SUCCESS STORY

# Reducing Test Times, Boosting Data

## Aerospace structural testing with ZEISS ARAMIS

**Location**
Dresden

**ZEISS Systems**
ZEISS ARAMIS, ZEISS T-SCAN hawk 2, TRITOP

**Software**
ZEISS CORRELATE

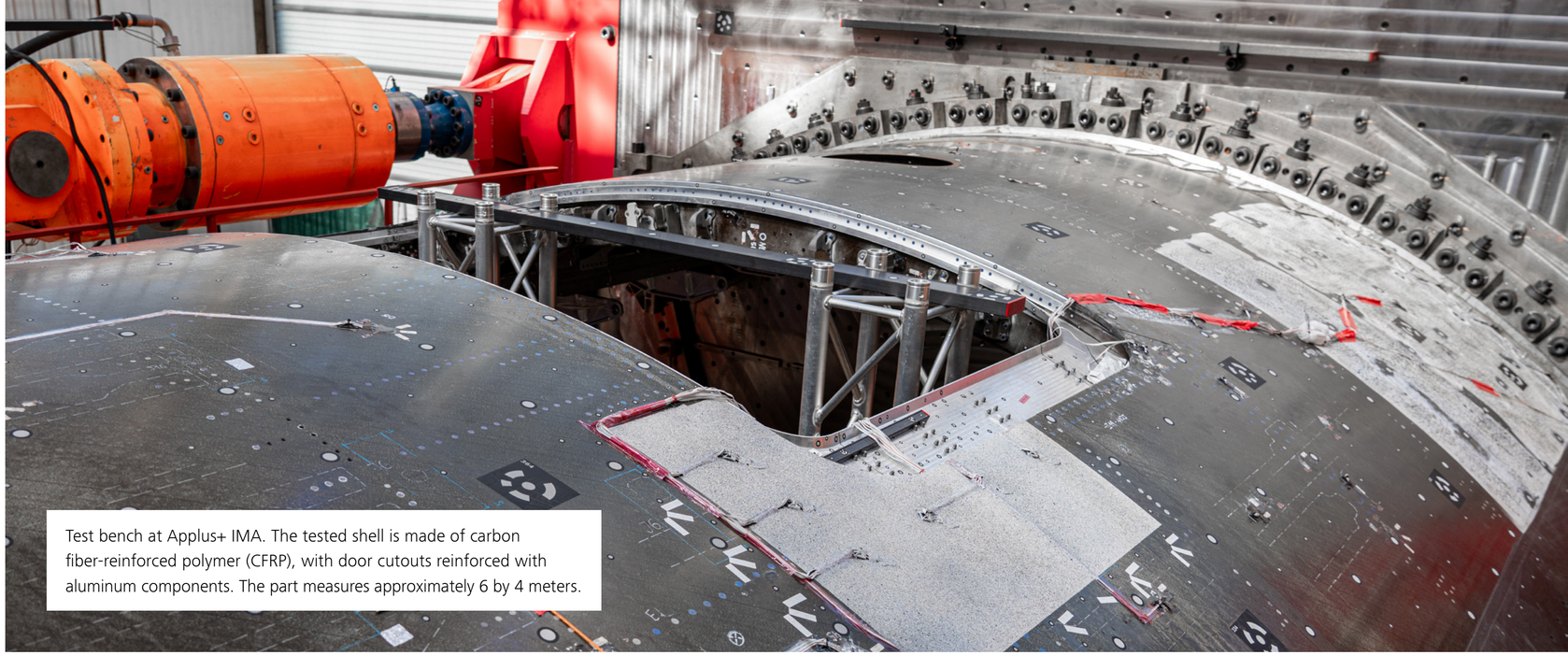
**Company's field of work**
Aerospace

Aerospace structural testing with ZEISS ARAMIS

# Optical 3D strain, deformation, and displacement measurement

Can structural testing be made faster and more cost-effective – while improving data density and quality? This was the question posed by Airbus in Hamburg as part of a federally funded research project. Project partners Applus+ IMA and ZEISS demonstrated the solution: By replacing traditional tactile measurement technologies with an optical (camera-based) measuring system, setup time per test campaign was reduced by several weeks. At the same time, the optical method delivered a large volume of meaningful, high-quality data using minimal resources. The results were automatically documented in straight-forward, visual reports, which improve traceability and facilitate the efficient fulfillment of aerospace verification requirements.

