

ZEISS Aerospace Solutions

Compressor Blade

Precision at all altitudes



Seeing beyond



Modern measurement of a critical high-volume product

Compressor Blade

The modern gas turbines typically contain thousands of compressor blades, which are subject to increasingly challenging specifications in terms of thickness, edge quality, and profile requirements.

From forging, to finished part and Maintenance Repair & Overhaul (MRO), we have solutions to meet the demanding requirements for improved business performance and efficiency. Common uses for the ZEISS Aerospace Solutions include:

- Metallurgy
- First article inspection
- Trend Analysis
- CFD/ FEA Analysis
- Production measurement for forging and machining
- Advanced, connected software
- MRO quality assurance
- Reverse engineering



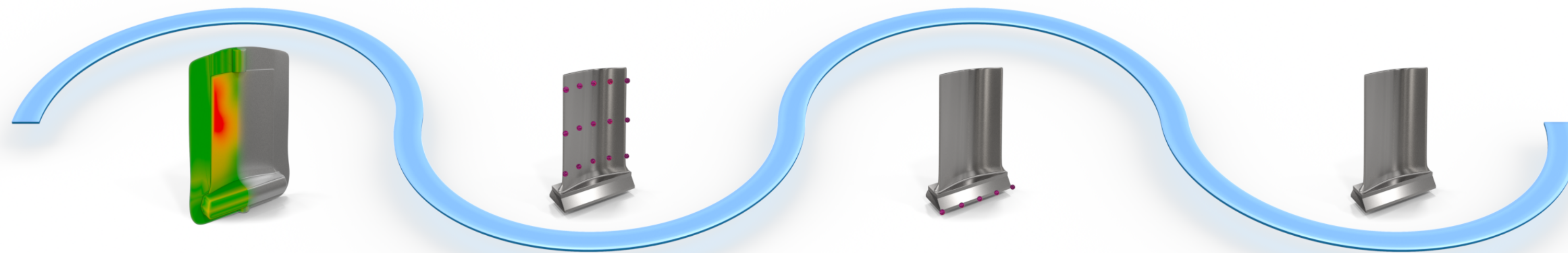
Forcing pressure

Compressor Blade Inspection

The aero engine compressors consist of thousands of blades, each between 25 – 200 mm. As modern compressor blade designs create thinner and more twisted airfoils, the bar for precision continues to rise. Even the slightest imperfection on the surface or a deviation in the profile of a compressor blade or vane can have a detrimental effect on airflow, compromising blade performance and reducing engine efficiency. Considering the global production volume of these parts, which reaches millions per year, alongside the significant number returning for MRO, having accurate measurement and inspection solutions becomes crucial for ensuring a seamless production process.

Get all steps of the manufacturing process right

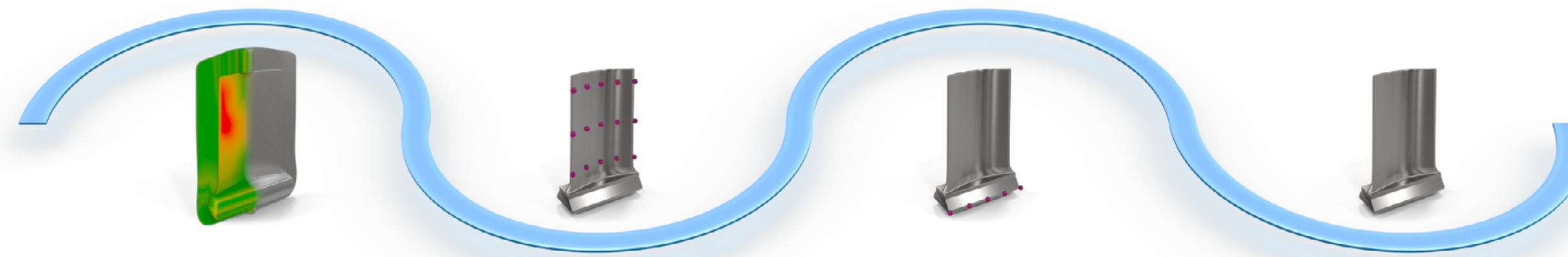
Follow us along to learn about the ZEISS know-how at every stage of the compressor blade inspection and production process: Four production steps need to be mastered thoroughly to ensure the overall safety requirements and quality.

