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Detection of delamination and impact damage in multilayered lightweight materials

Tobias Gautzsch, Andreas Bodi, Manuel Lucas, Ralf Steinhausen, Mario Kiel

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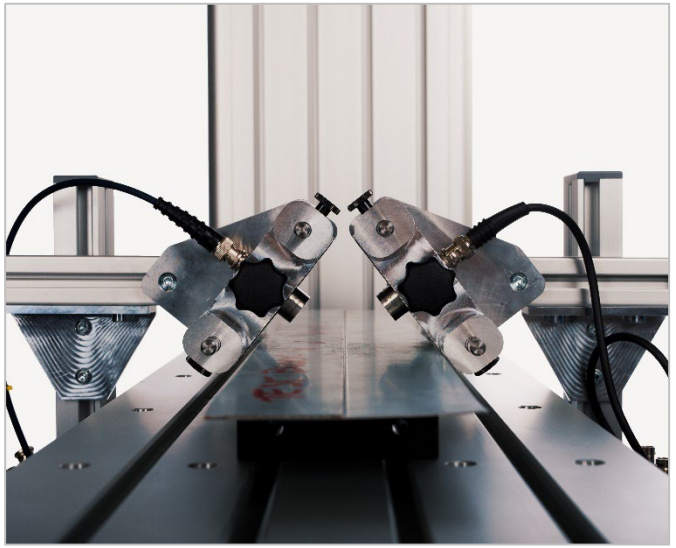
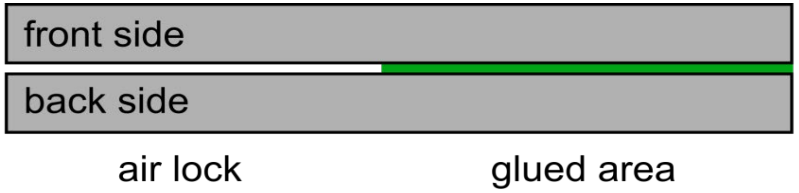


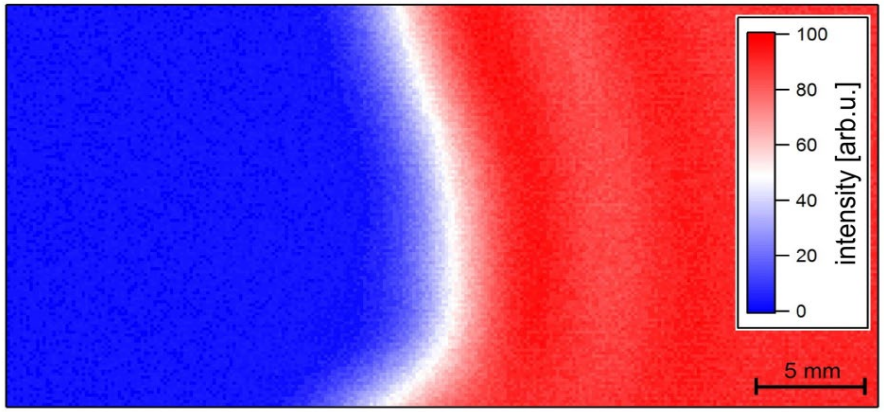
Outline

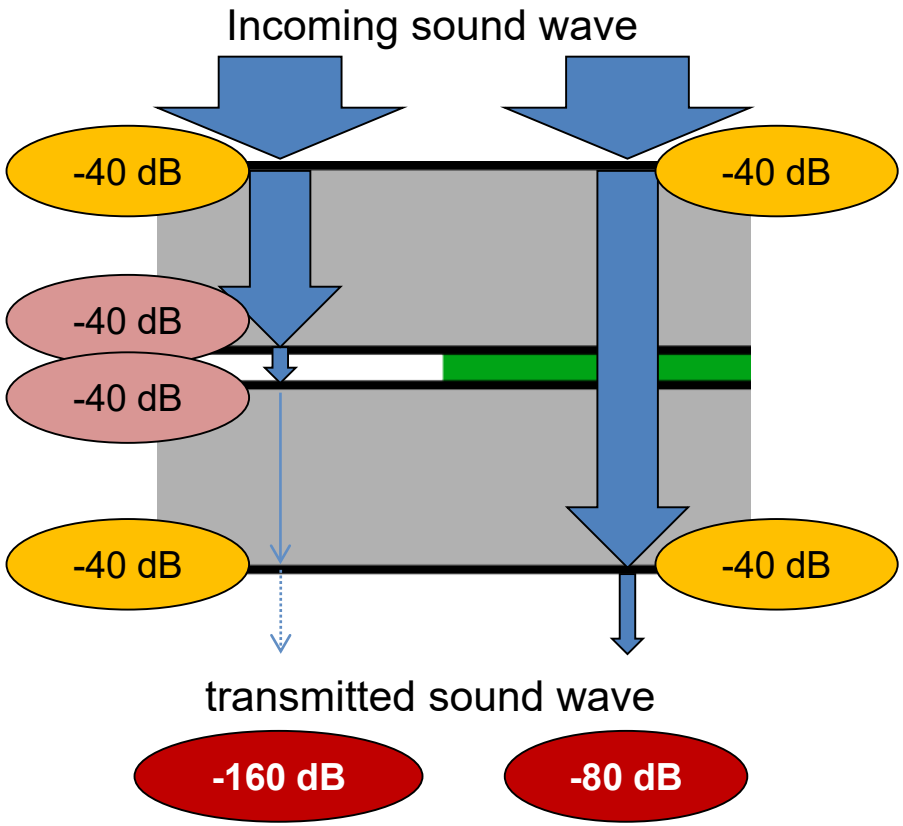
- Trough-Transmission Measurement of Adhesive Bonds
- Measurement Task
- Application Development
  - Frequency Comparison
  - Indications
- Transducer Development
- Measurement Results with the customer specific setup
- SNR Analysis
- Conclusion

Trough-Transmission Measurement of Adhesive Bonds

- State of the art
  - Missing adhesive leads to additional interfaces
  - Intensity losses indicate vacancies

