

INNOVATIONS IN METROLOGY

# METROLOGY FOR BLADES

Our solutions for your blades



WENZEL  
**METROLOGY FOR BLADES**

# TURBINE BLADES

## HOW TO MEASURE

---

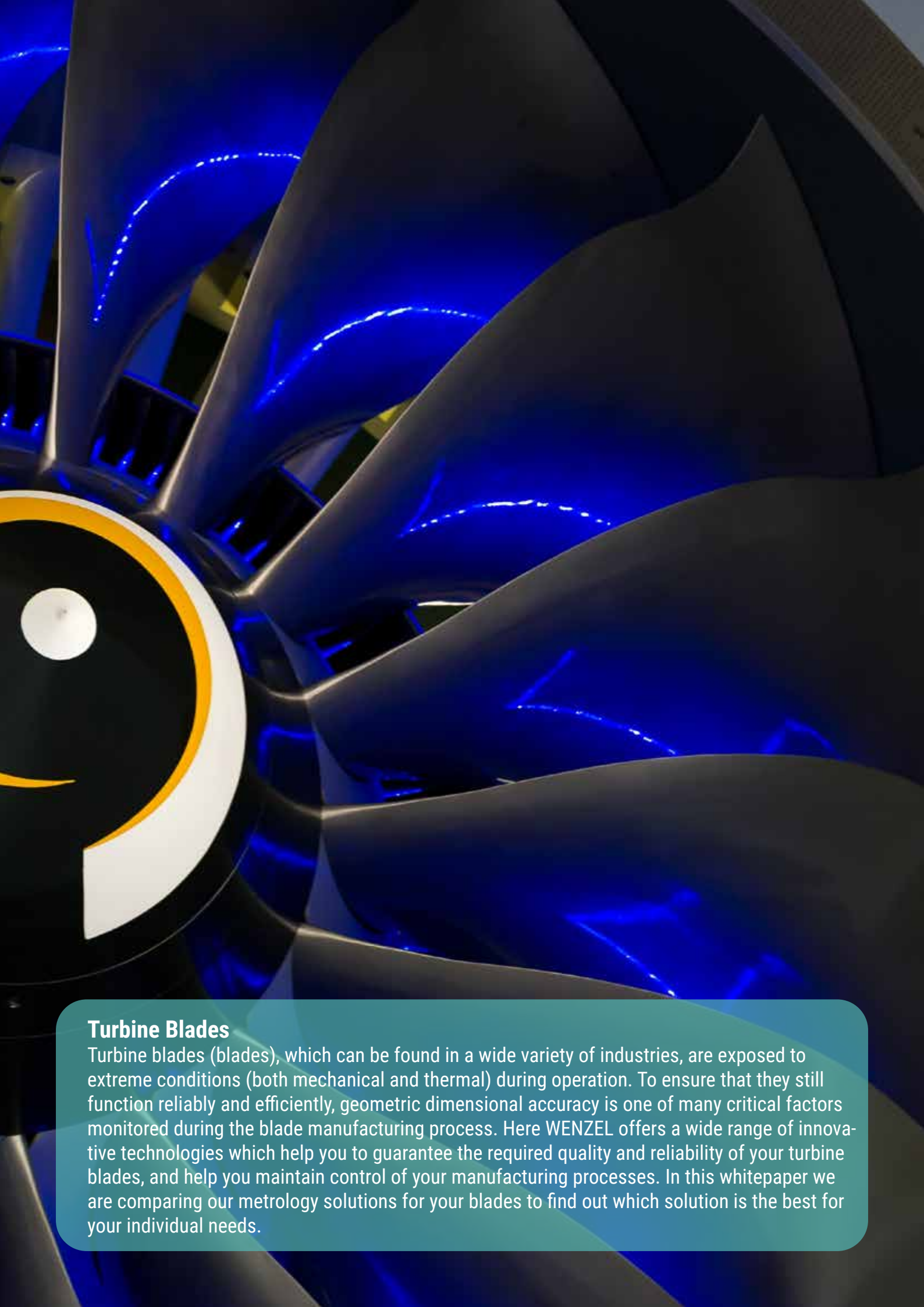
### **Purpose of the document**

*Thank you for downloading/reading the WENZEL the WENZEL Blade Metrology Paper*

The world of Quality, Inspection, and Metrology is a broad one, with different meanings to almost everyone. Add to that dozens of companies, hundreds of measuring technologies, and thousands of possible applications and finding the best measuring tool available can be quite daunting.

This guide serves as a compilation of data that quantifies the strengths, weaknesses, and ideal uses of a suite of metrology tools and technology in a variety of applications. Its goal is simply to summarize the abilities of WENZEL's most prominent CMM products to aid in the decision making process of purchasing a new Metrology Solution.





## **Turbine Blades**

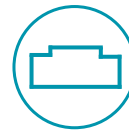
Turbine blades (blades), which can be found in a wide variety of industries, are exposed to extreme conditions (both mechanical and thermal) during operation. To ensure that they still function reliably and efficiently, geometric dimensional accuracy is one of many critical factors monitored during the blade manufacturing process. Here WENZEL offers a wide range of innovative technologies which help you to guarantee the required quality and reliability of your turbine blades, and help you maintain control of your manufacturing processes. In this whitepaper we are comparing our metrology solutions for your blades to find out which solution is the best for your individual needs.

