnessed by, among other things, the award of the 'Job and Family Audit' certificate in September 2005. A whole range of family-oriented measures contributes towards improving the reconcilability of work and family life including, for instance, flexible working hours and working-time models, tailored-work options, sabbaticals, part-time work during certain periods in family life, family services, reemployment agreements, and in-house or subsidised child care. Employee development programmes specifically targeting the promotion of women and the sensitisation of managers towards this issue complement this aspect of DLR's human resources policy. Participation in the job and family audit system ensures that all measures are continually reviewed and optimised.

Personnel development at DLR

Forming part of the holistic process of personnel management, human resources development at DLR is guided by the strategic objectives of its institutes and facilities. Its purpose is to identify and develop the employees' qualifications, competences, development needs, and performance potentials, and to bring them into line with the requirements of their respective jobs. Human resources development serves to secure a high level of personnel quality and improve operational efficiency; by responding flexibly to the needs and potentials of the employees. It also serves to optimise job satisfaction and motivation. At DLR, employee development is directly interfaced with organisation development, with strategic and structural changes in institutes and facilities in particular being supported by moderated team workshops.

Tools and services in employee development

DLR's human resources development is a demand-oriented service (see Fig.). Demand is analysed systematically through structured employee interviews, strategic talks at the management level, and comparisons against corporate objectives. Based on this foundation, qualified personnel developers generate personnel and organisation development concepts tailored to specific organisational units. They advise and support staff in the implementation of a wide variety of human resources development measures (one face to the customer) and evaluate their efficiency.

Next to general advice on all issues relating to in-service training as well as employee guidance and promotion, PE offers the following primary services:

- Local and DLR-wide education programmes focussing on language and IT training, social competences, management competences, and health promotion,
- differentiated development programmes for senior and junior managers,
- team workshops on organisation development (e.g. change management, strategy development, leadership and cooperation, training seminars tailored to specific teams),
- support in recruiting, selecting, and settling in new employees,
- coaching for management personnel and employees as well as small groups,

- mentoring, especially to promote young scientists,
- management feedback to optimise leadership and cooperation,
- management of projects on equal opportunities and the work-life balance, and
- centralised training coordination (256 trainees).

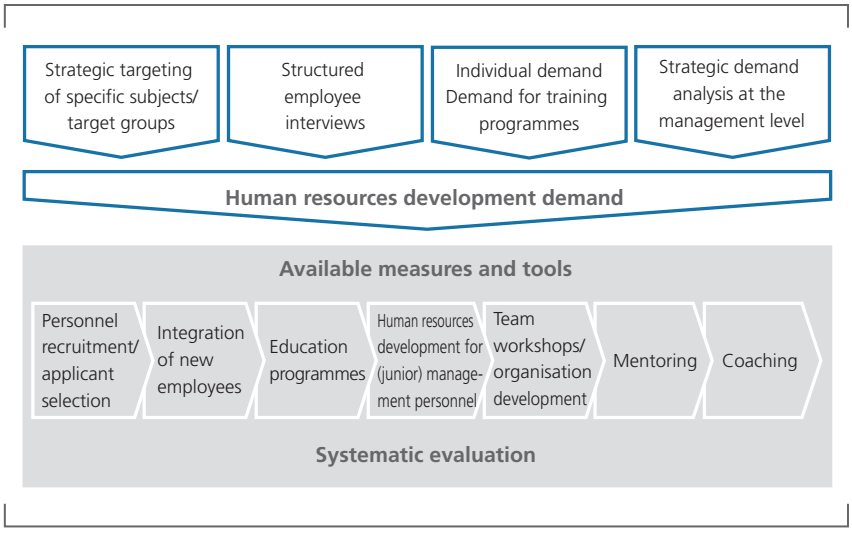
43% of the workforce attended at least one education programme, human resources development programme for management personnel, or team workshop in 2005. Each employee spends an average of 1.5 days per year on human resources development measures (in-service training events or team workshops), a total of 7,691 days for the entire workforce in 2005.

The average number of in-service training days per employee declined slightly compared to the previous year (from 1.7 to 1.5 days). At the same time, the number of in-service training events increased. The duration of events at which employees attend tends to decline. On the one hand, scientific assistants find it more and more difficult to reserve several days for in-service training in the face of project-related pressure. On the other hand, E-learning and blended-learning methods (combining phases of self-learning and personal attendance) are used more and more frequently.

A total of 9 mentoring tandems were supervised by personnel development in 2005. In addition, a cross-mentoring project operates within the Helmholtz Association that is directed by DLR.

First and foremost, human resources development aims to promote young scientists. In 2005, a dialogue between young managers and the entire DLR Executive Board was held for the first time in a moderated event. This exchange serves to integrate potential holders into important strategic developments and decisions and projects an authentic picture of the work of the Executive Board. Leapfrogging hierarchy demarcations, such events promote the corporate identity. Standard project-management offerings were extended (crash training courses, E-learning programmes, project-management portal). Employees are assisted in obtaining certification under the American PMI standard and may take advantage of related coaching. At the moment, options of offering certifiable project-management qualifications including MBA exams are being reviewed, the objective being to improve individual career promotion and wage-group upgrading options.

Demand orientation and human resources development measures/tools



New developments and projects

From 2003 onwards, the new integrated human resources development system was implemented continuously on the basis of internal local agreements (except at Oberpfaffenhofen). A differentiated evaluation process uses established quality criteria to evaluate human resources development and/or education programmes at all locations. Its results are important for the location-specific allocation of resources and the comprehensive management of quality in human resources development.

The process will be optimised to improve service efficiency and customer satisfaction. Next to matrix certification across the entire administrative infrastructure of DLR, human resources development is seeking certification under DIN EN ISO 9001.

Human resources development and mobility

	2003	2004	2005
Training days per employee	1.6	1.7	1.5
Mentoring tandems	11	11	9
Postings abroad* (months)	450	274	485

* Exclusive of DNW postings from 2004 onwards

Performance and potential evaluation is a tool that will gain in importance in DLR's human resources management, partly because of the performance-oriented elements in the pay structure of public-service employees. Potential-analysis tools based on complex competence models have already been integrated in the selection process of the mentoring programme to facilitate evaluating the feasibility of targets and the capability profiles of individuals. In the future, competence models tailored to concrete requirement profiles will permit harmonising the processes used to select employees, evaluate their performance and potential, and determine their individual development needs.