Airbus aims to establish a new testing and certification standard for aircraft components. As part of the federally funded research project LuFo VI-2 “Rapid EF Enablers”, the focus is on reducing setup time and optimizing structural fatigue testing to improve the certification process.

Test bench at Applus+ IMA. The tested shell is made of carbon fiber-reinforced polymer (CFRP), with door cutouts reinforced with aluminum components. The part measures approximately 6 by 4 meters.

## Structural testing of a quarter-shell element

The aerospace giant scheduled deformation tests on an aircraft fuselage section to assess how advanced measuring technology can streamline the testing process. The test object – a quarter-shell element with a door cutout – was ideally suited for the planned test series. The door cutout is a well-known structural weak point that can lead to local instabilities, which must be captured and analyzed in detail. Moreover, preparing the measurement setup using conventional methods is highly time-consuming. Installing strain gauges, strain gauge rosettes, and displacement sensors typically takes days to weeks. The process demands the utmost precision: even slight deviations in sensor placement or orientation – especially in the case of strain gauges –can result in inaccurate or unusable measurement data.

## Ultra-modern test bench

Applus+ IMA, based in Dresden, joined the project as the testing partner. The internationally recognized testing, inspection, and certification body is accredited in the aerospace industry and has the necessary testing facilities. “Our test bench allows us to examine shell structures from all sections of the fuselage,” explains Dr. Silvio Nebel, Head of Aerospace at Applus+ IMA. “The multi-axial and continuously applied cyclic loads on the shell structures accurately replicate real-world conditions. We can simulate internal pressure and the resulting circumferential loads, tensile and pressure loads in the longitudinal direction, along with thrust loads.”

*“Our test bench allows us to examine shell structures from all sections of the fuselage.”*

Dr. Silvio Nebel, Head of Aerospace at Applus+ IMA

The mobile system is suitable for testing all materials, geometries, and object sizes.

## High-resolution data in real time

ZEISS was selected as the measurement technology partner. The company has extensive experience with measurement tasks in the aerospace sector and offers advanced measurement systems for aerospace applications. “Our measuring system ARAMIS is perfectly suited for aerospace structural testing – Airbus Testing has been using it for a long time,” affirms ZEISS Senior Application Engineer André Burg. “It’s an optical 3D measuring system for performing full-field and point-based measurements in real time.” ARAMIS provides three-dimensional displacement and strain data across multiple load levels. Additionally, derived analyses, such as velocities, accelerations, and six degrees of freedom (6DoF), are also possible. All measurement data from the entire test campaign were live-streamed into Applus+ IMA’s data acquisition (DAQ) system, called HAMSTER. ARAMIS uses the precision PTPv2 time protocol for highly accurate time synchronization with the test bench and other measuring systems.

### Key features

ARAMIS is suitable for measuring strain, deformation, and displacement throughout all stages of the development phase – from coupon testing to full-scale structural testing. The measurement data can also be used to validate simulations.

- Suitable for high-end applications in the aerospace industry
- Available in different configurations – the system can be customized for typical use cases
- Measures parts of any size – from specimens of just a few millimeters up to structural components of several meters
- Supports flexible measurement rates – from quasi-static experiments to dynamic tests
- Simultaneously monitors the test bench: threshold control and maximum displacement
- Realizes significant time savings in test preparation
- Optical displacement transducer and strain gauge in one
- Equipped with powerful software for measurement, analysis, and reporting
- Continuous data flow simplifies the demonstration of compliance with regulatory standards