The background of the slide features a close-up, blurred image of a turbine blade, showing its curved, metallic surface. A large, white, stylized letter 'A' is superimposed on the right side of the image. At the bottom, there is a teal-colored banner with white text.

# Typical blade features



TE thickness & radius



Shroud / root



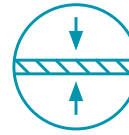
LE thickness & radius



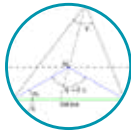
Transitional areas



Chord length



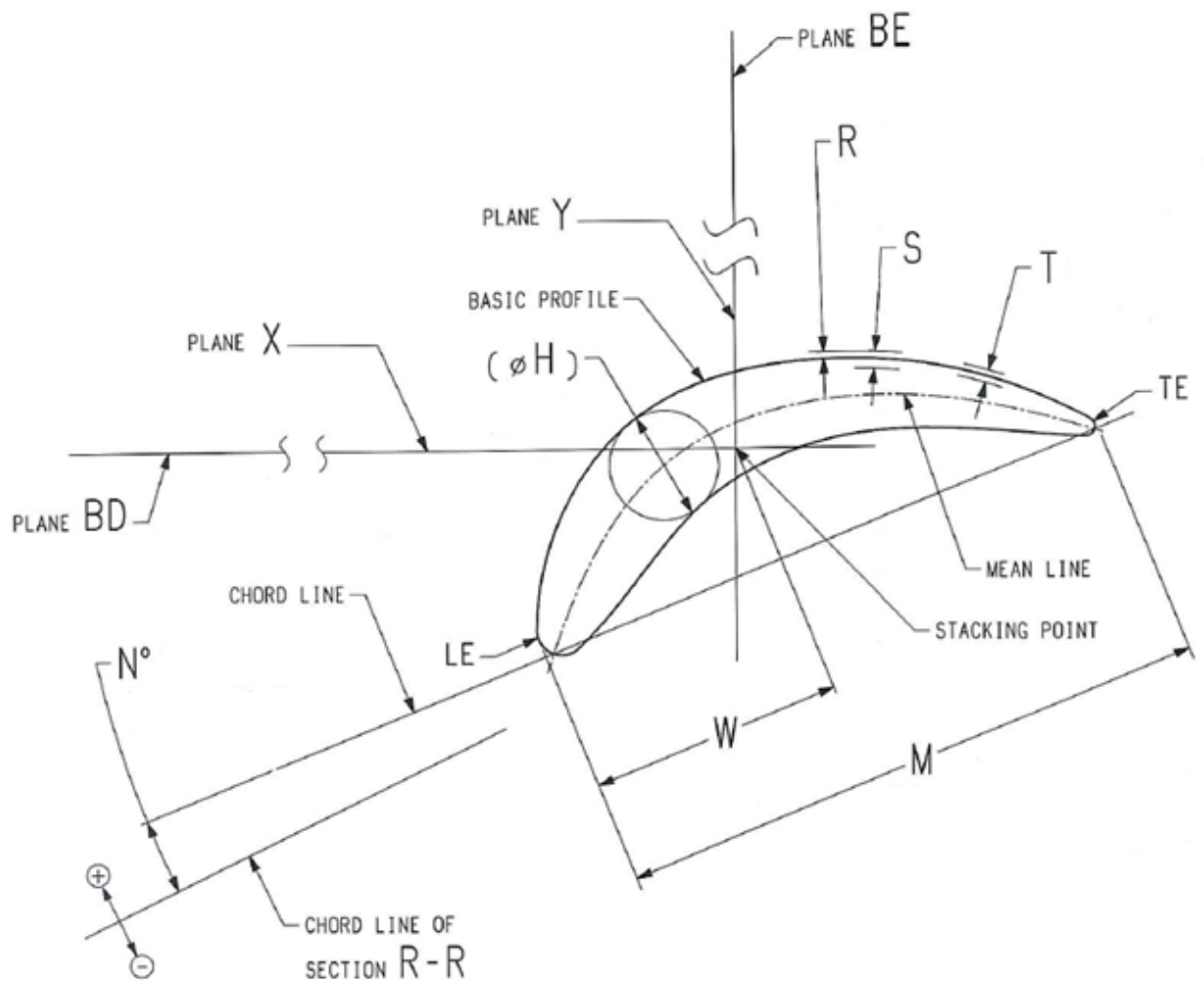
Maximum thickness



Chord angle



Customer specific features



TYPICAL AIRFOIL SECTION  
NOT SCALE

# CHALLENGES

## OF BLADE MEASURING

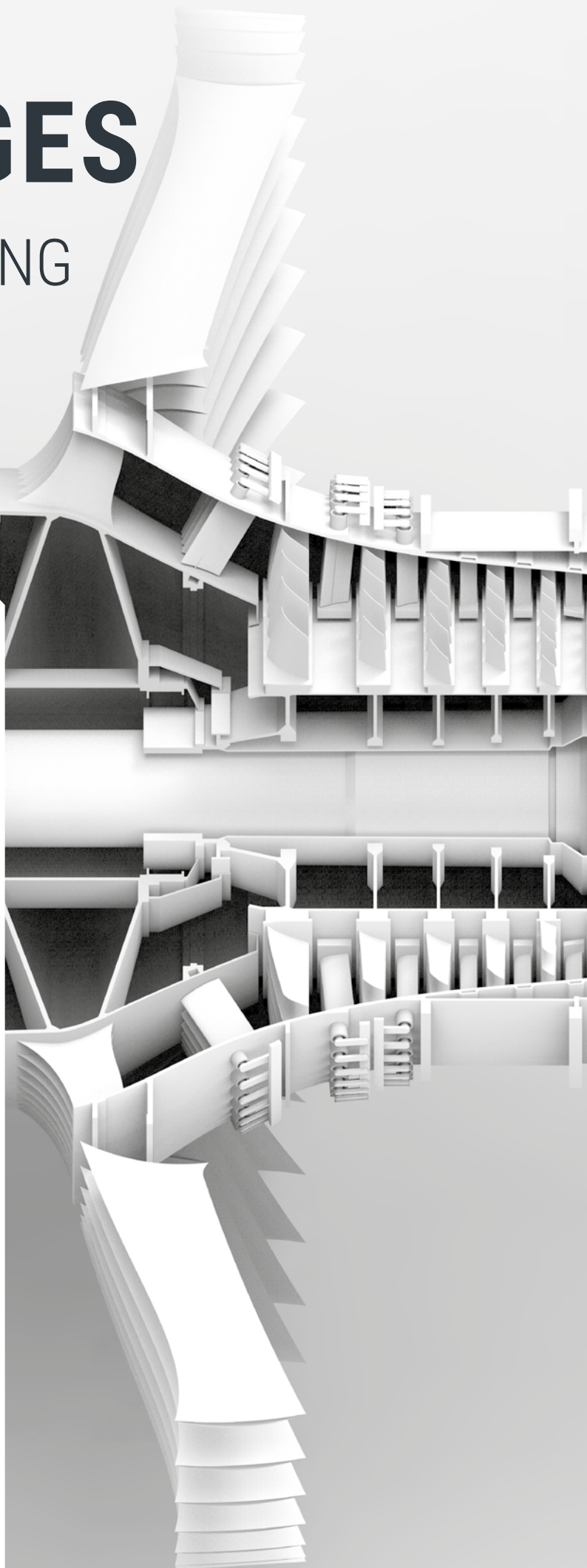
---

### Challenge 1: Alignment

The relationship between the alignment surfaces and overall length of a blade often can cause challenges when it comes to accuracy and repeatability.

In our study, the part alignment is generated from a relatively small root area, trying to align a relatively tall blade and its sections. This creates great leverage as the length we are trying to control is very large, which the features used for control, are very small.