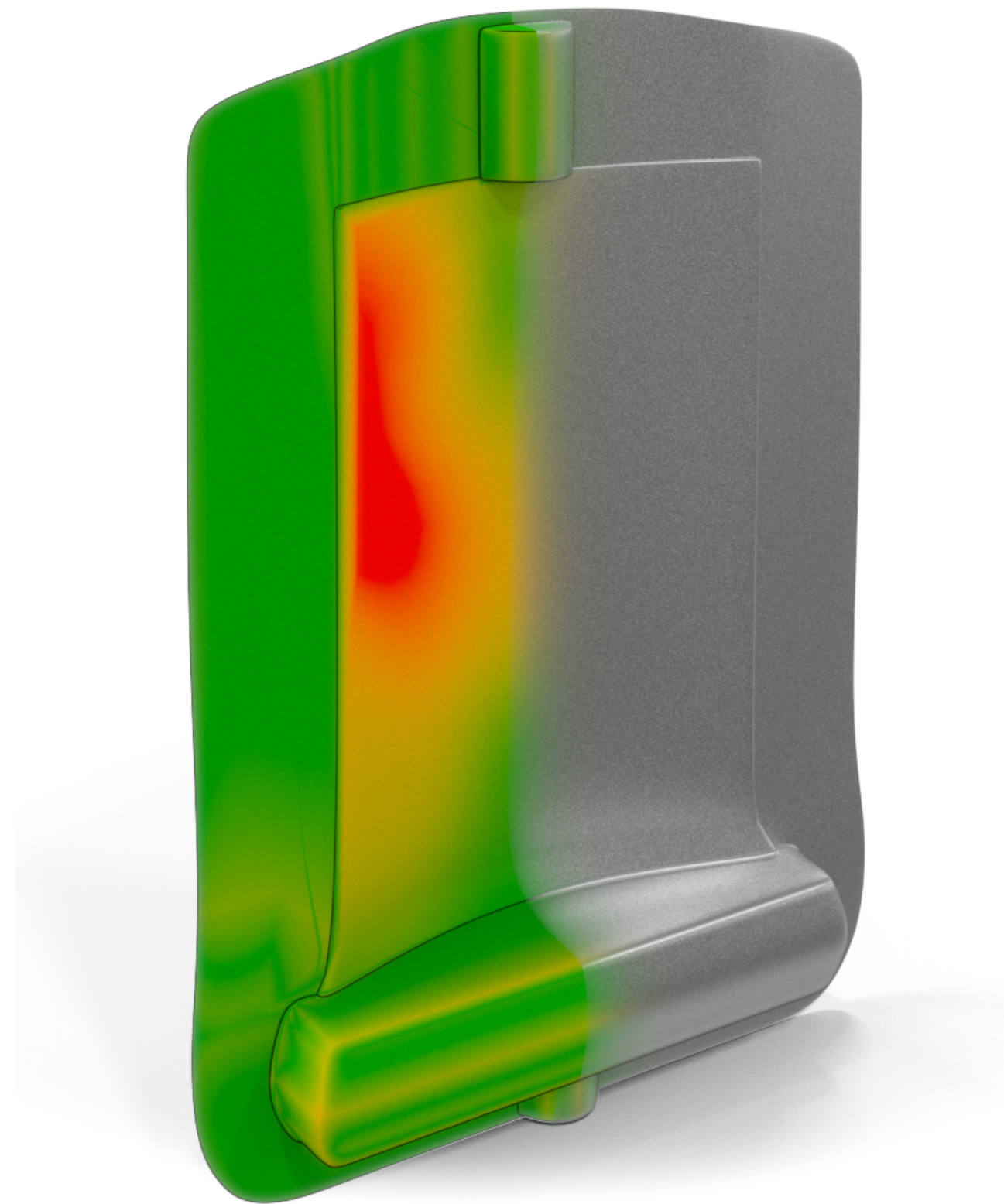


Design and Composition

Measuring at the point of manufacture

Building in quality is a vital part of the compressor blade manufacturing process. With millions of parts in production every year each with very short cycle times, there could soon be a lot of non-conformance without careful monitoring in place within your process. The ZEISS quality solutions enable our aerospace customers to put the right piece of equipment on the shop floor at the point of manufacture and provide real time feedback with our software tools where customers need it the most.





Production Step 1

Forging Process

The transformative effect of modern tools and analysis on traditional processes like forging is truly remarkable, enabling significant advancements in productivity and achieving higher levels of right-first-time outcomes.

