

ZEISS Aerospace Solutions

Turbine Blade

Precision at all altitudes



Seeing beyond



Modern measurement of a critical high-volume product

Turbine Blade

There are hundreds of turbine blades in any modern gas turbine, with increasingly challenging requirements for shape, wall thicknesses, profiles, size and positions to cover a small sample of requirements.

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

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



Powered by precision

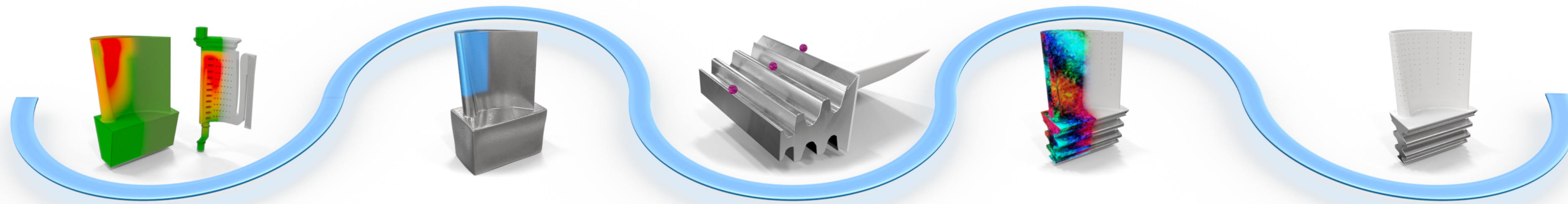
Turbine Blade Inspection

Turbine blades are the workhorse of the modern aero engine. They operate in an extreme environment, with temperatures exceeding 1,600° C / 2,732° F (enough to melt the materials) and centrifugal forces of multiple tonnes generated by rotations of up to 12,000 rpm. Since the shape of the turbine blade determines energy efficiency, airflow and thrust, any surface or dimensional imperfection can cause blade and ultimately engine failure.

Furthermore, turbine blade designs have become increasingly intricate and harder to measure as they incorporate new geometries and different composites and castings. There is no room for error when measuring and inspecting these parts. With millions of turbine blades are produced each year, the cost of non-quality is critical and the desire for “right-first-time” products is at the center of forward thinking manufacturers. The ZEISS solutions are the perfect compliment, with equipment and software designed for in process control checks, final inspection and closed loop data handling tools such as ZEISS PiWeb.

Get all steps of the manufacturing process right

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



Production Step 1

Wax and Ceramic Core Processes

The relationship between inputs and outputs is well-known: by controlling your inputs, the outputs will typically take care of themselves. This principle holds significant importance in the turbine blade casting process, where even minor factors like the quality of the wax or ceramic core can substantially impact the final casting.

Challenges

Gaining a comprehensive understanding of the impact of wax and ceramic core shape, size, profiles, and impurities on the final cast product.

- Accurate shape and form
- Tool/die wear, monitoring and life
- High volume production
- Process impurities

