

# A New Approach to Air-Coupled Broadband Measurement:

## Effective Testing of Composite Laminates by Using A New Multi-Element Transducer

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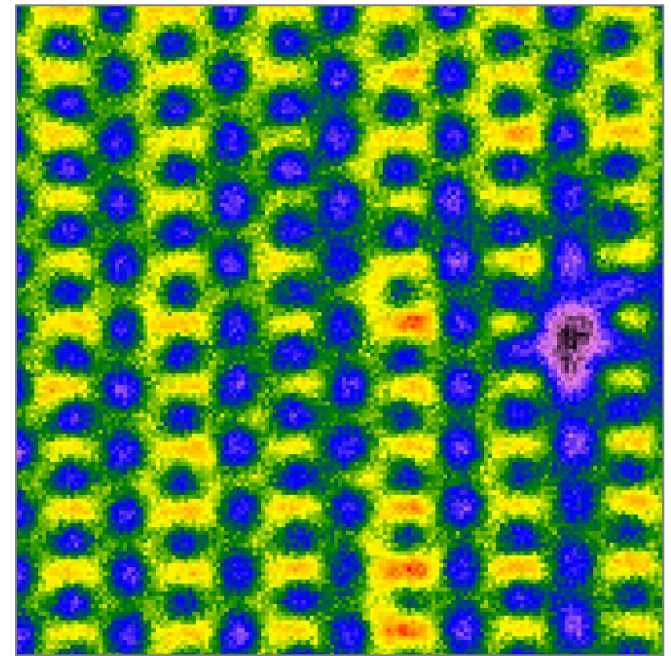
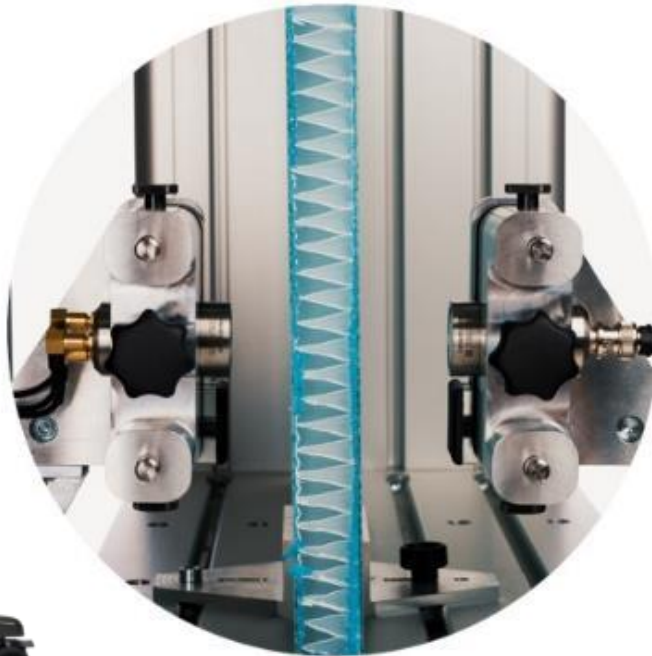
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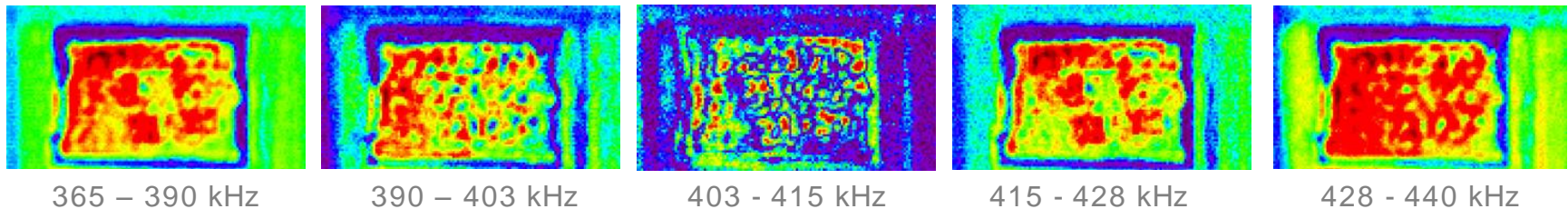
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# Introduction