Challenges

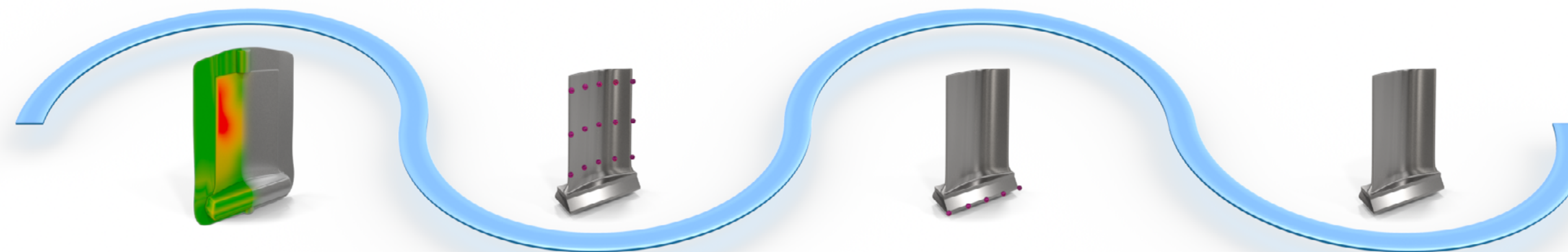
The die used in the forging process plays a critical role in the production of the compressor blade. Ensuring the conformity of both the die and the resulting blades is where ZEISS technologies excel.

- Shape and form which meets requirements
- Tool/die and tear, monitoring and life
- High volume production

Our Solutions

Optical 3D metrology is a great tool at this stage in the process for:

- Instant feedback at the point of manufacture – points, profiles and 3D
- Measuring the mold/die over time to establish wear limits
- Complete autonomy with ZEISS ScanBox
- Scalability to meet high production demands with fully in-line and near-line automated solutions
- Reusable data to enable advanced manufacturing techniques like adaptive machining



Production Step 2

Milling Rough Shape

Given the potential variability introduced during forging, the rough milling stage of the blade before final machining is a crucial aspect of the process.

Challenges

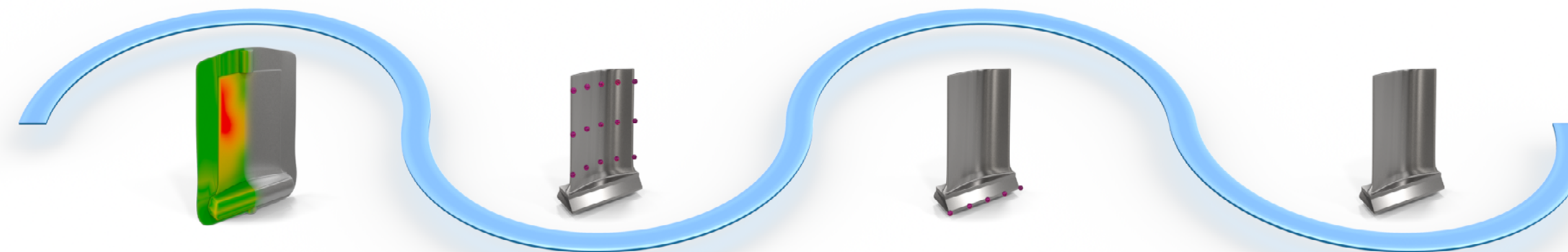
Rough milling is a fast process in harsh conditions leaving similar challenges for the measurement and inspection.

