



## DEVELOPMENT AND TEST CENTRE FOR THE AEROSPACE INDUSTRY

As an independent, accredited testing, monitoring and certification body, we test your components, materials and complete systems according to the applicable standards and guidelines or individual test programs.





## FIRST ADDRESS FOR STRUCTURE AND MATERIAL TESTING IN THE SPACE INDUSTRY

A strong space industry needs efficient and reliable partners on whom it can rely one hundred percent, regardless of whether it is a matter of initial ideas for the development of space structures and components or whether the product is already ready for series production.

# IN ACCREDITED HANDS WITH APPLUS+ IMA DRESDEN

Applus+ IMA Dresden is an internationally recognised and accredited partner of the aerospace industry. We support the development departments of manufacturers and suppliers throughout the entire process of creating a product. We test:

- durability
- function
- safety

Within the framework of major European launch vehicle programs, IMA Dresden engineers have been entirely responsible for developing test rigs for large structures and testing them to failure, including but not limited to:

- the Vega-C Interstage 1/2,
- the Intertank structures (Upper & Lower),
- the tank structures and
- the Trust Frame of the upper stage of the Ariane 6 launcher.

In addition, accompanying tests on lower-level structures and elements such as the coupons, Lap-Joint samples, or breadboard tests were part of the IMA engineers' area of responsibility.

Whether you want to develop new construction methods or require approval of aerospace components, our tests experimentally investigate various influences on strength, compare material use and construction principles, and verify calculation methods for you.

You can rely on us: our laboratories are certified according to DIN EN 9100, accredited according to ISO 17025 in general, and accredited according to NAD-CAP for material testing of metals and non-metallic materials. This means we can offer you customised solutions for a wide range of structures and testing requirements.

accredited:



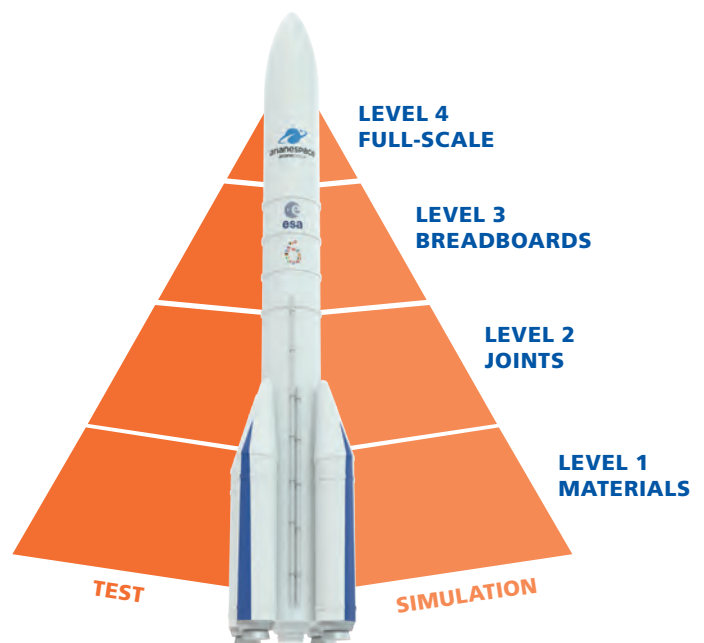
**AIRBUS**

Non Metallic Materials Testing  
Metallic Materials Testing

## APPLUS+ IMA DRESDEN — AND IT WORKS:

- material testing
- structural and component testing
- non-destructive testing
- electrical testing
- materialography and failure analysis
- Simulation and strength assessment
- Systems for test and laboratory data

## FROM MATERIAL TO LARGE STRUCTURE — EQUIPPED FOR A LONG JOURNEY





## IN FOCUS: LARGE SPACE STRUCTURES

To qualify a launch vehicle for its flight, the strength and stiffness of certain structures must be tested under realistic loads. Applus+ IMA Dresden develops concepts and solutions for customised test sites. These not only withstand the required loads, but can also map stiffness-equivalent boundary conditions on the test structure and avoid undesirable load increases.



