

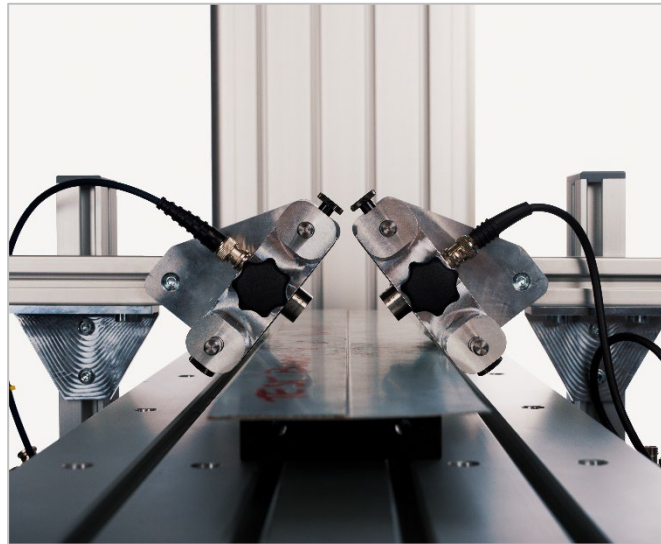
SONOTEC

Ultrasonic Solutions – Made in Germany

NDT with Air - Coupled Ultrasound – Quality Control and Competitive Advantage for Suppliers

Manuel Lucas, Tobias Gautzsch

2019 NDTMA Annual Conference, Las Vegas Feb. 12th - 14th



Outline

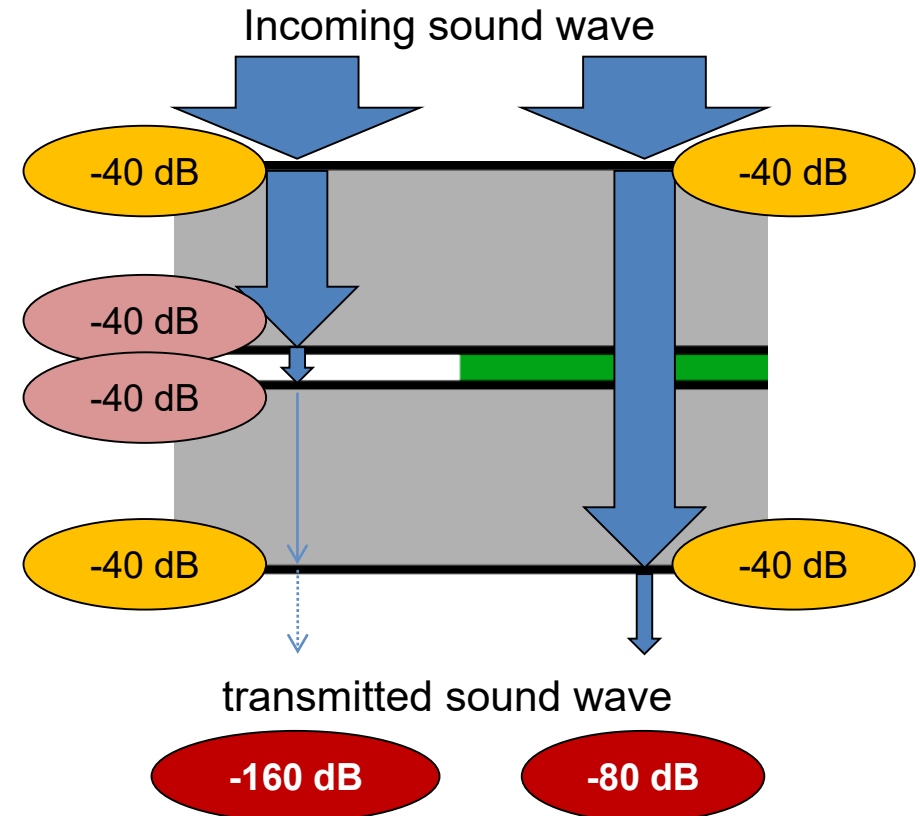
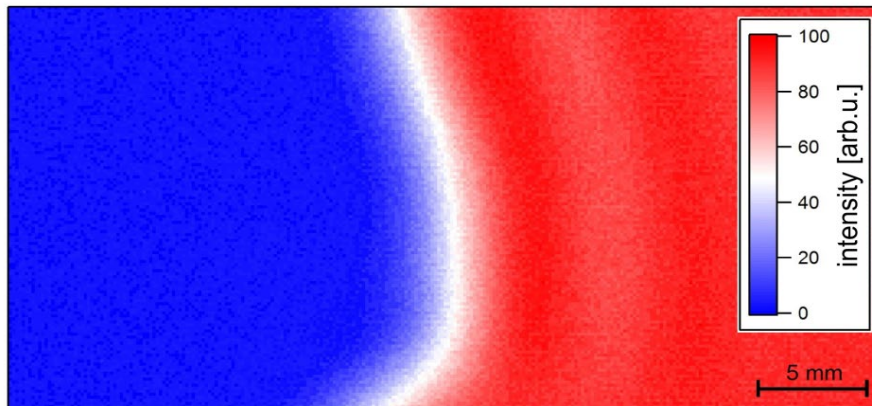
- ▶ Air-Coupled-Ultrasonic Testing (ACUT)
 - ▶ Through-Transmission Measurement
 - ▶ ACUT of CFRP
 - ▶ ACUT of Foam
 - ▶ ACUT of Honeycombs
- ▶ Inspection Task
- ▶ Inspection Setup
- ▶ Result of the Feasibility Study
- ▶ Measurement Results with the customer specific setup
- ▶ Business Case Considerations
- ▶ Conclusion



Through-Transmission Measurement

State of the art

- Missing adhesive leads to additional interfaces
- Intensity losses indicate vacancies

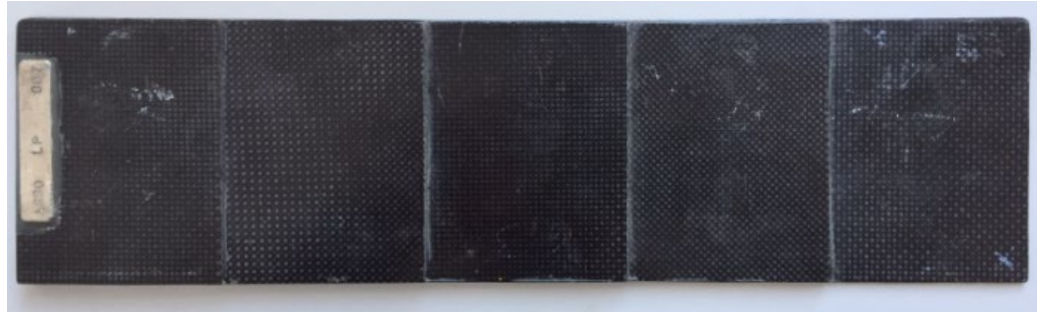


CFRP reference specimen

Standard reference
(aviation industry)