Learn more

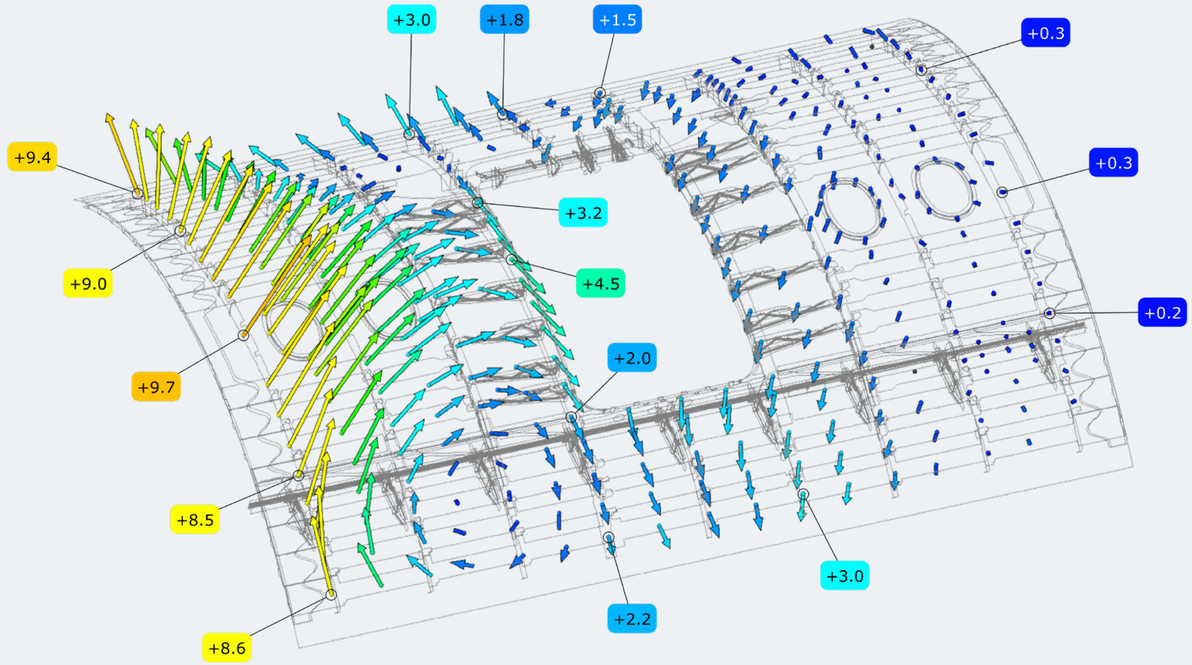
## Offering a modern alternative to traditional sensors

Preserving the integrity of surfaces and specimens, ARAMIS non-destructively acquires a vast amount of three-dimensional data (XYZ coordinates). The optical measurement approach offers an additional advantage: since ARAMIS measures the deformation in each spatial direction, time-consuming and expensive preparations of the test object for applying strain gauges and LVDTs (Linear Variable Differential Transformers) are rendered unnecessary on the upper side of the shell. For other applications, e. g., ground vibration tests, ARAMIS also replaces accelerometers.

“To capture 3D coordinates for displacements, we applied measurement targets in a predefined grid across the shell. Additionally, one edge of the door cutout was prepared with a stochastic pattern for full-field strain analysis. The entire setup was completed in just two workdays,” reports André Burg.

## Improved insights into failure mechanisms

ARAMIS measuring data is automatically processed by the data acquisition and analysis software ZEISS CORRELATE, which is part of the ZEISS INSPECT software package. As ARAMIS captures large-scale data, it is possible to detect unexpected strain hotspots even when simulation models predict maximum deformation elsewhere. André Burg explains, “In the software, the user can adjust the positions of optical strain gauges, extensometers, or LVDTs after the test, so there is no longer any risk of placing sensors incorrectly. This flexibility significantly improves measurement reliability and reduces the need for repeated test setups.”




Deformation analysis with ARAMIS – measurement results on 3D displacements visualized on the CAD model of the shell element

## Minimized uncertainty through accurate spatial referencing

ZEISS established a consistent global reference system before the ARAMIS measurements. “To accurately evaluate deformations, displacements, or strains, you need a part-specific coordinate system that matches the component’s actual position in the test bench,” explains André Burg. “Our photogrammetry system TRITOP creates a point cloud as a spatial reference grid that helps align and orient all measurement targets.”

