Institute of Composite Structures and Adaptive Systems

DLR

Institute of Composite Structures and Adaptive Systems

The DLR Institute of Composite Structures and Adaptive Systems is an expert in the design and development of innovative lightweight systems. The research serves the improvement of safety, cost-efficiency, functionality, comfort and environment protection.

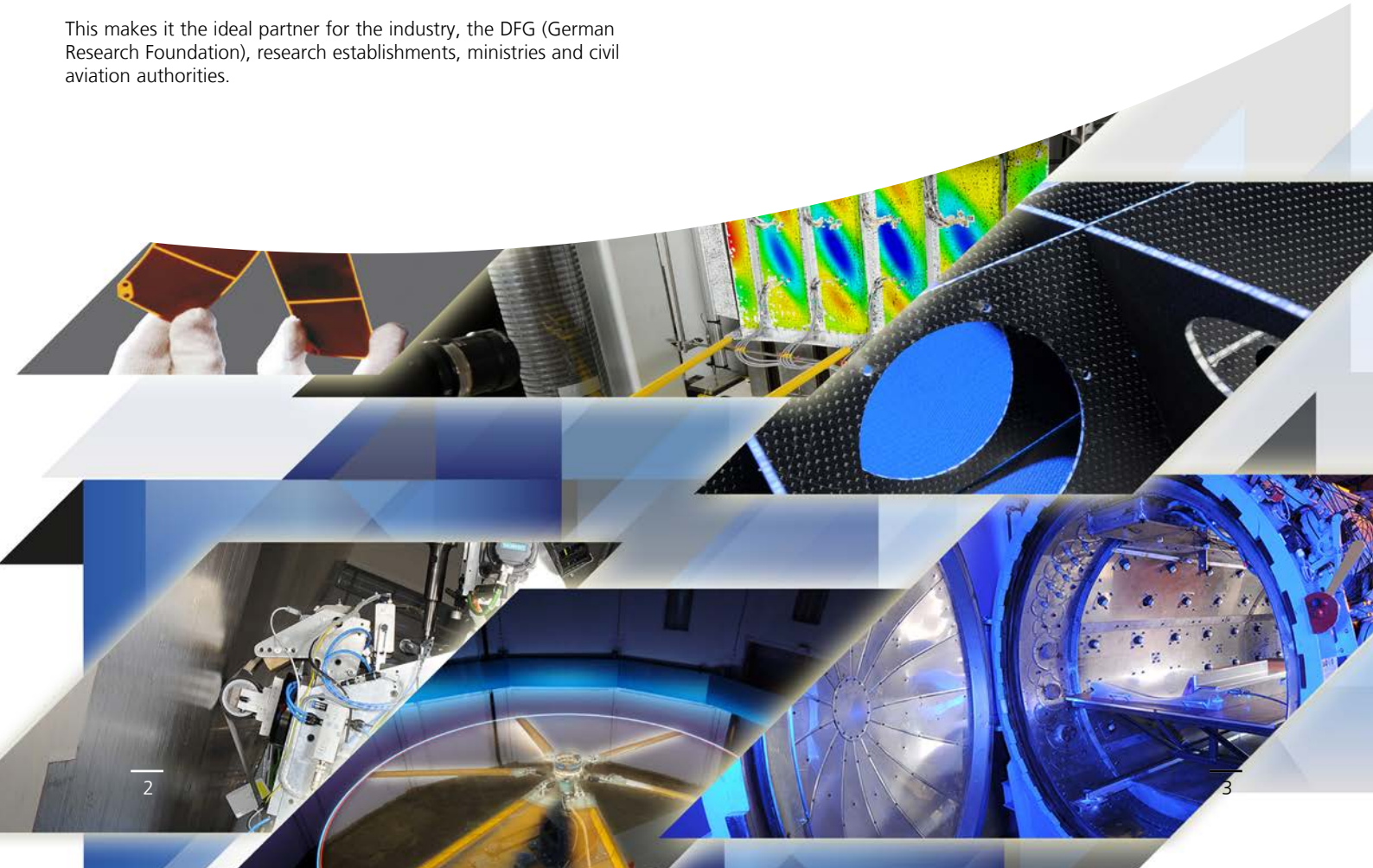
The institute bridges the gap between fundamental research and industrial application. The expertise of the Institute of Composite Structures and Adaptive Systems in multifunctional materials, structural mechanics, composite design, composite technology, adaptronics, composite process technology is orientated along the entire process chain of making adaptable, tolerant, efficient manufactured, lightweight structures.