# Motivation – Frequency Dependent Flaw Detection

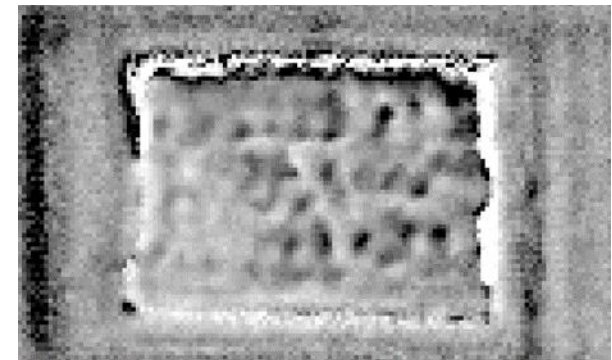
Test object: Composite with delamination



- 5 Scans
- Equal Setup
- 5 different center frequencies

→ The detectability of delaminations and the outline of the flaw is frequency dependent

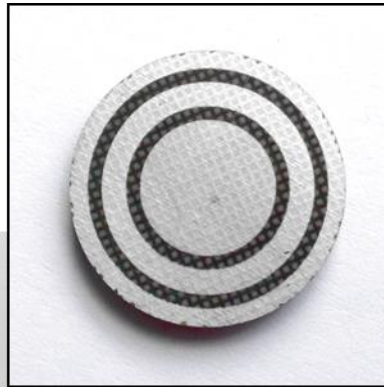
→ High Bandwidth Transducers could lead to a better detection and sizing of delaminations



Spectral Analysis

# Phased-Array ACUT Probe

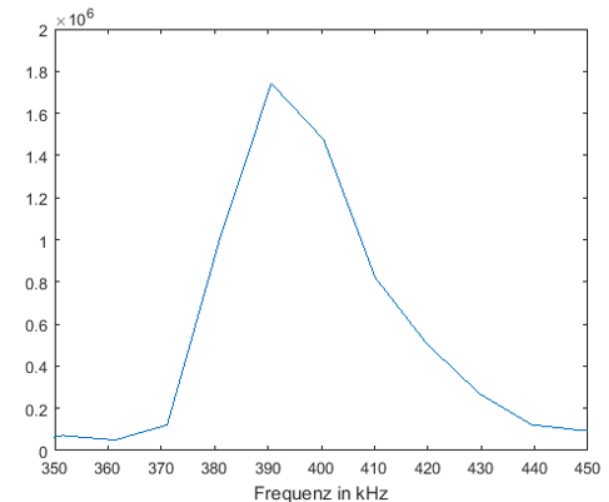
- ▶ Piezocomposite Transducer
- ▶ Dice and Fill



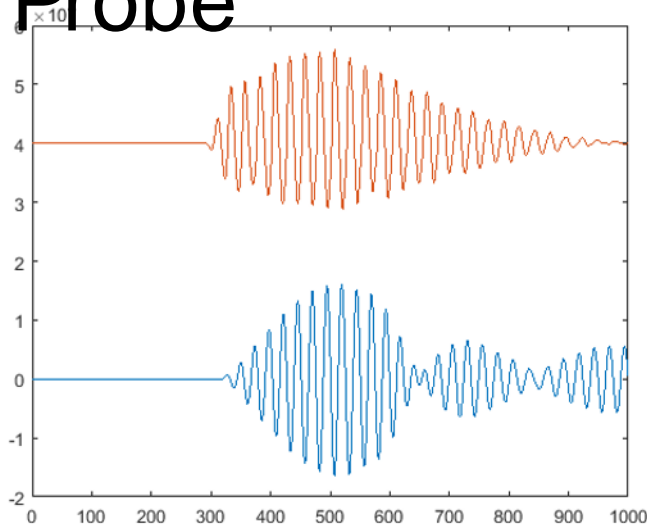
- ▶ 3 Elements
- ▶ Equally sized
- ▶ Structured Electrode
- ▶ Annular Array