Depending on the test requirements, we equip test specimens and test equipment with force measuring devices, strain gauges, displacement transducers, temperature and pressure sensors, and more. This enables us to meet a wide range of customer requirements, not only in our halls, but also on-site at your production facility.



We have many years of experience with test projects, from test site development to logistics. With this know-how in the background, we guarantee you a tightly organised and high-quality process.

The specialists at IMA Dresden work hand-in-hand: from design to FE analysis to the finished complete test site with measurement and control technology as well as hydraulic, pneumatic or electric load units.





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## STRUCTURAL TESTS ON INTERSTAGES

We develop the entire loading system for you, which allows for very large axial forces with superimposed bending within the test structure.

During the design of the system, we focus our attention on how the stresses to which the test specimen is subjected are distributed. To reproduce as realistic a scenario as possible in the test rig, our engineers carry out numerous linear and non-linear analyses of the test specimen connections (Adjacent Structures). On the one hand, this allows us to optimally adjust the stiffness of the structures and, on the other hand, we prevent them from failing too early, even when overloaded.

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### APPLUS+ IMA DRESDEN IN USE

In the course of the further development of the Vega launch vehicle, Applus+ IMA Dresden received a major order. As part of a program funded by the European Space Agency (ESA), involving Ariane Group as prime contractor and Airbus Defence and Space Netherlands as project partners, the test on Interstage 1/2 of the VEGA-C launcher took place at Applus+ IMA Dresden.

The equipment of the test specimen with measuring instruments was highly complex with more than 450 strain measuring points and almost 200 displacement transducers. In addition, there were several high-speed cameras as well as the 3D measuring system Aramis.

Thanks to our specially developed test procedures and our state-of-the-art measurement and control technology, we met all the requirements for the test.



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## STRUCTURAL TESTS ON THRUST FRAMES

We push your thrust frames to their limits: For the complex components, we build our own test rigs to test the thrust frames to their ultimate failure. The demands on the testing process are high, especially when it comes to the correct application of loads and measurement procedures — but our state-of-the-art measurement and control technology guarantees you a smooth process.

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### ARIANE PUSH FRAME IN ENDURANCE TEST

As part of a test programme for the Ariane 6 launcher launched by the European Space Agency, we tested the Vinci Thrust Frame. Ariane Group acted as prime contractor and Airbus Defence and Space Netherlands was again our direct project partner.

The Vinci Thrust Frame is the load-bearing structure of the VINCI rocket engine that carries the Ariane 6 upper stage and payload into the correct orbit. We developed our own test rig for the complex test component and tested the structure there.



## IN FOCUS: INTERTANK STRUCTURES (ITS)



### FATIGUE TESTS ON INTER-TANK STRUCTURES (ITS)

For many years, Applus+ IMA Dresden has been testing large, thin-walled structures — the inter-tank structures — which are to be used in aviation.

We would also be happy to examine your intertank structures. We can introduce both static and cyclic loads such as forces, internal pressure, and temperatures into your ITS structures and combine them as desired. In order to reliably measure and control all relevant variables, we provide scalable systems during the tests and optimally adapt them to the respective requirements.

We have a lot of experience in this, because we often measure forces, deformations, temperatures, strains, etc., even on the most diverse test structures.

We use functional software solutions to evaluate and process the test data. We convert the measurement data into the desired format for our customers.

### TESTED TO THE EXTREME: ARIANE INTERTANK STRUCTURES AT APPLUS+ IMA DRESDEN

We were able to draw on our wealth of experience in ITS structure testing for an order from our project partner MT Aerospace: As part of a test programme for the Ariane 6 launcher, we tested the upper and lower intertank structures of Ariane 6.

In the case of the Ariane 6 intertank structures, there was a particular focus on two things: the central introduction of several independent, large forces in one point and the introduction of a load along distributed points.