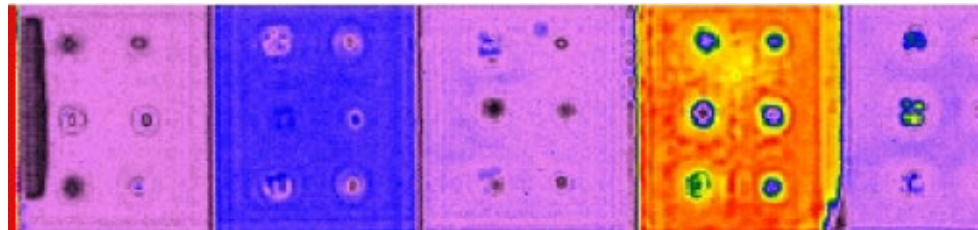
Multiaxial CFRP



Steps:
10 – 8,8 – 6,6 – 4,4 – 2,2 mm

300 kHz C-Scan

Through transmission
measurement

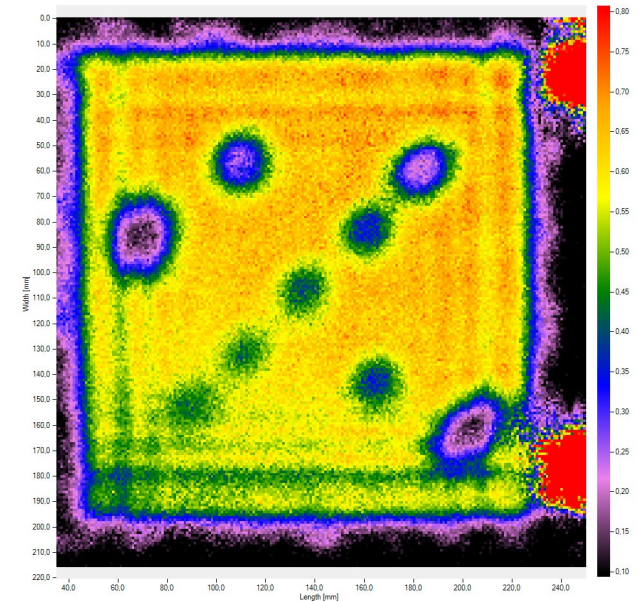
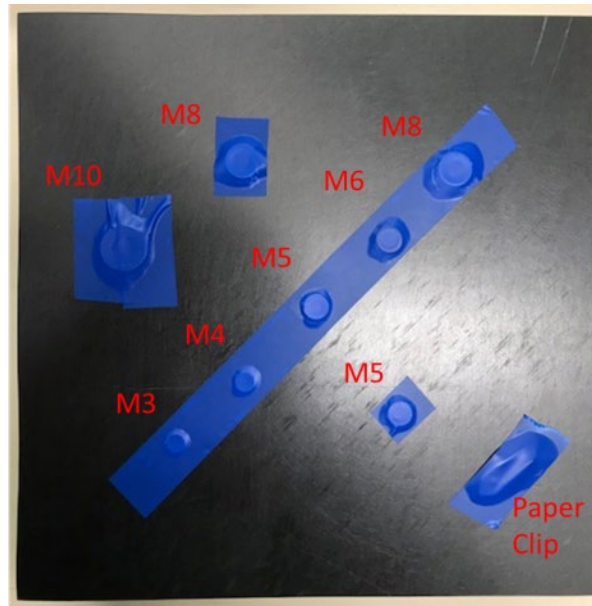
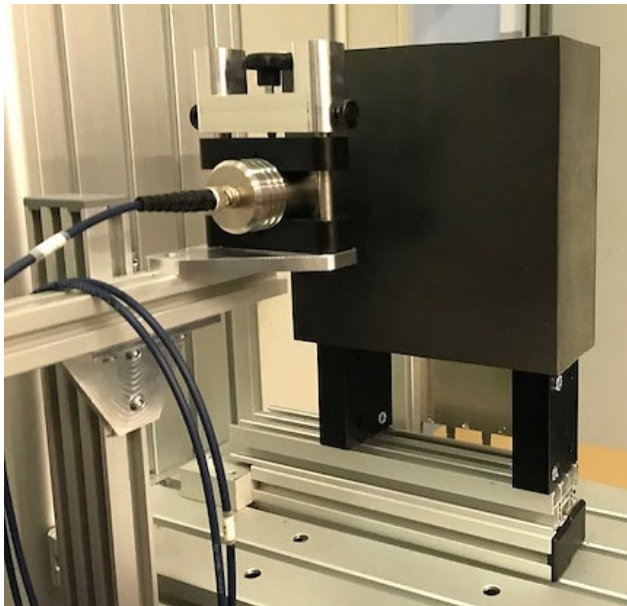
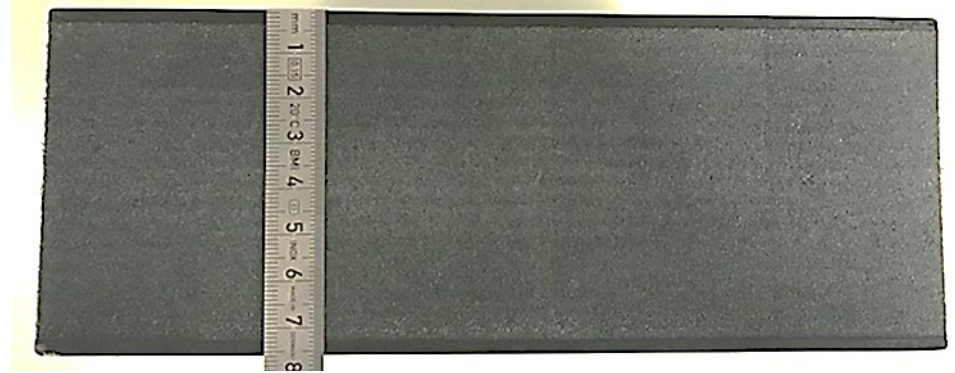


