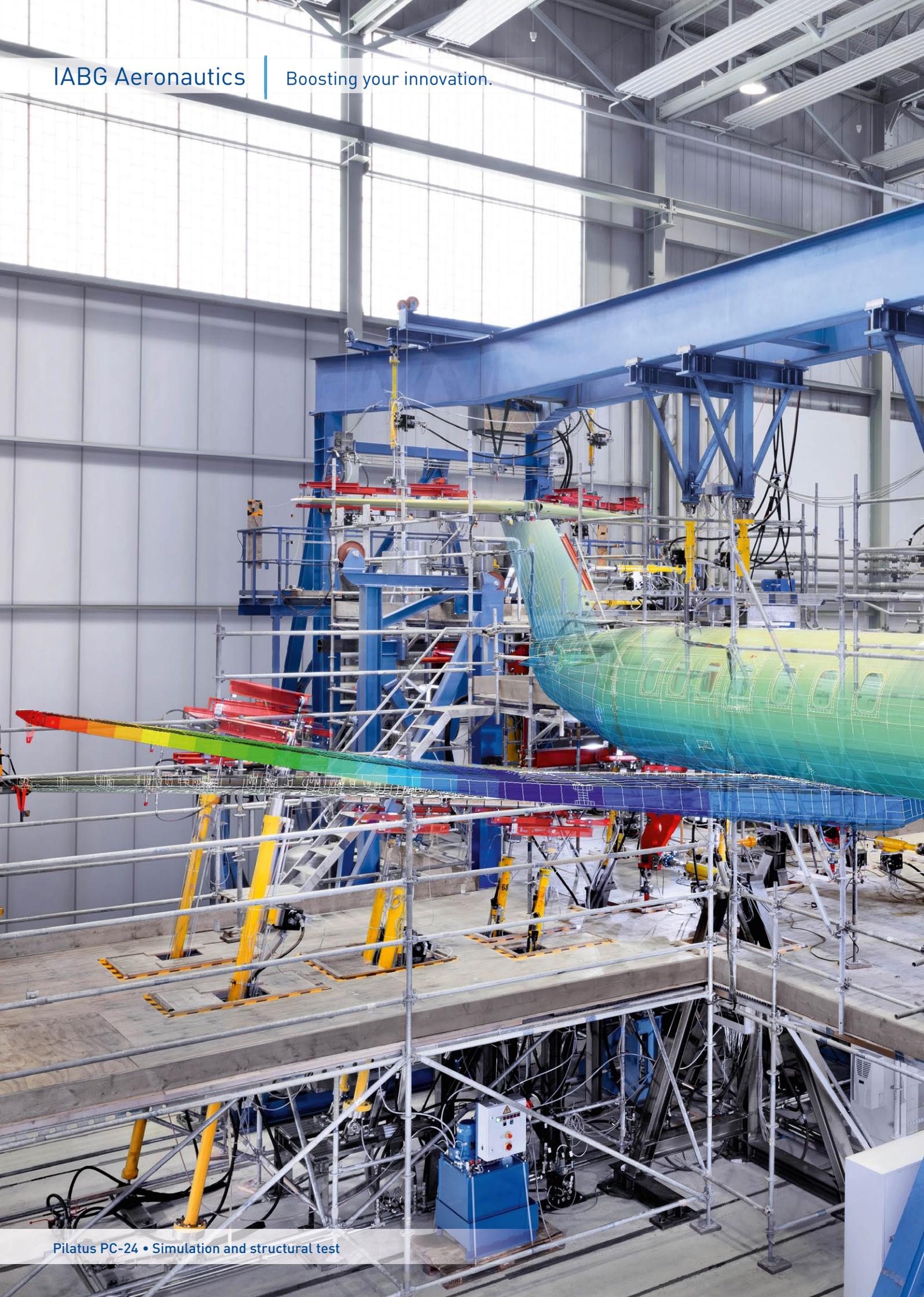


Boosting your innovation.



**AERONAUTICS**

**iABG**





## Aeronautics

As an important strategic partner of the international aeronautics industry, IABG supports its customers with intelligent, tailored solutions in the fields of testing, simulation, analysis and engineering for the successful qualification and approval of complex systems.

Our range of services covers the entire product life cycle – from the definition of requirements to deployment – and includes all product levels from the material sample to the entire aircraft. We are your partner for the evolution of methods and tools for virtual product development and virtual testing. Current developments and research on the topics of digitalisation, virtualisation, data analytics, artificial intelligence, structural health monitoring (SHM), alternative drives and additive manufacturing (AM) flow into our projects.