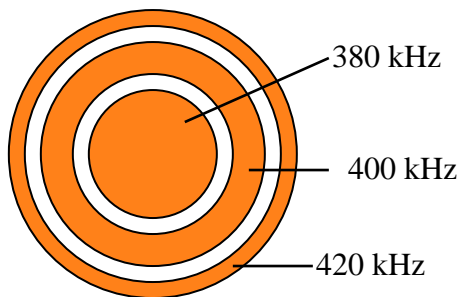
- ▶ 400 kHz
- ▶ Small Bandwidth
- ▶ Single Peak Spectrum



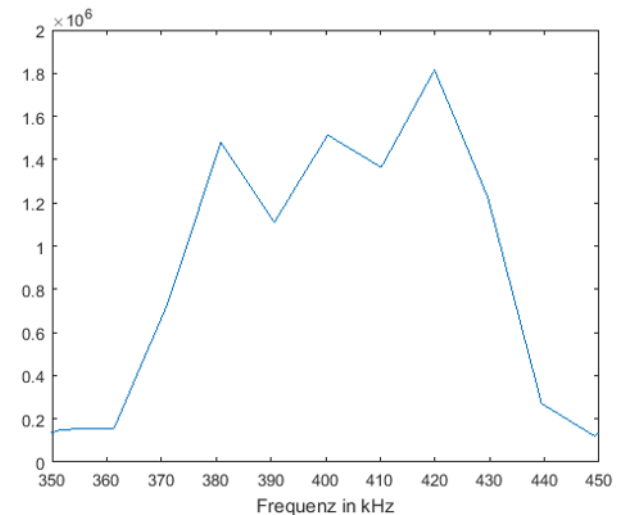
# Broadband Multi-Element ACUT Probe



- ▶ 3 Elements
- ▶ Equally sized area
- ▶ Structured Electrode
- ▶ Annular Array

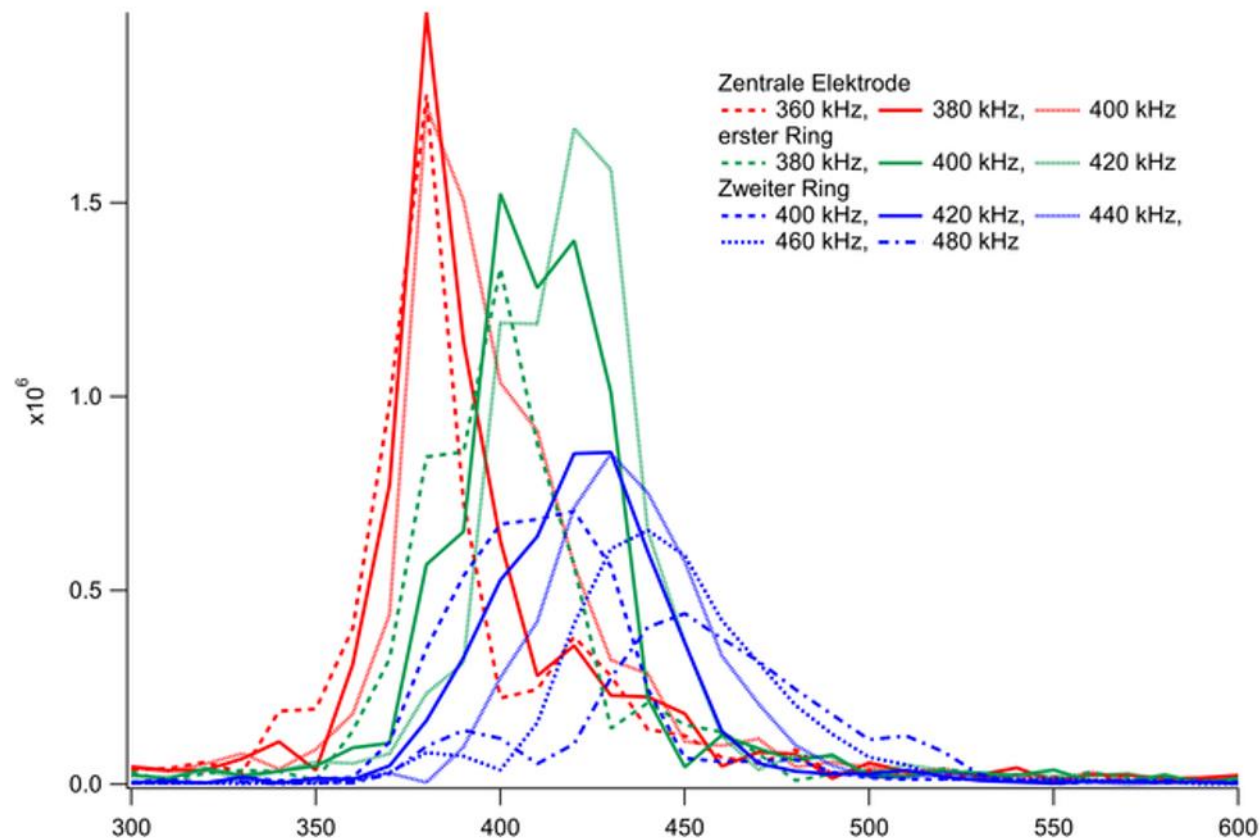


- ▶ 380, 400 and 420 kHz Elements
- ▶ Wider Bandwidth
- ▶ Three Peak Spectrum
- ▶ Shorter A-Scan Burst