300KHz C-Scan

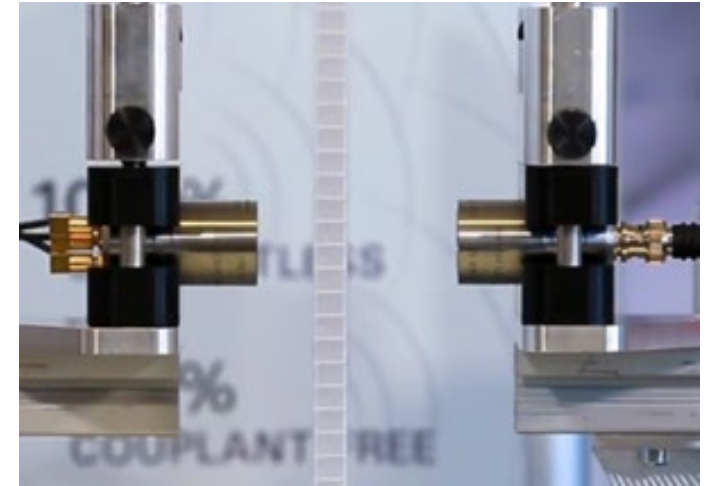
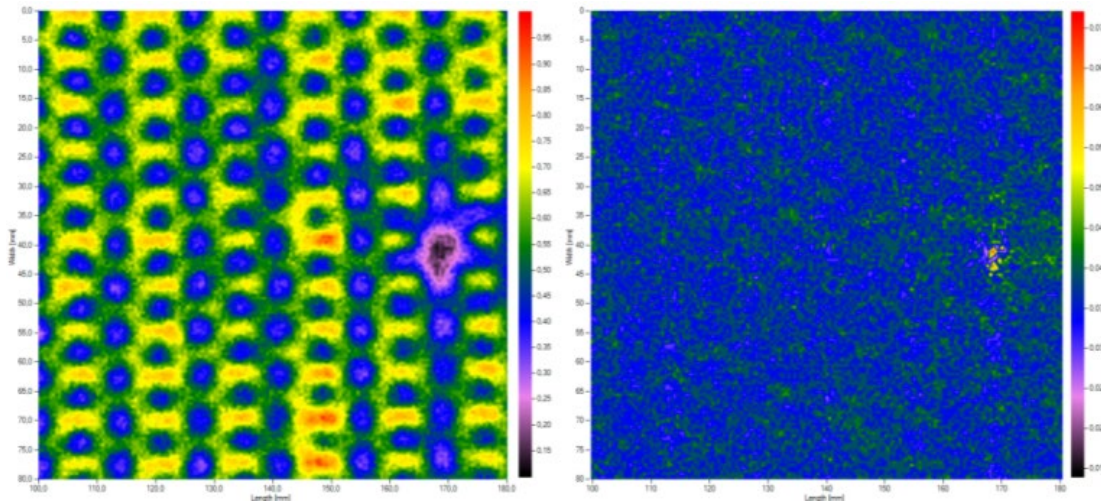


CFRP Sandwich with Foam Core

Electronics: SONOAIR
Transducer: CF050 & CF075
Specimen: CFRP with 70 mm Foam- Core
Flaws: washers as artificial flaws



Thermoplastic CFR with Honeycomb Core

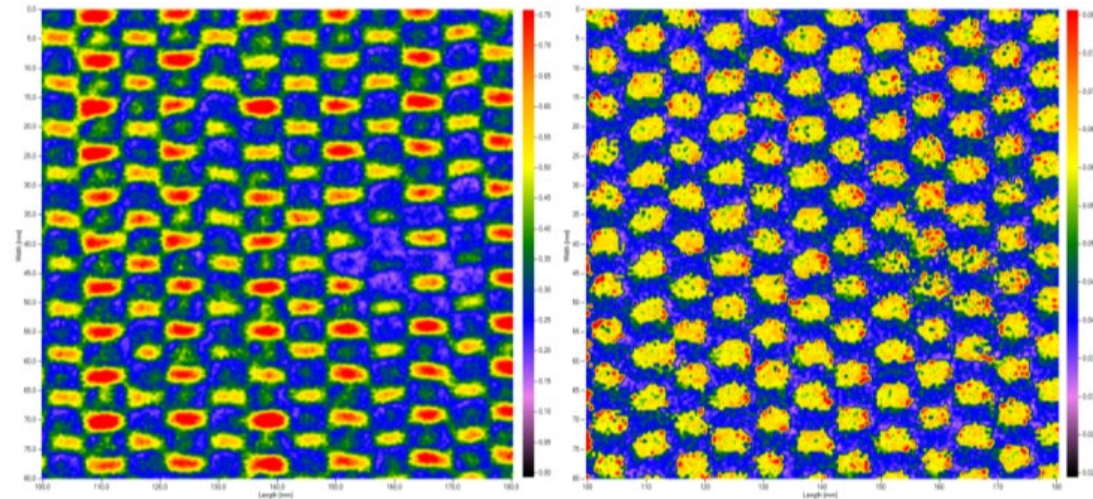


Impact damage detection with ACUT above:

- CF200 Transducer
- impact damage visible as amplitude reduction

right:

- CF400 Transducer
- Honeycomb structure visible
- Impact damage can only be detected in the C-Scan image



Test parts provided by ThermHex Waben GmbH, thanks to Mr. Pflug



Inspection Task

Sheet Molding Compound

- ▶ GFRP manufacturing method
- ▶ Multiple Layers of Glass Fiber
- ▶ Up to 130 mm total
- ▶ Common Flaws
 - ▶ Delamination
 - ▶ Air Bubbles
 - ▶ Insufficient infiltration