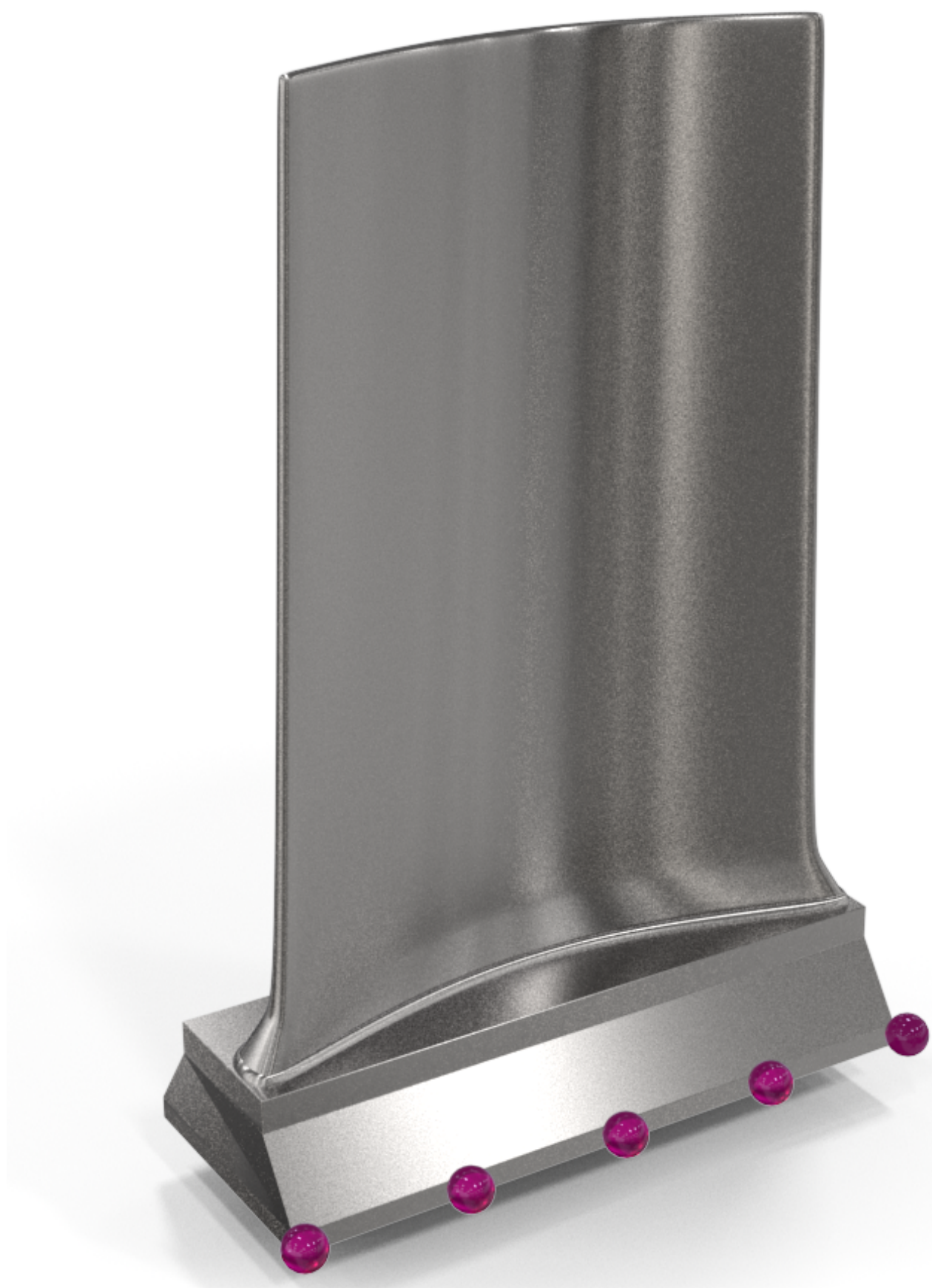
- Rough machining operation
- Fast machining cycle times
- Harsh environment with small working areas

Our Solutions

Among the range of ZEISS measurement and inspection solutions, the ZEISS DuraMax stands out as an ideal choice specifically tailored for shop floor environments.

- Space saving footprint (1.5m²)
- Fast single-point and scanning options
- Linear drives with dust and moisture protection to IP54 rating
- Extremely flexible with ZEISS Duplex and full automated options for increased production throughput
- HTG version for widest temperature ranges up to 40°C





Production Step 3

Final Machining

The final machining ensures the part is fit for its intended final use. The airfoil edges with the small radii for performance, the root form for fit to the compressor disc and airfoil tip to ensure no leakage of compressed gas.

Challenges

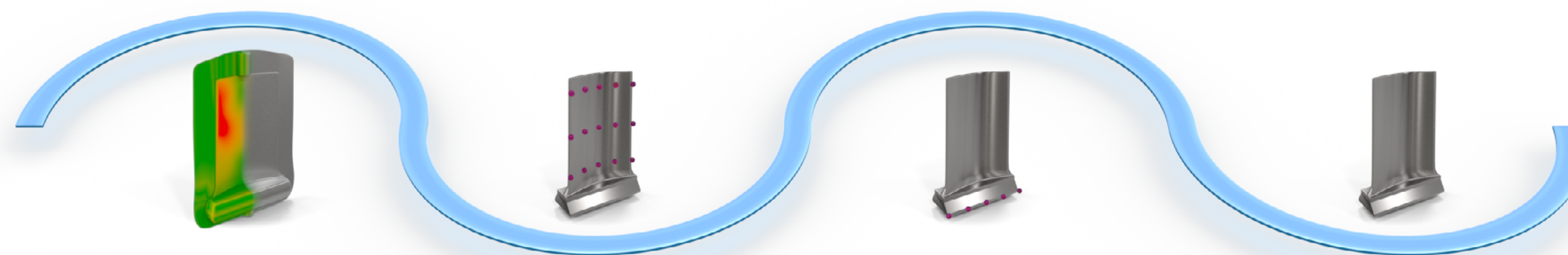
Final machining is a fast process matched with small tolerances on many of the critical features. This type of process typically demands a high-end solution.