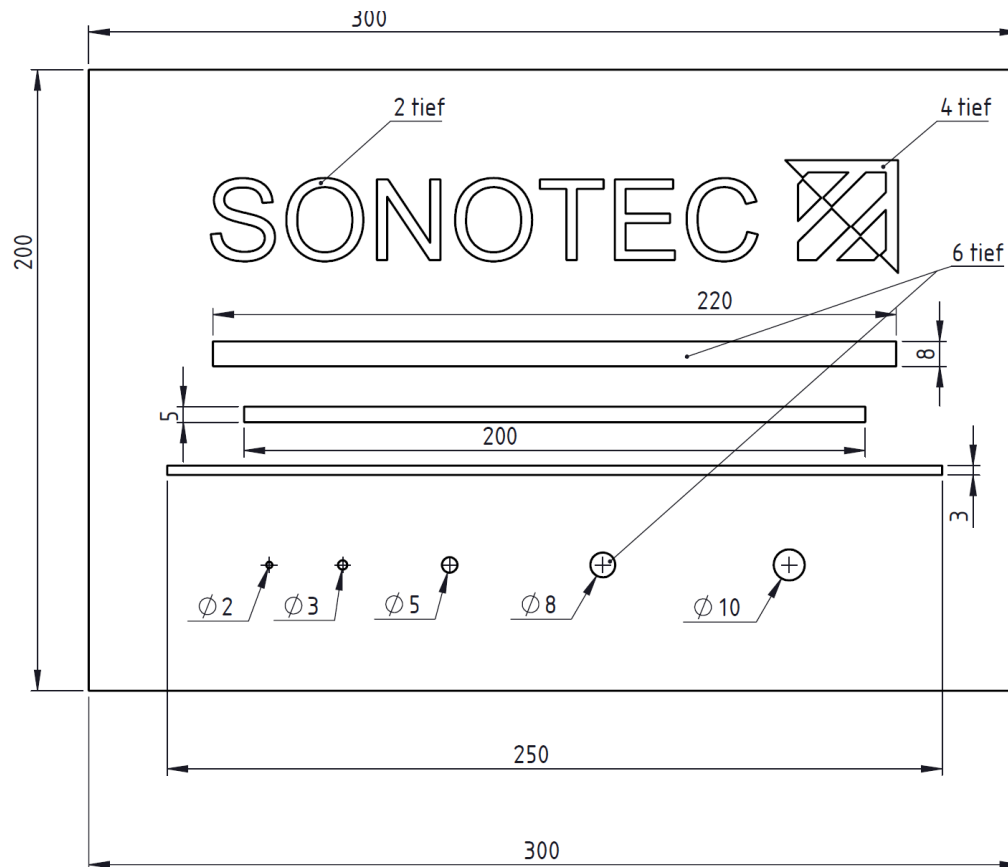




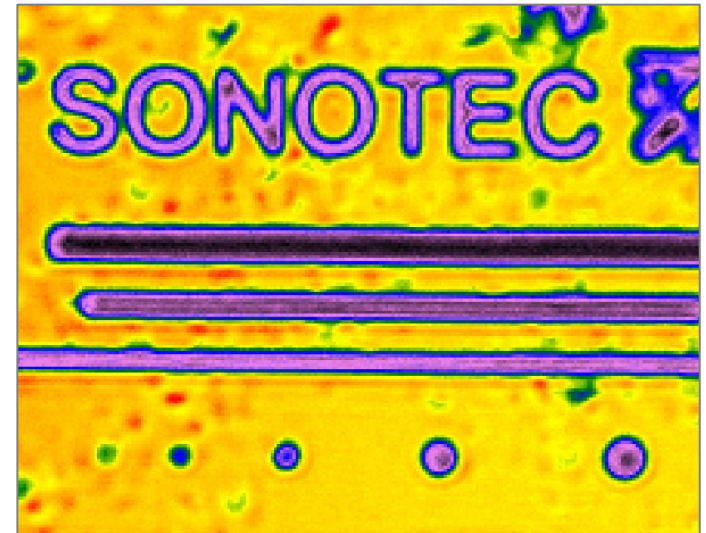
# Broadband Multi-Element ACUT Probe – Test Results



# Application



## Reference scan



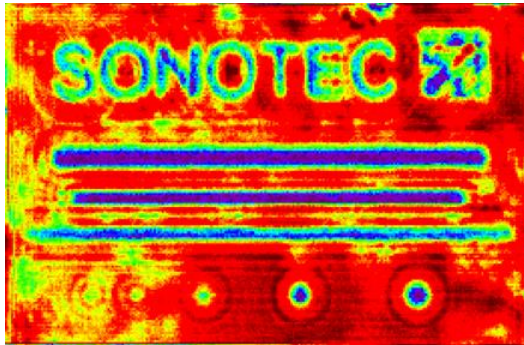
