VISUALIZING EDDY CURRENT; COMBINING EDDY CURRENT AND C-SCAN

AGENDA

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- Eddy Current History
- Foerster Group
- Understanding Eddy Current Theory
- Challenges to Traditional Eddy Current
- Combining C-Scan and Eddy Current with STATOVISION CM
- Features
- Test Environment
- Basic Setup
- Testing procedure/data collection
- Application Studies
- Edge Effect Suppression
- Summary

FOERSTER GROUP HISTORY

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Prof. Dr. phil. Dr.-Ing. h. c. mult.

FRIEDRICH FÖRSTER

* 13th February 1908, Hundisburg
† 29th March 1999, Reutlingen

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FOERSTER GROUP HISTORY

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1937

Friedrich Förster discovered the influence of the Earth's magnetic field on a detection coil of test equipment during the examination of magnetic properties of metals.

Based on this result he developed a most sensitive magnetometer, the fluxgate magnetometer, also named after him as Förster-Probe

1948

Foundation of INSTITUT DR. FOERSTER

BACK TO MAIN

FOERSTER GROUP NUMBERS & FACTS

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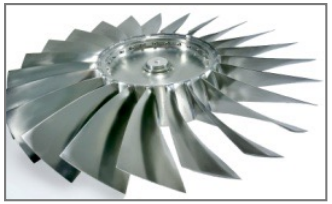

Markets

- Metal producing and metalworking industry
- Contaminated sites detection
- Space services
- Magnetic field measurements
- Aerospace
- Maintenance companies

Employees

600 world wide

Group sales per year

approx. 100 million Euro

Agencies

in more than 60 countries

Export

80% in 60 countries

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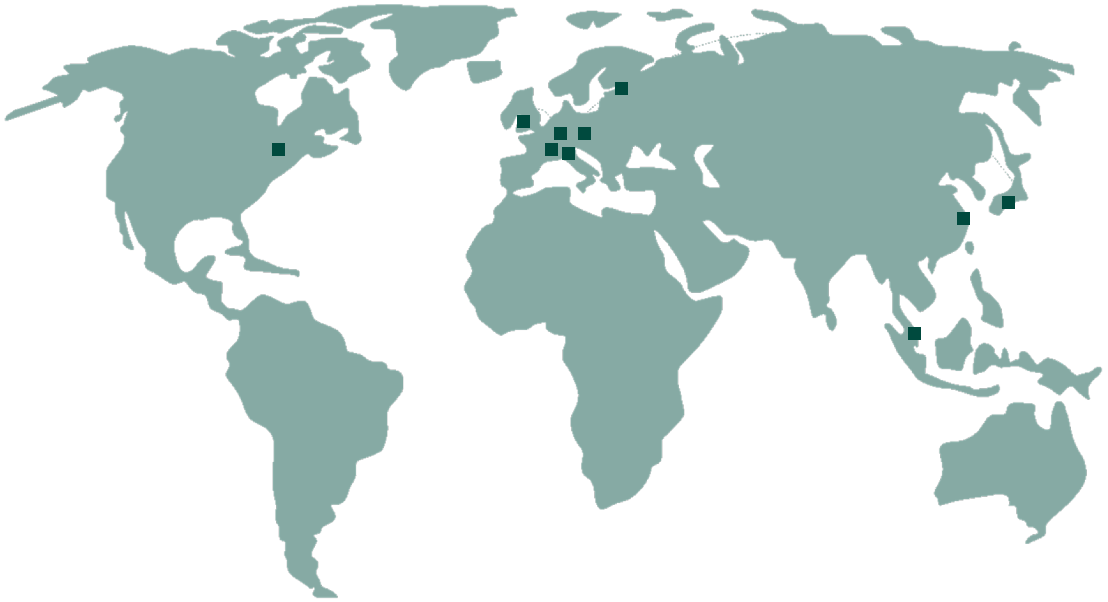
Subsidiaries



- **FOERSTER INSTRUMENTS INC.**
  USA
- **FOERSTER ITALIA SRL**
  Italy
- **FOERSTER FRANCE SAS**
  France
- **FOERSTER UK Ltd.**
  United Kingdom
- **FOERSTER TECOM, s.r.o.**
  Czech Republic
- **FOERSTER JAPAN LIMITED**
  Japan
- **FOERSTER RUSSLAND CJSC**
  Russia
- **NDT INSTRUMENTS PTE. LTD.**
  Singapore
- **FOERSTER NDT INSTRUMENTS Co., Ltd.**
  China
- **MAGNETISCHE PRUEFANLAGEN GMBH**
  Germany

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Head Office,
in Reutlingen, Germany

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UNDERSTANDING EDDY CURRENT

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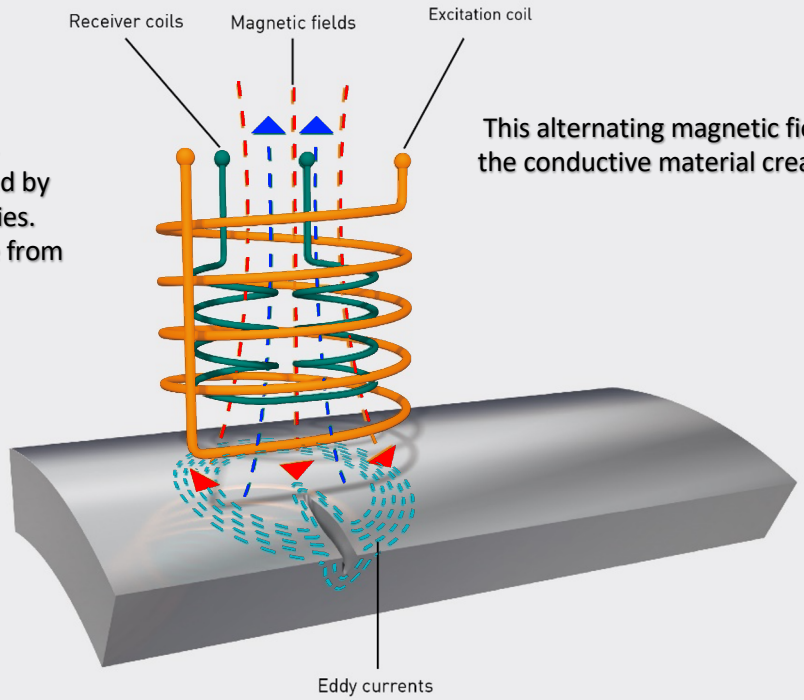
Alternating current moves through excitation coil creating an alternating magnetic field perpendicular to the direction of current flow through the coil

Two differential receiver coils receive the signal that is influenced by the material surface discontinuities. Each coil is looking for a difference from one another



This alternating magnetic field is induced into the conductive material creating eddy currents

The disturbance of the alternating magnetic field effects the coupling of the test probe and changes the impedance feedback

The eddy currents move on the surface of the conductive material because of a higher excitation frequency. Surface condition and the presence of surface defects has an effect on the magnetic field