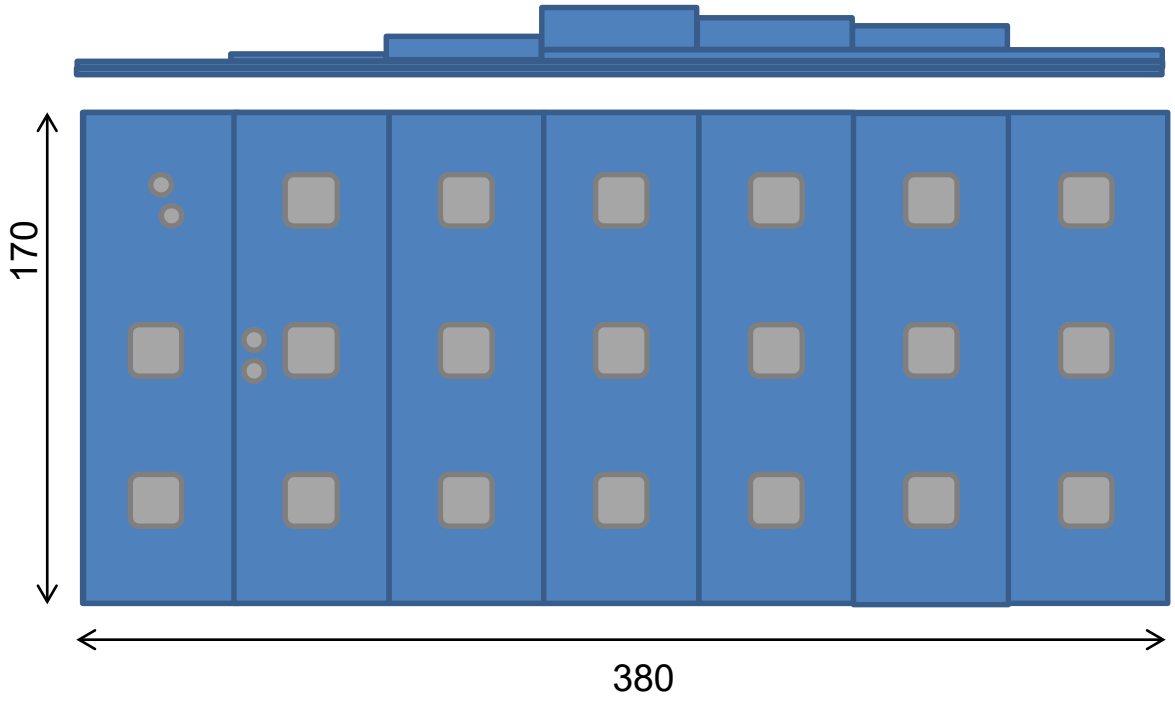






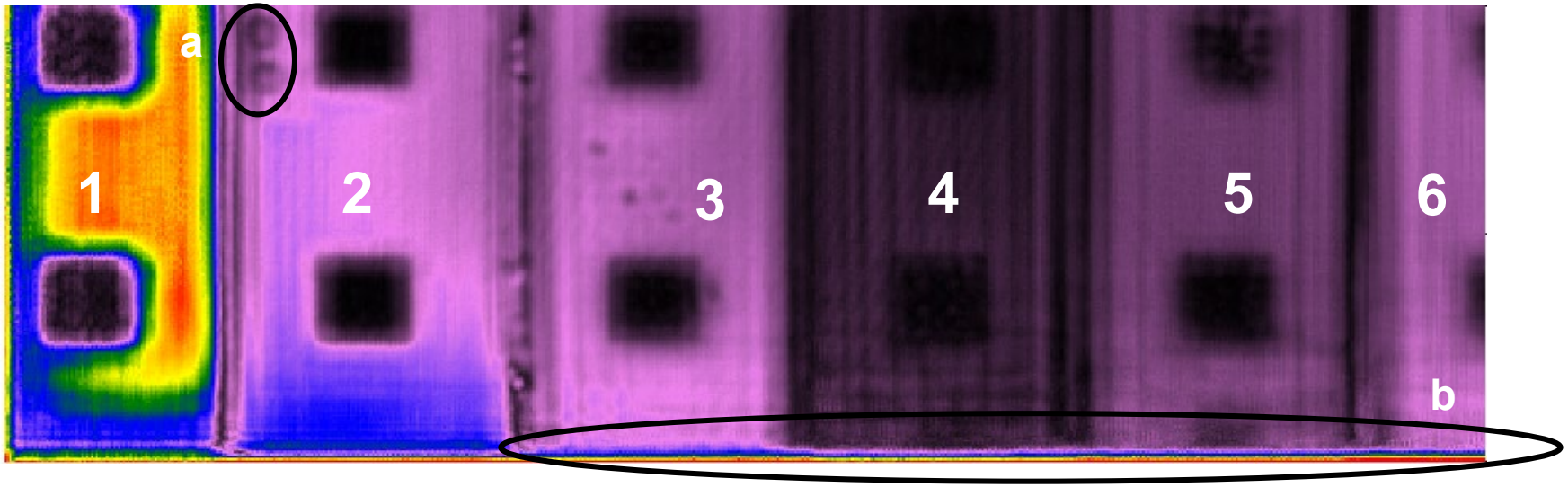
Measurement Task

- Specimen
  - Aluminum Sheet Metal
    - Multiple Layers
    - 3.6 mm – 17.2 mm
  - Adhesive Bonds
    - Artificial Delamination
- Measurement Setup
  - Trough Transmission
  - Standoff Distance
    - 115 mm Transmitter
    - 20 mm Receiver
  - 600 mm / s