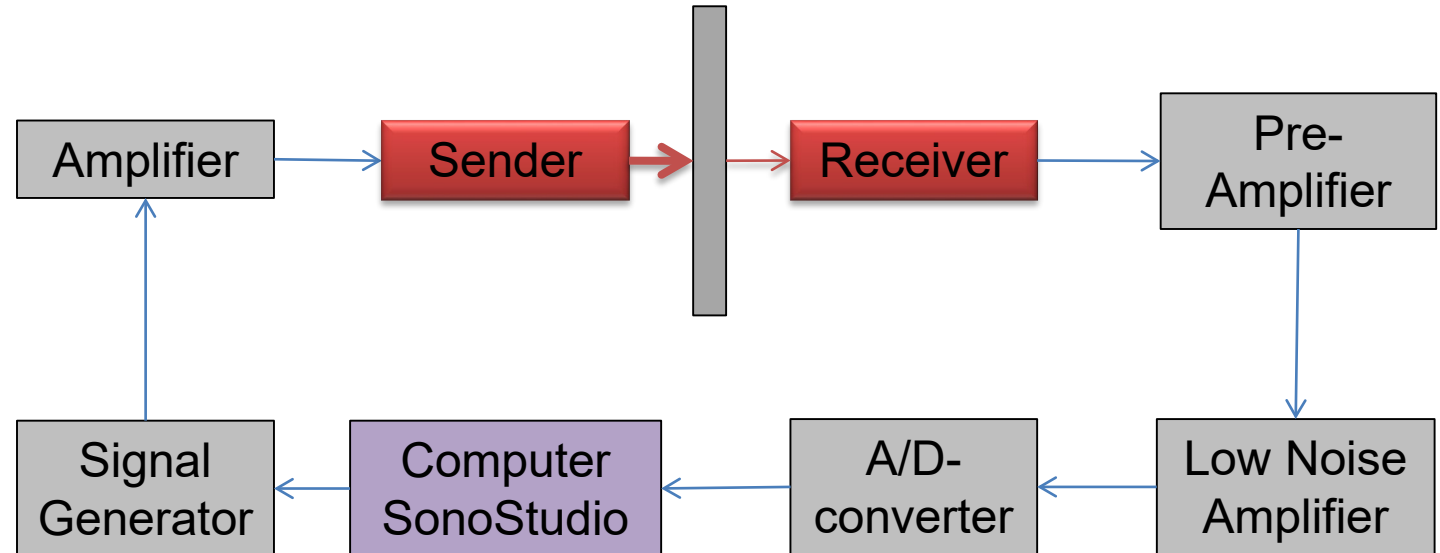


Specimen

- ▶ Trough Transmission Measurement
- ▶ 4000 x 2000 x 130 mm for real life Application
- ▶ 380 x 380 x 80 mm for Application development



Inspection Setup



Setup

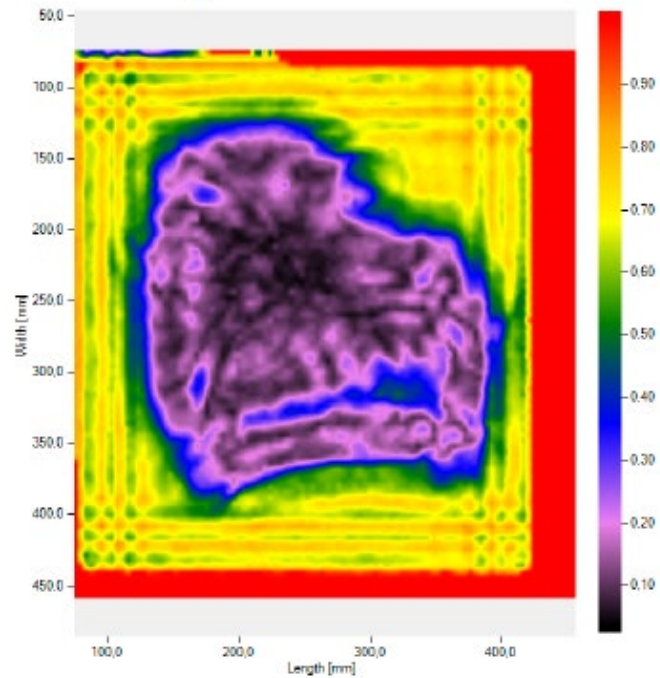
- 75 kHz Air-Coupled Ultrasound
- 4 mm x 4 mm Scan Stepping
- 100 mm/s
- No Filters
- No Average
- No Post-Processing