The stability of the measuring platform, and the precision of its sensor allows the CORE system to achieve accuracies that exceed the requirements of almost all measuring tasks.

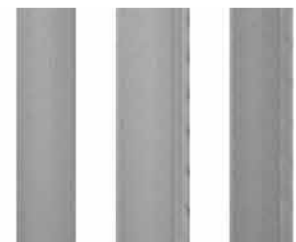
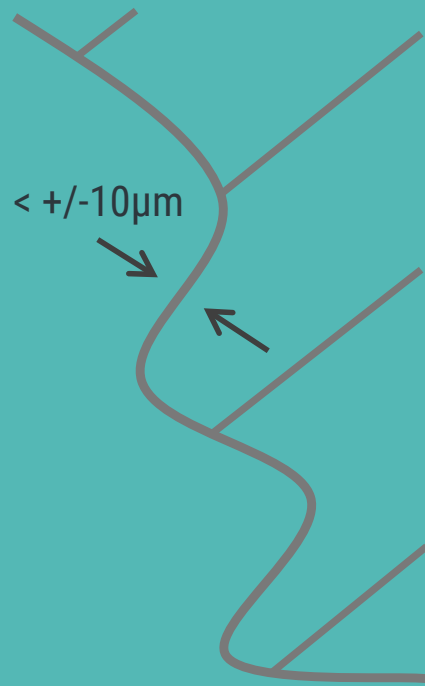




## Challenge 2: Root tolerances

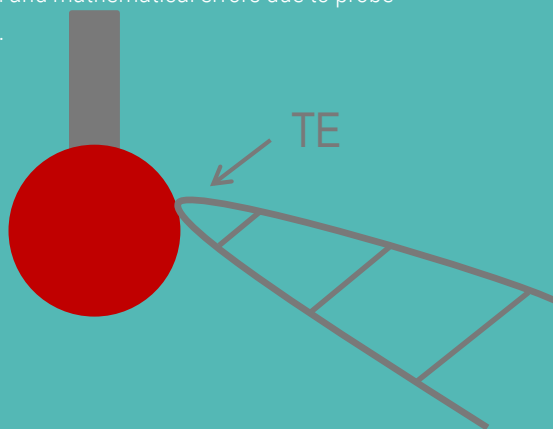
The root of this blade must have tight tolerances on finish ground surfaces. The physical features themselves are also very close to each other, presenting challenges for workholding and access for measurement.

The WENZEL CORE system is able to manage this in a fast and accurate way.



## Challenge 3: Sharp edges

Leading and trailing edges on our study piece are made of very small profiles, and measuring these sharp edges with touch probe can be difficult. By using the white light dot sensor leading and trailing edge can be measured without any problems. Physical and mathematical errors due to probe contact are eliminated.