Supporting the entire administration in implementing a process-based organisation is a project of eminent importance. To develop the necessary culture, a concept of sustainable change was drawn up by HR which is to be implemented within 2 years. Next to developing new guidelines for managers and employees, the concept highlights employee surveys with a feedback to the management. For 12 months, about 380 employees will provide 40 managers with comprehensive feedback on job satisfaction, perceived quality of leadership, and options to improve cooperation. These assessments will be set against the managers' own self-assessment. Results will be analysed in a moderated workshop and translated into concrete agreements on measures to improve

Human resources administration

In human resources administration, the key issue this year was implementing the new collective agreement for the public service (TVöD). There are several reasons why this presented an unusual challenge to all human resources administration employees.

The outstanding difficulty was that the TVöD had only been signed by the negotiating parties in the middle of September 2005 but came into force on October 1 of the same year. Consequently, the preparations for its implementation (creating and testing an IT map of the new collective agreement, adjusting the data of the 5,100 active employees so that they could be transferred mechanically, reviewing master contracts and forms from start to finish), which normally take several months, had to be done on the basis of drafts of the agreement and comments from the negotiating parties. In a race against time, the employees in human resources administration were qualified for the job, and clients as well as the employees operating at the interfaces between institutes/facilities and the administration were informed comprehensively. In effect, the process of changing to the TVöD was largely completed by November 2005.

As the TVöD, contrary to the demands of the Federal and Land research establishments, did not contain special regulations for the science sector, negotiations with representatives of the Federal Ministry of the Interior and the Federal Ministry for Education and Research were begun early on by the HGF personnel committee together with representatives of the Fraunhofer and Max Planck Societies. Their objective was to obtain authorisation for creating terms and conditions outside the collective agreement that would be attractive to research employees. In the event, they succeeded in securing financial improvements which may now be used to recruit and retain top performers as well as to reward outstanding achievements. Furthermore, they obtained approval for regulations that make it easier for scientific staff to change from one research establishment to another as well as between industrial enterprises and research establishments. On the other hand, regulations covering the recruitment of top scientists and managers remain unsatisfactory. What is more, discrepancies between the regulations laid down in collective agreements and in civil-service legislation increasingly affect the process by which appointments are made jointly by DLR and universities.

Youth promotion developed satisfactorily. Although the number of young scientists declined slightly, trainee numbers increased marginally, and the number of doctorate candidates supported internally and externally increased by around 13% in the period from 2004 to 2005 (see Table).

Personnel

	2003	2004	2005
Number of employees	5,069	5,055	5,125
Scientific assistants	2,354	2,336	2,603
Untermed/termed contracts	2,935 / 2,134	2,913 / 2,142	3,064 / 2,061
Proportion of women			
- overall	28%	28%	28%
- in leading positions	12%	12%	12%
- scientific assistants	12%	13%	12%
Young scientifics	135	128	113
Doctorate candidates (internal/external)	437	453	519
Trainees	242	251	256

Awards and prizes

Internal awards

DLR Science Prize 2005

Dr. rer. nat. Thomas Volkmann and Dipl.-Phys. Jörn Strohmenger, Institute of Space Simulation, for „Observation of a metastable phase during solidification of undercooled Nd-Fe-B alloy melts by in situ diffraction experiments using synchrotron radiation“

- Dr.-Ing. Eike Stumpf, Institute of Aerodynamics and Flow Technology, for „Numerical study of four-vortex aircraft wakes and layout of corresponding high-lift configurations“
- Dr. rer. nat. Johannes Hendricks, Institute of Atmospheric Physics, for „Simulating the global atmospheric black carbon cycle: a revisit to the contribution of aircraft emissions“

DLR Senior Scientist

- Dr. rer. nat. Alexander Gundel, Institute of Aerospace Medicine
- Prof. Dr. rer. nat. habil. Diedrich Möhlmann, Institute of Planetary Research

DLR research semester 2005

- Dr. rer. nat. Jürgen Brillo, Institute of Space Simulation
- Dr. rer. nat. Luca Bugliaro, Institute of Atmospheric Physics
- Dr. rer. nat. Andreas Dörnbrack, Institute of Atmospheric Physics
- Dr.-Ing. Bernhard Eisfeld, Institute of Aerodynamics and Flow Technology
- Dr. rer. nat. Elke Goos, Institute of Combustion Technology
- Dr.-Ing. Winfried Halle, OE Optical Information Systems
- Dr. rer. nat. Jörn Helbert, Institute of Planetary Research
- Dr.-Ing. Rainer Schnell, Institute of Propulsion Technology
- Dr. rer. nat. Norbert Wagner, Institute of Technical Thermodynamics

Prizes awarded by the Society of DLR Friends

Hugo Denkmeier Prize 2005

- Dr. Daniela Christina Voss, Institute of Space Simulation, the youngest doctorate candidate to be awarded a prize for her aerospace thesis on „Thermally Decomposable Carbon Aerogel Sands“, Fritz Rudorf Prize 2005
- Dr. Christoph Becker and Dr. Hans-Joachim Kroh, corporate development and external relations, for „Embedding Aeronautics in the European Constitution“, Innovation Prize 2005
- Christoph Kindervater, Institute of Structures and Design, for the project „Steering-column Absorbers of Fibre-plastic Composite Material“, Otto Lilienthal Research Semester 2005
- Prof. Dr. Jan Delfs, Institute of Aerodynamics and Flow Technology, for „Grid-free Methods for Second-generation Aeroacoustic Simulation“

For the first time, the prize of the president of the Society of DLR Friends was advertised by Dipl.-Ing. Horst Rauck, the president of the Society of DLR Friends in 2005, to be awarded for eminent achievements by young scientists which ultimately lead to patentable results. The first winner of the prize is Dipl.-Ing. Ulrich Seibold, Institute of Robotics and Mechatronics.