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# UNDER PRESSURE: TANK-TESTS

At what pressure does a tank burst? We find out! To do this, we build a test site complete with refuelling and pressurisation procedures and then subject the test item to loads until it reaches its limit and fails.

Equipping a tank with the necessary measuring instruments for a test procedure is a special challenge. Because inside a tank, for example, there is no orientation to external reference points. In addition, the thin outer wall of the tank must not be damaged when an application is placed inside. So our engineers proceed with extreme sensitivity.

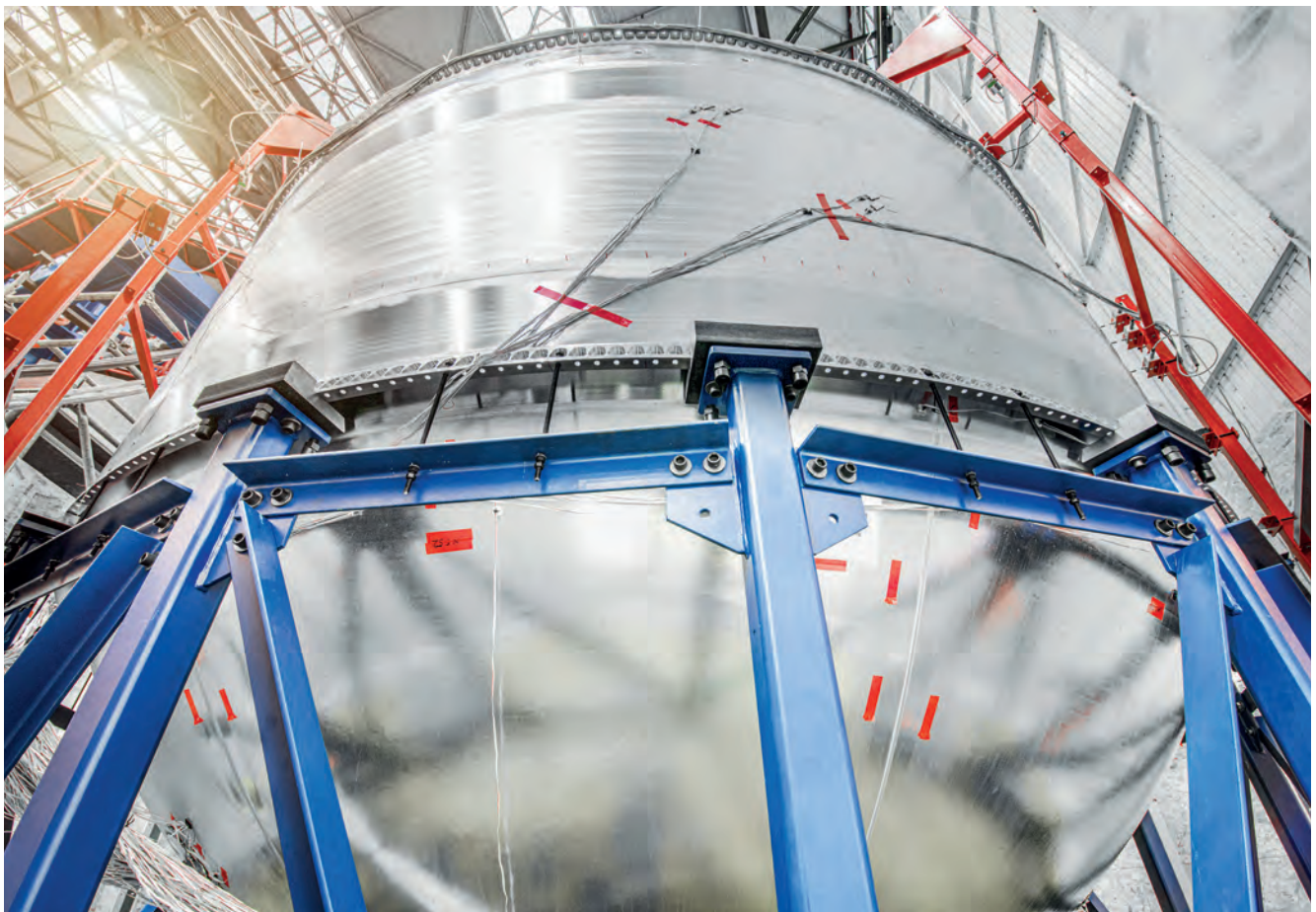
The destruction potential of such test series is also enormous. That's why Applus+ IMA Dresden works remotely and with state-of-the-art control and regulation technology. The measurement data are visualised and recorded live. Many other optical measuring systems support the subsequent evaluation of the test results and damage events.