Our Solutions

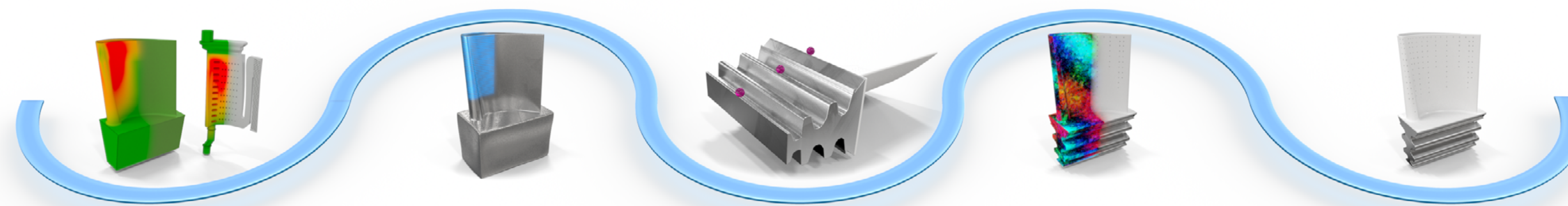
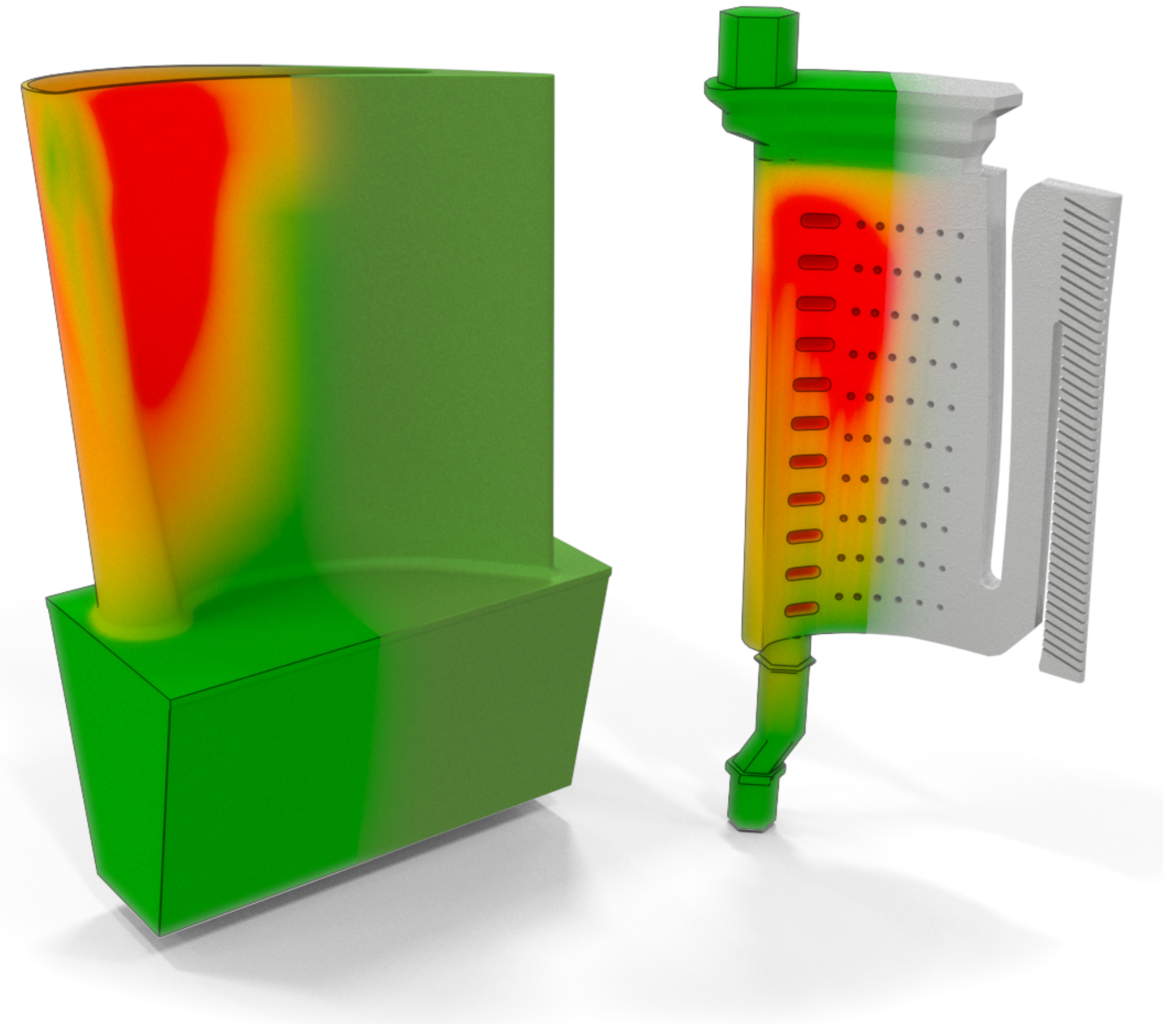
ZEISS measurement solutions construct and digitally document the product, facilitating process improvement evaluation. They effectively address challenges, ensuring optimal outcomes. Additionally, Blade Inspect software enables 3D trend analysis.