DLR Quality Prize 2005

- Dr. habil. Ulrike Mrwa, director of the quality management, quality assurance, and ESF testing staff unit within the Project Management Agency
- Dr. Viktor Oubaid, quality commissioner of the aerospace psychology department at the Institute of Aerospace Medicine
- Dr. Alfred Geiger, T-Systems SfR
- Uwe Molzberger, T-Systems SfR
- Rolf Page, T-Systems SfR

The above were honoured for their outstanding commitment to systematic quality assurance and quality management to the benefit of DLR, as well as for merits acquired through introducing and consistently implementing the quality management system in their facilities and/or jurisdictions to enhance the quality of DLR's products and services.

External Awards 2005

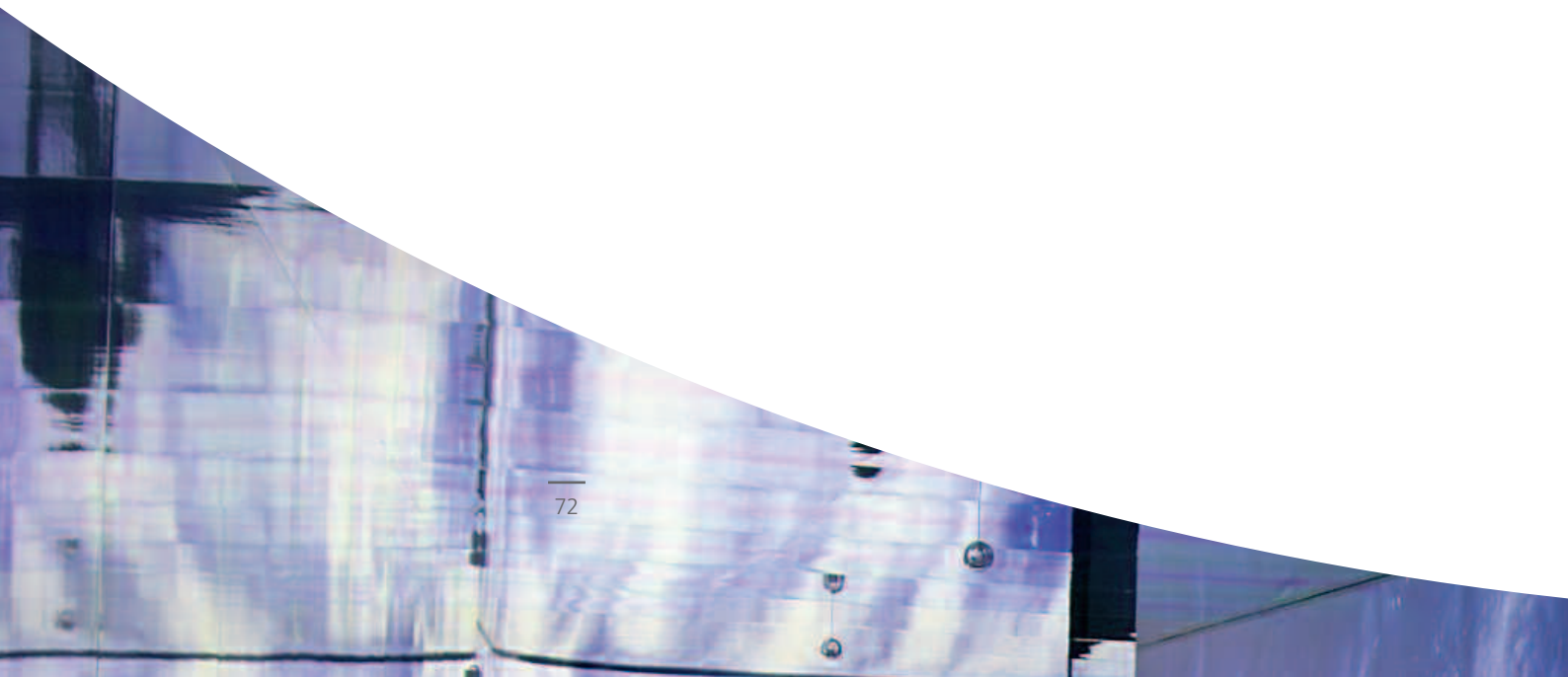
Award	Winner
Aachener und Münchener Prize for Technology and Applied Natural Sciences	Prof. Dr.-Ing. Ulrich Schumann
ASME Best Paper Award ISEC 05	Prof. Dr.-Ing. Robert Pitz-Paal et al.
Best Mechatronics Paper Award 2005, VDI Knowledge Forum	Dr.-Ing. Tobias Ortmaier
DGM Best Poster Award	Dipl.-Phys. Susanne Lisinski
DGON Honorary Prize (radar technology)	Dr. rer. nat. Dr. -Ing. E.h. Wolfgang Keydel
DGS Solar Prize	Dr.-Ing. Joachim Nitsch
EADS Argus Award 2005	Martina Gabele
ECO TEC Award Expo 05	Dr. rer. nat. Christian Sattler Dr. rer. nat. Martin Roeb
Erna Scheffler Promotion Prize	Franziska Zacharias
Galileo Masters	Frank Hermanns
Honorary Professor of Budapest Tech	Prof. Dr.-Ing. Gerhard Hirzinger
Honorary professorship, Northeastern University, Shenyang, China	Prof. Dr. rer. nat. Dieter Herlach
Innovation Prize 2005, medical technology	Dipl.-Ing. Thomas Schmid
Munich Business Plan Contest "TechVenture Stage", 2nd Prize	Dipl.-Ing. Thomas Schmid
NASA Group Achievement Award for Science Operations	Dr.-Ing. Lutz Richter
OTTI Best Poster Award	Prof. Dr.-Ing. Hans Müller-Steinhagen Dr.-Ing. Henner Kerkes
Pioneer in Robotics and Automation Award	Prof. Dr.-Ing. Gerhard Hirzinger
Reinhard Furrer Prize 2005	Dr.-Ing. Dennis Göge
Springorum Memorial Medal	Dipl.-Ing. Roland Schweikhard
VDI Promotion Prize 2004/2005	Dipl.-Ing. Christian Zwiener
Wernher von Braun Gold Medal	Dipl.-Ing. Klaus Landzettel
ZARM Promotion Prize	Dipl.-Ing. Martin Bechle

Compilation of Performance Indicators

Third-party funding	2003	2004	2005
Total third-party funding	Euro 240 m	Euro 242 m	Euro 275 m
Year-on-year revenue growth, R&D revenues from the domestic economy	-11%	18%	1%
Third-party share in the revenue total	49%	49%	52%
Share of revenues from foreign clients (revenue volume)	39%	35%	31%
Success of EU proposals in the last three years (accepted/submitted)	33%	42%	40%
Coordinator/total ratio (EU projects)	14%	18%*	21%

* The figure for 2004 was corrected to read 18% instead of 13%, as in the Research and Corporate Results 2004/2005.