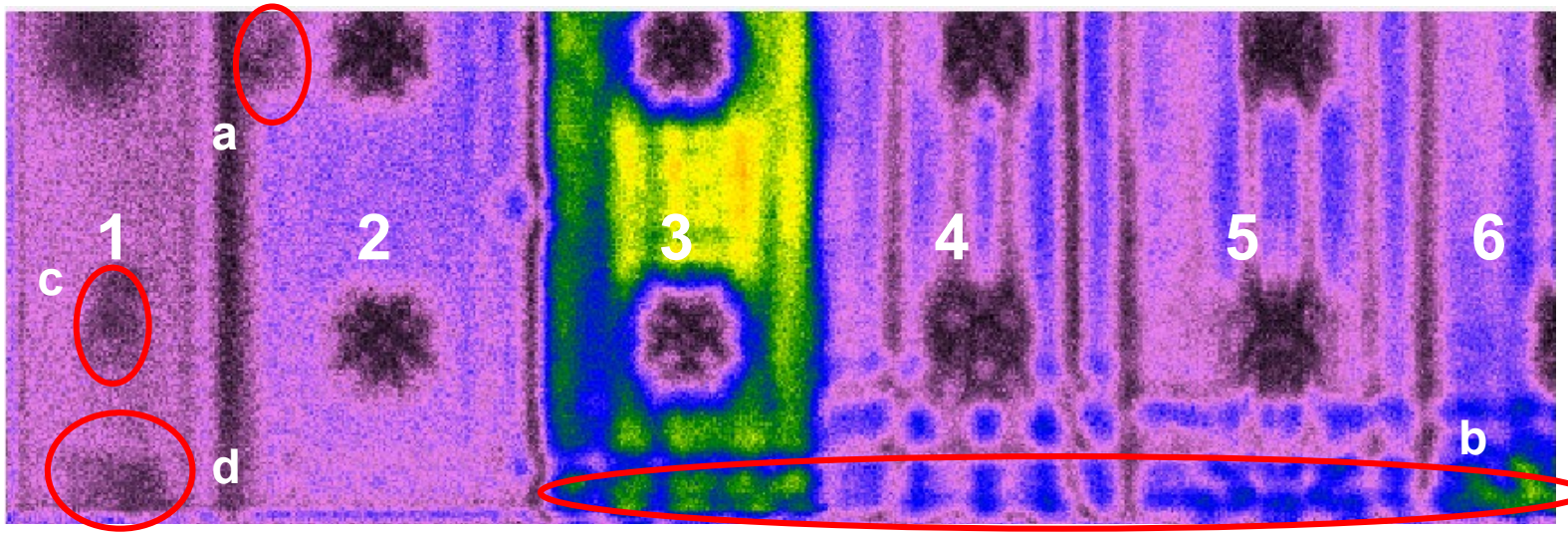
	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7
1st Sheet				10.5 mm	8.7 mm	6.0 mm	
2nd Sheet		1.5 mm	5.7 mm	1.9 mm	1.9 mm	1.9 mm	1.9 mm
3rd Sheet	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm
4th Sheet	1.7 mm	1.7 mm	1.7 mm	1.7 mm	1.7 mm	1.7 mm	1.7 mm
Total	**3.6 mm**	**5.2 mm**	**10.0 mm**	**17.2 mm**	**14.7 mm**	**12.5 mm**	**6.0 mm**

400 kHz - 25mm sender and receiver distance



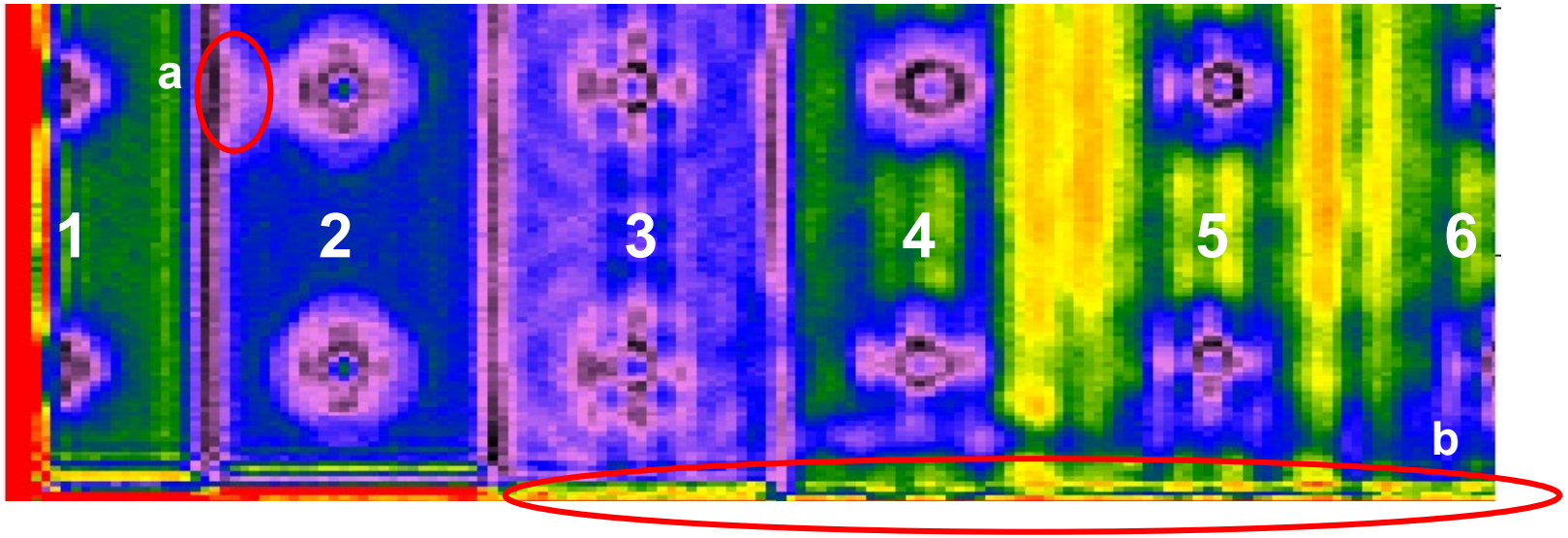
- Very good spatial resolution
- ~12dB more amplitude in Segment 1 than in in the others
- All discontinuities detectable including air bubbles in segment 3
- Round flaws (a) well separable
- Slight edge effects at the boundary of the object (b) and at the edges of each segment