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## UNTIL THEY BURST: APPLUS+ IMA DRESDEN TESTS ARIANE 6 TANKS.

The tanks of a rocket have to withstand a lot — we have tested those of the Ariane 6 to failure. One challenge was the complex sealing of the applied strain gauges and lines inside the tanks.

Once all the gauges and lines were in place, we filled the tanks completely with water and pressurised them several times over a few weeks until they finally burst.





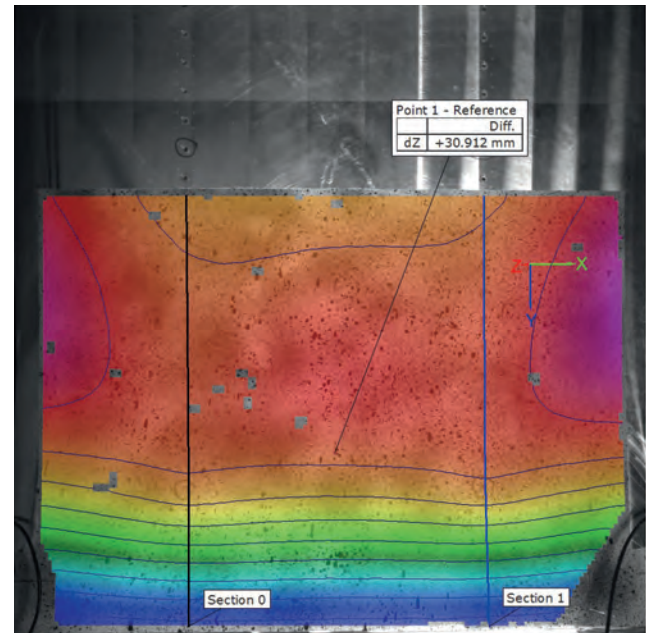
## IN FOCUS: BREADBOARD TESTS

known as the breadboard, which means "pegboard", we reproduce in detail many relevant parameters for you that are also found in the final full-scale structure. At the same time, due to the simplified panel sample geometry, we can carry out more test runs than with the final large-scale structure, at comparatively low cost and with a low turnaround time.

Additionally, it is possible to focus specifically on certain detailed areas that can have a critical effect on the overall structure, such as rivets, stringer outlets, or window cut-outs. We would be happy to develop the necessary concepts, special testing equipment, and elements for load introduction for your load-bearing component.



Static and dynamic panel tests of aircraft fuselage structures have been part of Applus+ IMA Dresden's portfolio for many years. This experience enables us to convert our testing machines, standardised fixtures as well as our optical measurement technology and high-speed camera systems to breadboard tests of aerospace structures in a short time.



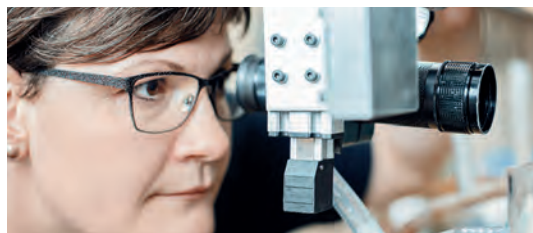
If a computational simulation of the predominantly static loads in the space sector is compared with the actual test results, conclusions can be drawn: on the one hand, about the quality of the calculation methods, and on the other hand, about the strength properties of the component.