Research-related results	2003	2004	2005
Publications in peer-reviewed journals	524	450	561
Peer-reviewed publications in proceedings, books, etc.	-	500	566
Presentations at scientific conferences, workshops, lectures	1,438	1,620	1,387
Calls to universities	11	12	9
Teaching posts	137	159	177
Diploma papers	199	235	264
Dissertations	77	86	71
Habilitations	4	5	5



Technology marketing	2003	2004	2005
Revenues from licences	Euro 3.9 m	Euro 4.2 m	Euro 2.7 m
Company hive-offs	1	1	1
New in-house technology transfer projects	10	12	1
Investments in technology transfer projects	Euro 2.2 m	Euro 2.4 m	Euro 3.5 m

Management tools	2003	2004	2005
Overall project work	64%	65%	63%

Quality management	2003	2004	2005
Certifications and accreditations **	13	13	13 **

** Because of a change in the counting mode, this figure will be quoted as 15 in future reports.

National and European networks	2003	2004	2005
DFG participations	34	36	30
Sponsorship contracts	37	43	54

International cooperation	2003	2004	2005
International visiting scientists (stay > 1 month) versus scientific assistants at institutes	6.1%	6.1%	7.9%

Personnel	2003	2004	2005
Employees	5,069	5,055	5,125
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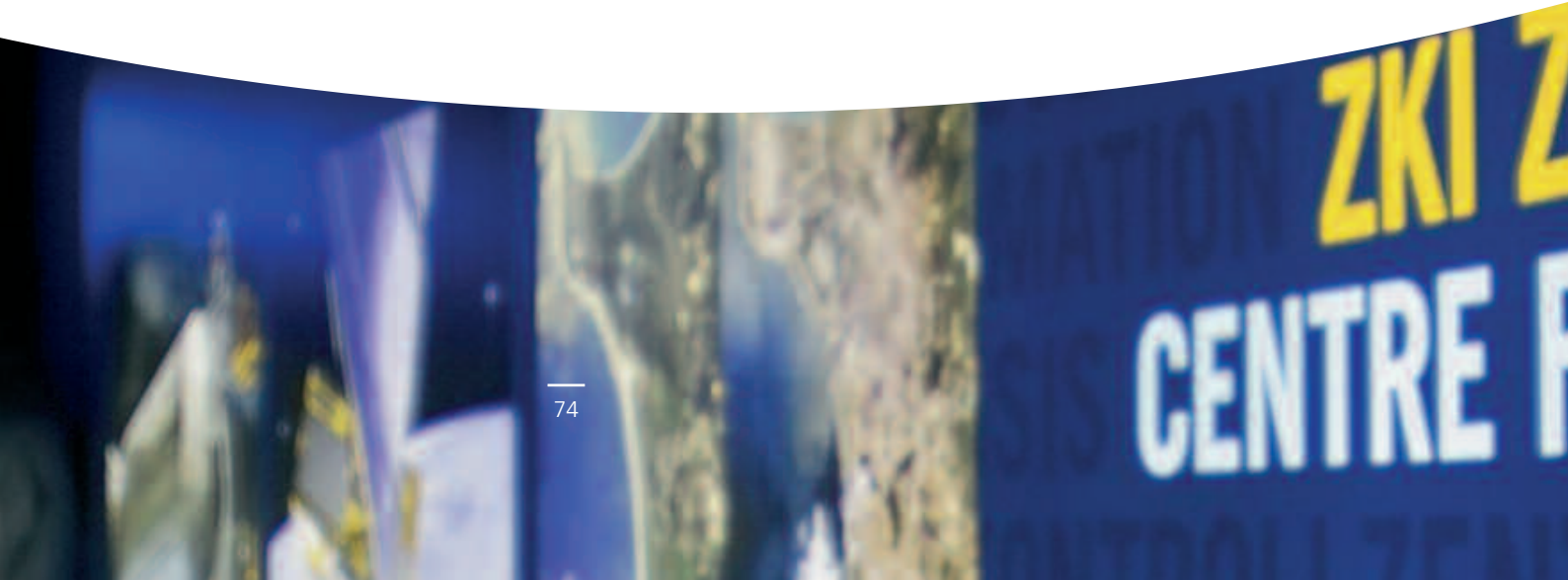
Trainees	242	251	256

Human resources development and mobility	2003	2004	2005
In-service training days per employee	1.6	1.7	1.5
Mentoring tandems	11	11	9
Postings abroad (months)	450	274	485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Members and executive bodies

As of June 30, 2006, DLR had 47 sponsoring members in addition to honorary members, scientific members, and ex officio members.