This makes it the ideal partner for the industry, the DFG (German Research Foundation), research establishments, ministries and civil aviation authorities.

High-Performance Structures adaptable – efficient – tolerant

In order to deal with strength, stability and thermo-mechanical problems we operate unique experimental facilities like thermo-mechanical test facilities, buckling facilities with the special feature of dynamic loading, and a new microwave autoclave.

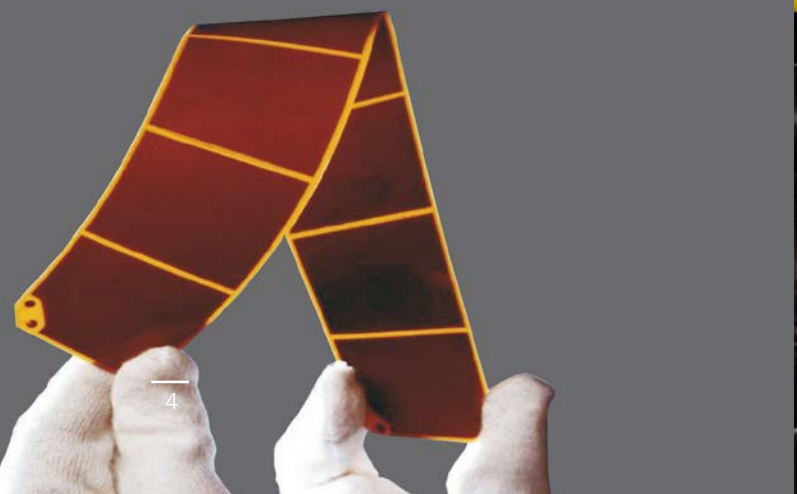
Besides basic research for the future, the institute focuses on six application areas. They serve for the realisation of large practice-oriented projects of a cross-departmental and cross-disciplinary nature.



Department Multifunctional Materials

From materials to intelligent composites

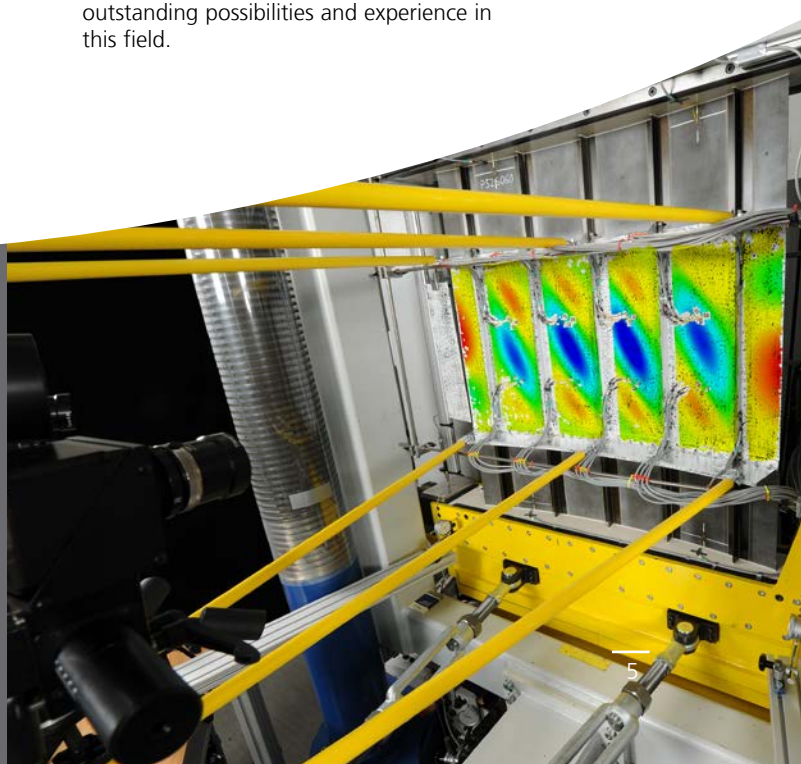
The Multifunctional Materials department focuses on the development, characterisation, and qualification of fibre-reinforced composites with unrivalled properties and new functionalities. For example, by conditioning resins with nano-scale particles a considerable improvement in terms of mechanical specific values, fire characteristics, and processability can be achieved. Moreover, additional functional materials with sensory and actuator properties for integration in adaptive composite structures are exploited. The field of activity ranges from basic research in the field of Carbon Nano Tubes (CNTs) to the development of piezo composites ready for series production in cooperation with partners from the industry.