TRANSVERSAL CRACK SIGNAL WITH DIFFERENTIAL PROBE

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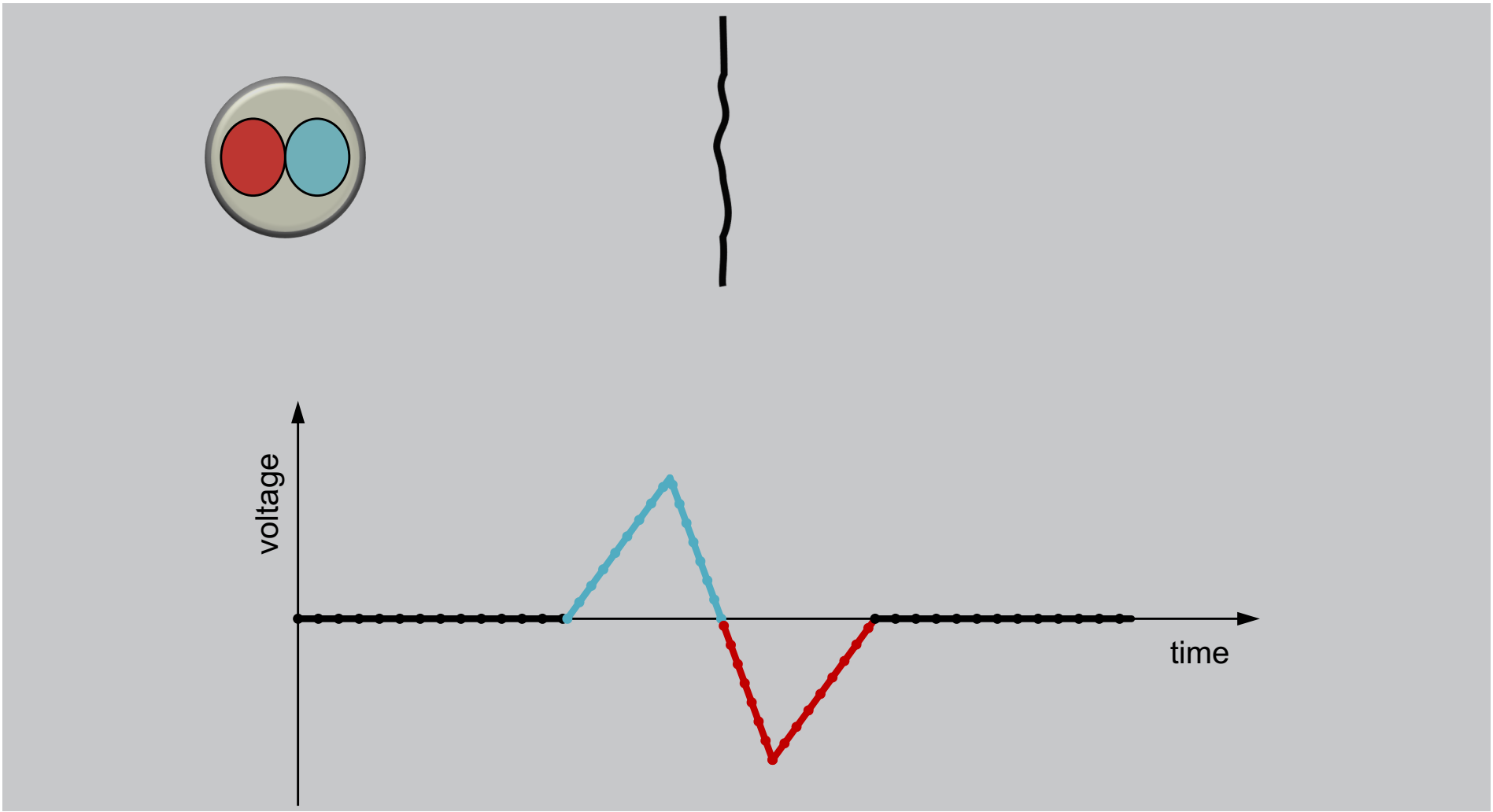

BACK TO STATOGRAPH® OVERVIEW BACK TO MAIN

PHYSICAL BACKGROUND FOR SCANNING

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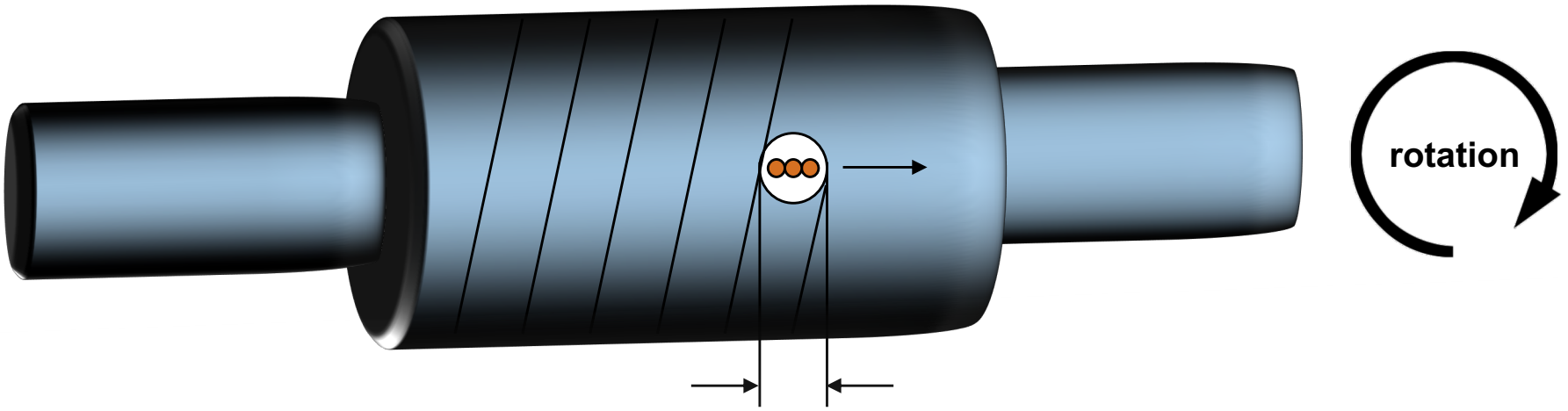
Selection of **number of probes** and **probe type**,
based on track width, defect type, defect size and defect orientation



SENSITIVITY REQUIREMENT FOR SERIES TESTING

pore detection: Ø 0,5 mm
crack detection: 5 mm (L) x 0,1 mm (D) x 0,05 mm (W)

BACK TO STATOGRAPH® OVERVIEW BACK TO MAIN

WHAT IS A REJECTABLE CONDITION?

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- Defect specifications are to be determined by the customer
- Foerster defines a defect condition as an area within a given part that creates an eddy current signal that satisfies a 3:1 signal to noise ratio
- The defective condition must be in accordance with surface condition
- We utilize a 3 threshold system during instrumentation set up and while in production
  - Allows for potential rework
  - Ex, if a certain part (or series of parts) surpasses the 2nd threshold, it can be sorted to go into a rework operation and potentially salvaged and retested
- Natural defect conditions can be used for application trials/studies, however for system builds/implementation an artificial defect must be generated
  - Generated part will be created such that the phase angle and amplitude matches the natural defect
  - Best practice to ensure master part can be replicated if necessary
  - Foerster can assist with establishing a flaw specification

CHALLENGES TO TRADITIONAL EDDY CURRENT

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- Primary challenges relating to eddy current testing
  - Part Geometry
    - Complex shapes
  - Edge effect
    - Signal effects from close proximity to hard edge of component
      - Limiting distance of scan relative to part edges (untested ends)
  - Features
    - Drilled holes
    - Keyways
    - Slots
    - Diameter variances
    - Etc.