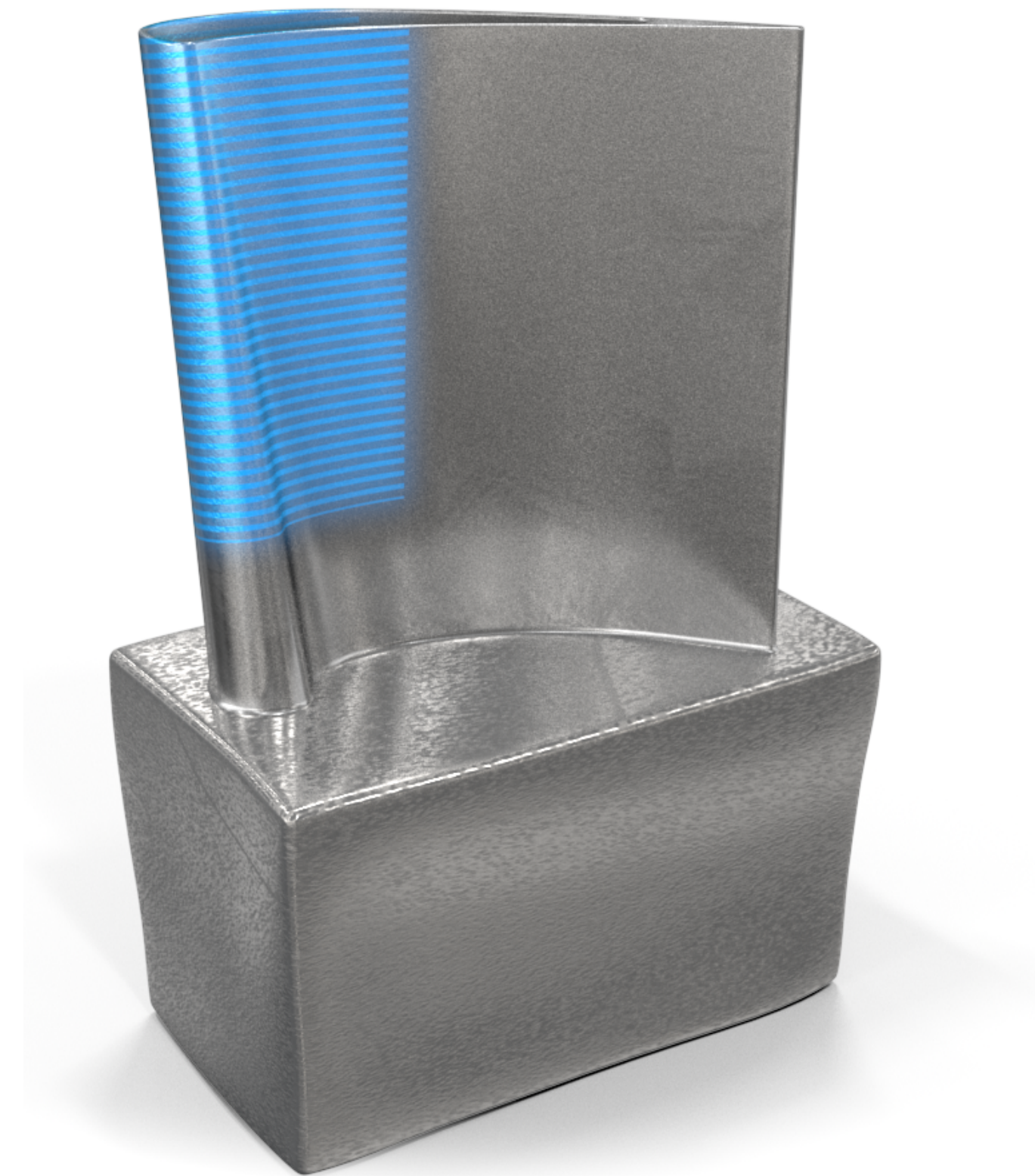
3D scanning and visualization for full process understanding

- Digitally assemble the parts with the mold/die to solve problems and establish wear limits
- Scalable production solutions with ZEISS ScanBox for complete autonomy

3D CT for cost reducing decision making

- Multipart set up to optimize the process time
- High resolution 3D data to perform process control checks (bubbles, thickness, size, shape, position)





Production Step 2

Investment Casting Process

The value of the turbine blade increases significantly the moment metal is poured, the result of all the hard work of the ceramic core, wax and shell processes. ZEISS products continue to add value and validate your process, ensuring the achievement of a high-quality final cast state.