Our aeronautics service portfolio includes:

- Experimental testing (structural tests, functional tests, product qualification, flight tests)
- Development of functional and system test benches
- Structural integrity management, structural inspection, structural analysis
- Functional Safety and Operational Safety
- Virtual Testing
- Provision of test infrastructure

Tests are carried out at our locations in Ottobrunn and Dresden in test halls encompassing an area of more than 15,000 m<sup>2</sup>, including a modern infrastructure, central supply of hydraulic fluid, compressed air and cooling water.



## Experimental studies

### Structural tests

Structural tests are indispensable for the development and certification of aircraft to guarantee efficient and safe in-service operation. Our services cover all levels of the test pyramid. We test and analyse entire aircraft structures and subsystems as well as components, parts and material samples, in particular their fatigue and strength characteristics.

Test items range from all categories of civilian aircraft to military fighter jets. In addition to the experimental testing facilities and computer simulations, we offer our customers a unique combination of experiment and analysis – a service we have been offering for more than 60 years.

- Fatigue tests
  - Fatigue tests on complete airframes, subsystems, components and parts
  - Investigations on damage tolerance characteristics, crack initiation and propagation
- Static load tests
  - Static load tests of complete airframes, subsystems, components and parts, including effects of thermal constraints
  - Determination of deformations, stiffness, fracture strength and fracture behaviour
- Residual strength tests
- Other structural tests regarding ageing characteristics, corrosion, wear
- Virtual Testing



Deutsche  
Akkreditierungsstelle  
D-PL-12001-02-00

Accredited by DAkkS in accordance with DIN ISO/IEC 17025:2018. Accreditation is only valid for the scope of accreditation listed in the document facility D-PL-12001-02-00.



Static stiffness test



High-speed impact

Functional test on barrier net



## Experimental testing

### Functional tests

#### Impact tests

We have various impact test facilities that support a multitude of applications with customer-specific projectiles.

Our services include:

- Impact tests/bird strike tests in accordance with international standards or customer requirements
- Hail impact tests with projectiles of different calibres
- Impact tests in accordance with FAA, EASA, ASTM, UIC 651 etc.
- Projectile velocities of up to approx. 450 m/s
- Various test projectiles (metal, stone, gelatine, ice, blades, electric components etc.)
- Virtually no limitations for the test component size

#### Landing gear tests

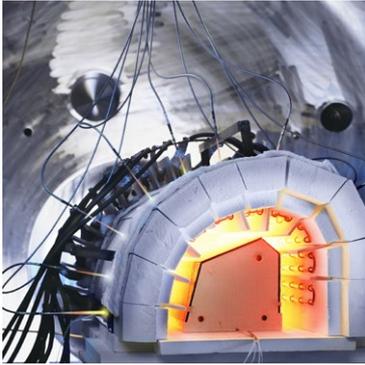
Our test facilities have all the equipment needed to meet the qualification requirements for landing gear.

Our services include:

- Static tests
- Calibration tests
- Fatigue tests
- Drop tests for development and qualification purposes on measurement table or rotating drum
- Brake and tyre burst tests



Aircraft engine in EMC chamber



High-temperature test on X-38 wing leading edge

Mission control room for flight tests



## Experimental testing

### Product qualification

The high standards that technical products are held to regarding reliability, robustness, durability and compliance with statutory provisions require sophisticated test procedures. Not only is it necessary to confirm the functionality of these aircraft, but it is also essential to evaluate the behaviour of a product while subjected to environmental influences during the real product life cycle. Our teams of experienced experts and our powerful, modern facilities can perform any environmental test for a wide range of applications.

All tests comply with national and international testing standards, e.g. MIL-STD 810, RTCA/DO-160:

- Temperature, Humidity, Splash, Waterproofness
- Altitude
- Sand & Dust
- Icing
- Pressure changes
- Vibration
- Windmilling
- Shock
- Acoustic Noise
- EMC

### Flight tests

For many years, our test and engineering departments have collaborated closely with customers to ensure that all of their specific flight test requirements are met:

- Test and campaign support at IABG test sites in Oberpfaffenhofen and Granada – and worldwide
- Assistance with test planning and execution, data evaluation and reporting for development and certification (of civilian and military aircraft) provided by flight test engineers
- Definition and manufacture of flight test measuring systems and avionics databus interfaces
- Encoder selection and instrumentation incl. related planning tasks, telemetry, experimental radio, data processing and data display on board and on the ground
- Specialised hardware, e.g. for icing, flutter tests, aircraft performance and Pitot-static
- Software for test management, test planning and requirement tracking

# Development of functional test benches



Parameter check system for aviation control units



Chassis drum test rig for chassis analysis, validation and HIL simulation

Functional test stand for aircraft landing gears

Load introduction systems for landing flaps



## Development of functional test benches

We design, develop and implement complex testing systems. Our range of services includes both standardised and customised test systems. Key applications are in the areas of operational strength assessment and the functional safeguarding of mechatronic systems. We offer our customers solutions from a single source. Depending on the specific solution, we combine our own services with the scope of external partners. We inspire our customers with demand-driven, individual solutions, a high degree of automation and flexible integration into existing processes and infrastructure.