STATOVISION CM

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STATOVISION
TEST ENVIRONMENT

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TEST DEVICE

- STATOGRAPH CM/CM+
- STATOGRAPH DS

STATOVISION CM

- Windows 10
- Intel i7 CPU 7700
- 250 GB SSD
- 32 GB RAM
- ProfiNET PCie Card
- 230V → 12V external power supply

KEY PRINCIPLES AND BASIC PROCESS

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- C-Scan representation of eddy current signals
- digital filtering with high dynamic range
- target suppression of interfering contours like drill holes, grooves, and bevels, etc.
- digital increase/decrease of sensitivity (gain) based on probe liftoff differences from steps or diameter variances
- storage and post-processing of raw data
- reporting: PDF, PNG, CSV formats
  - Simple pass/fail reporting or full detailed c-scan image/data for every piece
- acceptance according to VDI / VDE / VDMA guideline 2632, classifying image processing systems

DEVICE CONNECTIONS

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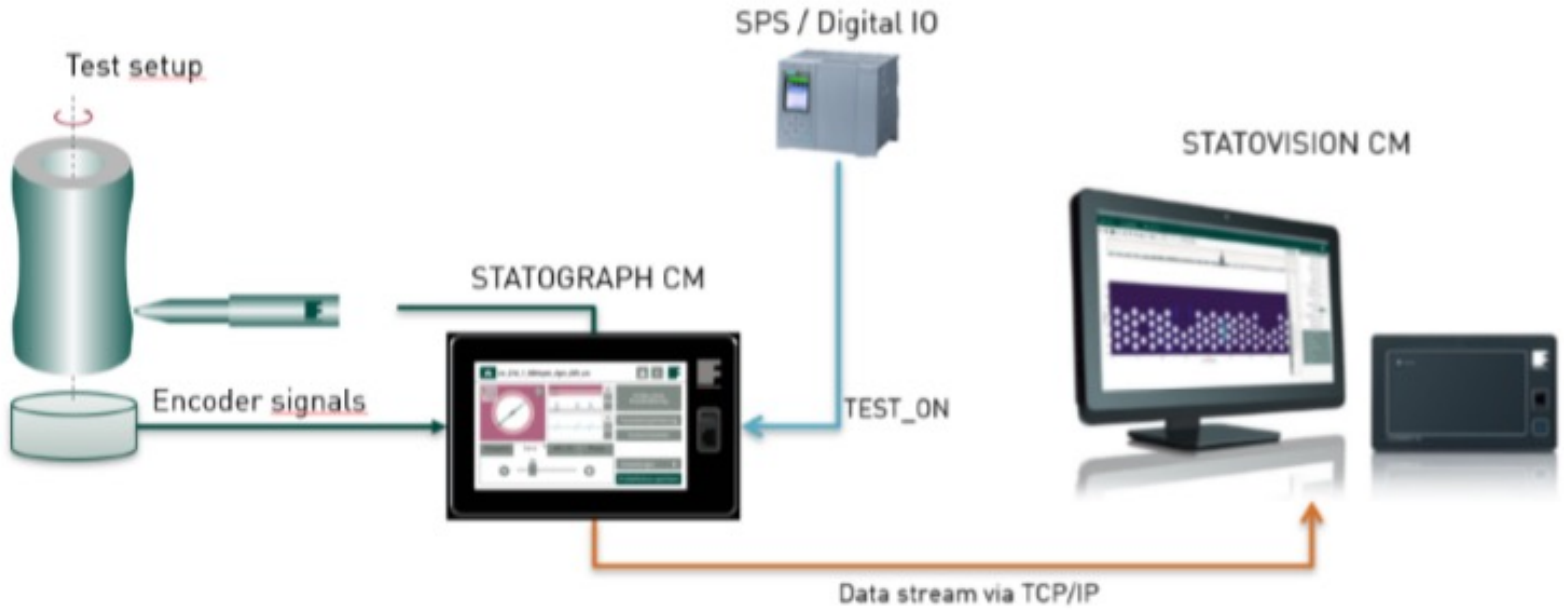

STATOVISION
CREATE A C-SCAN

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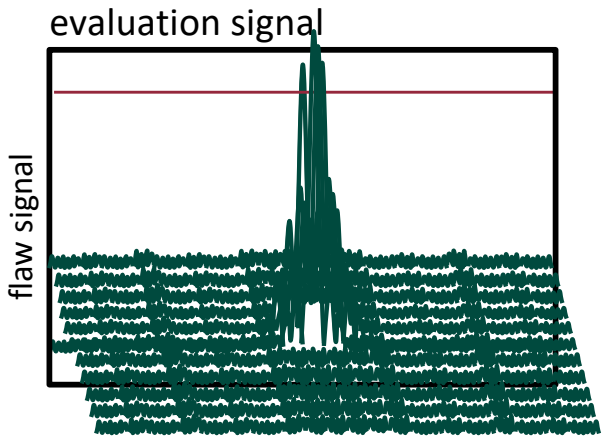