# MATERIAL TESTING ON PLASTICS AND METALS

Determining the failure limits of a material under different types of load to verify the service life of a component is a demanding task - and for us it is a core competence.

We take care of the comprehensive determination of material characteristics as well as the determination of the stressability of metallic and non-metallic materials, joints or hybrid material combinations.



## LAMINATE AND SPECIMEN PRODUCTION

Our laboratory offers many options when it comes to producing test laminates, from textile semi-finished products, pre-impregnated semi-finished products, fiber yarns, and resin systems.

Benefit from our experience in thermoplastic processing but also laminate production with vacuum infusion, RTM, and winding processes. From the test laminates we produce high quality test specimens compliant with national and international testing standards.

## TESTING SPECTRUM

- Physical testing
- Static-mechanical material testing Material fatigue testing Material creep testing
- Thermal analysis
- Environmental testing
- Fracture mechanical testing Corrosion testing
- Impact testing

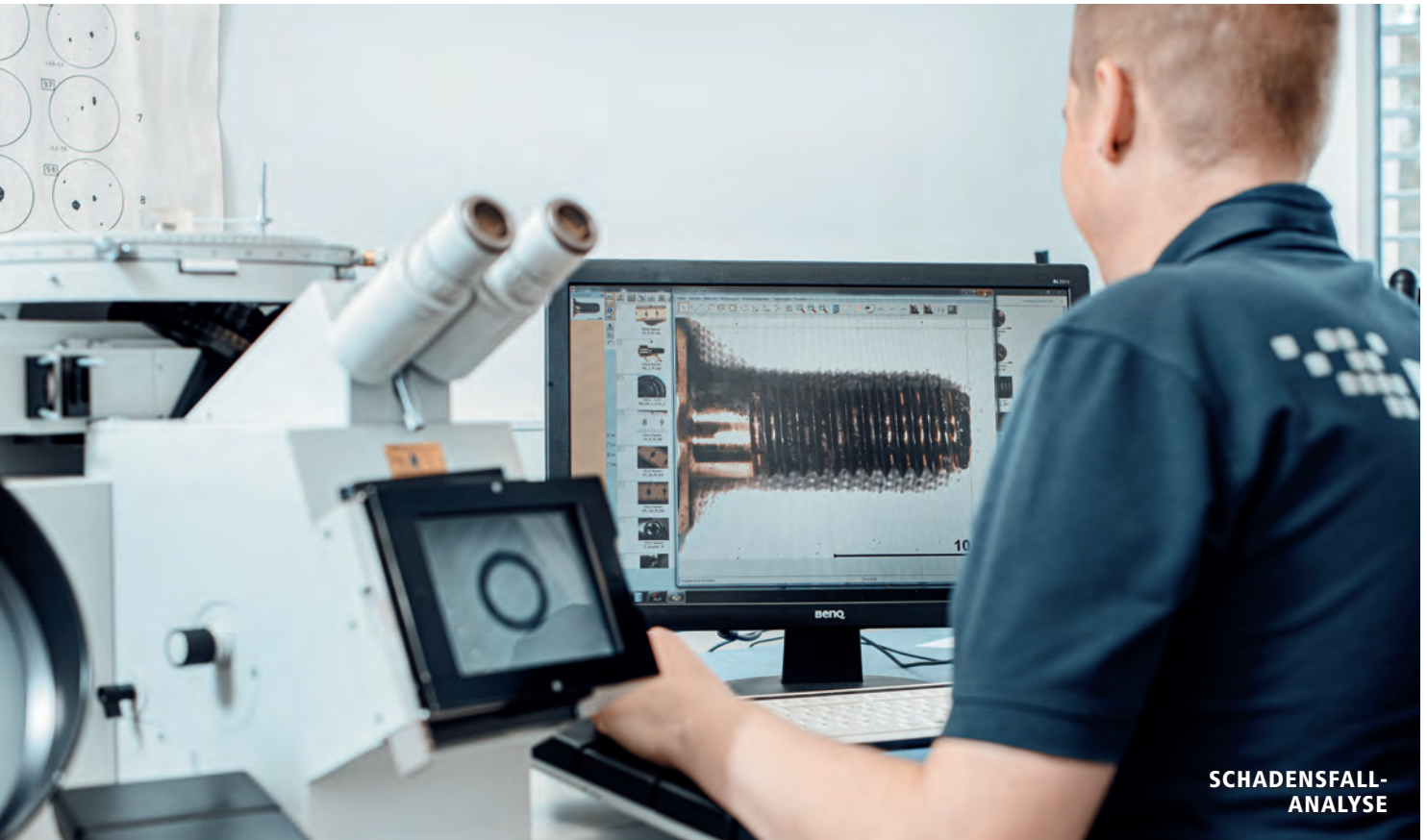
## MATERIALOGRAPHY

Whether for quality assurance, damage analysis, or research and development in our accredited materialography laboratories we examine both metallic and non-metallic materials of the most varied compositions using the appropriate qualitative and quantitative characterization methods. This includes sample preparation procedures and the application of all microscopic methods from light to electron microscopy up to the analysis, evaluation, and documentation of the microscopic examination results. If required, the investigations can be supported and accompanied by further material-analytical, mechanical-technological, and physical methods.





# THE FULL SERVICE TEST CENTER



## DAMAGE ANALYSIS

Once damage has occurred, many questions arise. Is it due to unfavourable force flow? Is it due to a lack of suitability of the material or technology? Is it due to unsuitable heat treatment, overstressing, friction or wear? Our experienced engineers will find the answers and help you to investigate undesirable damage phenomena in detail.

We carry out our tests by:

- microscope (light, scanning electrons, AFM)
- spectrometer
- acoustic damage detection (burst signal analysis)