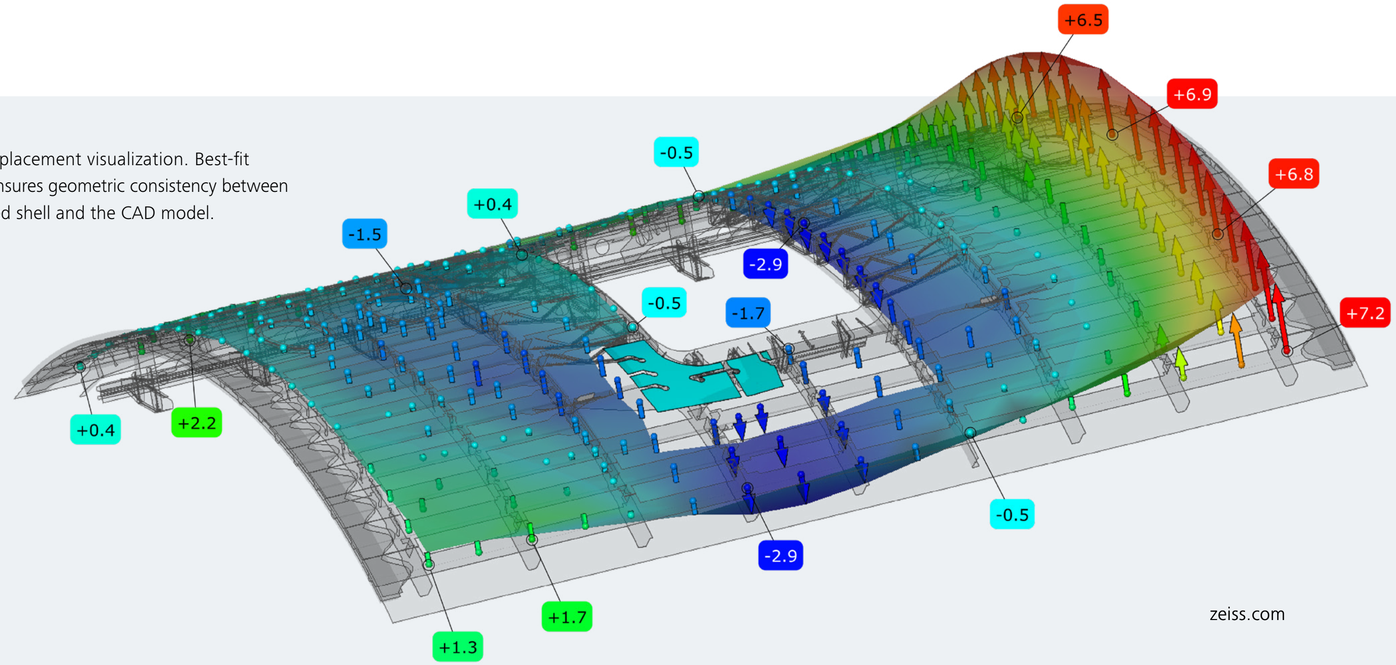
In this project, the photogrammetric digitization only took about 30 minutes. Subsequently, the shell was scanned in its mounted condition using the hand-held 3D scanner T-SCAN hawk 2 to document its actual positioning on the test bench, including any preload or deformation resulting from the installation. A best-fit alignment was then used to match the real component with the CAD model geometrically.

*“We’ve been collaborating with the ZEISS team for many years – and we even have our own ARAMIS systems in-house, which we use regularly for various testing tasks. Regardless of the test object, setup time is significantly shorter than that of conventional methods. At the same time, the system delivers a wealth of valuable data – in some cases, more data than tactile sensors could ever generate. It’s a powerful tool that we rely on whenever precision, efficiency, and speed are crucial.”*

Dr. Silvio Nebel, Head of Aerospace at Applus+ IMA

## All-in-one software

All measurement data – including photogrammetry and 3D scans – are managed in a single, unified software platform, ZEISS INSPECT. This integration enables faster and more error-free data processing, analysis, and documentation. Additionally, it enhances overall traceability and serves as an ideal tool for creating the digital twin of any component.




Full-field displacement visualization. Best-fit alignment ensures geometric consistency between the measured shell and the CAD model.

Applus+ IMA is an internationally certified and accredited test center for manufacturers and the entire supplier industry for the qualification, validation and monitoring of materials, components and structures. In order to make developments marketable fast and safely, Applus+ IMA supports the aerospace industry as a recognized partner along the entire product development process. Durability, function and safety are verified by engineers by testing, simulation and calculation for every construction group of an aircraft or rocket. As a part of Applus+ Laboratories, an division of the Applus+ Group, Applus+ IMA is embedded in a global network that provides testing and certification to improve the competitiveness of the client products and encourage innovation.

**www.appluslaboratories.com** | **Follow us on LinkedIn** | **www.ima-dresden.de/en**

Supported by:

Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag


Seeing beyond