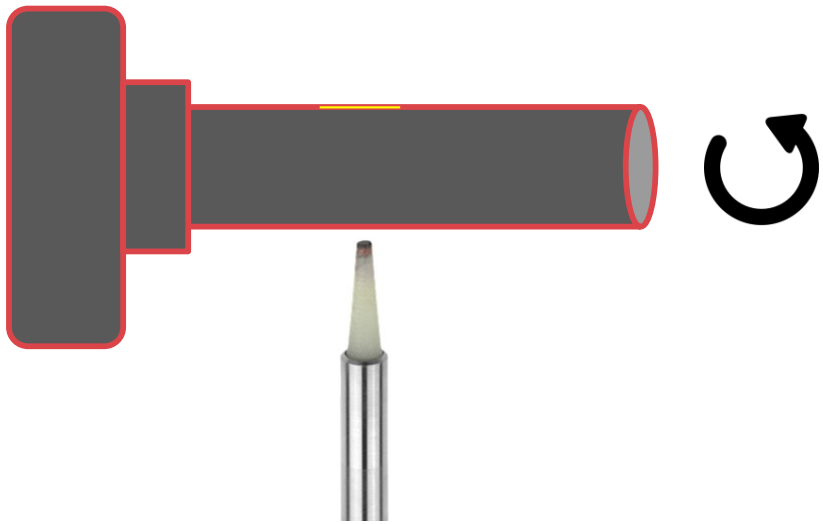

HOW IT WORKS

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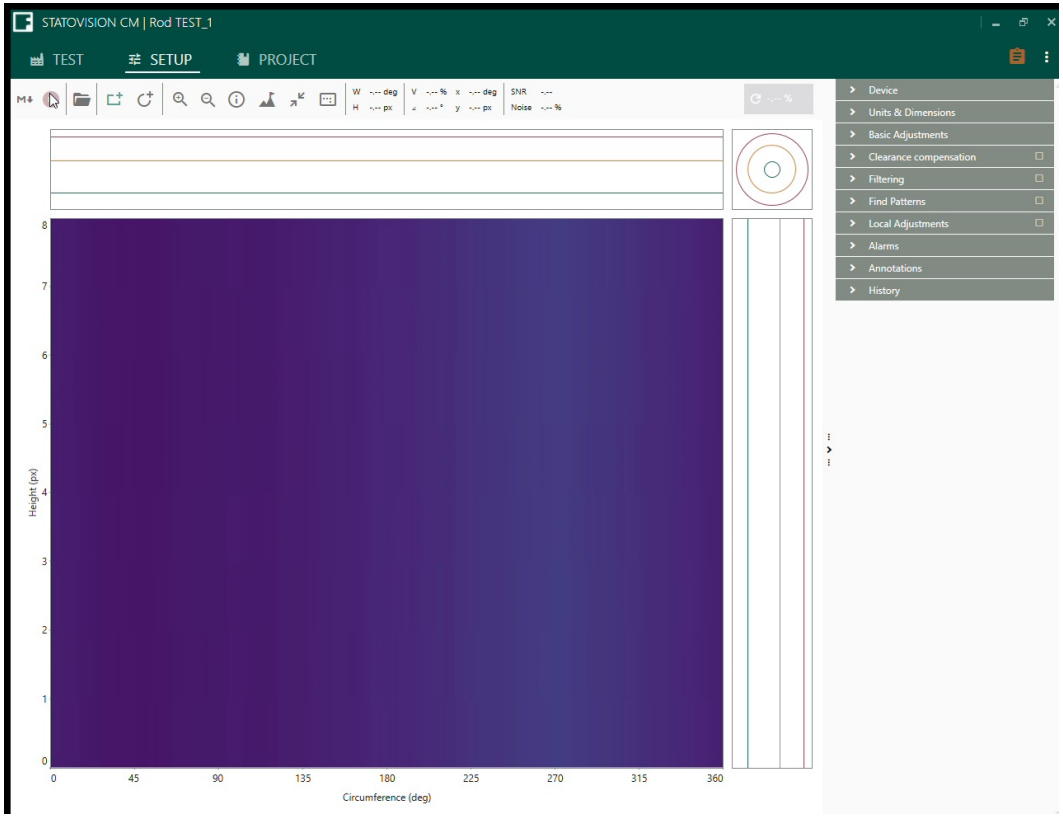
COMPLETE INITIAL SCAN



SETUP – INITIAL ADJUSTMENTS

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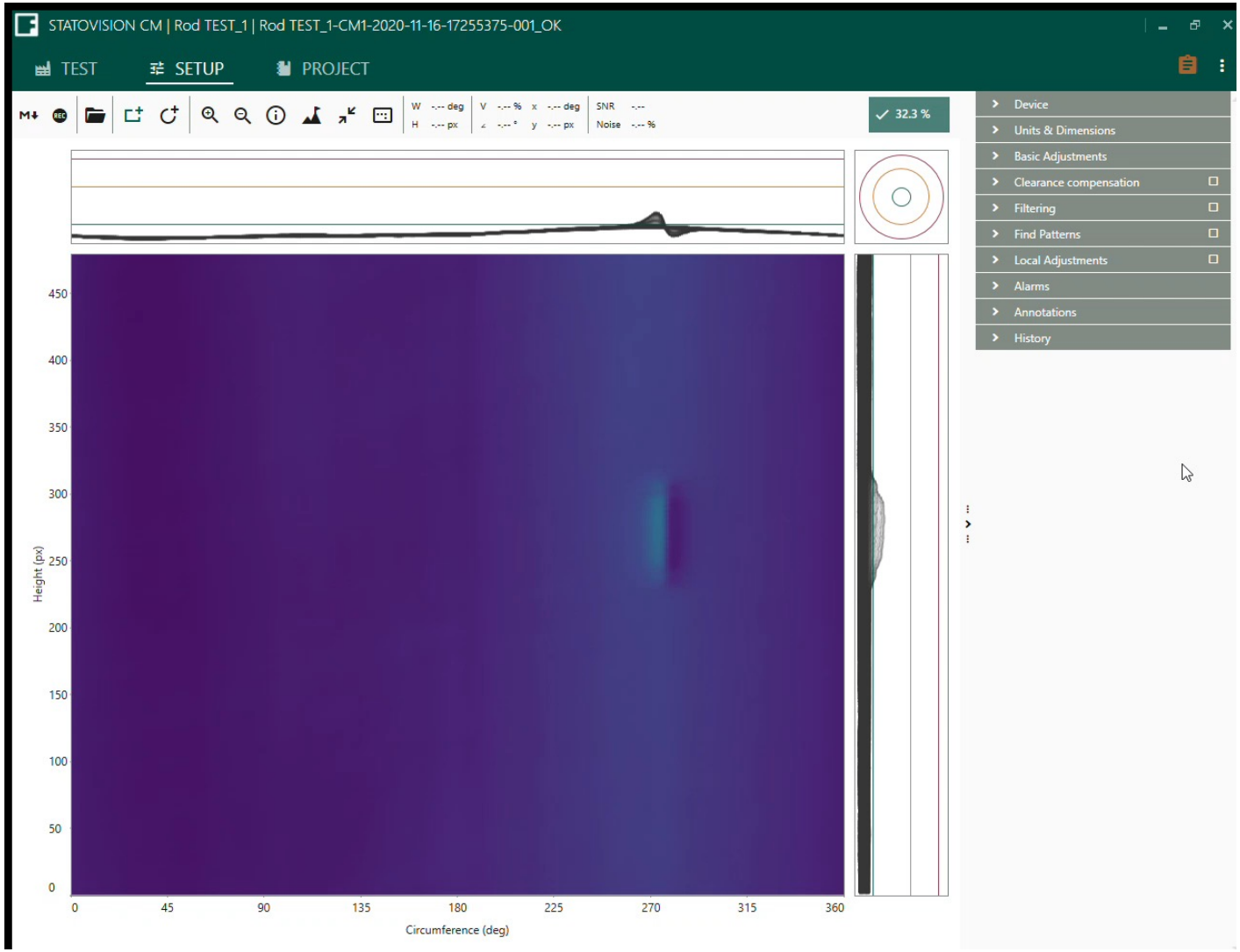