### Our services portfolio

- **Feasibility studies**  
The launch of a complex test bench is generally preceded by a model-based feasibility study. We analyse the task, develop and evaluate various solutions and accompany their implementation if requested. We advise or take over the preparation of the specification, the requirement specification and the invitation to tender.
- **Planning and configuration**  
We draft the detailed configuration as well as the entire product and assembly documents for a test stand.
- **Consultation and analysis**  
We analyse existing test fields, derive optimisation potential and plan modifications and modernisations in this regard.
- **Construction supervision, project management**  
Our experienced experts manage the installation, implementation and acceptance of your test stand on site.
- **Test benches modernisation**  
We bring your test benches up to the latest state of the art, using standard products as well as our own high-performance control and automation systems.
- **Realisation of test benches**  
As your general contractor, we assume responsibility for the implementation of the test bench and set it up on site, ready for you to use.
- **Metrological services**  
Benefit from IABG's many years of experience and knowledge in metrology and associated fields. Our experts have extensive experience and specialist knowledge, which we are happy to apply to your tasks. A comprehensive range of sensors and data acquisition systems enables us to react quickly and flexibly to a wide variety of measurement requirements. Our services include sensor application (force, torque, pressure, temperature, displacement, acceleration, strain etc.), flight test instrumentation, optical deformation and strain measurement, photogrammetry as well as measurement data evaluation and calibration.



Eurofighter Typhoon



Major Airframe Fatigue Test on PA-200 Tornado

PA-200 Tornado



## Integrity management for safe operation, efficient maintenance and optimised availability

The safe and economically optimised use of aircraft is realised through continuous product support – from design, via operation to final retirement – and through targeted integrity management. Service life monitoring as well as knowledge of load and stress lead to more safety, more reliability and increase availability. The comparison of actual stresses with results from verification qualifications enables efficient control of maintenance measures, modifications and service life extension programmes. We actively contribute our long-term experience in structural monitoring to the optimisation of maintenance.

### Structural Health Monitoring (SHM)

Continuous structural monitoring provides knowledge on stress and strain:

- Application of modern technologies for the acquisition and evaluation of flight parameters and structural stresses in operation
- Software-supported and automated determination of lifetime consumption in use
- AI-supported analysis of measurement data for monitoring and condition prediction