## Challenge 4: 100% measurement

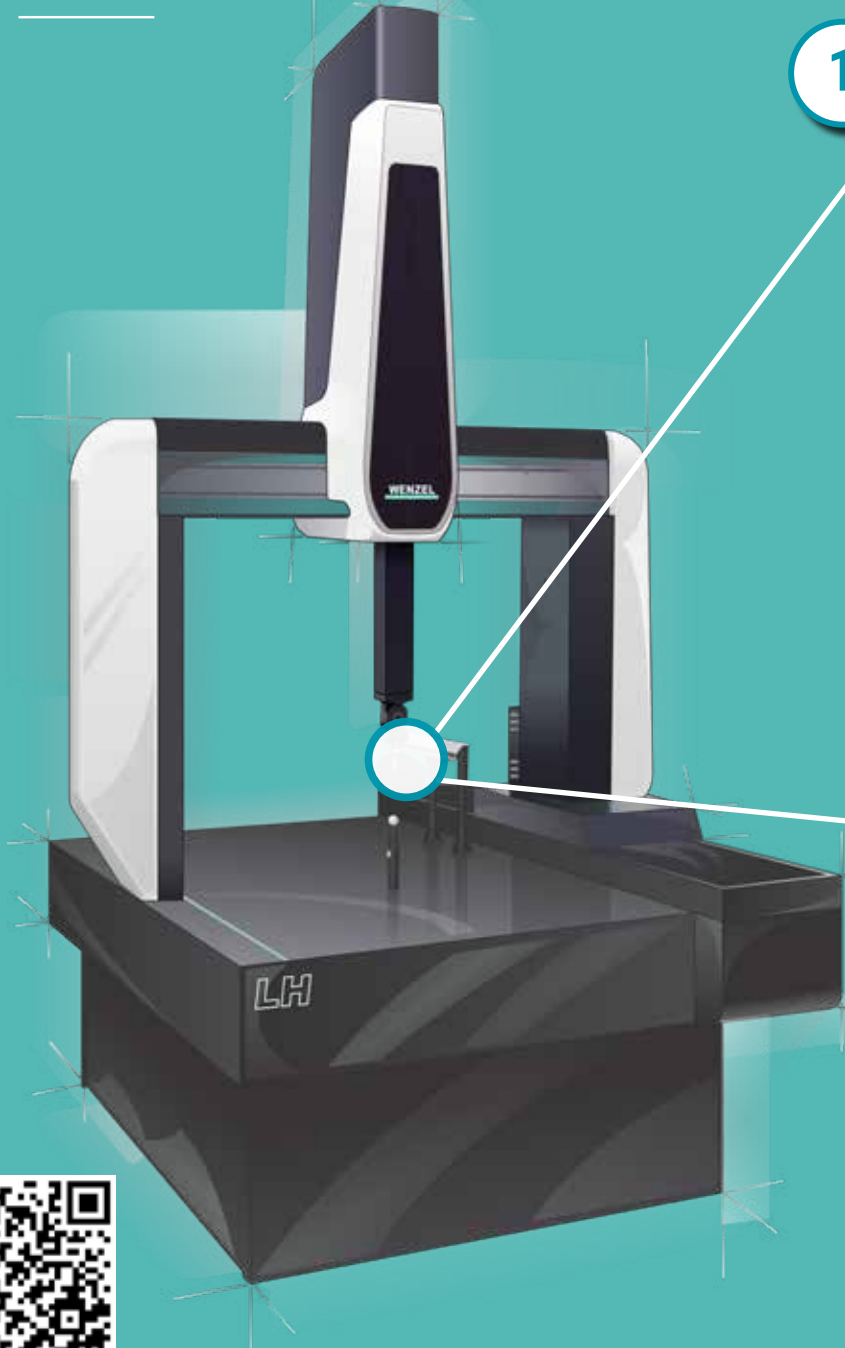
Because of the often required 100% measurement of the blades, measuring time is a critical issue.

The WENZEL Core System measures fast and accurately.

# OUR SOLUTIONS

## THE LH SERIES

WITH SP25M & REVO



1



### SP25M

The most compact and versatile probe system for scanning on a global scale.

2



### Revo

The revolutionary 5-axis probe system REVO™ coupled with WM | QUARTIS provides an extremely fast high scanning speed solution with a high degree of measurement flexibility, and thus an extremely high throughput.





# FOR YOUR BLADES

## THE CORE SERIES

WITH WM | HS & WM | DS



3



### WM | HS

WM | HS is a hybrid sensor, which fulfills your measuring task at top speed by the combination of optical and tactile at a CORE with a 5-axis scanning

4



### WM | DS

The WM | DS is based on a double-eye principle which enables the precise measurement of particularly small radii.



# RESULTS

## OF TEST MEASUREMENT

	Core	LH with REVO	Deviation
ID			
MX1_A	-0,072	-0,071	-0,001
MX2_A	-0,050	-0,049	-0,001
MX3_A	-0,064	-0,065	0,000
MX4_A	-0,058	-0,056	-0,002
MX5_A	-0,083	-0,082	-0,001
MY1_A	-0,051	-0,050	0,000
MY2_A	0,292	0,292	0,000
MY3_A	0,302	0,300	0,002
PX1_A	-0,074	-0,074	0,000
PX2_A	-0,051	-0,050	-0,002
PX3_A	-0,067	-0,066	-0,001
PX4_A	-0,057	-0,057	-0,001
PX5_A	-0,080	-0,080	0,000
PY1_A	-0,044	-0,045	0,001
PY2_A	0,299	0,299	0,001
PY3_A	0,301	0,300	0,001

### Comparison of the systems

In order to compare the performance (accuracy & speed) of the different systems we did a test measurement of a gas turbine blade on each setup. These were the results.