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- The Honourable Daniel Saul Goldin, Washington
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- Jean Sollier, Rueil-Malmaison, France
- Prof. Dr.-Ing. Gerhard Zeidler, Stuttgart

Sponsoring members

Public entities that regularly give at least Euro 50,000 annually:

- Federal Republic of Germany, represented by the Federal Minister of Economics and Technology, Berlin
- German state of Baden-Wuerttemberg, represented by the Baden-Wuerttemberg Minister of Economics, Stuttgart
- Free State of Bavaria, represented by the Bavarian State Minister of Economics, Transport, and Technology, Munich
- German state of Berlin, represented by the State Secretary of Science, Research and Culture, Berlin
- German state of Lower Saxony, represented by the Lower Saxony Minister for Science and Culture of Lower Saxony, Hanover
- German state of North Rhine-Westphalia, represented by the Minister of Innovation, Science, Research and Technology of North Rhine-Westphalia, Duesseldorf

Individuals, legal entities, and associations and societies without legal capacity:

- Aerodata AG, Braunschweig
- AIR LIQUIDE Deutschland GmbH, Duesseldorf
- ALSTOM Power Generation AG, Mannheim
- AOPA-Germany, Verband der Allgemeinen Luftfahrt e. V., Egelsbach
- Arbeitsgemeinschaft Deutscher Verkehrsflughäfen e. V., Berlin
- AUDI AG, Ingolstadt
- Robert Bosch GmbH, Berlin
- Bundesverband der Deutschen Luft und Raumfahrtindustrie e. V., Berlin
- CAE Elektronik GmbH, Stolberg
- CAM Computer Anwendung für Management GmbH, Unterfoehring
- Carl-Cranz-Gesellschaft e. V., Weßling/Obb.
- Commerzbank AG, Großkundencenter West, Duesseldorf
- DaimlerChrysler AG, Stuttgart
- Deutsche BP Holding AG, Hamburg
- Deutsche Gesellschaft für Luft- und Raumfahrt – Lilienthal Oberth e. V. (DGLR), Bonn
- Deutsche Gesellschaft für Ortung und Navigation e. V., Bonn
- DFS Deutsche Flugsicherung GmbH, Langen
- Diehl VA Systeme Stiftung & Co. KG, Ueberlingen
- Dornier GmbH, Friedrichshafen
- Dresdner Bank AG, Cologne
- EADS Deutschland GmbH, Munich
- ESG Elektroniksystem- und Logistik-Gesellschaft mbH, Munich
- Fraport AG, Frankfurt/Main
- GAF AG, Munich
- Municipality of Weßling, Weßling/Obb.
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- MTU Aero Engines GmbH, Munich
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- Rheinmetall Defence Electronics GmbH, Bremen
- Röder Präzision GmbH, Egelsbach
- Rohde & Schwarz GmbH + Co. KG, Cologne
- Rolls-Royce, Deutschland Ltd & Co. KG, Dahlewitz
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- Siemens AG, Munich
- Snecma Moteurs, Vernon
- Stadt Braunschweig, Braunschweig
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- ZF Luftfahrttechnik GmbH, Calden

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- Prof. Dr.-Ing. Maria Esslinger, Braunschweig
- Prof. Dr.-Ing. Philipp Hartl, Munich
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- Prof. Dr. rer. pol. Achim Bachem, Cologne
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- Andreas Kleffel, Duesseldorf
- Prof. Dr.-Ing. Wolfgang Kubbat, Darmstadt
- Dr.-Ing. Norbert Rüdiger Ninz, Ueberlingen
- Dr.-Ing. Manfred Peters, Cologne
- Dipl.-Kfm. Gerhard Puttfarcken, Hamburg
- Dipl.-Ing. Horst Rauck, Weßling
- Prof. Dr.-Ing. Gottfried Sachs, Garching
- Dipl.-Kfm. Burkhard Schuchmann, Werdohl
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- Prof. Dr.-Ing. Joachim Szodruch, Cologne
- Uwe Teegen, Braunschweig
- Prof. Dr. Ernst-Ludwig Winnacker, Bonn-Bad Godesberg
- Prof. Dr.-Ing. Dr.-Ing. E. h. Dr. h. c. mult. Sigmar Wittig, Cologne
- Prof. Dr.-Ing. Johann-Dietrich Wörner, Darmstadt

DLR Senate

As of June 30, 2006, the Senate included eleven members from the scientific sector, ten members from the economic and industrial sector, and eleven members from the governmental sector.

Members from the scientific sector:

- Prof. Dr.-Ing. Dr. h. c. mult. Hans-Jörg Bullinger, ex officio
- Prof. Dr. rer. nat. Berndt Feuerbacher
- Prof. Dr. rer. nat. Ursula Gather
- Prof. Dr. rer. nat. Peter Gruss, ex officio
- Prof. Dr.-Ing. Peter Horst
- Prof. Dr.-Ing. Wolfgang Kubbat (Vice-Chairman)
- Dr.-Ing. Manfred Peters
- Prof. Dr.-Ing. Gottfried Sachs
- Uwe Teegen
- Prof. Dr. Ernst-Ludwig Winnacker, ex officio
- Prof. Dr.-Ing. Johann-Dietrich Wörner

From the economic and industrial sector:

- Dipl.-Ing. Frieder Hartmut Beyer
- Dipl.-Ing. Rainer Götting
- Dipl.-Betriebswirt Dieter Kaden
- Andreas Kleffel
- Dr.-Ing. Norbert Rüdiger Ninz
- Dipl.-Kfm. Gerhard Puttfarcken
- Dipl.-Ing. Horst Rauck (Vice-Chairman)
- Dipl.-Kfm. Burkhard Schuchmann
- Dr. rer. pol. Rainer Schwarz
- Dr.-Ing. Klaus Steffens

From the governmental sector:

- Staatssekretär Georg-Wilhelm Adamowitsch (Chairman)
- Ministerialdirektor Dr. rer. pol. Hans-Jürgen Froböse
- Leitender Ministerialrat Dr. rer. pol. Gerd Gruppe
- Staatssekretär Dr. Hans-Gerhard Husung
- Ministerialrat Helge Kohler
- Staatssekretär Dr. phil. Josef Lange
- Vortragender Legationsrat 1. Klasse Dr. rer. nat. Karl-Ulrich Müller
- Ministerialdirigent Uwe Schröder
- Staatssekretär Dr. jur. Michael Stückradt
- Ministerialdirigent Dr. jur. Armin Tschermak von Seysenegg
- Ministerialdirektor Dr. Christian D. Uhlhorn

DLR Senate Committee

As of June 30, 2006, the Senate Committee included six members from the scientific sector, six members from the economic and industrial sector, and six members from the governmental sector.