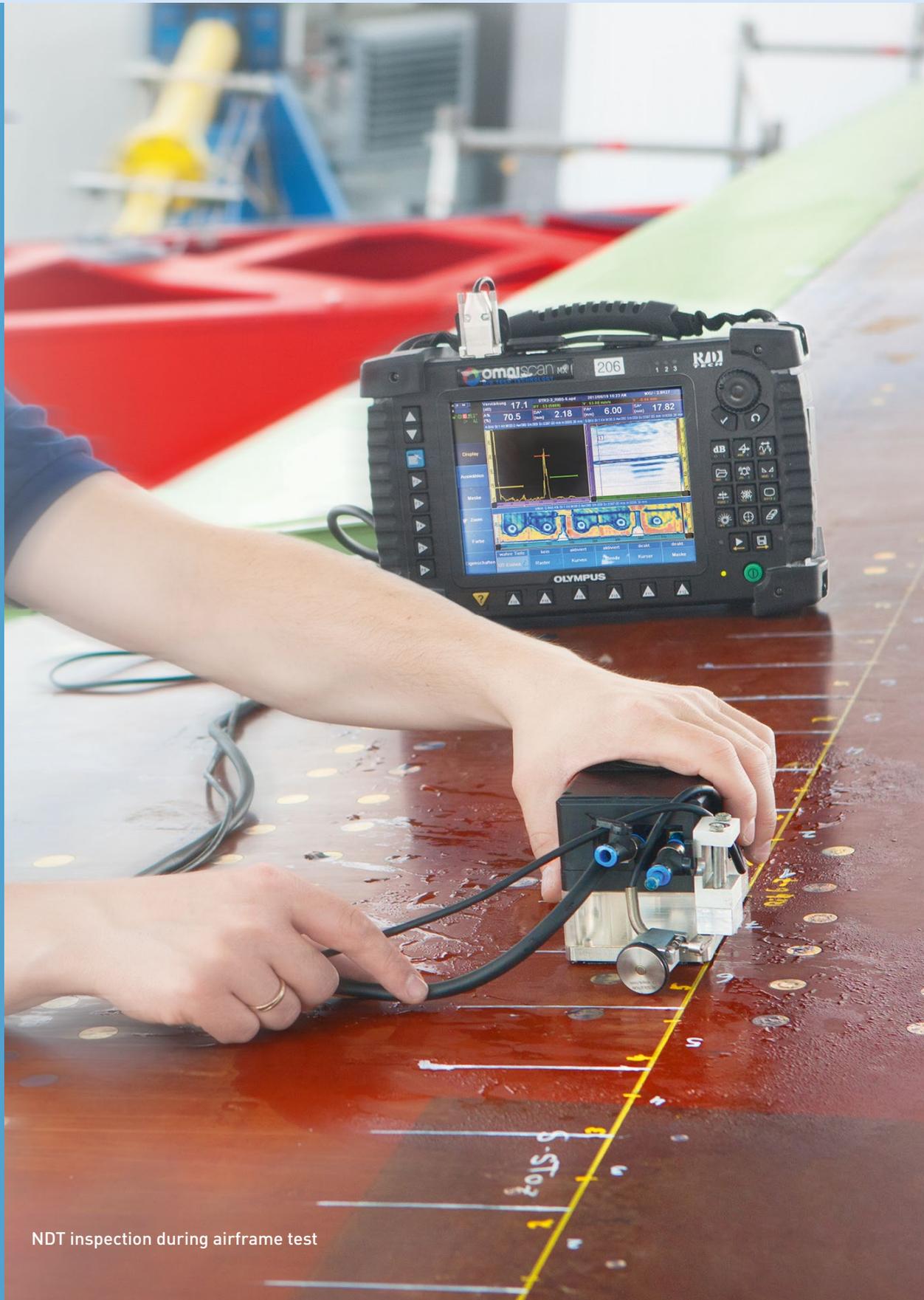
### Fleet management

Database-supported control of service life-relevant material maintenance measures

- Comparison of operational and qualification stresses
- Identification and analysis of structural weaknesses
- Transfer of findings from operational measurements (OLM) to individual aircraft and/or the entire fleet
- Analyses of large data volume with various AI methods

### Maintenance optimisation

- Targeted reduction of maintenance expenditure through the development and monitoring of “Structural Sampling Programs”
- Database-supported control of general material maintenance measures, Fleet Leader inspections and corrosion protection measures
- Consideration of failure analyses and assessments in the holistic context of maintenance
- Advice on the implementation of modifications and product optimisation



NDT inspection during airframe test

## Structural inspection

Ensuring the structural integrity of an aircraft requires specific structural analyses and adapted structural inspections (visual, NDT). IABG provides expert advice concerning suitable measures for sustaining structural integrity and provide qualified technical personnel to perform structural inspections.

### Structural inspections

- Non-destructive tests (NDT) with state-of-the-art equipment (UT, PAUT, ET, PT, MT – Levels 2 and 3 – as well as visual inspection incl. video endoscopy)
- Destructive inspections (e.g. teardown inspections)
- Use of dedicated inspection procedures for composite materials such as CFRP, GLARE, etc.
- Application of optical systems to establish a geometrical data-base (ARAMIS, PONTOS) and to detect plastic deformations, buckling etc.
- Preparation of inspection programmes and instructions

### Damage documentation

- Development and use of a location-independent damage documentation platform (DamDoc)
- Definition and implementation of customer-specific interfaces (VNC)
- Interaction with software-based customer platforms for structural inspection programmes

## Structural analysis

Structural components can be analysed in our own materials testing laboratory (accredited in compliance with DIN EN ISO 17025). We conduct the tests in combination with structural strength calculations and damage analyses.

### Material investigations

- Determination of material properties
- Material qualification
- Further development of test methods and repair procedures
- Characterisation of composite materials