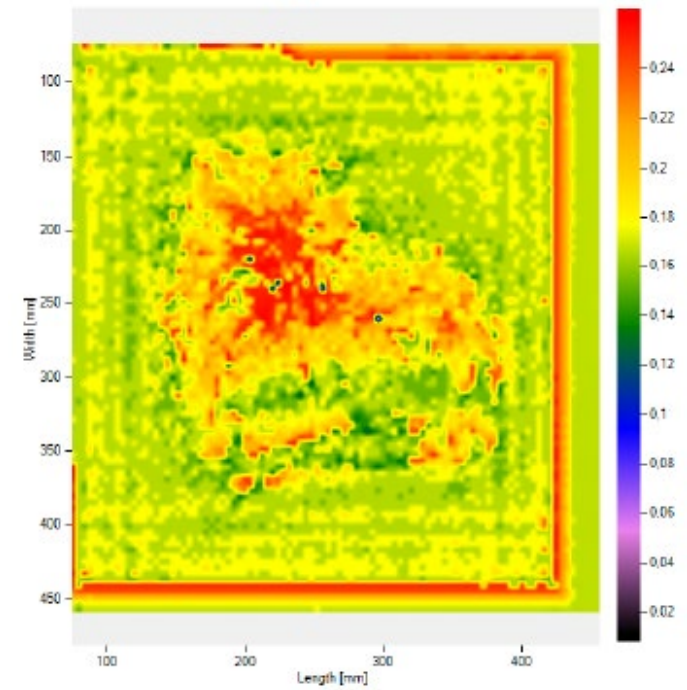
Result of the Feasibility Study



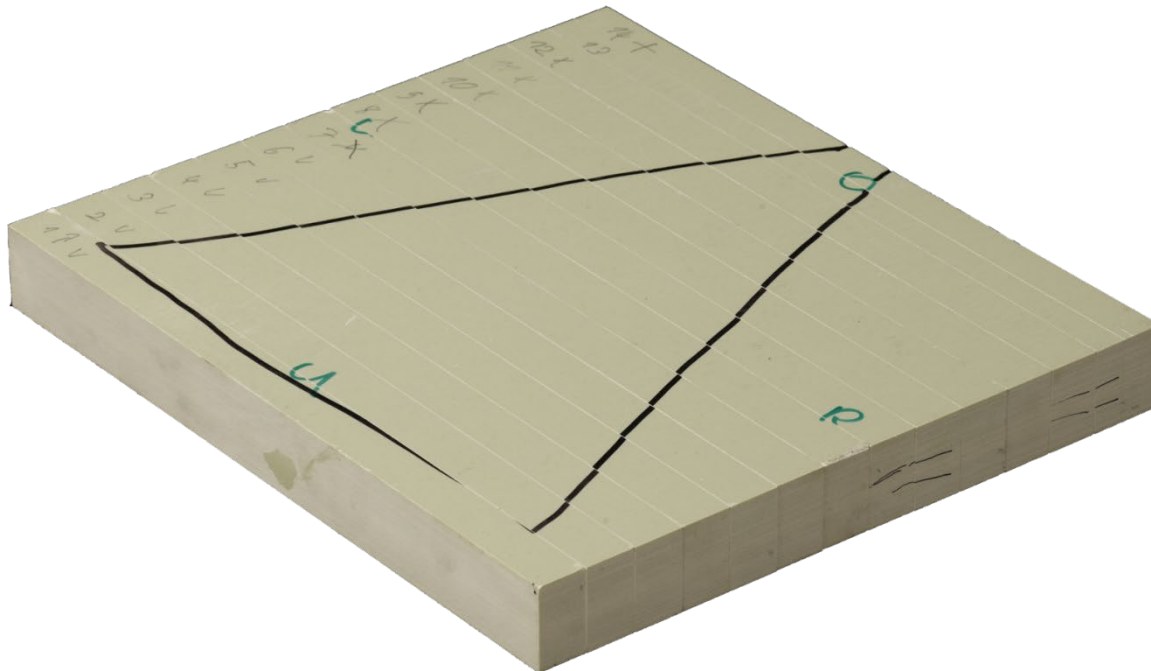
Intensity



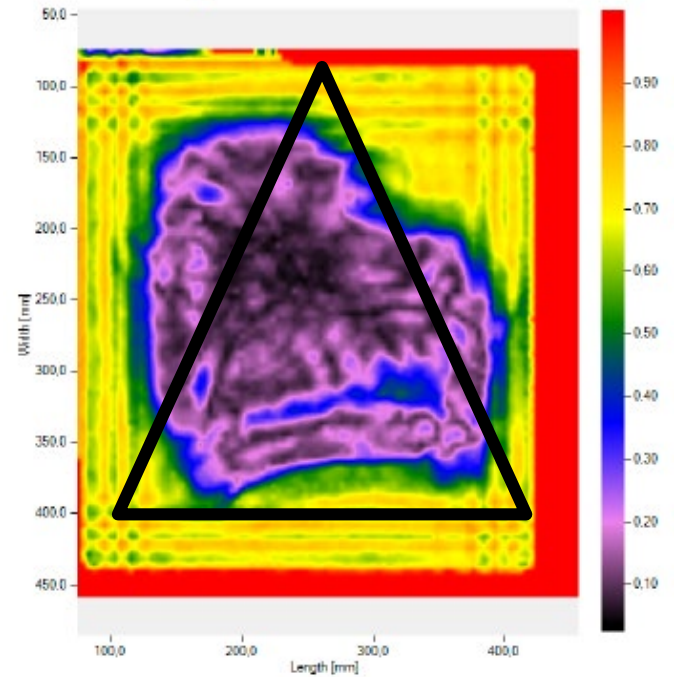
Time-of-flight



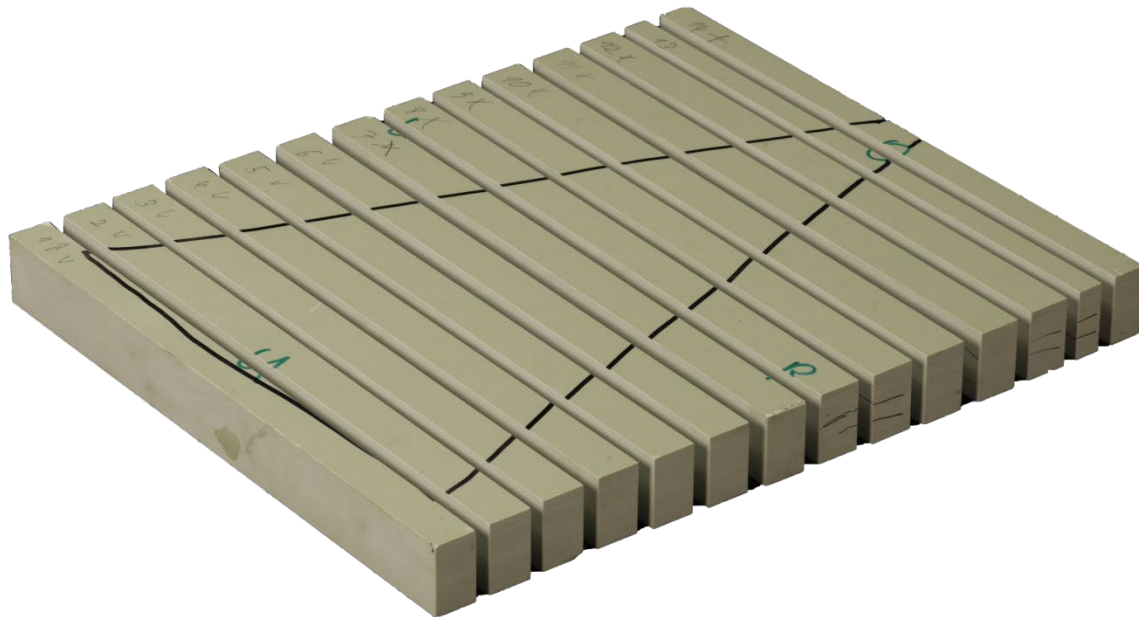
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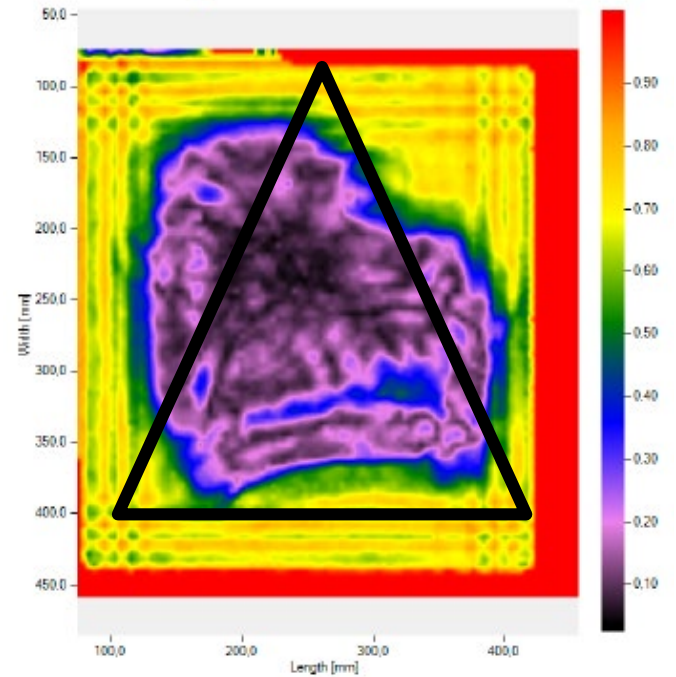
Intensity