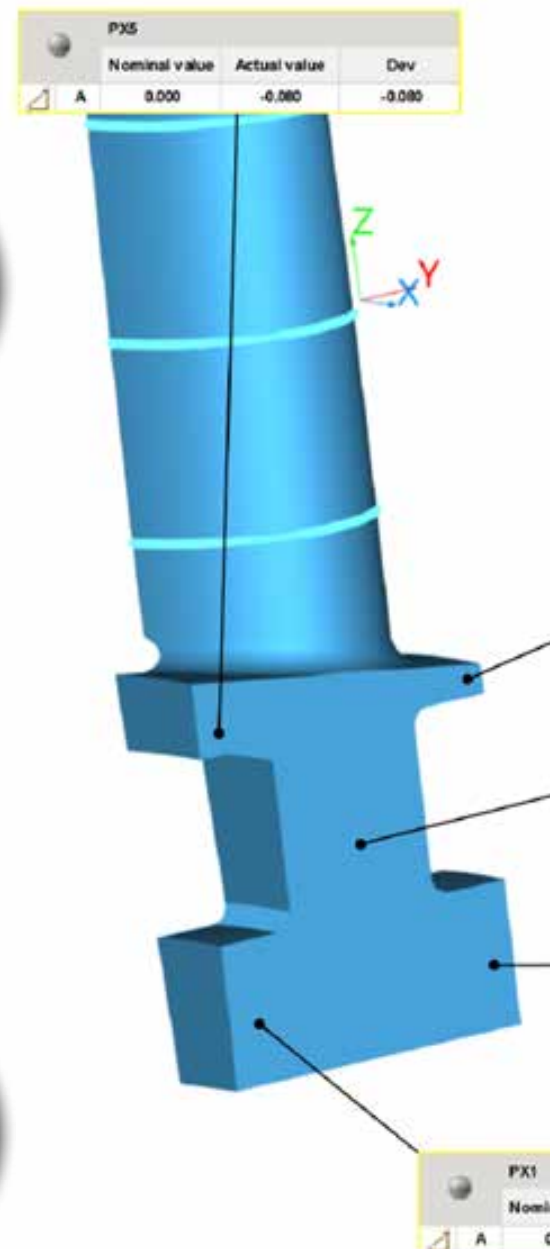
max. derivation

2  $\mu$

	Core	LH with SP 25	Deviation
ID			
MX1_A	-0,072	-0,071	-0,001
MX2_A	-0,050	-0,049	-0,001
MX3_A	-0,064	-0,065	0,000
MX4_A	-0,058	-0,057	0,000
MX5_A	-0,083	-0,083	0,000
MY1_A	-0,051	-0,054	0,003
MY2_A	0,292	0,287	0,004
MY3_A	0,302	0,299	0,003
PX1_A	-0,074	-0,074	0,000
PX2_A	-0,051	-0,051	0,000
PX3_A	-0,067	-0,068	0,000
PX4_A	-0,057	-0,058	0,000
PX5_A	-0,080	-0,080	0,000
PY1_A	-0,044	-0,048	0,004
PY2_A	0,299	0,296	0,004
PY3_A	0,301	0,297	0,004

max. derivation

4  $\mu$





PX4			
	Nominal value	Actual value	Dev
A	0,000	-0,058	-0,058

PX3			
	Nominal value	Actual value	Dev
A	0,000	-0,068	-0,068

PX2			
	Nominal value	Actual value	Dev
A	0,000	-0,052	-0,052

	Nominal value	Actual value	Dev
	0,000	-0,075	-0,075

	LH with SP25	LH with REVO	Deviation
ID			
MX1_A	-0,071	-0,071	0,000
MX2_A	-0,049	-0,049	-0,001
MX3_A	-0,065	-0,065	0,000
MX4_A	-0,057	-0,056	-0,001
MX5_A	-0,083	-0,082	-0,001
MY1_A	-0,054	-0,050	-0,004
MY2_A	0,287	0,292	-0,004
MY3_A	0,299	0,300	-0,001
PX1_A	-0,074	-0,074	0,000
PX2_A	-0,051	-0,050	-0,001
PX3_A	-0,068	-0,066	-0,001
PX4_A	-0,058	-0,057	-0,001
PX5_A	-0,080	-0,080	0,000
PY1_A	-0,048	-0,045	-0,003
PY2_A	0,296	0,299	-0,003
PY3_A	0,297	0,300	-0,003