200 kHz - 114mm sender and 25 mm receiver distance



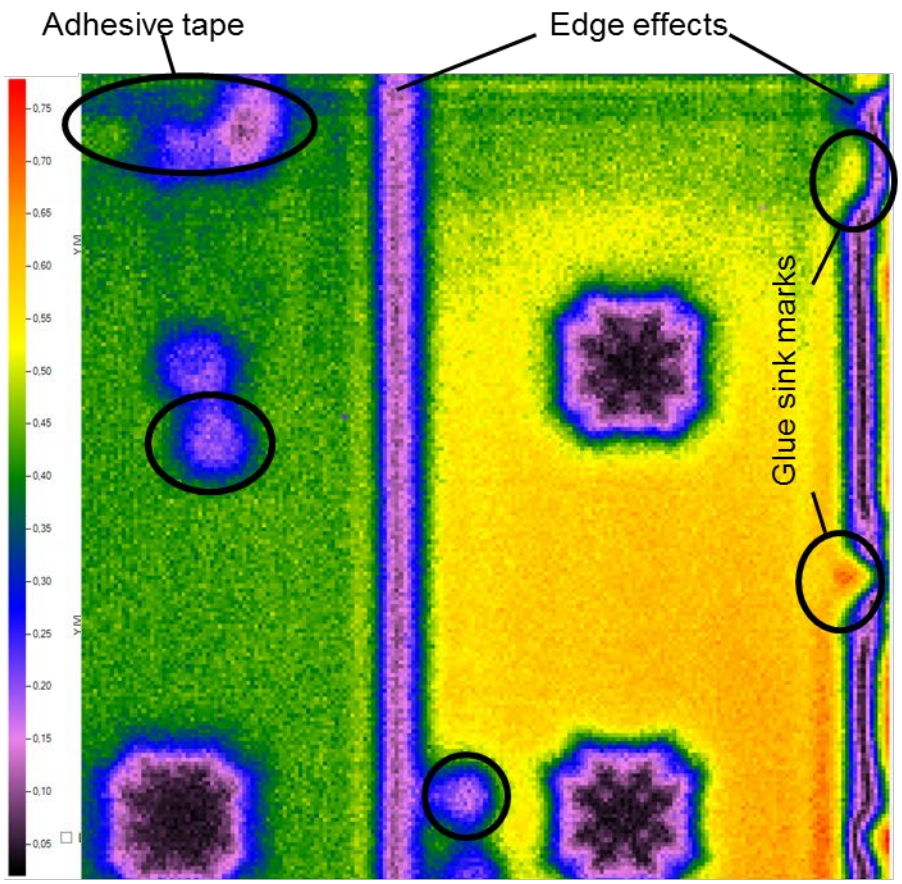
- Well testable with 200 kHz, improved detail due to 0,5 mm stepping
- All discontinuities detectable
- Round flaw (a) not separable
- Round flaws (c) at the surface and (d) at the backside detectable
- Significant edge effects at the boundary of the object (b) and at the edges of each segment
- Segment 3 significantly more permeable then the other segments

125 kHz - 114mm sender and 25 mm receiver distance

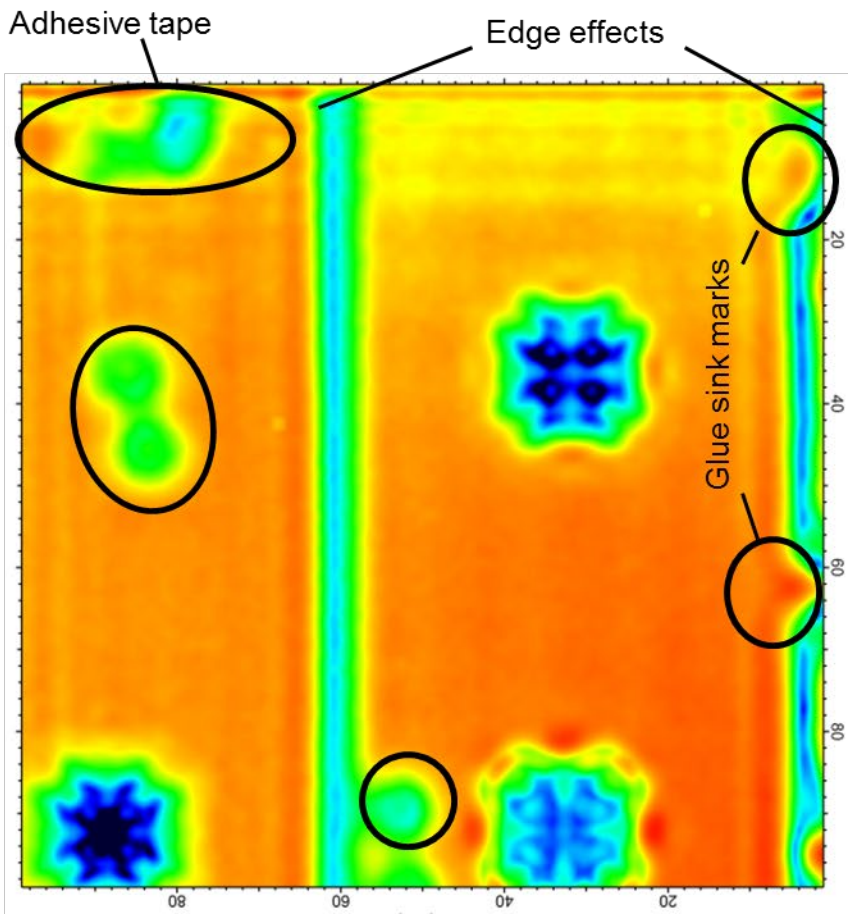


- Better SNR with 125 kHz than with 200 kHz
- Less spatial resolution than with 200 kHz
- All discontinuities detectable, but the resolution is to low to represent the squares correct
- Round flaws (a) not separable
- Significant edge effects at the boundary of the object (b) and at the edges of each segment