Challenges

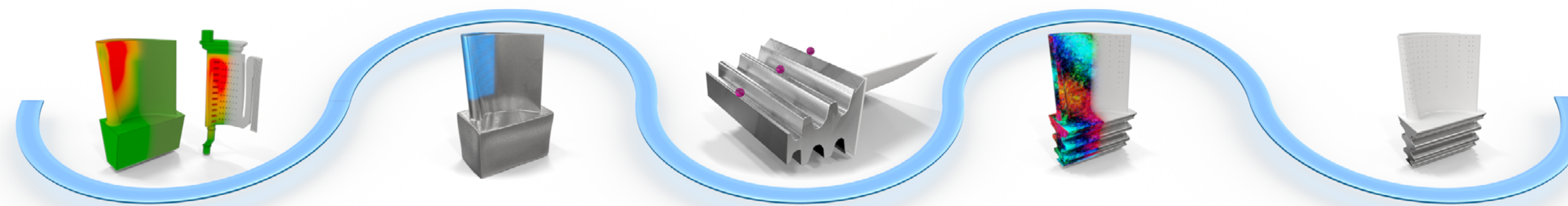
Ensuring the product is fit for its intended purpose in terms of the external and internal characteristics.

- Harsh environment with large batches of blades
- Blade casting final dimensions
- Non-destructive analysis
- Wall thickness measurements

Our Solutions

In process measurement is used to create 3D data which is fed to CAD/CAM software to finish machine metal pins, die lines on the airfoil or create performance enhancing trailing edge geometries. A final inspection is performed utilizing high-precision 3D measurement systems to guarantee the integrity of internal cavities and wall thicknesses. High-throughput and automated measuring solutions like the ATOS Scan-Box help eliminate waiting times in inspection areas, ensuring seamless workflow.

- ZEISS ScanBox with ATOS 5 for Airfoil - for high-throughput dimensional inspection
- ZEISS BOSELLO MAX - for NDT inspection of complex internals
- ZEISS Microscopy Solutions - for metallurgical property inspection such as grain structures and boundaries



Production Step 3

Machining

The machining processes involved in transforming a casting into a finished, operational component are intricate, requiring fine tolerances and high-throughput setups. Frequently, compact cells incorporating machining centers, measurement systems, and automation are utilized to enhance efficiency and eliminate operator influence from the process.