max. derivation

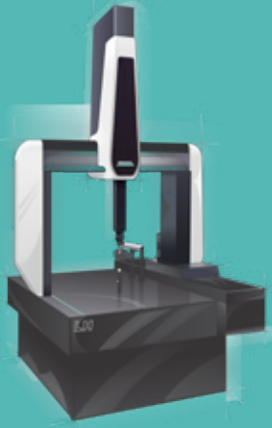
3  $\mu$



# RESULTS

## OF TEST MEASUREMENT

LH with Revo

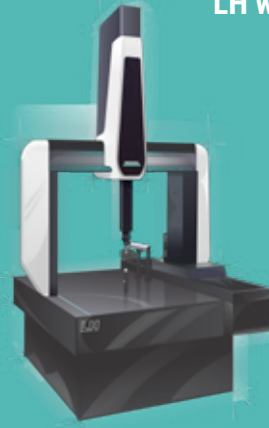


+



VS

LH with SP25M



+

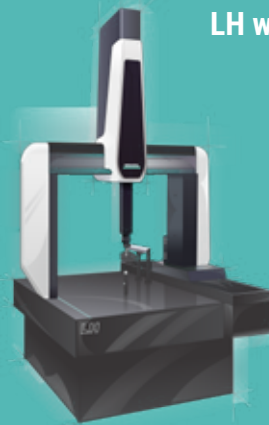


CORE



VS

LH with Revo



+

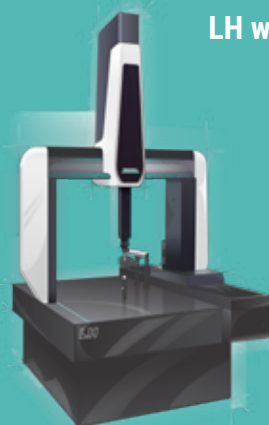


CORE



VS

LH with SP25M



+



## Flexibility vs Simplicity

The LH combined with the REVO from Renishaw is the most flexible system in this comparison. The system can measure almost any part with high accuracy. The LH with SP25 combines almost the same performance (40 sec. slower | 3  $\mu$  max. derivation) while offering much lower entry costs than its REVO equipped counterpart. Though with a traditional 3 + 2 probing system it offers less flexibility than the LH with Revo.



## Performance vs Flexibility

The WENZEL CORE is THE expert when it comes to measuring turbine blades. It outperforms other systems by far in terms of speed (less than half the measuring time) while offering no accuracy loss (2  $\mu$  max. derivation). The CORE is tailor made for parts with shiny features and features that are hard to reach for any other measuring system, which makes it less flexible for other applications, but ideally suited for turbine blades and other critical applications like medical implants.



## Performance vs Simplicity

This test is a comparison of a purpose built system, the CORE, versus more flexible and traditional systems, LH CMM. In any such comparison many factors contribute to the outcome. Speed, Cost, Adaptability, and Ease of Use are all factors to be considered in determining what is the best system to support your manufacturing process.



Performance



LH with SP25M

- Lowest investment
- Good accuracy but lower speed
- High flexibility



Inv



CORE



- Specialized for blades
- Highest performance
- Medium investment

LH with Revo



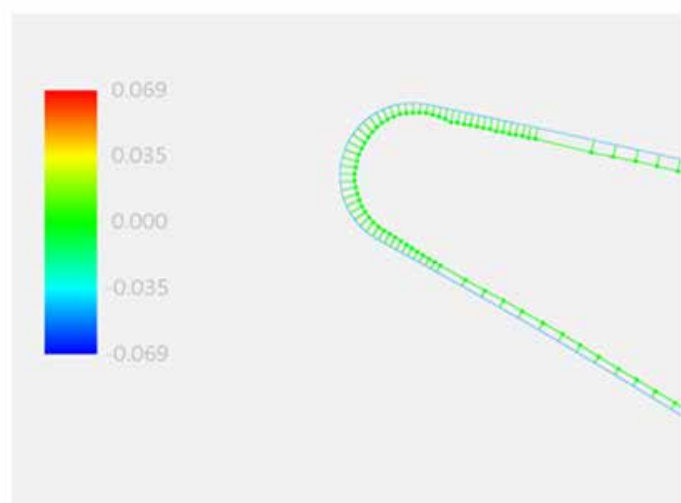
- Highest flexibility
- Medium investment
- High accuracy but lower speed