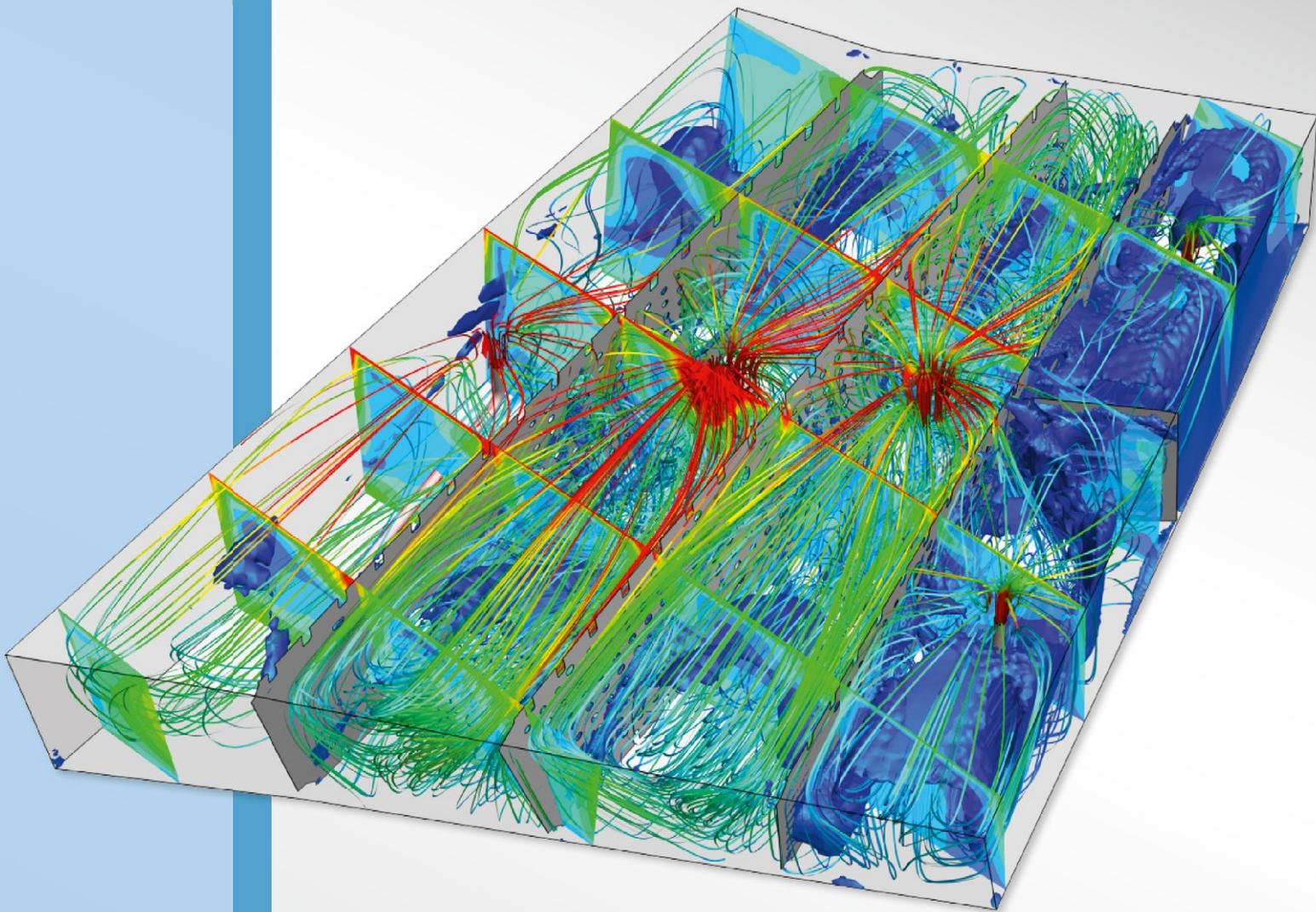
### Strength tests, calculations, method development

- Identification of static, cyclic and fracture-mechanical properties in sample tests, including effects of thermal constraints
- Establishment and parameterisation of material models
- Evaluation of operational loads
- Calculation of local strains and damage distribution
- Optimisation of components with respect to fatigue strength
- Development and optimisation of calculation and verification methods
- Fatigue strength verification

## Certification advice

Our experienced employees provide the following support in connection with the certification of new aircraft:

- Consulting, certification-related technical evaluation and analysis of airframe, propulsion system, aircraft performance, avionics, software safety and IT security
- Consulting and assistance with project planning, test management, certification methodology and procedures
- Technical and scientific advice on structural issues in connection with the development and operation of aircraft
- Evaluation of structural issues in connection with the certification and qualification of aircraft
- EASA-qualified entity [EASA.2012.DE.QE.IABG.01]



Flow simulation of a wing segment



Digital twin for optimising development times and reducing costs

## Virtual Testing - with virtual analyses and simulations to an optimised and qualified product

Today, important components of product qualification are mapped and calculated virtually with powerful simulation tools and fast optimisation methods. Already in the development stage, loads of real operation, also including parametric variants of the structure, are simulated and optimised as products at an early stage. The digital twin shortens development times and reduces costs.

Especially interesting when new materials or innovative structural designs are used: Material, structural parameters and determination of loads is important before starting tests – to know the sensitivity of the test specimen. Damage tolerance, residual load-bearing capacity and vulnerability of the primary structures must be critically examined.