APPLICATION INITIAL SCAN

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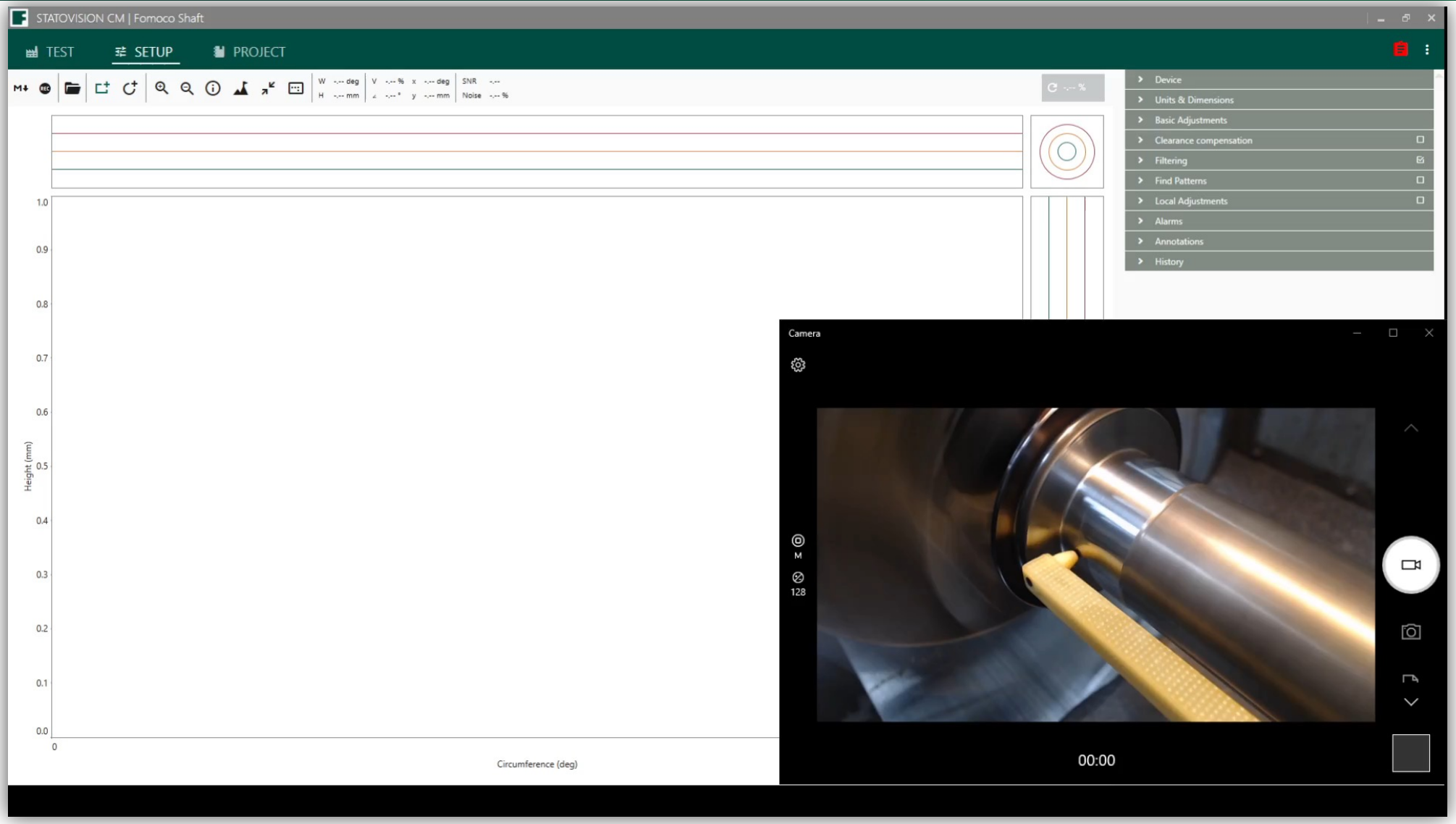

APPLICATION SAMPLE – GAIN MASK

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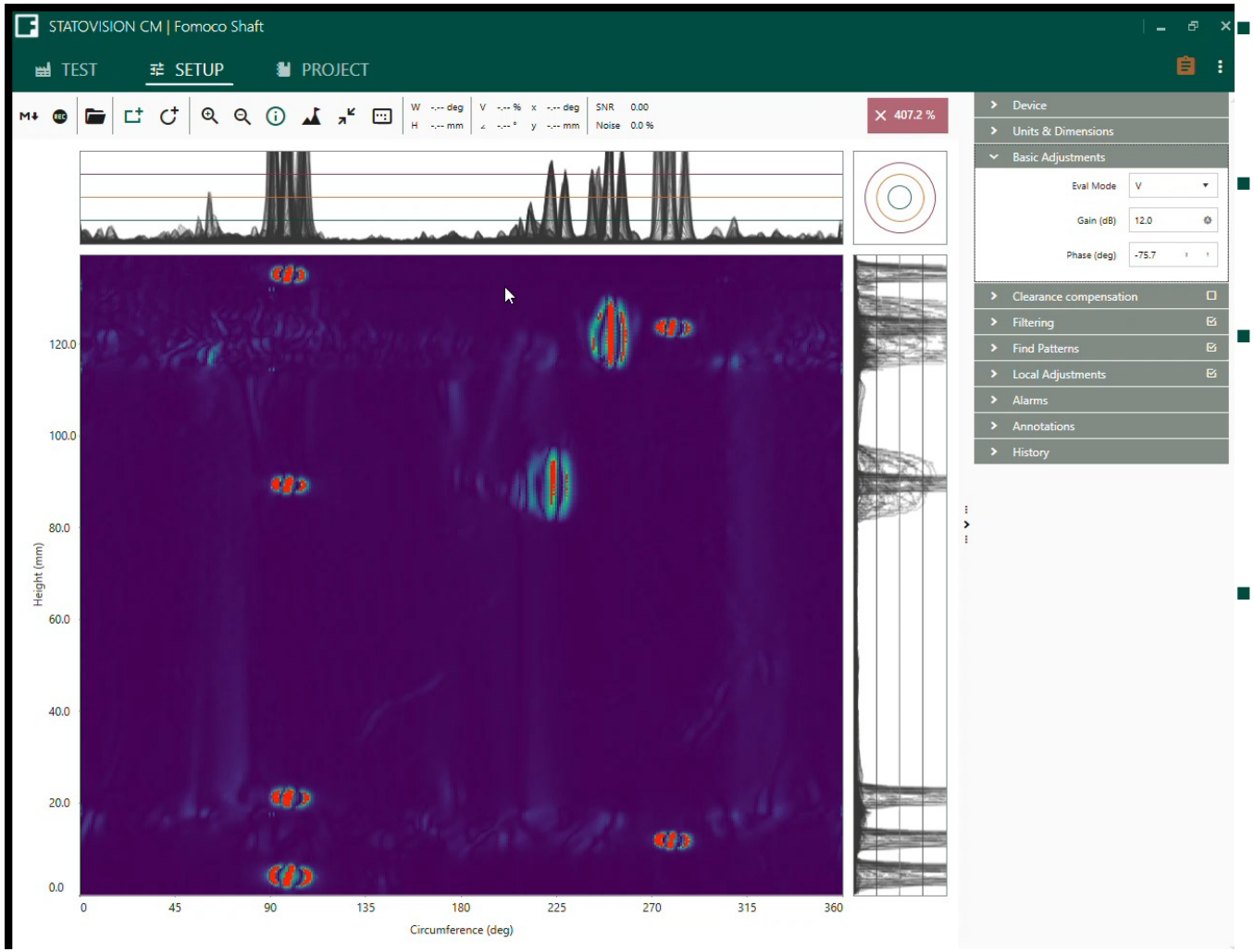

- Identify high and low areas and where they start and stop
- Create masks for all low area zones
- Create a local adjustment for each mask to increase the gain in those zones to compensate for the added distance
- Each mask can have individual gain adjustments to compensate for different probe gaps