200 kHz - 10 mm sender and receiver distance



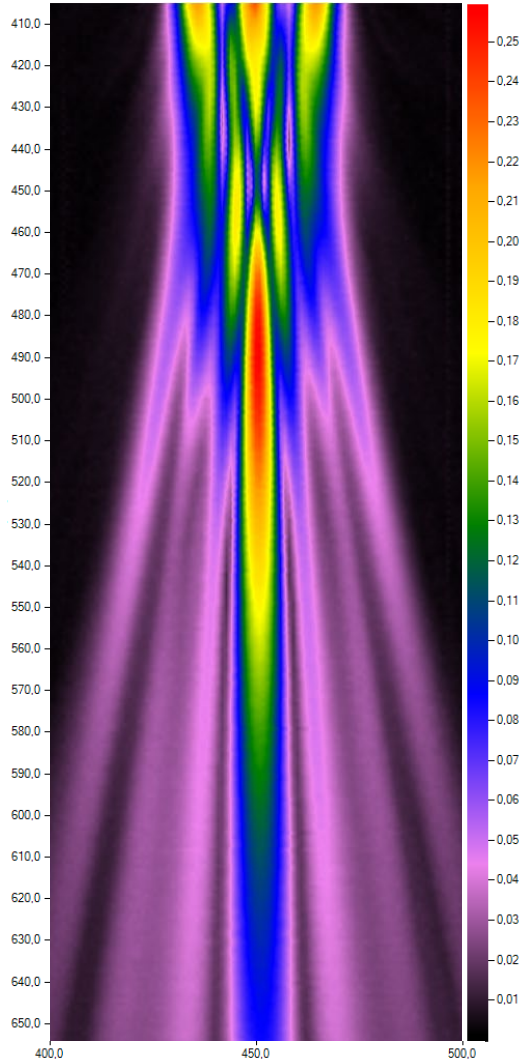
Linear Scale



dB Scale

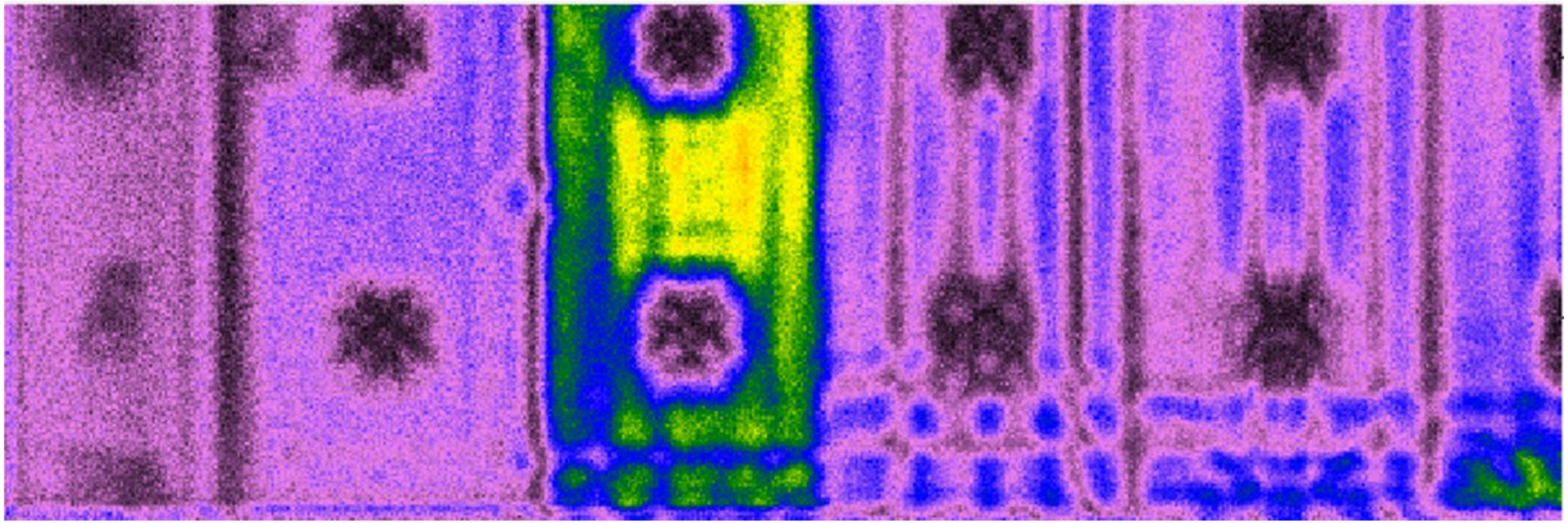
Transducer Development

- Multi-Element Transducer
  - Seven Elements
  - 45 mm Apparture
  - 115 mm Focal Distance