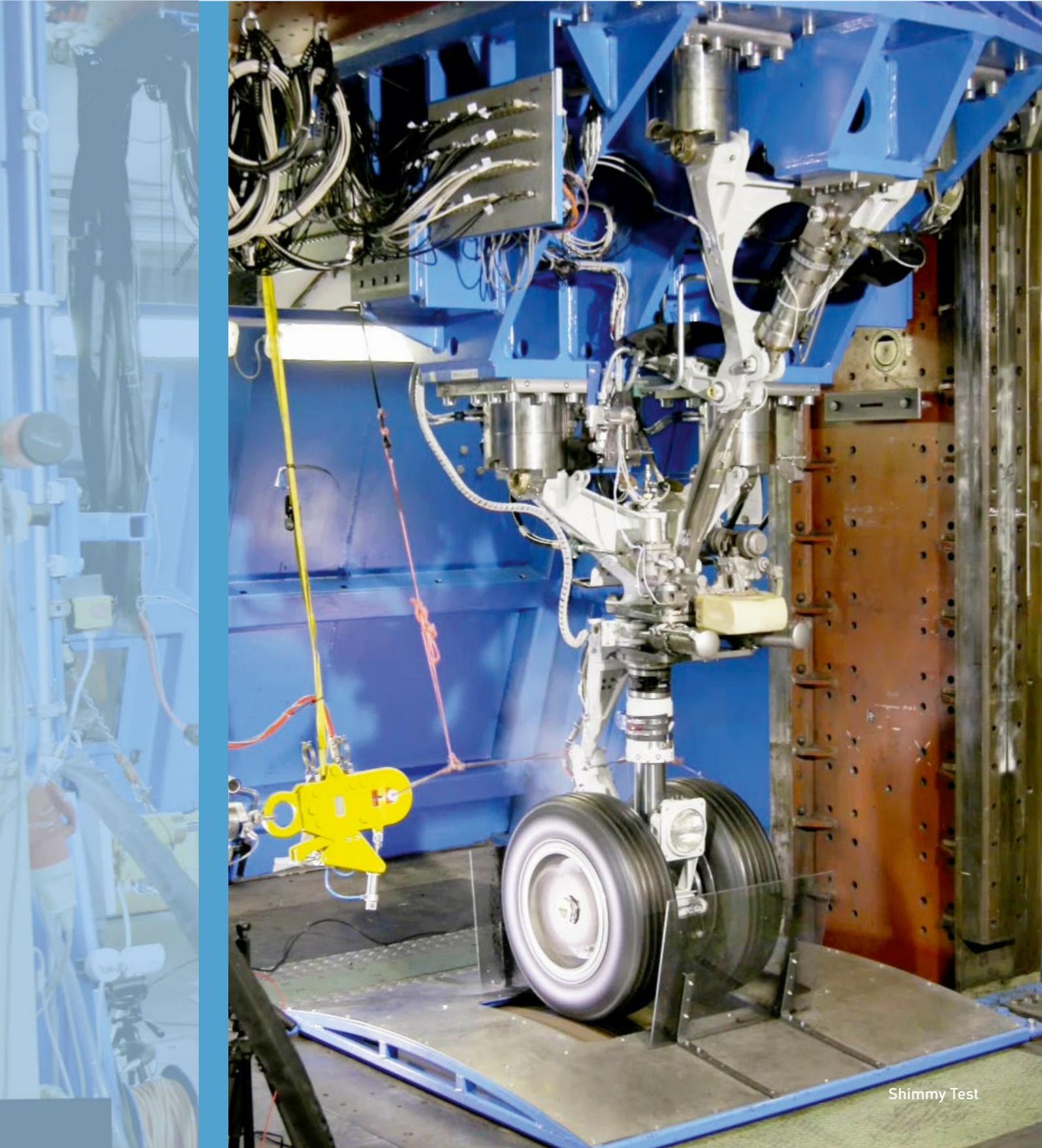
We offer numerical experiments and analyses with virtual prototypes of partial or complete structures on virtual test benches in the development and approval process. Nevertheless, there may be difficulties in the experimental qualification and verification process when transferring results to the real test specimen. We quantify and evaluate possible influences of boundary conditions even before the real test.