Result of the Feasibility Study



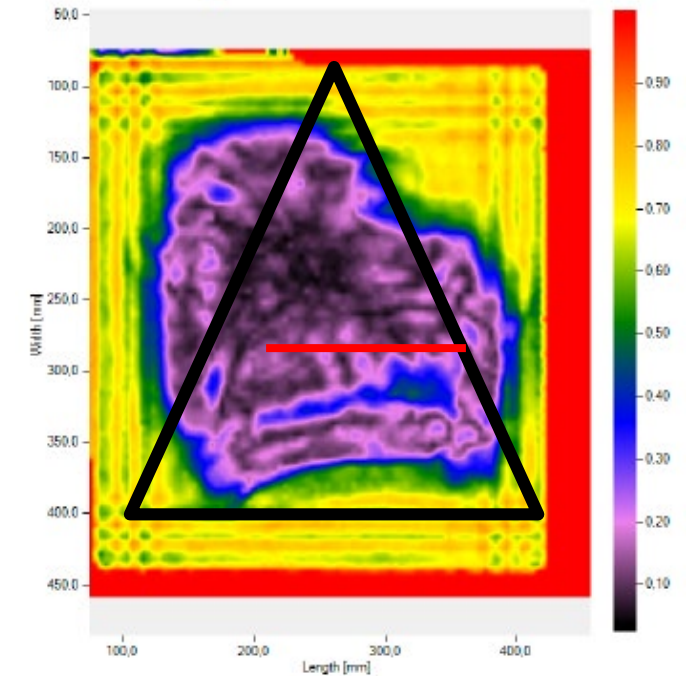
Intensity



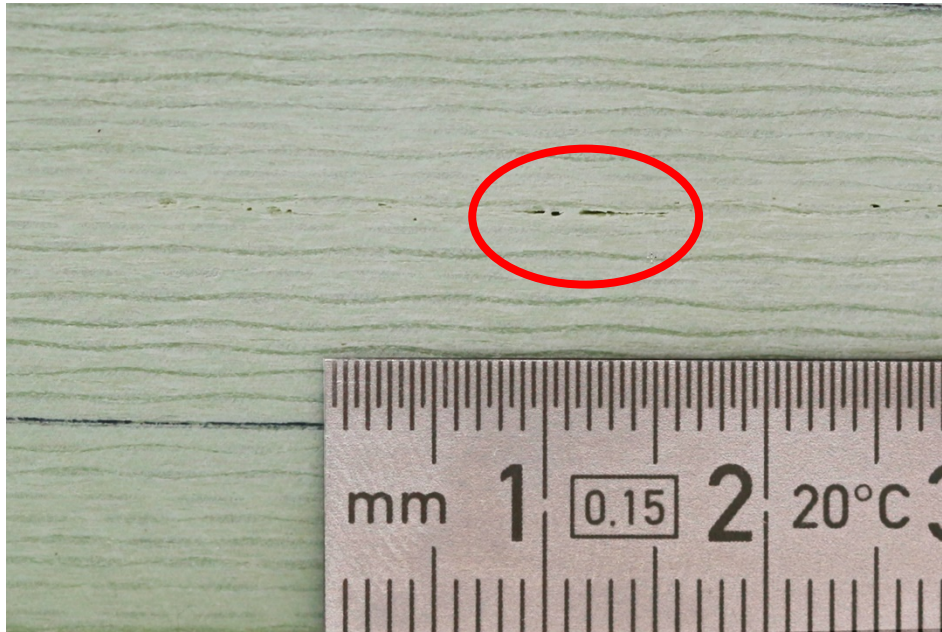
Result of the Feasibility Study



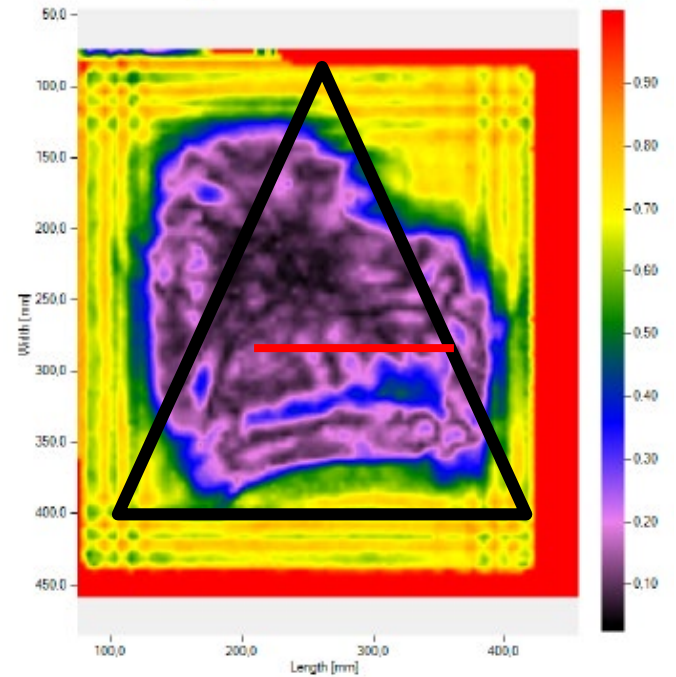
Intensity



Result of the Feasibility Study

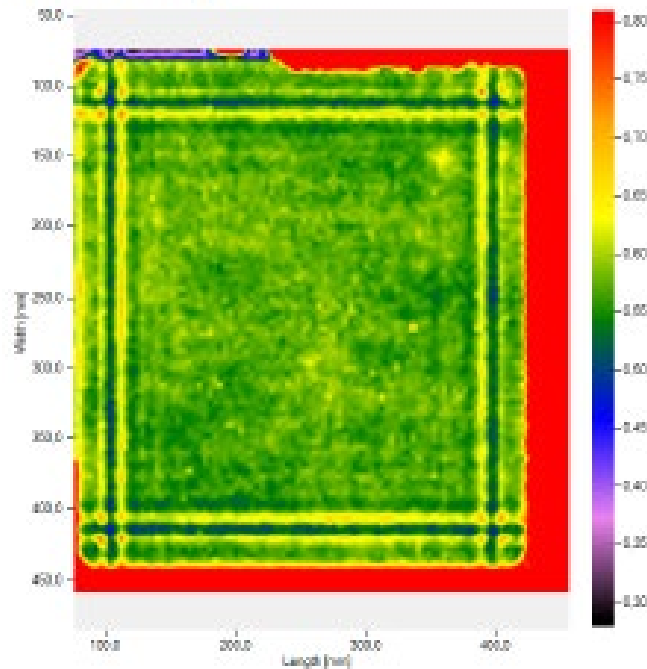


Intensity

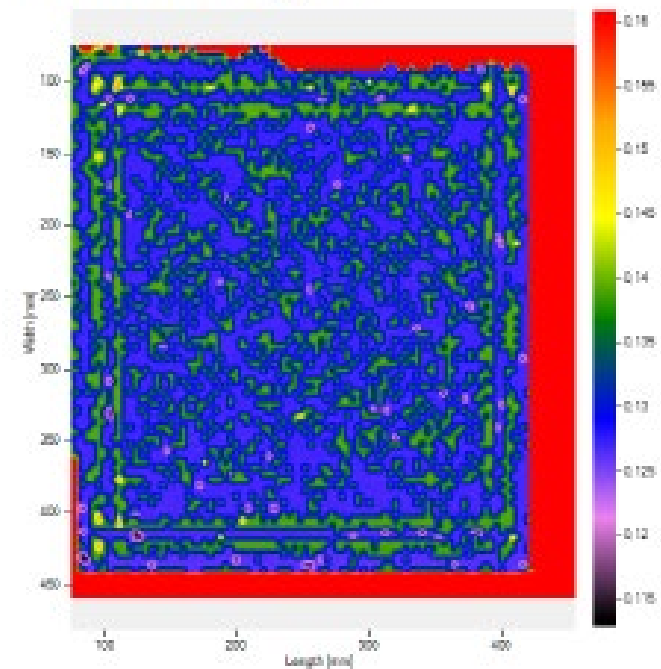


Measurement Results with a Customer Specific Setup

Intensity



Time-of-flight

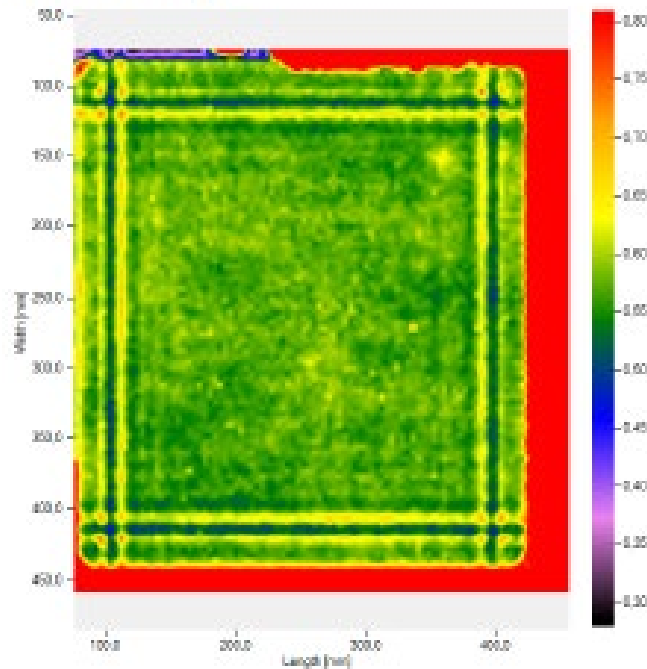