APPLICATION SAMPLE – DEFECT ADJUSTMENT

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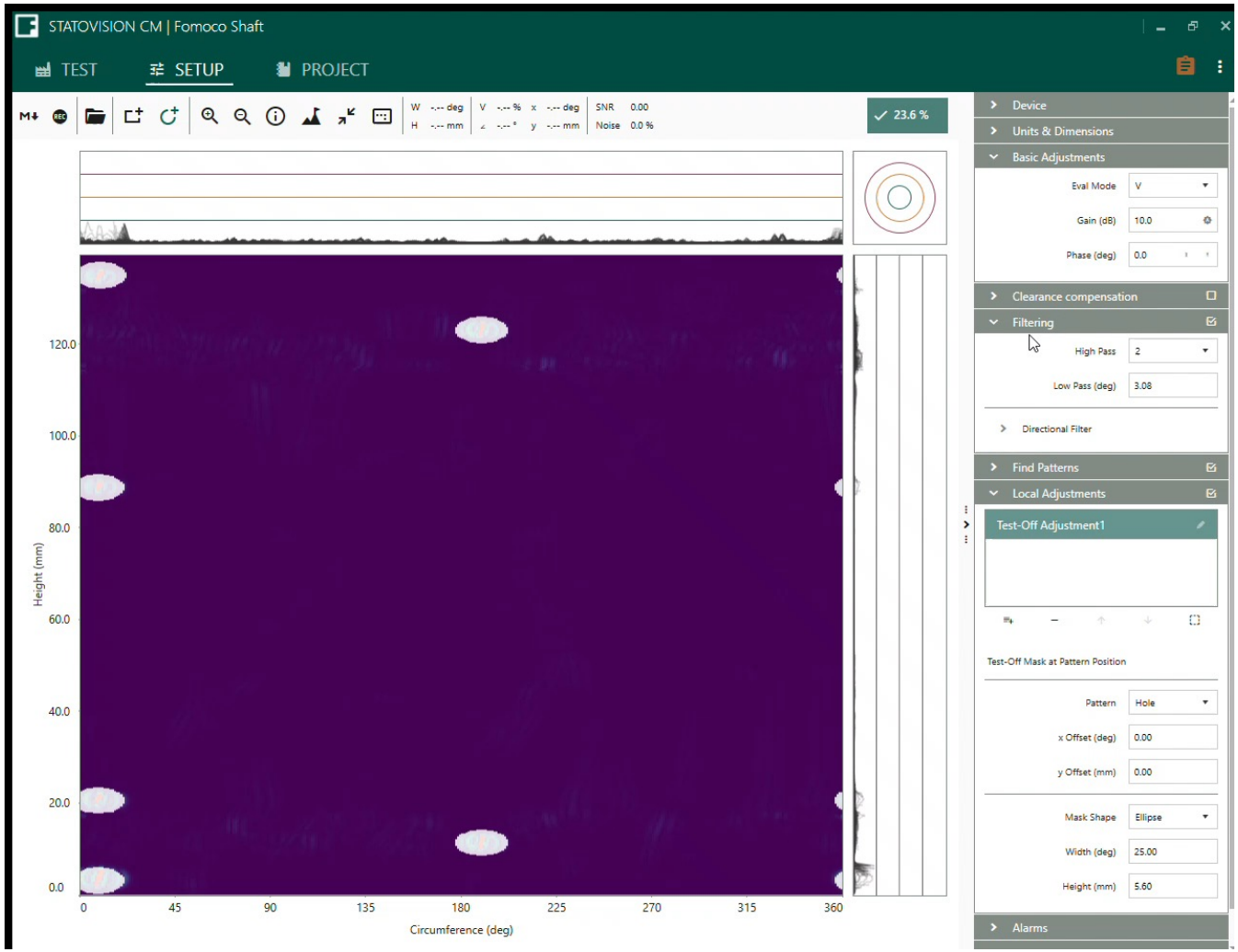

- Scan defective part
- Make gain adjustment to increase amplitude of defects to reject level
- Make mask adjustments as needed
- *note* changing the filtering at this point will void the pattern recognition
- Confirm signal to noise is adequate

APPLICATION SAMPLE – PHASE ANGLE ADJUSTMENT

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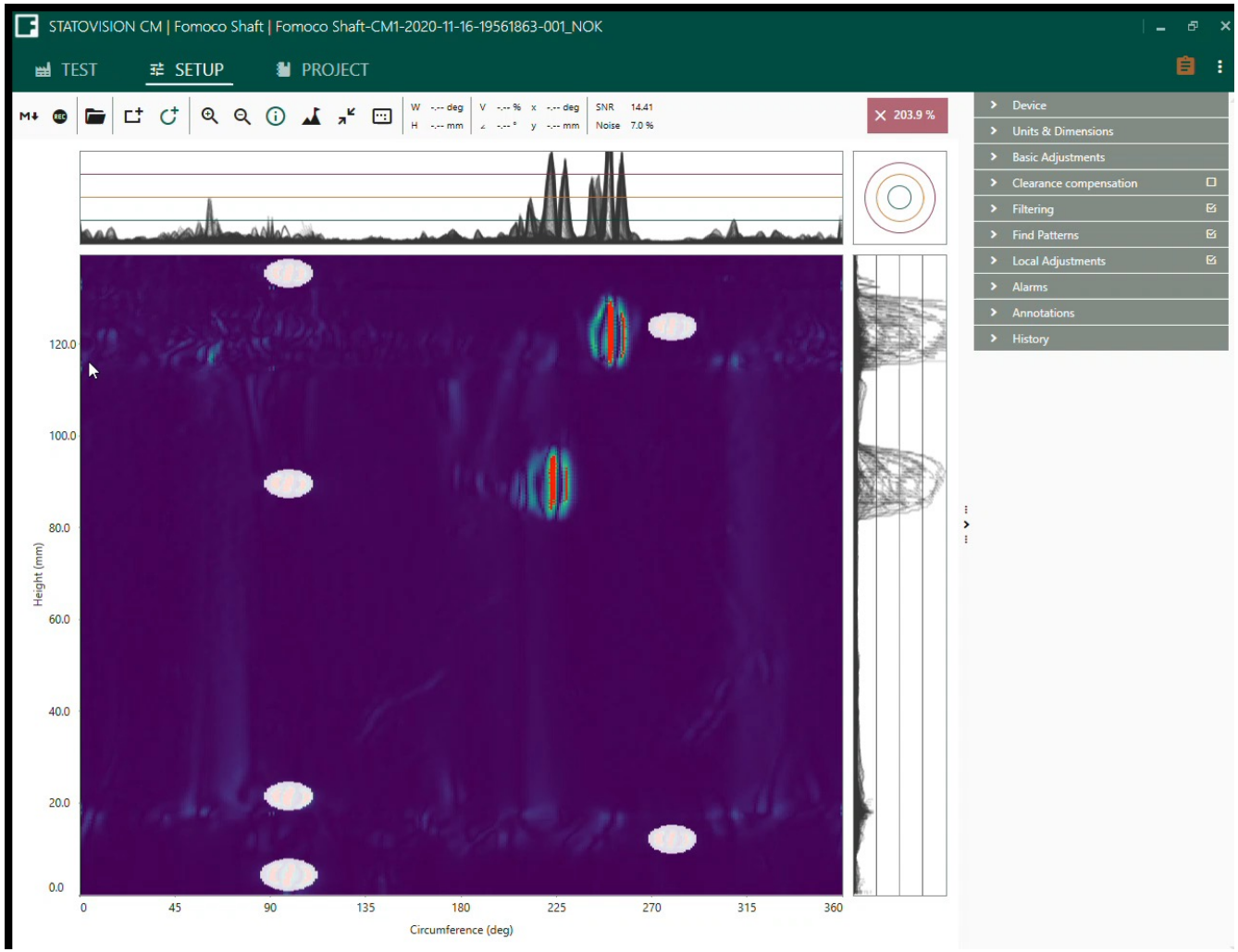

- Make selection of defect or feature signal on c-scan image
- Open “Basic adjustments” tab
- Select the small “X” or “Y” automatic phase angle adjustment icons in the box next to “Phase (deg)”
- Make finer adjustments by manually entering in degrees between 0 and 360