From the scientific sector:

- Prof. Dr.-Ing. Manfred Aigner
- Dr.-Ing. Martin Bruse
- Prof. Dr.-Ing. Klaus Drechsler
- Prof. Dr. rer. pol. Martin Grötschel
- Prof. Dr.-Ing. Reinhard Niehuis
- Prof. Dr. rer. nat. Sami K. Solanki (Vice-Chairman)

From the economic and industrial sector:

- Prof. Dr.-Ing. Klaus Broichhausen
- Christa Fuchs
- Dipl.-Ing. Rainer Götting (Chairman)
- Dipl.-Betriebswirt Josef Kind
- Dipl.-Ing. Georg Rayczyk
- Dr.-Ing. Peter Tropschuh

Voting members from the governmental sector:

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- Ministerialdirigent Helge Engelhard
- Ministerialrat Dipl.-Ing. Helge Kohler
- Senatsrat Bernd Lietzau
- Regierungsdirektor Dr.-Ing. Ulrich Stöcker
- Ministerialdirektor Dr. Christian D. Uhlhorn

Non-voting members from the governmental sector

- Ltd. Ministerialrat Dr. rer. pol. Gerd Gruppe
- Ministerialrat Dr. jur. Axel Kollatschny
- Heinz Krommen
- Vortragender Legationsrat 1. Klasse Dr. rer. nat. Karl-Ulrich Müller

Members of the Executive Board

(Status: June 30, 2006)

- Prof. Dr.-Ing. Dr.-Ing. E. h. Dr. h. c. mult. Sigmar Wittig (Chairman)
- Dipl.-Kfm. Klaus Hamacher (Vice-Chairman)
- Prof. Dr. rer. pol. Achim Bachem
- Dr. rer. pol. Ludwig Baumgarten
- Prof. Dr.-Ing. Joachim Szodruch

Space Committee

(Status: June 30, 2006)

- Ministerialrat Jürgen Meyer, Federal Ministry of Economics and Technology
- Ministerialdirektor Dr. Christian Uhlhorn, Federal Ministry of Education and Research
- Vortragender Legationsrat 1. Klasse Dr. rer. nat. Karl-Ulrich Müller, Foreign Office
- Ministerialdirigent Dr. G. Kühne, Federal Ministry of Finance
- Wolfgang Reimer, Federal Ministry for Consumer Protection, Food and Agriculture
- Ministerialdirigent Thilo Schmidt, Federal Ministry of Transport, Building and Urban Development
- Dipl-Ing. Erwin Bernhard, Federal Ministry of Defence
- Ministerialdirigent Dr. Rainer Sontowski, Federal Ministry of Environment, Nature Conservation and Reactor Safety

Scientific Technical Council

WTR members
(Status: June 30, 2006)

- Michael Bauschat
- Dr. M. Braun-Unkhoff
- Dr. Reinhold Busen (Vice-Chairman)
- Prof. Dr. Stefan Dech
- Dipl.-Wirtsch.-Ing. Volkert Harbers (Chairman)
- Dr. Thomas Holzer-Popp
- Prof. Dr.-Ing. Karsten Lemmer
- Prof. Dr. Ing. Stefan Levedag
- Prof. Dr. Alberto Moreira
- Peter-Michael Nast
- Prof. Dr. Hans Müller-Steinhagen
- Dr. Stephan Ulamec

Affiliates and joint ventures

Equity interest

DLR Joint Ventures Limited Liability Company, Bonn
100.00%

Founded in 2003, the business manages participations in European economic stakeholder groups as mandated by the statutes of the German Aerospace Center.

German-Dutch Wind Tunnel Foundation (DNW), Noordoostpolder, Netherlands
50.00%

The Foundation was established by DLR on an equal-share basis with its Dutch partner organisation NLR (www.nlr.nl) as a non-profit organisation. Its mission is to operate, maintain, and develop its own low-speed wind tunnel at Noordoostpolder as well as other wind tunnels owned by DLR and the NLR (www.dnw.aero).

European Transonic Wind Tunnel GmbH (ETW), Cologne
31.00%

Built and sponsored by Germany, France, Great Britain, and the Netherlands, the European transonic wind tunnel (ETW) is the world's most advanced aeronautical wind tunnel. Downscaled models of new aircraft designs are tested and optimised in the ETW under real-life flight conditions. The knowledge thus gained is crucial for the success of an aircraft project (www.etw.de).

T-Systems Solutions for Research GmbH, Weßling
25.10%

T-Systems Solutions for Research, a joint venture of DLR and T-Systems ITS GmbH, offers long-term IT partnerships to clients from science and research. DLR has hived off its data processing center into the joint venture (www.t-systems-sfr.com).

TeleOp Limited Liability Company, Weßling
25.00%

The company was founded in 2005 by DLR, T-Systems, EADS, and the Bavarian LfA Förderbank. Its business is to carry out any negotiations required within the framework of the GALILEO project to acquire an interest in the future holder of the licence to implement and operate the European satellite navigation programme GALILEO (www.teleop.de).

Anwendungszentrum Oberpfaffenhofen GmbH, Weßling
25.00%

The business of the company is to build and operate an application center for satellite navigation and other technologies, to intensify cooperation between research and industry in the development of new products and services in these areas, and to provide comprehensive business-consultancy services. Established as a public-private partnership in 2005, the company took over the incubation center created by DLR for establishing and siting satellite-navigation enterprises at the Oberpfaffenhofen location (www.anwendungszentrum.de).

Europäische Akademie zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen Bad Neuenahr-Ahrweiler GmbH, Bad Neuenahr-Ahrweiler
25.00%

The European Academy addresses itself to researching and assessing the impact of scientific and technological developments on man's individual and social life as well as on his natural environment, concentrating on processes that are critically influenced by the natural and engineering sciences and/or by the medical disciplines. Maintaining scientific independence, the European Academy conducts a dialogue with the economic, cultural, political, and societal sphere. Its other partner is the German state of Rhineland-Palatinate (www.europaeische-akademie-aw.de).

TTIB Technologietransfer- und Innovationszentrum Region Bonn Verwaltungsgesellschaft mbH i.L., Bonn
17.33%

The company manages the business of the Technologietransfer-und Innovationszentrum Region Bonn GmbH & Co. KG (TTIB) which has ceased business operations. The company is being wound up.

ZFB Zentrum für Flugsimulation Berlin GmbH, Berlin
16.67%

The business of the company is to provide aircraft simulators for applied research in flight guidance and flight procedures, system simulation and manipulation and related technologies as well as for training aerospace engineers and aircraft crews (www.zfb-berlin.de).