Department Structural Mechanics

From the phenomenon via modelling to simulation

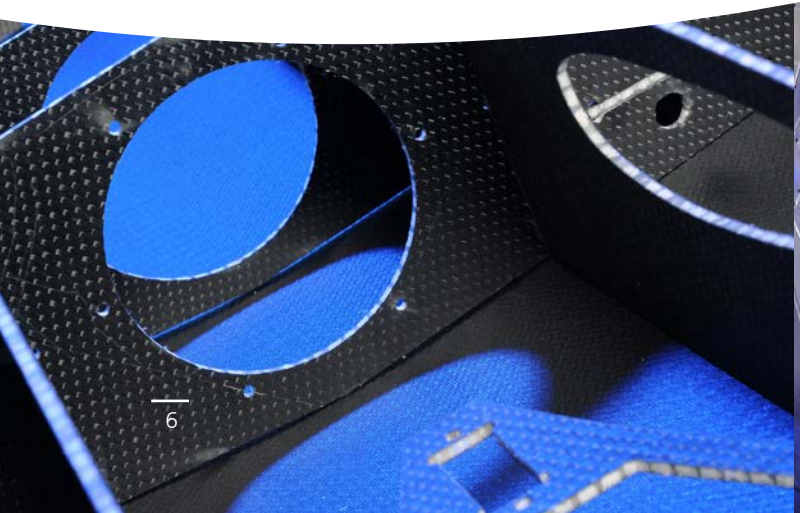
The Structural Mechanics department deals with the development of new simulation methods and tools that can effectively be integrated in the total calculation process and thus are applicable within the framework of a concurrent/integrated engineering concept already in the early design phase. In doing so, methods for simulation-based design and modelling the life cycle of lightweight structures in aerospace industry, transport, and wind energy are developed. Simultaneously, a special focus is on experimental validation of the new methods for which this department with its testing equipment can offer outstanding possibilities and experience in this field.