## NON-DESTRUCTIVE TESTING

Our interdisciplinary field of non-destructive testing examines structures and components in the test phase and also in real use for damage — and for when and where damage occurs, how it grows and how a structure reacts, for example, to cyclic loads after an impact.

In our own laboratories or at your site, we offer you:

- visualisation of delaminations, material deviations, cracks and material inclusions
- conclusions on material, technology, process and operation as well as their optimisation

Our inspection staff is qualified according to the ISO 9712 and EN 4179 standards and offers you numerous methods of non-destructive testing. We work according to German and international standards and guidelines (DIN, ASTM, ISO etc.) or according to factory specifications. We use state-of-the-art testing technology and customised testing concepts. In addition to the classic methods using manual testing, we also use special procedures, such as:

- immersion technology
- phased array technology on CFRP, GFRP and GLARE®.
- four-frequency red tests



## ELECTRICAL TESTING

Whether short-circuit, short-time withstand current, switching capacity, or continuous current tests, Applus+ IMA Dresden uses in-house transformers to test with test currents of up to 25,000 amperes alternating current at 1,000 volts and 20,000 amperes direct current at 1,100 volts.

- PLC-controlled switching of the test currents
- Recording of data (current-voltage curves, temperatures)





# SIMULATION AND STRENGTH ASSESSMENT

We support the development departments of manufacturers and suppliers throughout the entire development of a product by examining its durability, function, and safety. Initially, we run the tests computationally by simulating loads on the computer. We then compare these results with the actual test results. This allows us to draw conclusions: on the one hand about the quality of the calculation methods and on the other hand about the strength properties of the component. We work with these methods:

## FE ANALYSIS

- large structures as well as components and assemblies
- contact simulation with/without friction
- material properties (isotropic/orthotropic, plastic/elastic/viscous, composites)
- stresses and deformations (linear, material, or geometrically non-linear)
- transfer behaviour in contact or in the connection
- investigation of bearing ring wander and other slip phenomena
- buckling and stability
- natural frequencies and natural modes
- transient processes
- harmonic analyses