ZTG Zentrum für Telematik im Gesundheitswesen GmbH, Krefeld
6.00%

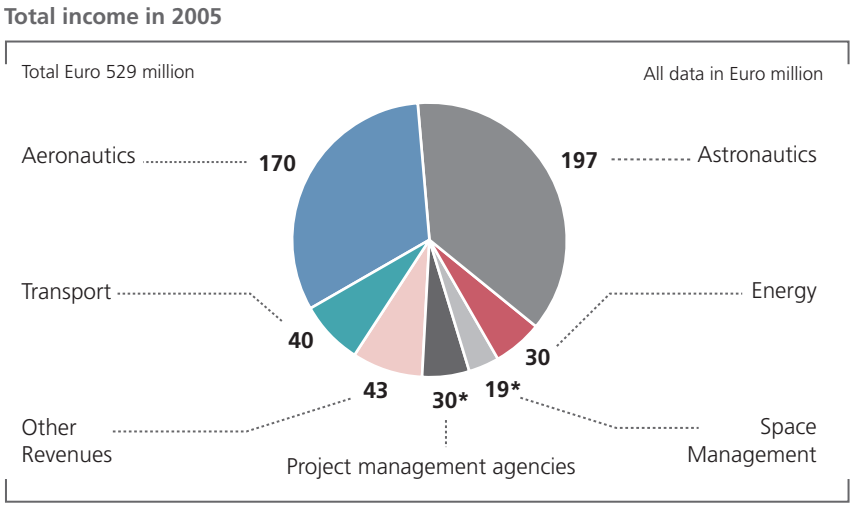
The competence center aims to introduce, develop, and spread modern information and communication technologies in health care. Its business is to provide nonpartisan consultation and project-management services for clients from the industry and the public health system, implementing interoperable solutions for integrated health services, and promoting the transfer of knowledge between the public health system and the economic, scientific, and political spheres (www.ztg-nrw.de).

Geophysica EEIG, Florence
5.10%

The company manages and coordinates the operation of the Russian high-altitude research aircraft, Geophysica, offering an opportunity for participating European research institutions to use the aircraft for research projects focussing on the impact of climate changes and ozone-layer pollution. Further partners include the Jülich and Karlsruhe research centers as well as four Italian organisations such as the Italian Space Agency, ASI, and the research organisation CNR (www.geophysica-eeig.eu).

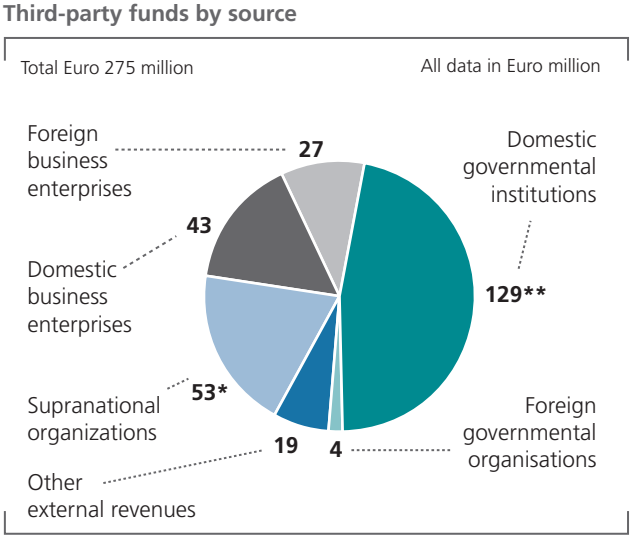
Use of funds

Total income in 2005 (third-party funding and basic financing)

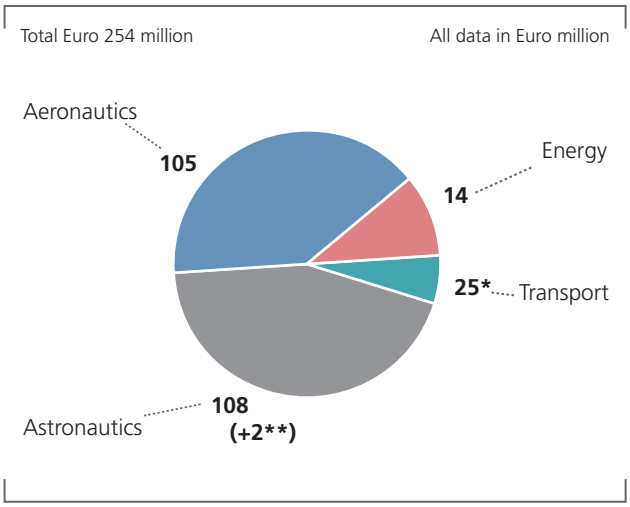


* Revenues from special assignments are not included here but under 'other revenues'

Third-party funds by source and institutional funding in 2005



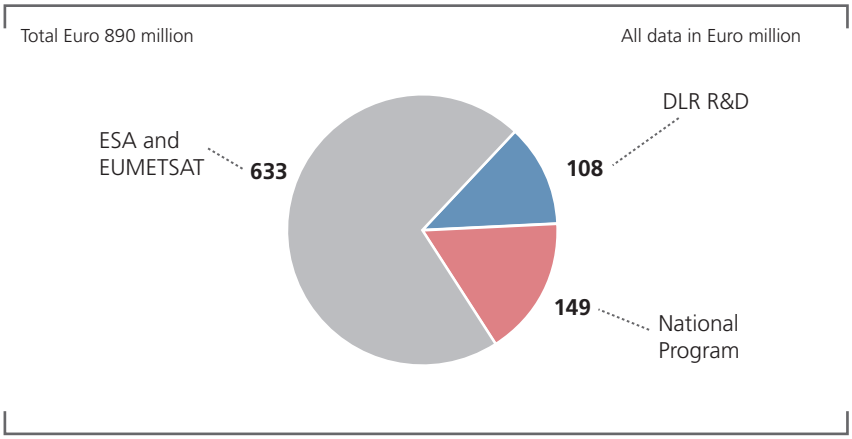
*Of which: ESA **36**, EU **16,** others **1**
Of which: Project management agencies **48, national governmental institutions **64**, other domestic governmental R&D third-party funds **17**



* A major proportion of the initial funding for the still-expanding transport business area is included under project funding, not under this item
** DLR receives another Euro 2 million under the national programme as it was unable to apply for national programme funding

German public funding for space in 2005

Public funds for space



In 2005, Euro 890 million were allocated in Germany to civilian space activities. Of that total, about 71% were spent on Germany's contribution to the ESA (BMBF and BMVBS) and EUMETSAT (BMVBS), 17% on the German national space programme, and 12% on research and development in DLR's space business area.