Department Composite Design

From requirements via concepts to multi-functional structures

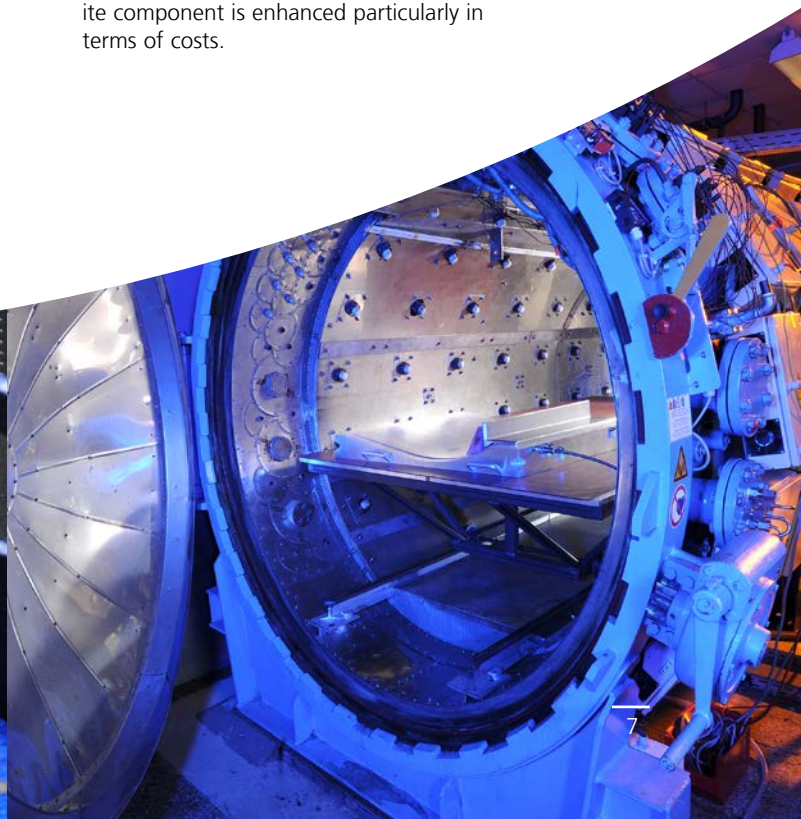
As basic design work, ways of construction suitable for fibre-reinforced materials are developed, including appropriate selection of materials that also comprise hybrid materials. By means of numerical methods, different ways of construction are optimised and assessed taking into consideration the probabilistic properties of the material's specific values and the manufacturing process. At the end of this process chain stands construction that includes the realisation of a tolerance management suitable for assembly and an appropriate tool concept. A special in-depth scientific evaluation is done in terms of constructive realisation of multifunctional structures that integrate additional functions like information transmission, acoustic absorption, etc. required for the end product. The "functional lightweight construction" effectively bridges the gap between research and industrial application by developing multifunctional lightweight structures.



Department Composite Technology

From the idea to the prototype and beyond

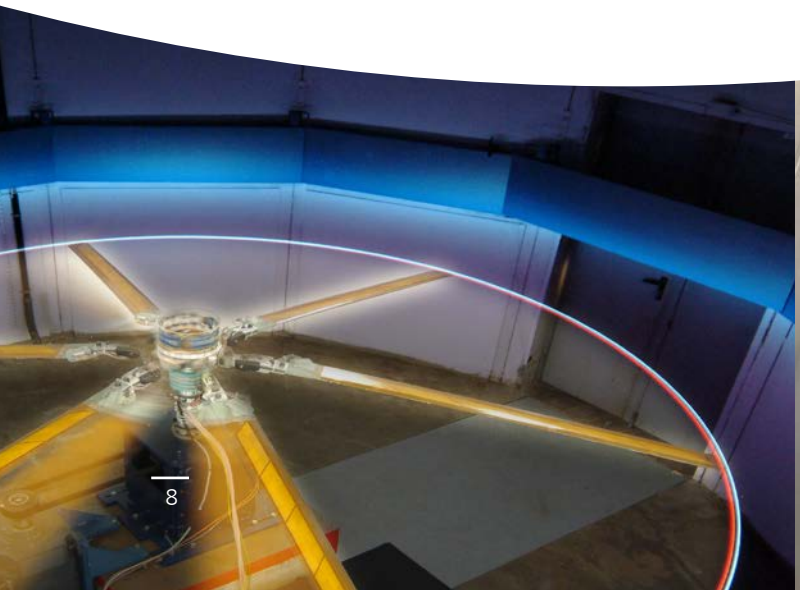
Customised manufacturing concepts and correspondingly adapted industrial manufacturing equipment for continuously fibre-reinforced high-performance components with maximum lightweight design are developed with resepect to application specific requirements. The range of research stretches from mass production for automotive applications to extreme lightweight structures for the aerospace industry. By integrating additional functions and reducing the time needed for assembly, the attractivity of the composite component is enhanced particularly in terms of costs.



Department Adaptronics

From functional composites to the adaptive systems

Thanks to many years of experience, adaptive systems uniting structural materials, distributed sensory and actuator properties, optimised control and power electronics can be realised across all lines of industry. The applications range from spaceflight systems to fixed-wing and rotary wing aircraft, from transport systems to optical systems, from machine tools to robots. An adaptive system is capable of responding to varying operational conditions (like, for example, vibrations or changes in shape). Microprocessors analyse the signals of the sensors and use integrated control algorithms for triggering the actuators to include local forces/deformation/damping in the adaptation of the elasto-mechanical structural behaviour.