- Small features
- Tight tolerance root form features
- High-volume production

Our Solutions

ZEISS PRISMO fortis is the go-to machine to meet the challenges of the final machined compressor blade.

- ZEISS PRISMO 7/12/7 fortis, incorporates ZEISS CMM Acceleration Mode for Aero Applications
- ZEISS C99m controller and parameters for ZEISS VAST Rotary (ZVR) and ZEISS VAST Rotary Axis (ZVRA)
- Up to 300mm/s scanning speed providing up to 70% time savings
- Excels on the shop floor as well as measurement rooms



Production Step 4

Final Validation

At the final production stage, ensuring the product validation is crucial. Meeting regulatory and OEM requirements such as AS9102 and AS13003 is essential which encompass stringent and comprehensive standards.

Challenges

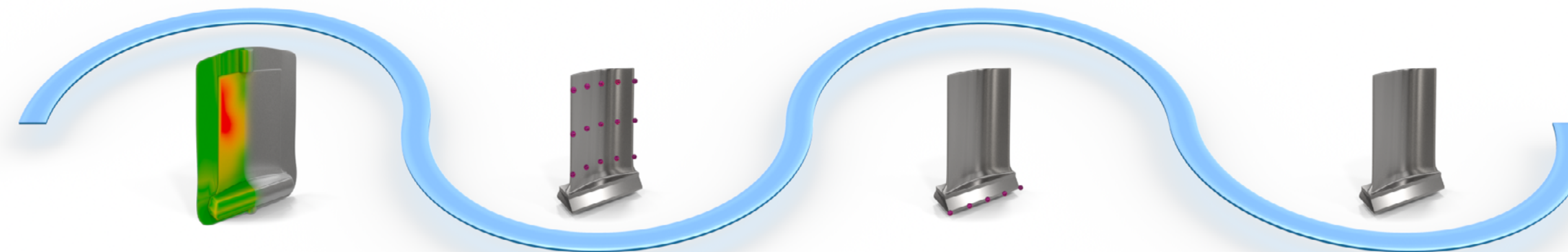
Compressor blades has an extensive set of validation requirements to demonstrate airworthiness.

- AS9102 Reporting style
- Hundreds, sometimes thousands of features
- Comprehensive requirements (GD&T, airfoil analysis, surface, metallurgical specifications and more)

Our Solutions

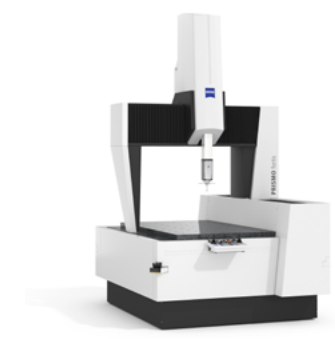
ZEISS has a comprehensive suite of tools to fulfill the needs of validation including; high-speed, high-accuracy optical and multisensory devices like CMM and ScanBox complemented with ZEISS Quality Suite for inspection analysis. Our recommendations are:

- ZEISS PRISMO 7/12/7 fortis – Highest accuracy guaranteed
- ATOS 5 for Airfoil – Confirmation of freeform geometries
- ZEISS Microscopy – Microstructure analysis, surface characterization and capture of visual defects
- Surface inspection with Surfcom or on ZEISS CMM with ZEISS ROTOS



ZEISS Industrial Quality Solutions

Enabling our customers to manufacture a better future



Bridge-Type & Multisensor CMMs

High accuracy and precision for repeatability and reliable results



Industrial CT- & X-Ray Solutions

Non-destructive quality control to make the invisible visible



ZEISS Services

Machine repair, software and hardware training, aftermarket services, contract inspection and more



Optical 3D metrology

Industrial non-contact 3D scanners for fast and precise measurements



Industrial Microscopy Solutions

Connected portfolio to accelerate decision making



ZEISS Integration Series

Automation and Integration Solutions for increased throughput and process optimizations.



Software & Quality Intelligence

Measurement, evaluation and management software for all quality data



ZEISS Aerospace Solutions

There is so much more to know

Connect with us to schedule your compressor blade application discussion, demo or visit to the ZEISS Quality Excellence Center today!