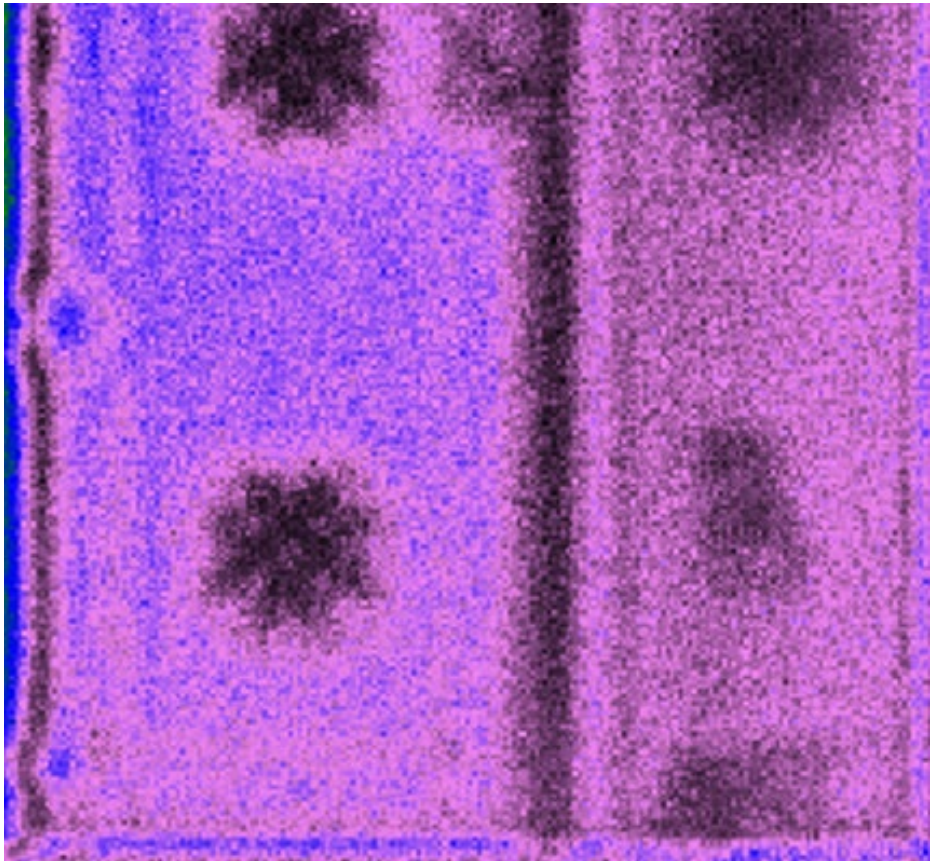
Measurement Results

- Standard 200 kHz Measurement

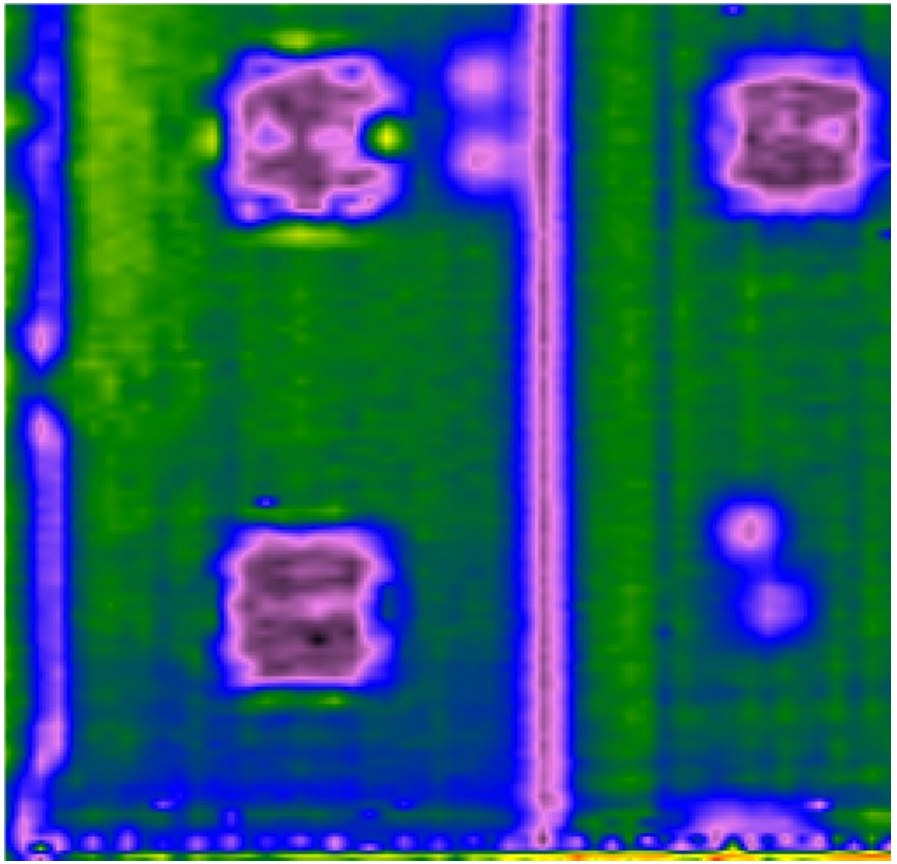


Measurement Results with 115 mm standoff distance

- Standard CF200 Transducer

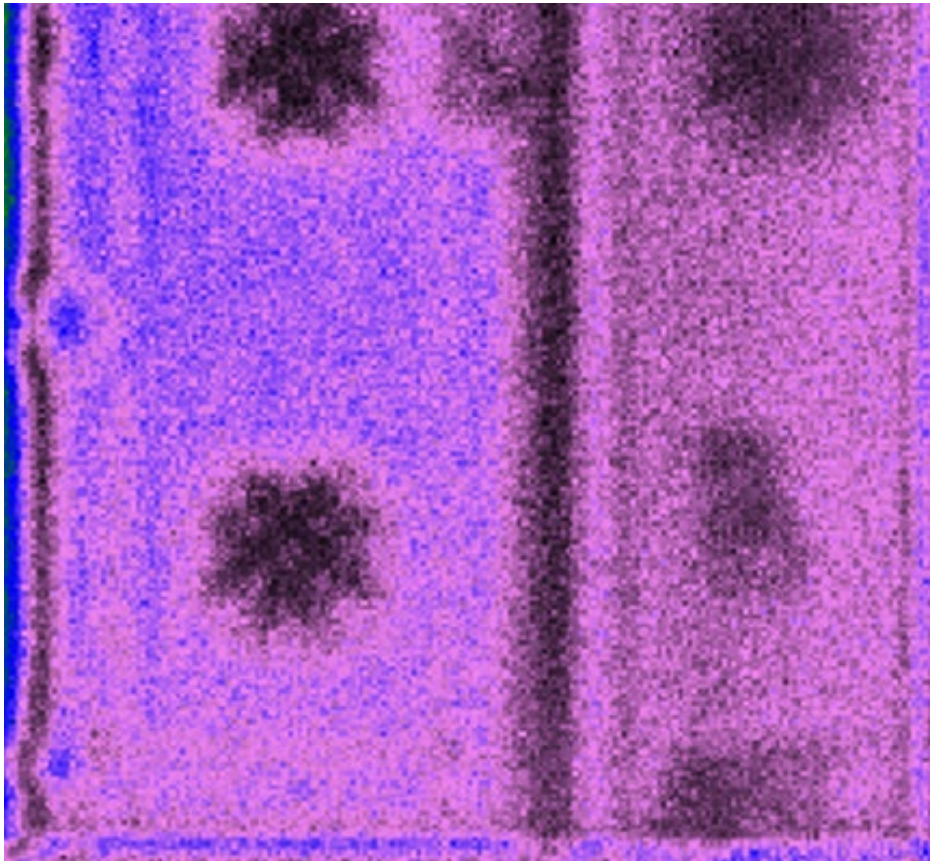


- Custom CF200 7ETransducer with 115 mm Focal distance

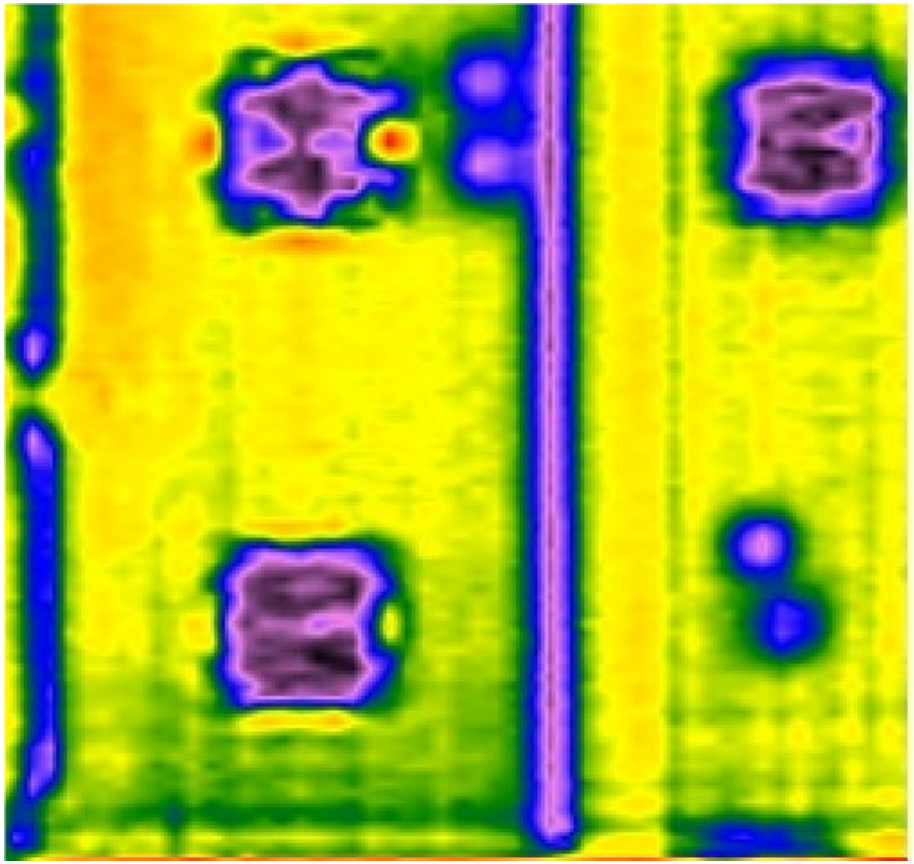


Measurement Results with 115 mm standoff distance

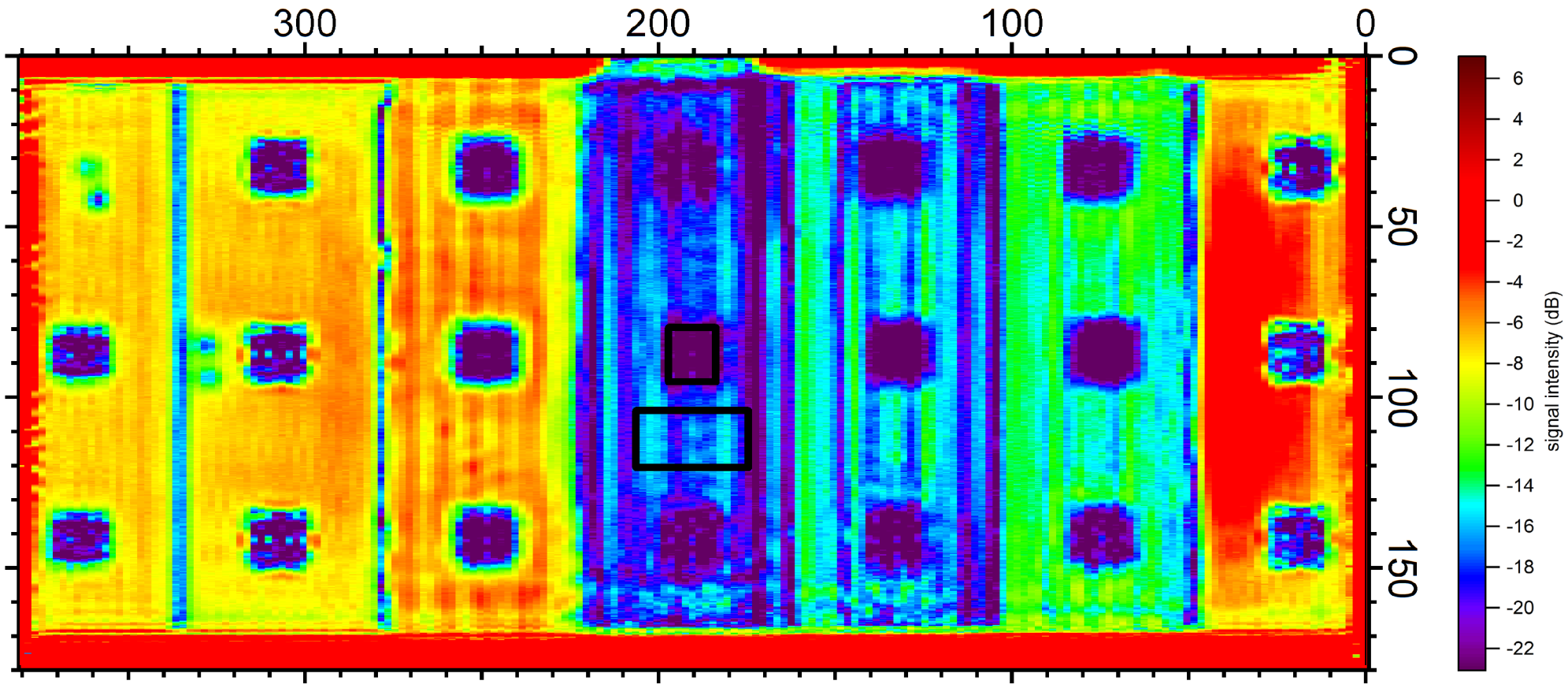