Department Composite Process Technology

For a sustainable production

The research on CFRP in terms of sustainable and resource-efficient production processes is a new approach which DLR pursues in the Center for Lightweight-Production-Technology (ZLP) in Stade. Interdisciplinary cooperation between research, design, and production plant manufacturers helps to acquire competencies enabling the assessment of the entire process chain. In doing so, the main objective is to find the optimal manufacturing technology in terms of efficiency, energy, and consumption of resources as well as quality and costs to generate a feedback for both design and materials and technology research.

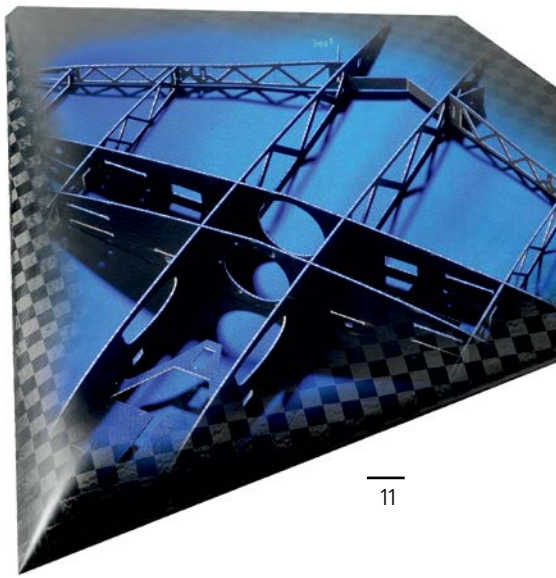
Application Focus CFRP Fuselage

This focus comprises concepts for the aircraft fuselage of the future, which includes structural components made of fibre reinforced plastics like CFRP. The objective is to achieve a weight and cost reduction at higher robustness, particularly in terms of stability, strength, and impact protection. For this purpose, decisively improved materials, design and verification procedures, manufacturing procedures, validation tests as well as integration of functions are intended to pave the way for innovative ways of construction that stand out from the classical stringer-frame construction and enable topologies suitable for fibres. Within the framework of national and international research projects, for example demonstrators in integral, grid and sandwich type of construction are developed, which, amongst other things, also include recesses for passenger cabin and cargo space doors as well as innovative structural elements and hybrid CFRP-metal composites.

10

Application Focus Special Structures

Special structures comprise all flying structures that cannot be attributed to the classical large components wing and fuselage of modern commercial aircraft, which, however, have to meet very special requirements. Naturally, this applies to a range of military applications, like, for example, the whole platform of unmanned aircraft (UCAV – Unmanned Combat Aerial Vehicle), to special aircraft parts like the radome of tactical aircraft or the laminar wing of high-altitude reconnaissance platforms, but also to special civil applications. Special electromagnetic requirements, like, for example, the embedding of antennas in the composite structure or low radar reflections, need technologies, methods, and materials that are subjects of this research focus.



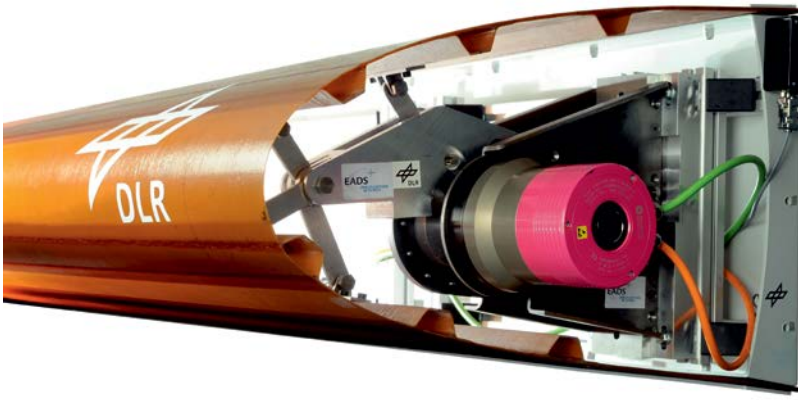
11

Application Focus Space Technologies

Space technology is a challenging interdisciplinary field of research and differs considerably from the aeronautical or ground-based research foci. A strong orientation at ESA's research missions, spaceflight-specific technologies, and the ECSS standards as comprehensive set of regulations is essential for the research focus of space technologies at the institute. A main field of activity is space probes and landers for exploration of the solar system, such as the comet lander "Philae" employed in the Rosetta mission and the planned Mascot asteroid lander. This field also includes newly developed design concepts and manufacturing technologies for the structures of compact satellites and instrument structures for interplanetary missions. A second main field of activity is the ultra lightweight unfolding structures, like, for example, structures for future solar sails or large antennas that can be unfolded in space.