Investment

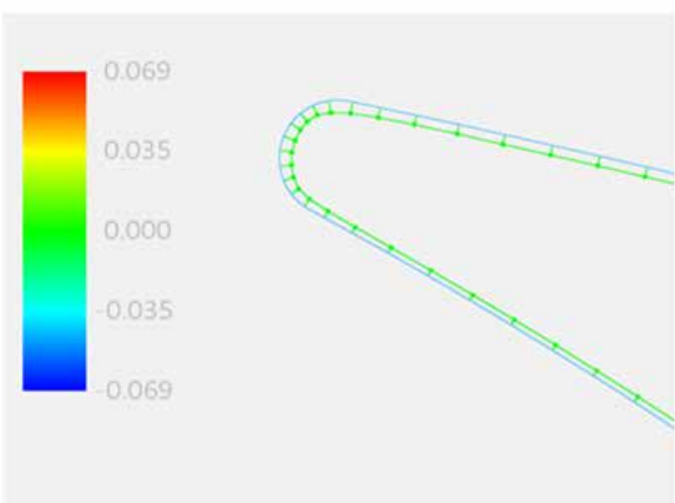
# RESULTS

## OF TEST MEASUREMENT

### Comparison of nominal and actual data (trailing edge)

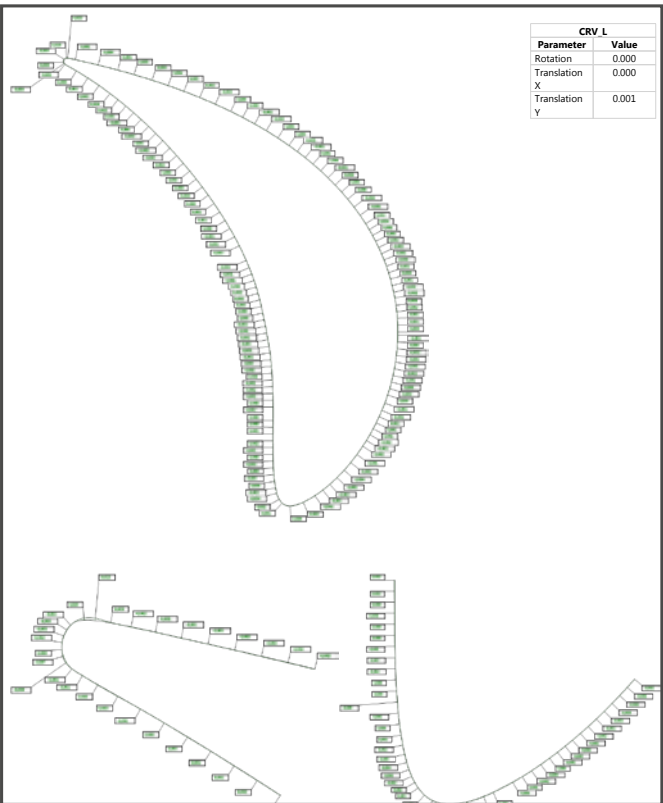


LH Series:  
The contour has some spikes in the edge area

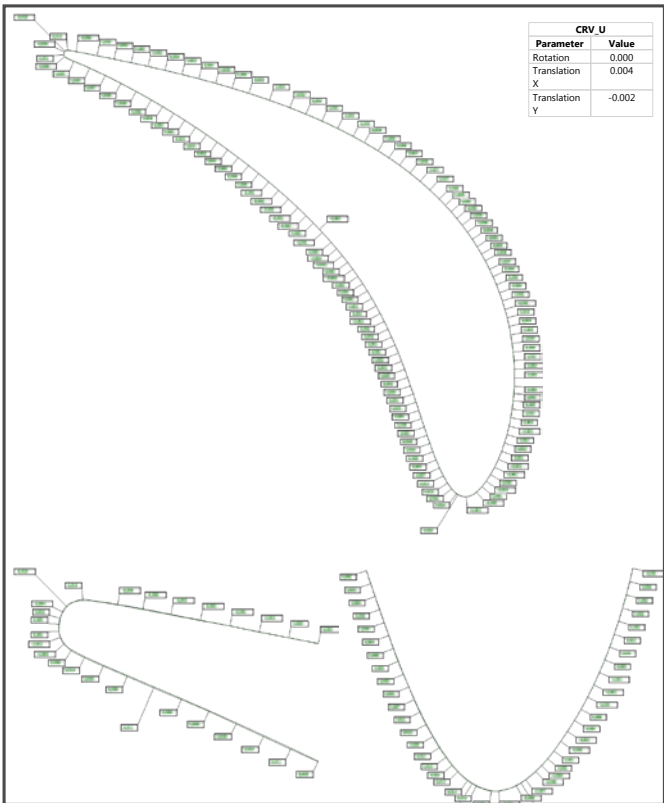


CORE Series:  
The contour is quite similar to the nominal curve

### Report comparison CORE vs. LH + SP25



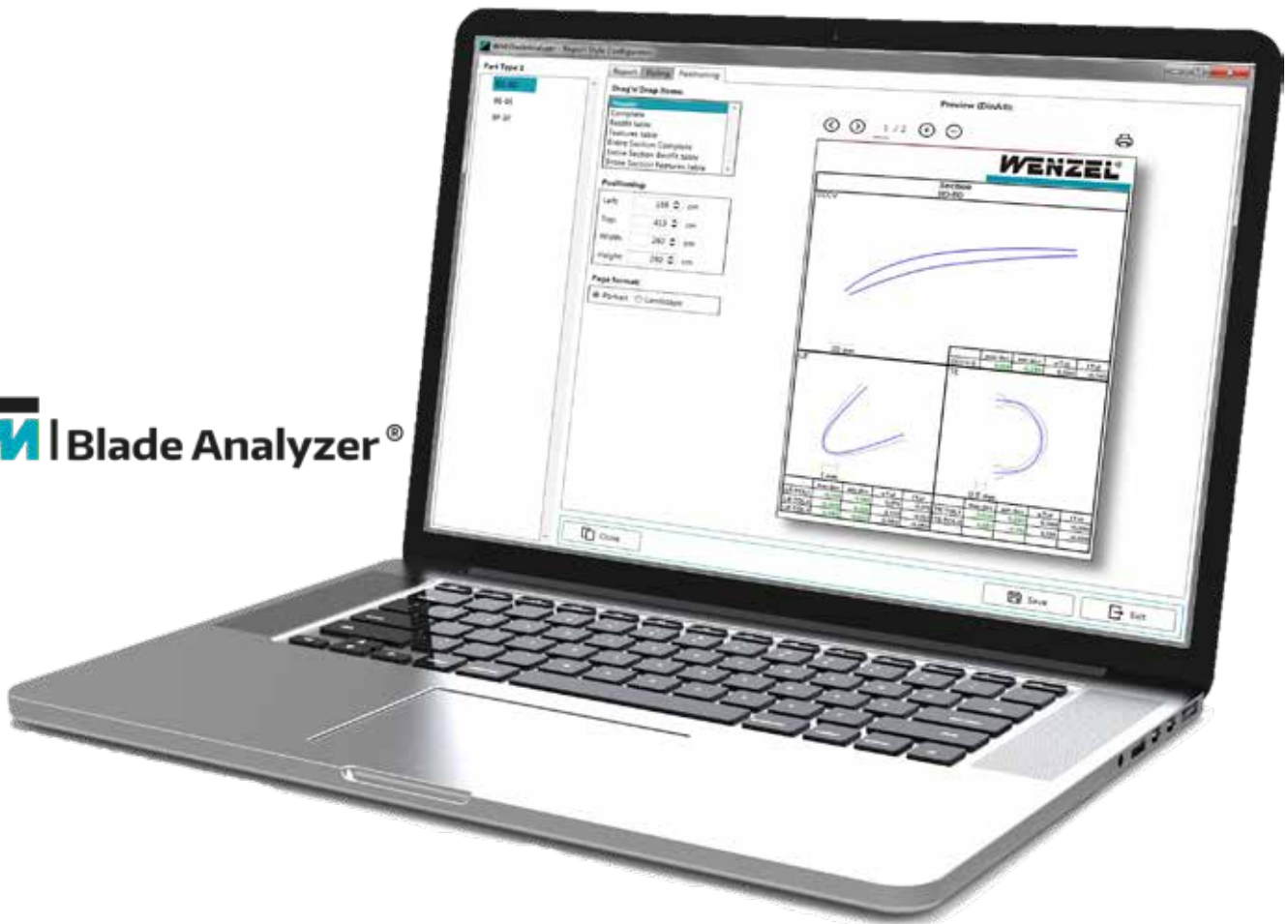
### Report comparison CORE vs. LH + REVO