- Standard CF200 Transducer



- Custom CF200 7ETransducer with 115 mm Focal distance in dB-Scale

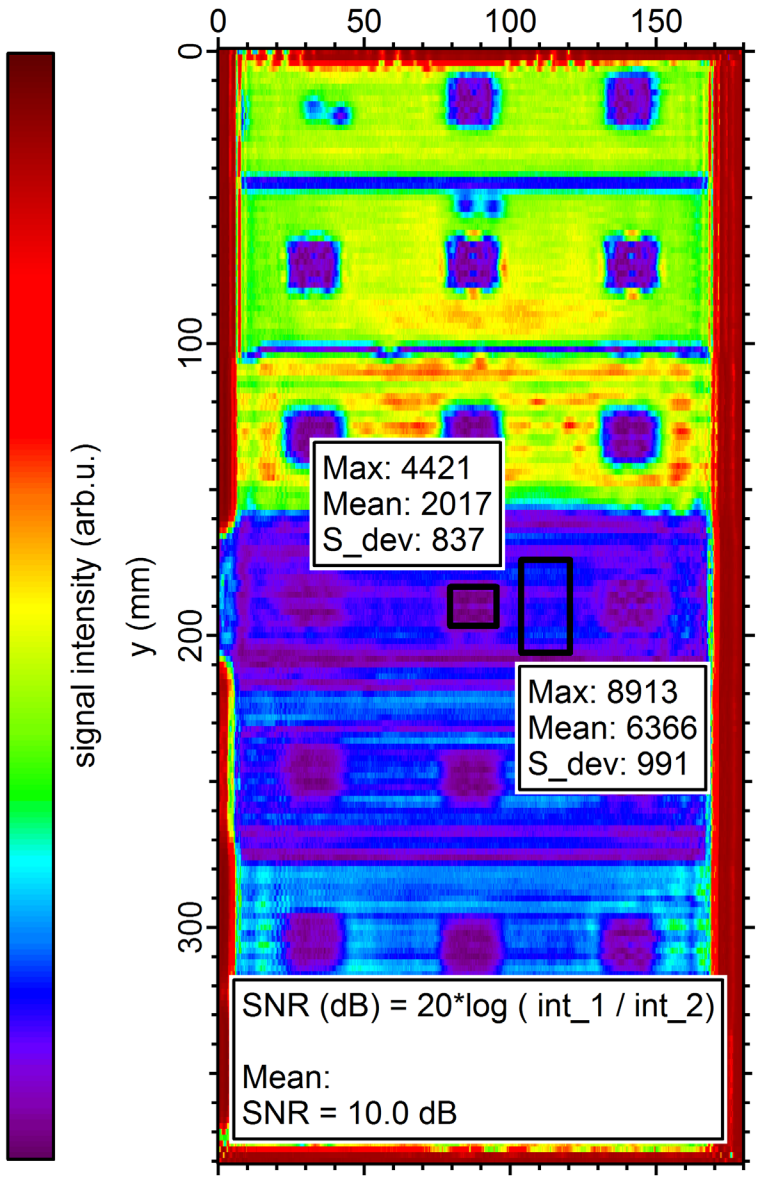


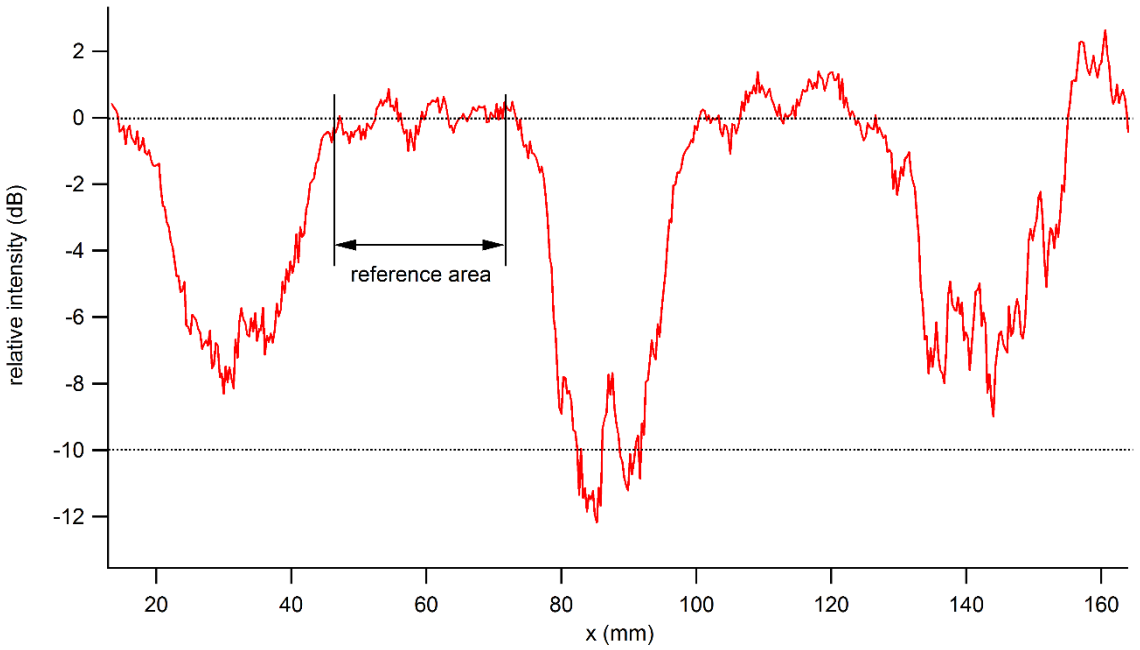
Full Scan with CF200 7E Transducer



- All Indications detectable

SNR Analysis





- ~10 dB SNR in region of interest
- Minimum of 6 dB SNR in the line profile

Conclusion

- The Measurement Task can be fullfiled with the SONOAIR System
- Frequency dependend changes in Trough Transmission Mesaurement could be found
- A custom Transducer with 115 mm focal distance and 200 kHz mean frequency was developed
- 6dB minimum SNR were achieved at 333 Hz PFR and 115 mm standoff distance

Ultrasound is our strength.

Address	**SONOTEC GmbH** Nauendorfer Str. 2 06112 Halle (Saale)
Managing Directors	Hans-Joachim Münch Michaela Münch Michael Münch
Phone	+49 (0)345 133 17 - 0
Fax	+49 (0)345 133 17 - 99
E-Mail	sonotec@sonotec.de
Internet	www.sonotec.eu