Application Focus High-Lift

The research focus "High-Lift" deals with the development of fibre-reinforced composite materials for high-lift systems of future fuel-efficient and low-noise aircraft. The "Smart Droop Nose" research projects aim at the development of a gapless system with adaptive deformation to be attached to the front edge of the wing, which is intended to significantly reduce the drag. Simultaneously, the noise emission during final descent is reduced. The aim of noise reduction, however, can also be achieved by a newly developed slat construction: in cooperation with the Institute of Aerodynamics and Flow Technology slats are developed that enable low-noise landing approach and nonetheless feature the same performance capability. In addition to passive systems, also the integration of measures for active flow control in fibre-reinforced composite structures is researched on.



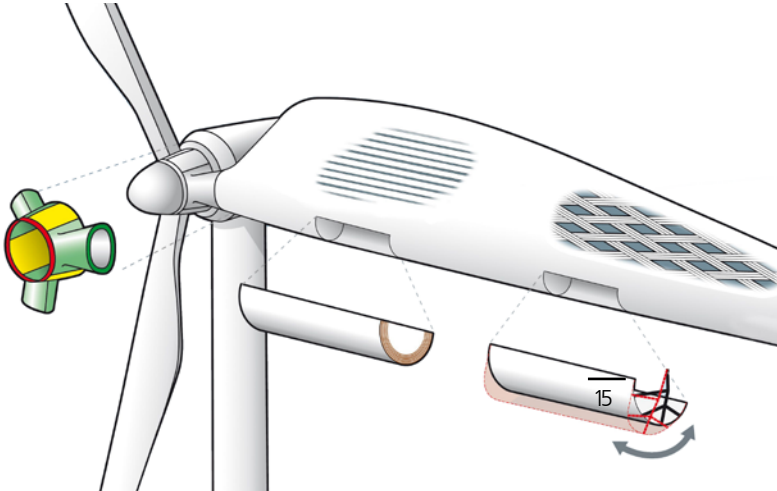
Application Focus Transport

The transport sector is a significant cornerstone of our industrial national economy. Between the conflicting priorities of demands for mobility and negative mobility effects the central challenges arise that are worked on in the transport business segment of DLR: ensuring mobility, economical and considerate exploitation of resources, improving safety. In this field, lightweight construction plays a crucial role also with a view on electromobility. The Institute of Composite Structures and Adaptive Systems provides expertise acquired in aerospace applications for the field of transport. The projects of ground-based transport, i.e. road and railway vehicles, are combined in the institute's transport research focus. In cooperation with manufacturers from the automotive and railway sector, economically efficient high-modular designs and concepts for industrial series production are developed and boosted.

14

Application Focus Wind Energy

Wind energy is an alternative energy source with a high potential for the future. Through optimising the rotor blade structure as well as new methods of construction and production processes both weight and costs can be reduced. At the Center for Lightweight-Production-Technology (ZLP) in Stade and in the laboratories in Braunschweig, research from coupon to industrial scale is possible. For reduction of operating costs and for better planning of maintenance intervals, research is done on systems for structural health monitoring. In future, the operating loads will be reduced by means of adaptive trailing edges and bending-twisting coupling. Through integration of additional functionalities in the material, rotor blades cannot only be manufactured in a cost-optimised way in the future, also service life and energy yield will be considerably enhanced. A further contribution to achieve this aim are developments towards a quality-controlled production. The interdisciplinary cooperation with other DLR institutes enables efficient assessment and comparison of new types of construction.



15

DLR at a glance

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

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

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German Aerospace Center

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