STATOVISION – EXAMPLE: BRAKE DISCS

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Scanning…

STATOVISION – EXAMPLE: SCAN OF A SHAFT WITH BOREHOLES

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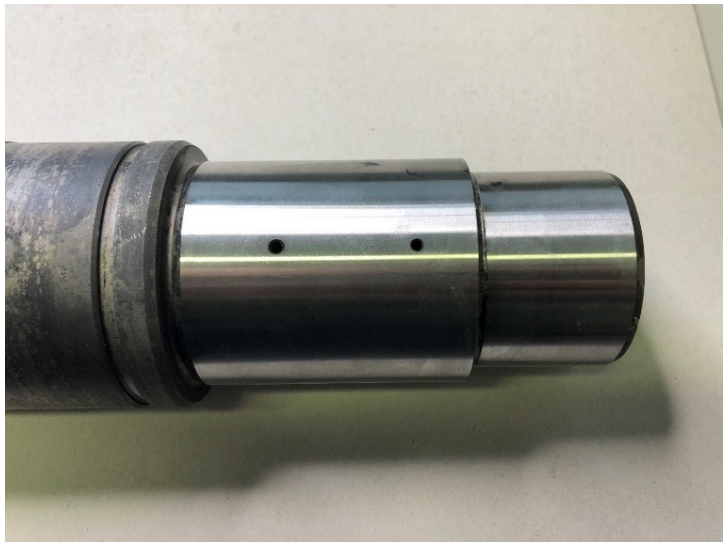

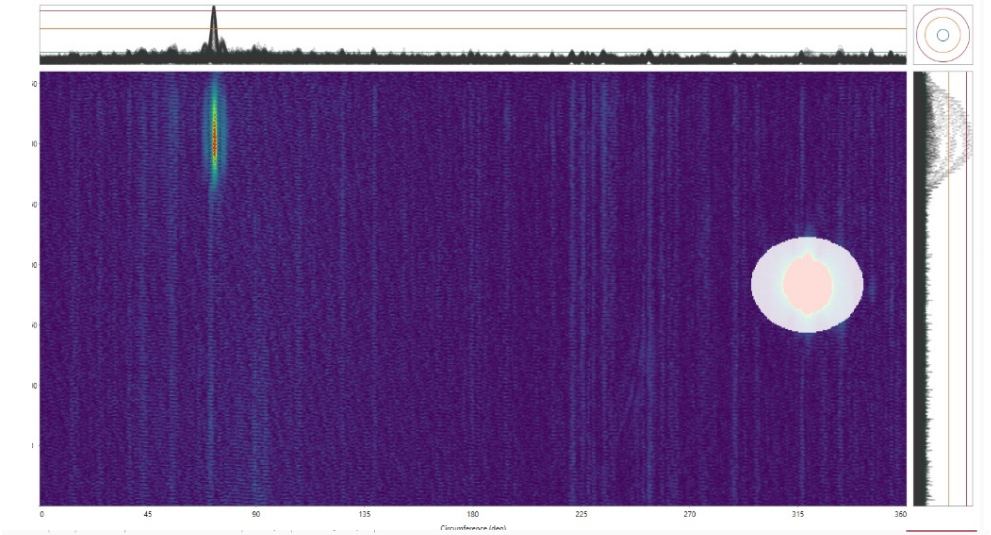

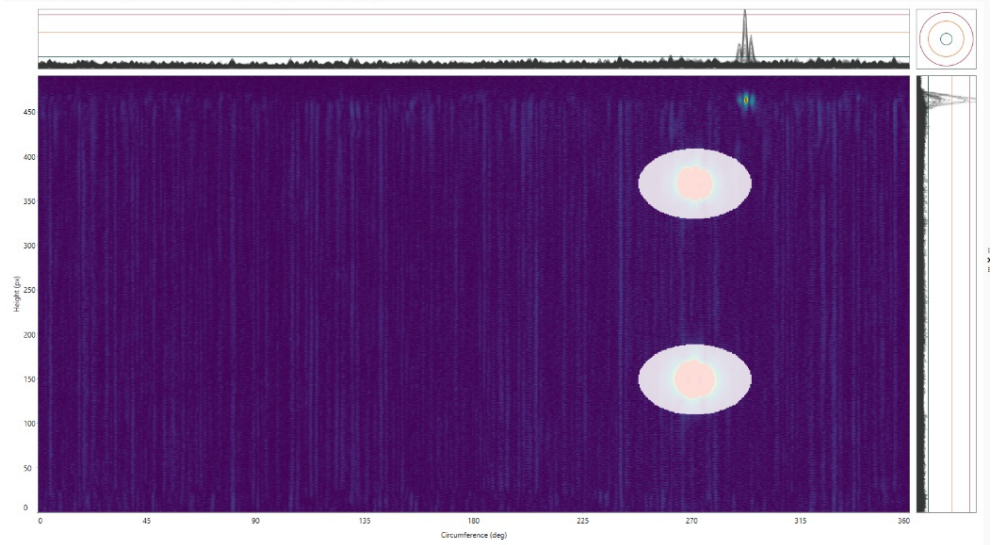

- Defect indication on the edge from the shaft
- Major advantage by using digital filtering
- Increased SNR in camparison to classical testing

EDGE EFFECT SUPRESSION

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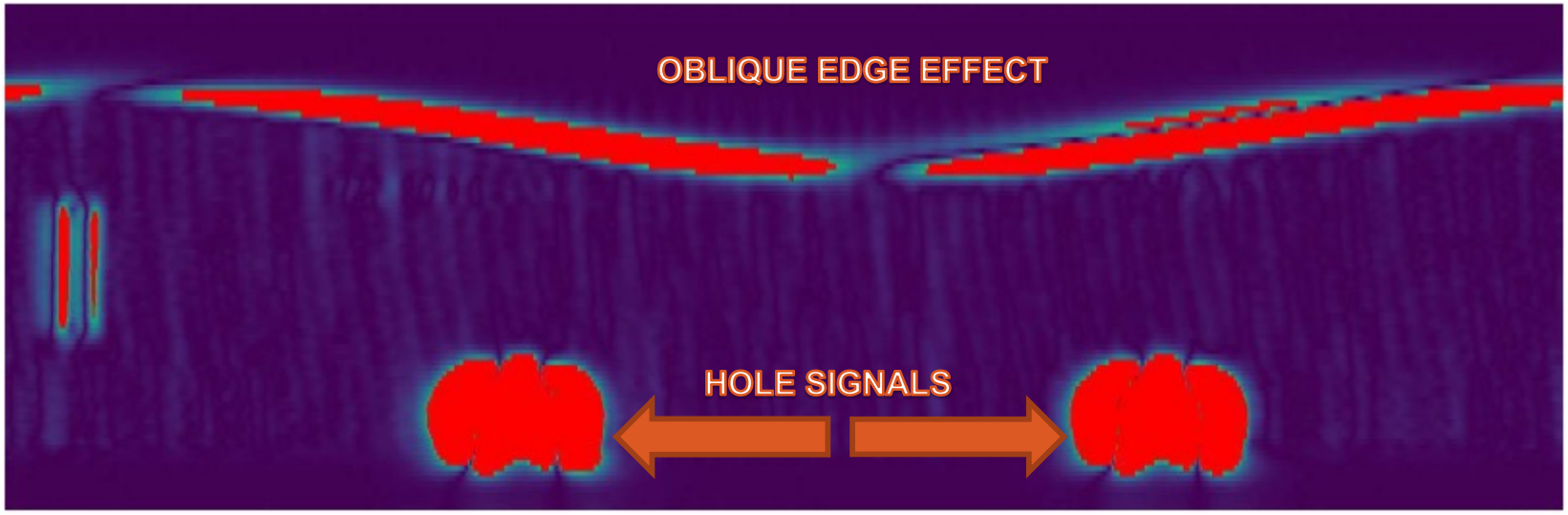