### Services

- Reference test: material selection and characterisation, feasibility check, comparative data for simulations
- Validation simulation: material model for static and dynamic loads, model simplification, virtualisation of the entire reference set-up, the test environment or the design load conditions
- Virtual design feasibility study, design optimisation, detailed analysis, preparation for qualification
- Product qualification: design specifications, qualification, certification

### Benefits

- Rapid virtual development of innovative structural solutions and evaluation of potential risks
- Optimisation of the test procedure and the test bench prior to the actual test
- Simulation of a test item's behaviour during the test and identification of a suitable test item
- Optional optimisation of the test item before time-consuming and costly test begin
- Optional substitution of individual load cases
- Early determination of possible damage and consequent optimisation of the real test bench
- Reduction of component or full-scale structure tests





Test hall Dresden 1

Test hall Dresden 2

Hydraulic supply



## Provision of test infrastructure

### Our test halls and test sites

Tests are carried out at our locations in Ottobrunn and Dresden in test halls encompassing an area of more than 15,000 m<sup>2</sup>, including a modern infrastructure and central supply of hydraulic fluid, compressed air and cooling water.

The test halls also provide equipment for simulating environment-related properties, e.g. temperature, climate, dust and corrosion, as well as for conducting fatigue strength tests. Material tests as well as failure and damage analyses are handled by the materials testing laboratory.

#### Ottobrunn Hall

- Area: 5,600 m<sup>2</sup>
- Height: 15 m
- Lift capacity: ≤ 20 t

#### Test hall #1 in Dresden

- Area: 5,000 m<sup>2</sup>
- Height: 26 m
- Lift capacity: ≤ 2x20 t

#### Test hall #2 in Dresden

- Area: 1,800 m<sup>2</sup>
- Height: 17 m
- Lift capacity: ≤ 20 t

#### Large drop facility – Service portfolio

- Drop and landing tests
- Roll tests, fatigue tests, slide tests, brake tests, tyre burst tests
- Driving over baffle plates and bumps

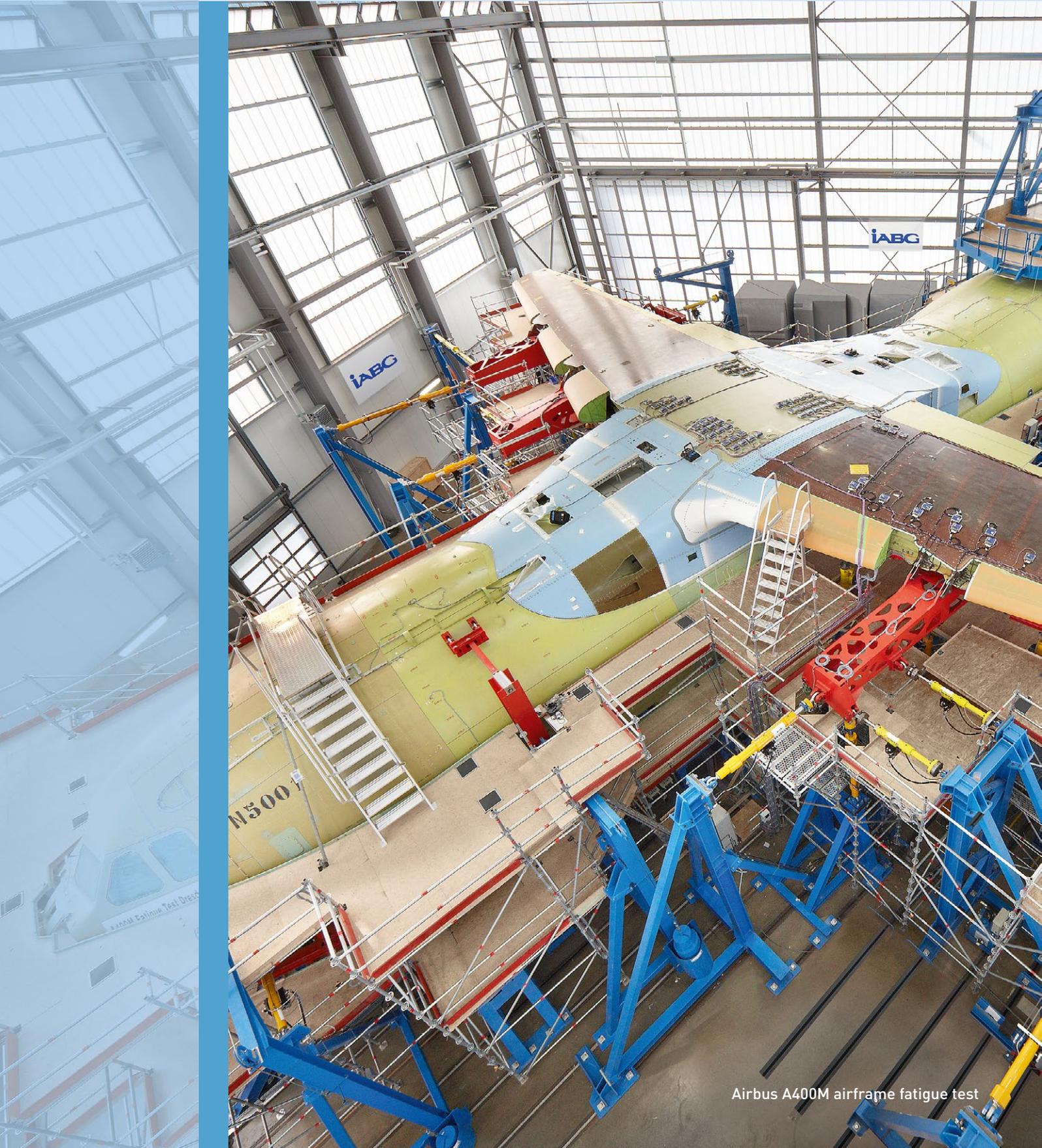
#### Modular test system – Services portfolio