Challenges

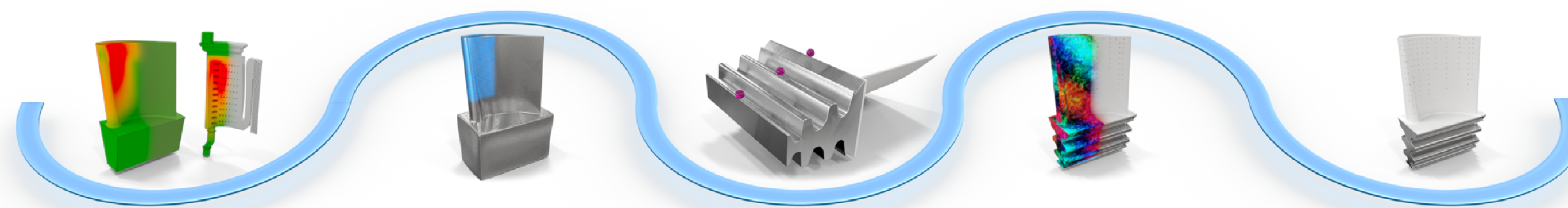
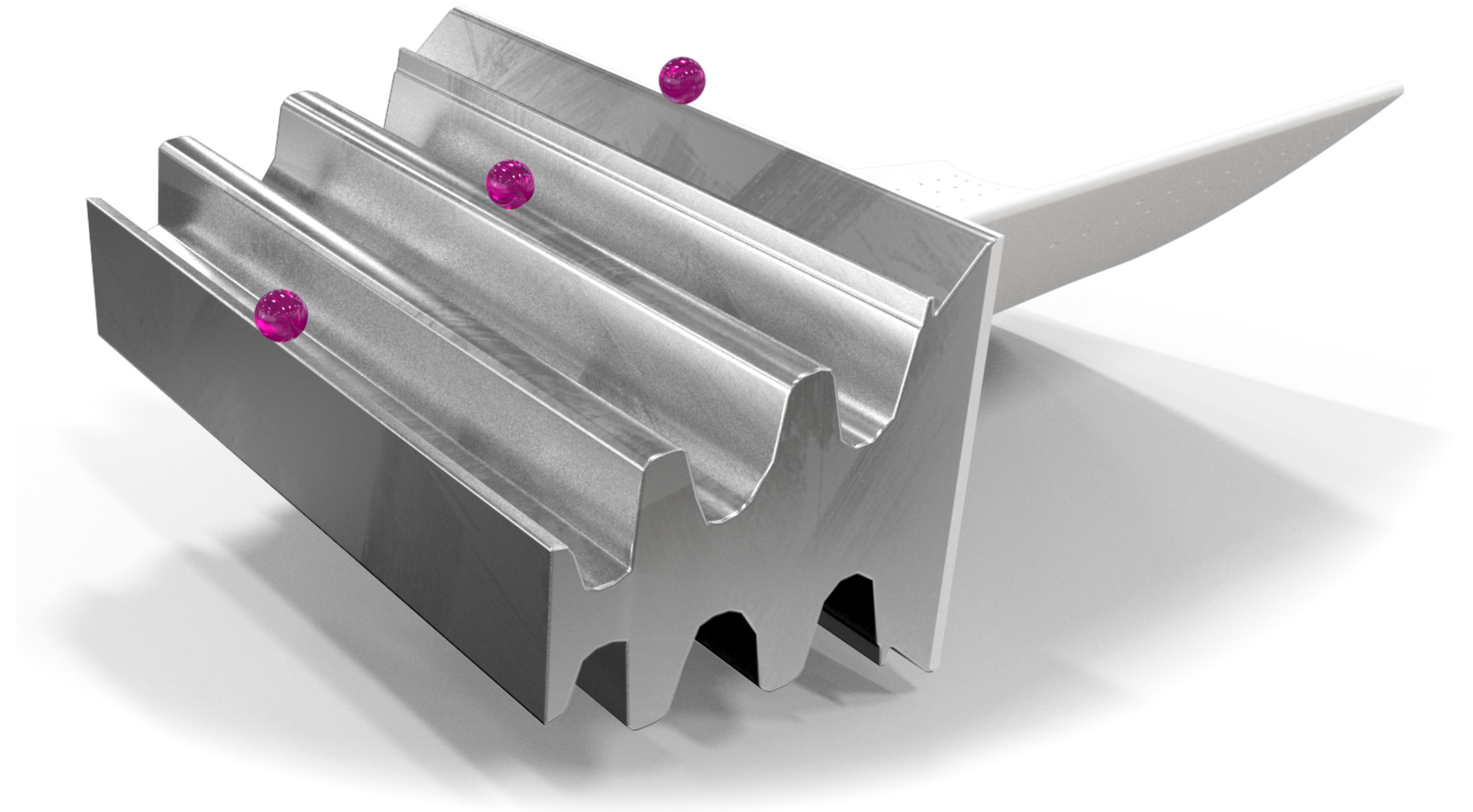
Collecting measurement data in the most efficient setup at the point of manufacture and providing rapid feedback to ensure key process characteristics are met, thereby supporting right-first-time manufacturing.

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

Our Solutions

The combination of our rugged, shop floor designed equipment like the ZEISS DuraMax and ZEISS O-INSPECT with tailor made automation solutions and ZEISS PiWeb reporting for complete closed-loop feedback at the point of manufacture. All ZEISS solutions can be combined flawlessly with ZEISS Integration Series for improved efficiency in production with manual, semi and fully automated systems to meet your Industry 4.0 needs.

- ZEISS PRISMO 7/12/7 fortis with CMM Acceleration Mode for Aerospace Applications
- ZEISS DuraMax – The natural choice for the shop floor
- ZEISS O-INSPECT - The multisensor measurement machine





Production Step 4

Coating Process

Coatings are an essential part of the turbine blade. They are added to protect the blades from corrosion in the harsh environments and for added thermal properties enabling high operating temperatures.