- Production of a flawless sample
- Significant scattering in amplitude and time of flight due to density
- Significant interference pattern on the edges

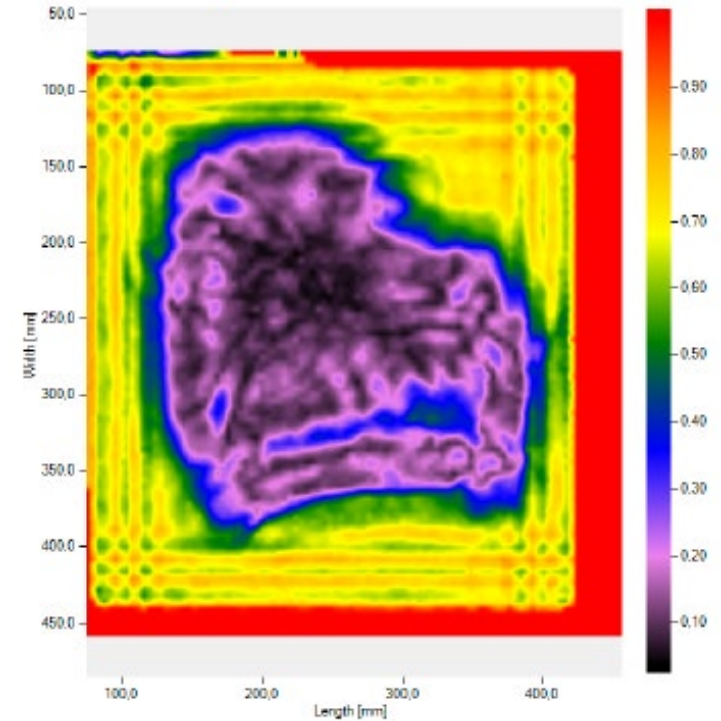


Measurement Results with a Customer Specific Setup

Intensity



Intensity

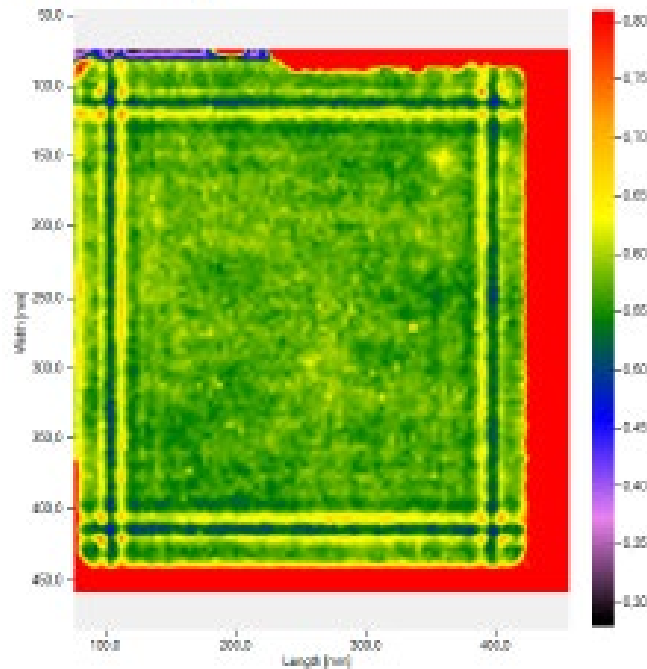


- Reference filter
- Automatic measurement of flawed area in %
- Direct feedback via ProfiNET to industrial standard SPS