# WM | BLADE ANALYZER

For turbine blade evaluation

**WM | Blade Analyzer®**



## YOUR ADVANTAGES AT A GLANCE

### ■ User-friendly data management

Input of parameters, evaluation specifications and tolerances | Any number of workpieces can be stored | Import / export of blade data including individual tolerances and evaluation specifications

### ■ Extensive evaluation possibilities

Support of recognized standards | Individual selection or deselection integrated standard evaluations | Bestfit operator for entire cuts or individual cut segments | Maximum flexible and configurable evaluation of point deviations

### ■ Interactive measurement report generation

Freely configurable report with display of any blade, foot or head section | Use templates for other blade types

### ■ High flexibility

Fully automatic measuring sequence | Flexible solution for the analysis of sheet sections | Seamless integration into any environment - defined by measuring machine type, measuring program and software



# ADVANTAGES

## OF THE CORE SERIES



### Accuracy - Up to 100%

As seen on the pages before the CORE offers almost no accuracy loss compared to tactile measurement solutions!



### Speed - More than 200%

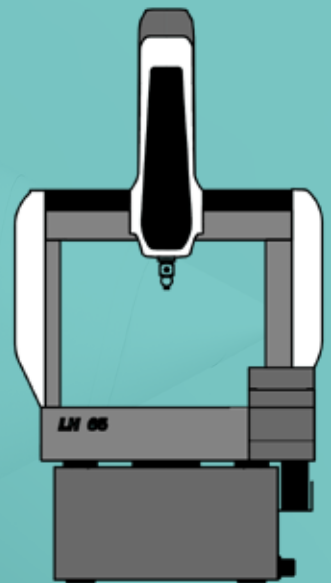
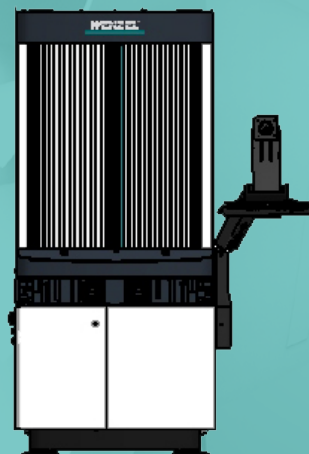
CORE high speed scanning system cuts more than half of the blade measuring time in comparison with tactile CMM

Measuring System	Measuring Time [mm:ss]
CORE D + WM   DS	03:00
CORE D + WM   HS	03:15
LH 87 + REVO	06:12
LH 87 + PH10 + SP25	06:52



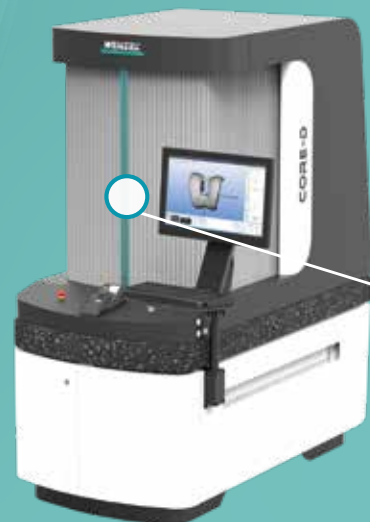
## Footprint

The CORE offers an optimized footprint and fits in small production places!



## No probe radius compensation

By using CORE with white light dot sensor probe radius compensation becomes no longer necessary



## INNOVATION MEETS TRADITION

The WENZEL Group is a market leader in innovative Metrology. WENZEL offers a comprehensive product portfolio in the fields of Coordinate Metrology, Computed Tomography and Optical High Speed Scanning. The technology of WENZEL is used in all industries, including the automotive sector, aeronautics, power generation and

medicine. WENZEL looks at today on an installed base of more than 10,000 machines worldwide. Subsidiaries and agencies in more than 50 countries support sales and provide after-sales service for our customers. The WENZEL Group today employs more than 600 people.



## YOUR LOCAL CONTACT PERSON

### WENZEL GROUP GMBH & CO. KG

Werner-Wenzel-Straße

97859 Wiesthal

Phone: +49 6020 201-6006

E-Mail: [sales@wenzel-group.com](mailto:sales@wenzel-group.com)

We are there for you worldwide. You can find our subsidiaries, sales and service partners at **[www.wenzel-group.com](http://www.wenzel-group.com)**.

Follow us & stay up to date!