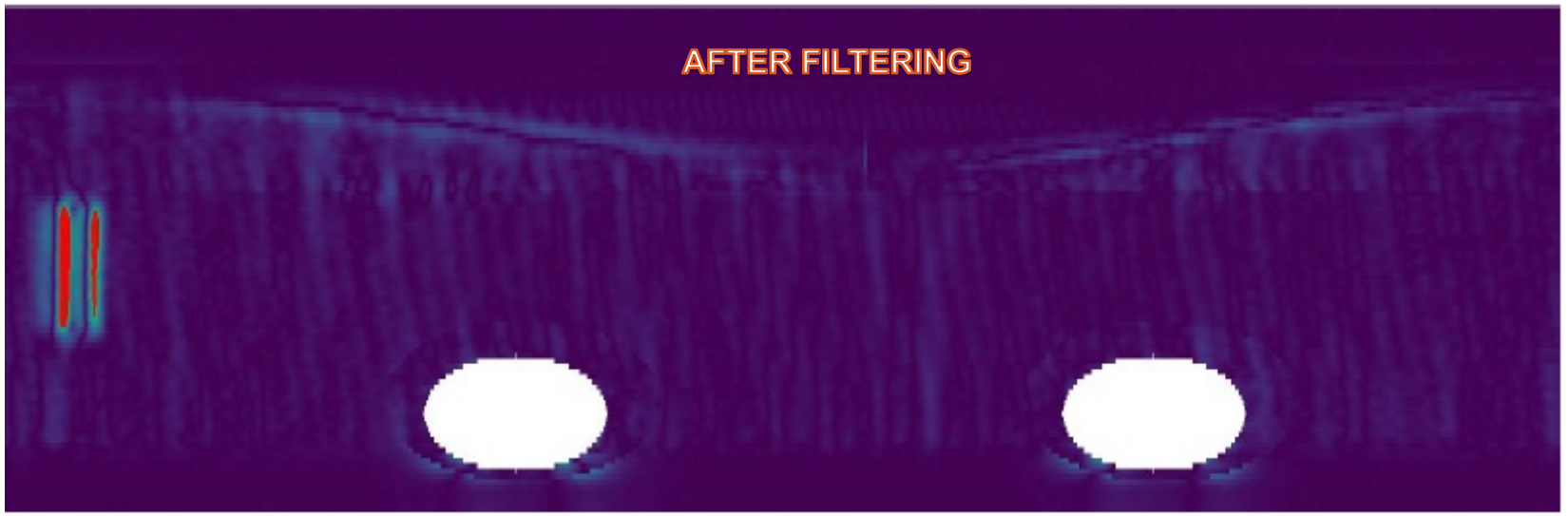

STATOVISION – EXAMPLE: PUMP WHEEL

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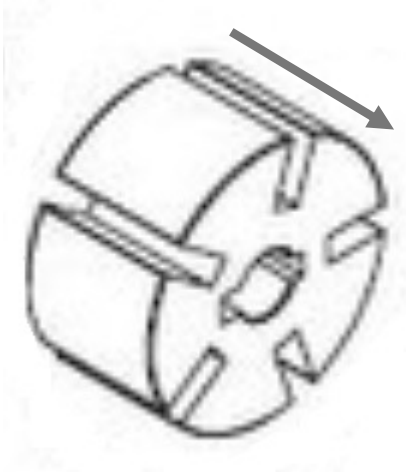
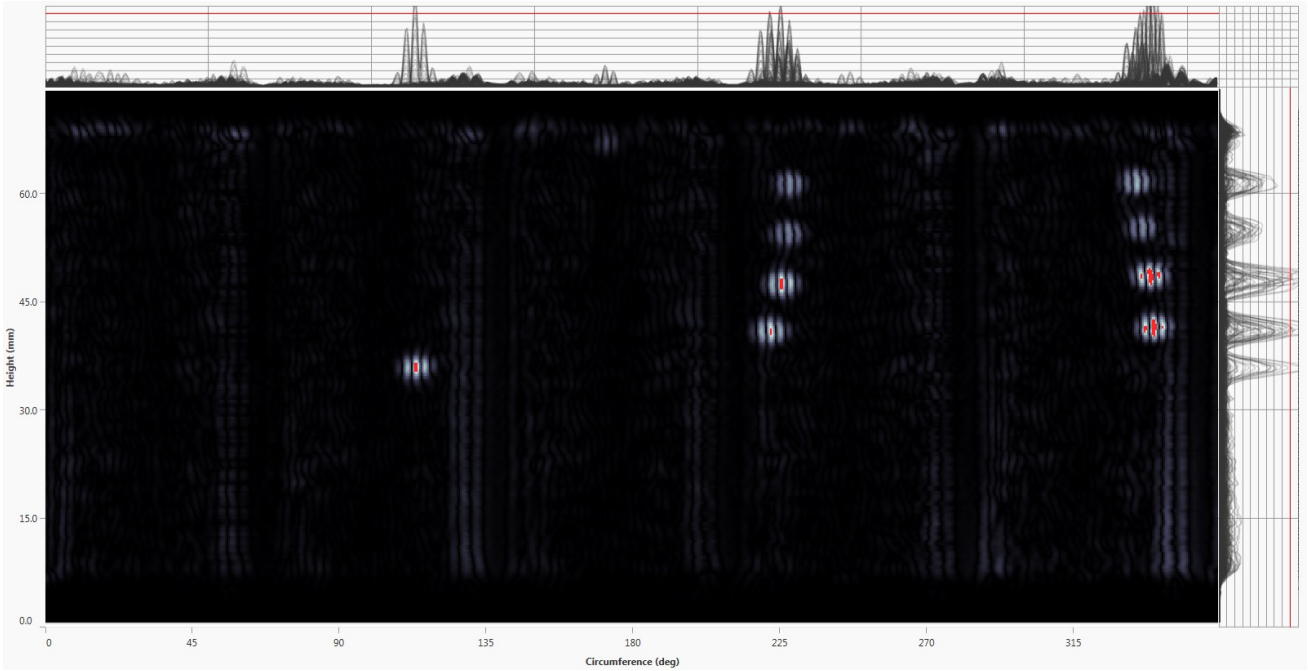
- C-Scan with digital filter
- The function Local Adjustments hide the 5 interfering edges





IN SUMMARY, REALIZED CAPABILITIES

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- Eddy current capable applications have been transformed
  - What was previously not visible to eddy current can now be easily detected
- Defects near features (holes, key ways, etc..) can now be detected with eddy current at full production speeds
  - Special features that cause false signal indications can now be signal suppressed such that they are rejected
  - Edge conditions and edge effect no longer are detrimental to inspection
- Feature tracking in conjunction with eddy current testing
  - Feature counting, eddy current signal pattern recognition
- Safety critical applications
  - 100% inspection of safety critical applications
- Relevant applications
  - Automotive
  - Aerospace
  - Agricultural
  - Industrial
  - Etc…

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Thank you for your attention.

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