List of abbreviations

AA	German Foreign Office
ACARE	Advisory Council for Aeronautical Research in Europe
ACCES	Airport and Control Center Simulation
ADS	Aeronautical Design Standard
ASME	American Society of Mechanical Engineers
ATI	Administrative and technical infrastructure of DLR
ATM	Air Traffic Management
BDLI	German Aerospace Industries Association
BMBF	Federal Ministry of Education and Research
BME	Bundesverband Materialwirtschaft, Einkauf und Logistik e.V.
BMFSFJ	Federal Ministry for Family Affairs, Senior Citizens, Women and Youth
BMG	Federal Ministry of Health
BMU	Federal Ministry for Environment, Nature Conservation and Reactor Safety
BMVBS	Federal Ministry for Transport, Building and Urban Development
BMWi	Federal Ministry for Economics and Technology
BVQI	Bureau Veritas Quality International
CAE	Chinese Aeronautical Establishment
CARERI	China National Aeronautical Radio Electronics Research Institute
CFD	Computational Fluid Dynamics
CIEMAT	Spanish Research Center for energy, environment and technology
CIRA	Italian Aerospace Research Center
CNES	Center National d'Etudes Spatiales
DFD	German Remote Sensing Data Center of DLR
DFG	German Research Foundation
DFS	German Air Navigation Services
DGM	German Society for Materials Science
DGON	German Society for Positioning and Navigation
DGS	German Society for Solar Energy
DLR	German Aerospace Center
DLR-GUT	Health and Environment Days
DNW	German-Dutch Wind Tunnels
EADS	European Aeronautic Defence and Space Company
EFQM	European Foundation for Quality Management
EML	Electromagnetic levitation apparatus of DLR
EnMAP	Environmental mapping and analysis programme
EOEP	Earth Observation Envelope Programme
EOS	Earth observation system
ERA	European Research Area
ERRAC	European Railroad Research Advisory Council
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
ESRANGE	European Sounding Rocket Range
ESTEC	European Space Research and Technology Center
EU	European Union
EWHSFFC	East West High Speed Flow Field Conference
FAA	Federal Aviation Administration

FIRES	Fire detection system
FM	Facility management
FRAPORT	Owner and operator of Frankfurt Airport
FRP	EU Research Framework Programme
FuE	Research and development
GAF	Society for Applied Remote Sensing
GARTEUR	Group for Aeronautical Research and Technology in Europe
GSOC	German space operations center
GMES	Global monitoring of environment and security
GSTP	General support technology programme
HALO	High altitude long endurance
HDTV	High definition television
HGF	Helmholtz Association of National Research Centers
HRSC	High resolution stereo camera
ICAO	International Civil Aviation Organization
IEA	International Energy Agency
IFEU	Institute for Energy and Environmental Research, Heidelberg
ILA	International Aerospace Exhibition (Berlin Air Show)
INPE	Brazilian space research institute
ISS	International Space Station
JAXA	Japan Aerospace Exploration Agency
JCM	Joint Committee meeting
KARI	Korea Aerospace Research Institute
KMU	Small and medium-sized enterprises
LCT	Laser communication terminal
LIDAR	Light detection and ranging
LUFO	Aeronautics Research Programme
MAKS	Moscow Aerospace Show in Zhukovsky
MoU	Memorandum of understanding
MPG	Max Planck Society
MPI	Max Planck Institute
MRO	Mars reconnaissance orbiter
MSG	Meteosat second generation
NASA	National Aeronautics and Space Administration
NKS	National contact unit Life sciences
NLR	Dutch aerospace research institution
NOAA	National Oceanic and Atmospheric Administration
NSAU	Ukraine National Space Agency
ONERA	Office National d'Etudes et de Recherches Aerospatiales
ORSI	Ocean Remote Sensing Institute of the Ocean University of China
OTTI	East Bavarian Technology Transfer Institute
PANCO	Physical Technology System Development and Consulting
POA	Power-optimized aircraft
PSA	Plataforma Solar de Almería
PT	Project Management Agency
QM	Quality management
RF-Agentur	Space Agency
ROSKOSMOS	Russian space authority
RWTH Aachen	University of Applied Sciences, Aachen, North Rhine-Westphalia
SAR	Synthetic aperture radar
SESAR	Single European sky ATM research
SHT	System house technology of DLR
SNECMA	Société Nationale d'Etudes et de Constructions de Moteurs d'Aviation
SOLLAB	Alliance of European Laboratories on Solar Thermal Concentrating Systems
SPOT	Système Probatoire d'Observation de la Terre, CNES satellite system
STREP	Specific Targeted Research Projects; application category under the EU RFP
TGMF	Thermal gradient mechanical fatigue
TP	European Technology Platform
TU	Technical University
TVöD	Collective agreement for the public service
UAV	Unmanned aerial vehicle
UN	United Nations
USGS	United States Geological Survey
VDI	Association of German Engineers
WSF	Defence technology and security research
WTR	DLR Scientific Technical Council
ZKI	Center for Satellite-based Crisis Information

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www.DLR.de

DLR at a Glance

DLR is Germany's national research center for aeronautics and space. Its extensive research and development work 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 5,100 people are employed in DLR's 27 institutes and facilities at eight locations in Germany: Koeln-Porz (headquarters), Berlin-Adlershof, Bonn-Oberkassel, Braunschweig, Goettingen, Lampoldshausen, Oberpfaffenhofen, and Stuttgart. 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 in its key areas Aeronautics, Space, Transportation and Energy 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.

German Aerospace Center

Corporate Development and External Relations

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