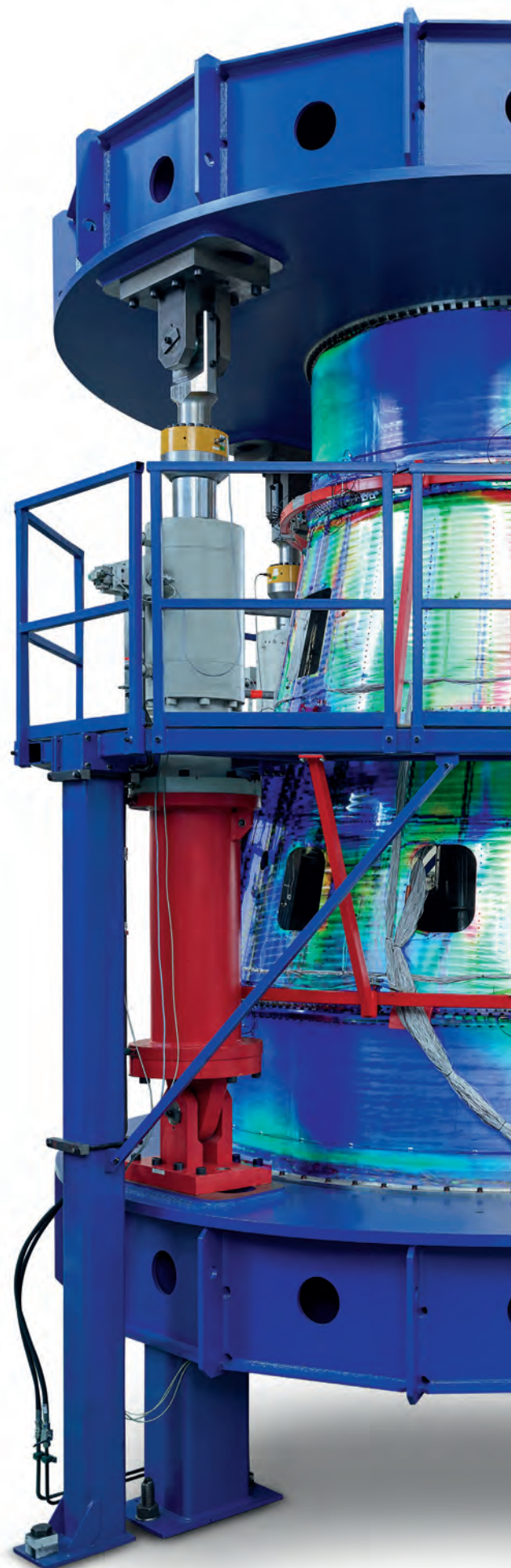
## STRENGTH ASSESSMENT

We make statements on the safety of constructions on the basis of calculated and measured stresses:

- static strength verification
- proof of operational strength
- fatigue strength verification

according to:

- FKM guideline
- DVS 1612, DVS 1608
- Eurocode 3, Eurocode 9
- DIN EN 12663, DIN EN 13749, VDV152
- DIN 743







## MEASUREMENTS AND ANALYSIS OF MEASUREMENT DATA

- equipment for measurements and measurement runs
- processing of large amounts of data (Big Data)
- rule-based measurement data cleaning (drift correction, peak elimination), also partially automated
- calculation operations with measurement channels (combinations, derived measured variables)
- calculation of statistical parameters
- correlation analyses, pattern recognition
- frequency analyses, rainflow classification
- allocation of measurement data to GPS positions, creation of "damage maps"
- test grid position
- indirect load measurement

## OPTICAL MEASURING METHODS

Applus+ IMA Dresden makes visible and numerically measurable what remains hidden to the human eye, thanks to state-of-the-art measuring techniques such as:

- Digital Image Correlation (DIC)
- trigonometry
- focus variation or confocal microscopy
- laser or white light interferometry (WLI)
- high speed digital video
- thermography

The optical or camera-based measurement and analysis methods can be used in a variety of ways:

- traceable calibrated measurement of 2D and 3D objects
- standard-compliant determination of surface roughness (also on 3D curved surfaces)
- monitoring of different structures by visualising deformations, displacements and strains in static and dynamic load cases
- measurement of temperature distributions and detection of local load peaks by means of thermography
- long-term recording of high-frequency vibration shapes

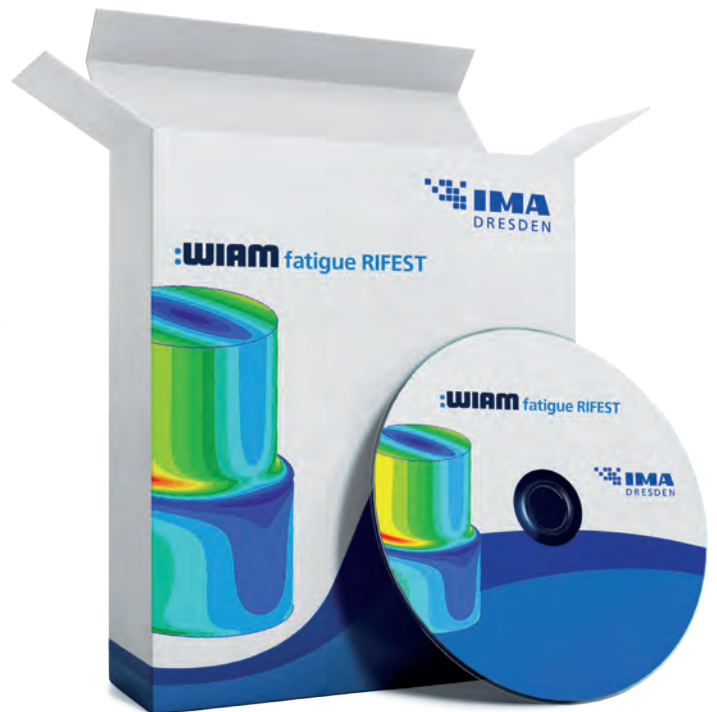


# OUR SOFTWARE SOLUTIONS FOR YOU

## WIAM® FATIGUE RIFEST

WIAM® fatigue RIFEST is a software for the design process and component stress analysis. It maps the guideline-compliant strength verification at verification points:

- for machine parts made of aluminium, steel, and cast iron materials, both non-welded and welded
- strength verification for point stresses based on e.g. FEM calculations or strain gauge measurements
- according to FKM guideline issue 6 from 2012; this was first developed in 1994 under the leadership of our company.



## WIAM® ICE

WIAM® ICE is a freely configurable data management system, which:

- structures and digitalises complex issues quickly and clearly
- checks, approves and traces technical data, which can be compared, calculated, prepared and further processed.
- can be individually configured
- can be supplemented with additional modules for product liability and quality assurance







# USE THE COMPETENCE OF APPLUS+ IMA DRESDEN FOR YOUR SPACE PRODUCTS

As an independent testing service provider, we offer reliable results and the strictest confidentiality. Thinking and acting in the interests of our customers more than just due diligence to us. It is a guiding principle. Behind that credo lies a serious striving for engineering perfection. This is how we develop intelligent solutions and offer sustainably useful results at fair prices. It is a matter of course for us to respond to the most diverse wishes and to achieve top performance that is not possible elsewhere. Each and every one of our employees bears a part of this responsibility.

If you have any questions or enquiries, please contact us at [ima@ima-dresden.de](mailto:ima@ima-dresden.de).



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### PHOTO CREDITS

Jan Gutzeit: Seite 2, 12/13  
Shutterstock: Seite 3) Rakete Ariane 6 "FoxPictures"  
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