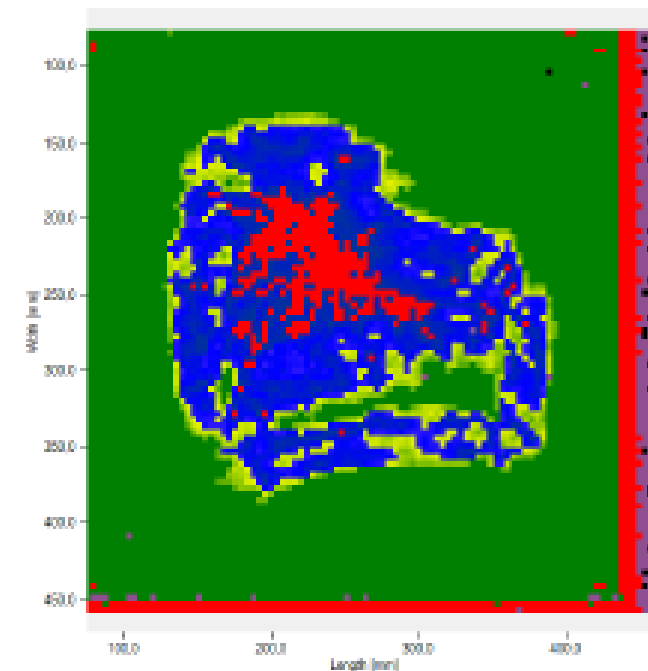


Measurement Results with a Customer Specific Setup

Intensity



Intensity



- Reference filter
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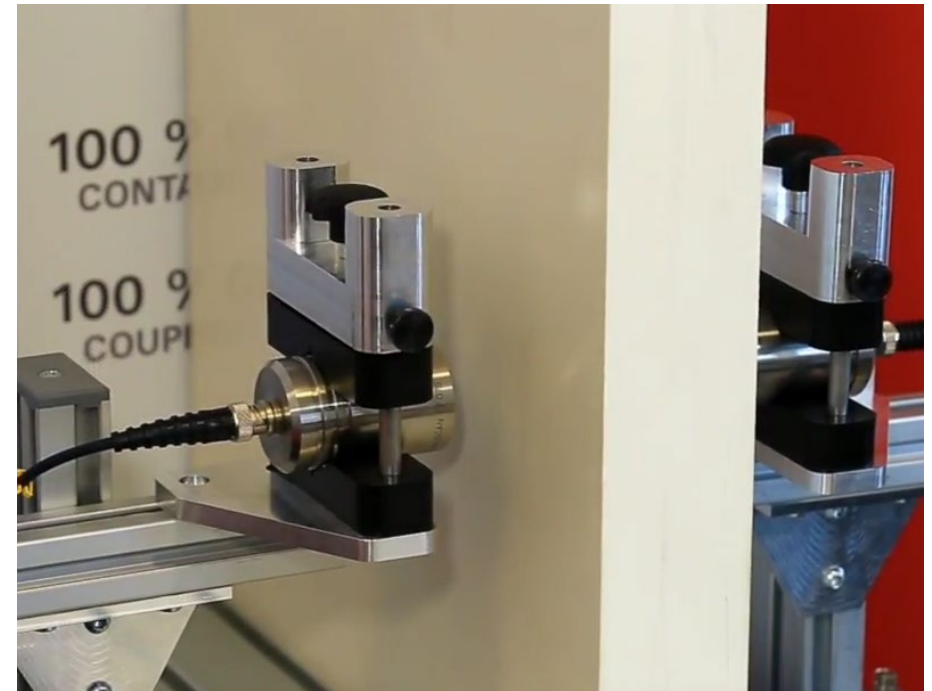


Industrial Size Measurement System

- ✔ SPS-controlled scanning system
- ✔ Fully integrated in SMC Process

- ✔ Channel: 4
- ✔ Size: 4000 mm x 2000 mm
- ✔ Stepping: 5 mm x 5 mm
- ✔ Scan speed: 1000 mm/s

- ✔ Flawed area is assessed and measured
- ✔ Feedback loop to subsequent CNC-Machinery
- ✔ Automatic Documentation of test reports for quality certificates



Business Case Considerations

- Machine Invest SONOAIR: ~250000\$
 - Inline system
 - No wearing parts in testing hardware
 - Automated detection of flawed areas
 - Minimal maintenance costs

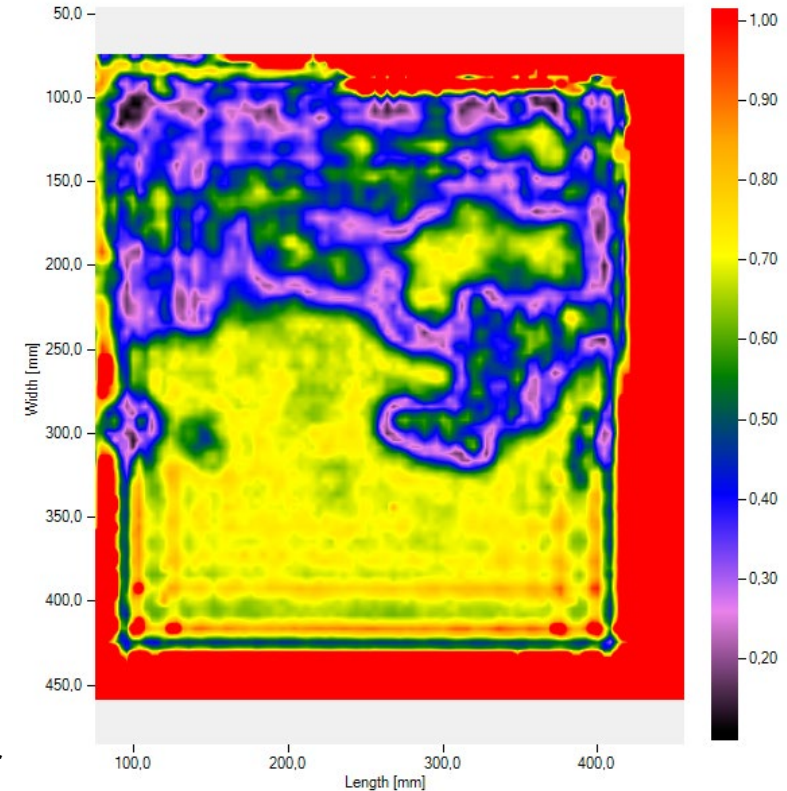
 - Machine utilization: 144h per month
 - Operating life: 10 years
 - Interest: 5%
 - Area costs for 15m²: 60\$ per month
 - Electricity consumption: max 2kW

 - Capital Costs: 2775\$ per month
 - Calculative interest: 535\$ per month
 - Maintenance costs: 215\$ per month
 - Area Costs 55\$ per month
 - Energy Costs: 18\$ per month
0,2\$ per hour
- ➔ **Machine Costs ~26\$ per hour**



Business Case Considerations

- ▶ Business opportunities
 - ▶ NDT Tool for quality und process improvement
 - ▶ Reduction in set-up time
 - ▶ Reduction of rejected parts forwarded to mechanical processing
 - ▶ No flawed half-finished products in further processing
 - ▶ Time Cost per hour CNC Milling: ~100\$
 - ▶ Attachment of Scan Results as quality certificate
 - ▶ Competitive advantage
 - ▶ Compelling reason for 10% price increase
 - ▶ Resale of flawed product to customers with lesser quality requirements
 - ▶ earning money on product that would otherwise have cost money due to complaints
 - ▶ Saving in recycling and waste costs



Conclusion

- GFRP SMC can be tested in through transmission with ACUT
- Small flaws affect the received amplitude
- Detection and localization of single air bubbles is not possible
- Coarse stepping is sufficient even for small flaws

- Integration in existing industry production system
- SPS – Feedback for subsequent production processes
- Automatic quality certification as competitive advantage



Thank you for your attention!