The modular test system is particularly suitable for structural and functional tests on aerospace components. The modular architecture ensures fast and cost-effective test set-up and preparation:

- Simultaneous installation of several single tests on the fixing plate
- Individual and fast integration of test components
- Independent execution of tests using fixed control units with 2x20 and 2x4 free control channels
- State of the art measuring system with optional online monitoring of selected measuring channels

All test halls are fully equipped with anchor rails for bearing loads and anchoring test frames.

Selected references



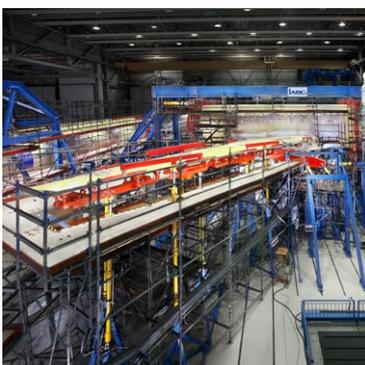
Airbus A400M airframe fatigue test



Complete airframe fatigue test  
F/A-18

Ground Vibration Test PC-24

Complete airframe fatigue test  
Airbus A320



## Selected references

### Structural experiments on whole cells

- Entire Airbus family (A300 up to Airbus A220)
- Commuter aircraft (Pilatus PC-12, PC-24)
- General aviation aircraft (Extra 400, Grob G180)
- Military aircraft (Airbus A400M, Tornado, F104G Starfighter, Eurofighter Typhoon, Swiss F/A-18 at RUAG, Pilatus PC-21)

### Structural tests for components

- Airbus A380: Engine pylon attachment, spoiler, vertical tail plane component and windmilling tests
- Pilatus PC-21, AW 189, C-Series: Airframe tests (static, fatigue, drop tests)
- Tornado: Main landing gear door
- Airbus A400M: Barrier net
- Various engine components
- Impact testing for leading aircraft manufacturers and suppliers

### Functional and system test benches

Load application systems for primary and secondary flight control systems

- Test benches for testing entire high-lift systems
- Functional test benches for landing gear

### Structural analysis

- NDT inspections under test and in-service conditions (Airbus family, Tornado)
- Damage documentation (DamDoc) for airframe fatigue test
- (Airbus A400M, Airbus A320, Airbus A380, Airbus A340-600)
- Structural damage analysis on in-service aircraft (e.g. Tornado)
- Technical/scientific advice on structural issues during the development and operation of aircraft (e.g. Eurofighter Typhoon)

### Structural monitoring

Through-life monitoring of PA200 Tornado, C-160 Transall, Eurofighter Typhoon, AlphaJet, F-4F Phantom, BR-1150 Breguet Atlantic, Mig 29

### Flight tests

- Saab Gripen: Hot-and-high test, Saab 2000: Test in Granada
- RUAG Dornier 228NG: Measuring system, telemetry
- CH53 G: New autopilot amplifier (measuring system, data evaluation, reporting)
- NH90: Whole-body vibration exposure tests (measuring system, instrumentation, data evaluation)
- Airbus S.A.S. A320 airborne icing tanker: Consulting, feasibility study
- Airbus A400M: Supplemental verification for national certification and qualification

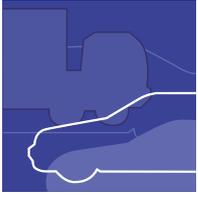
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**About IABG** | IABG offers integrated, ground-breaking solutions in the sectors Automotive • InfoCom • Mobility, Energy & Environment • Aeronautics • Space • Defence & Security. We provide independent and competent consulting. We implement with future viability and target orientation. We operate reliably and sustainably. Our success is based on an understanding of market trends and requirements, on our staff's technological excellence and a fair relationship with our customers and business partners.



**AUTOMOTIVE**



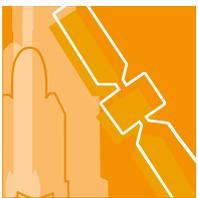
**INFOCOM**



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