Challenges

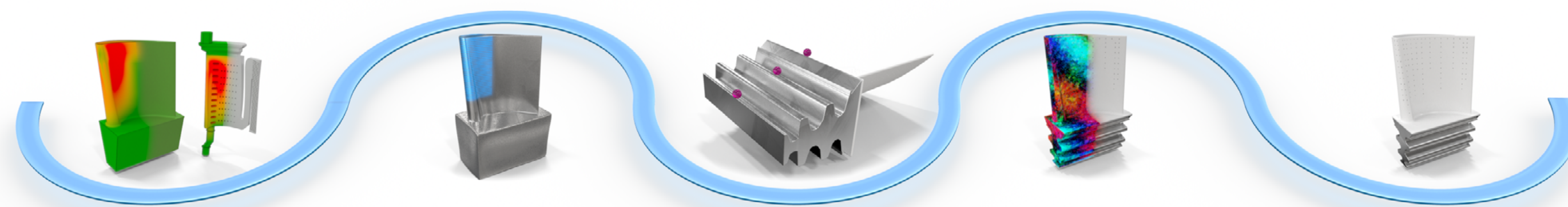
The process for validating the coatings is vital to ensure integrity and lifing of the turbine blade. Small variables in the process have the potential to have a detrimental effect on the conformity of the product, making it crucial to possess the appropriate quality tools.

- Thin layers of coating
- Manual sampling inspection process

Our Solutions

ZEISS has two primary solutions for ensuring the coating thickness and integrity in process setup, validation and high-scale production. For the destructive testing which is common to check the integrity of the coating as well as thickness, we use our microscopy solutions for 100% confirmation of material properties, adhesion and layer thicknesses. When a process is established and regular checks like thickness are required, the ZEISS ScanBox is the right solution for a quick inspection. By analyzing the blade before and after coating, it accurately calculates the coating thickness, providing a cost-effective alternative that eliminates the need for blade cut-ups.

- ZEISS ScanBox with ATOS 5 for Airfoil - for high-throughput dimensional inspection
- ZEISS Microscopy Solutions - for complete confirmation of metalurgical properties and material thicknesses



Production Step 5

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.

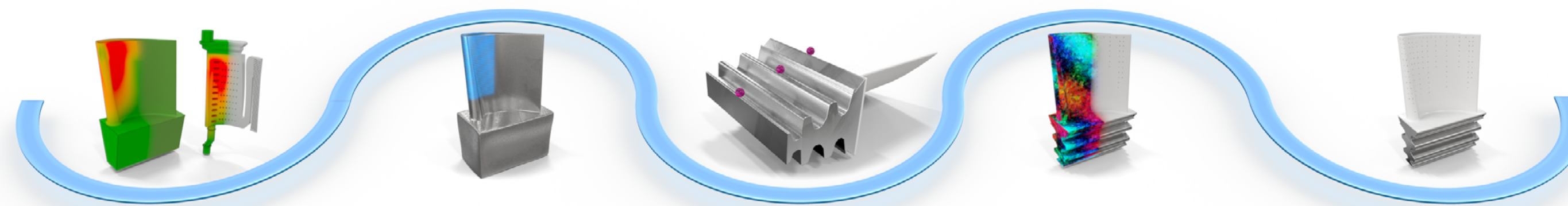
Challenges

With a turbine blade presenting an extensive set of validation requirements, no single solution can fulfill them all. That is where the wide range of ZEISS measurement solutions comes into play, offering the perfect match for addressing the diverse validation requirements.

Our Solutions

Within the ZEISS suite of hardware and software solutions, there is high-accuracy tactile, optical and microscopy solutions to fulfill the many thousands of characteristics necessary to be validated.

- ZEISS PRISMO fortis – Maximum precision and efficiency
- ZEISS ATOS 5 for Airfoil – Confirmation of freeform geometries
- ZEISS Microscopy Solutions – Microstructure analysis, surface characterization and capture of visual defects
- Surface inspection with ZEISS SURFCOM or ZEISS PRISMO with 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 turbine
blade discussion, demo or visit to the ZEISS
Quality Excellence Center today!