400 kHz through transmission

Phased-Array transducer

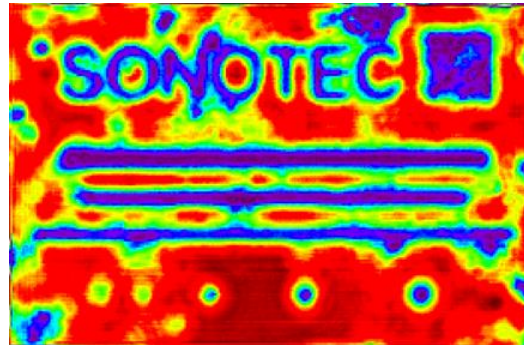
$\phi 2$  mm detectable



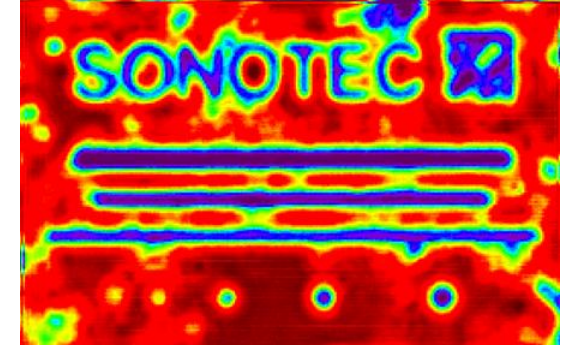
# Test Results - Scans



380 kHz



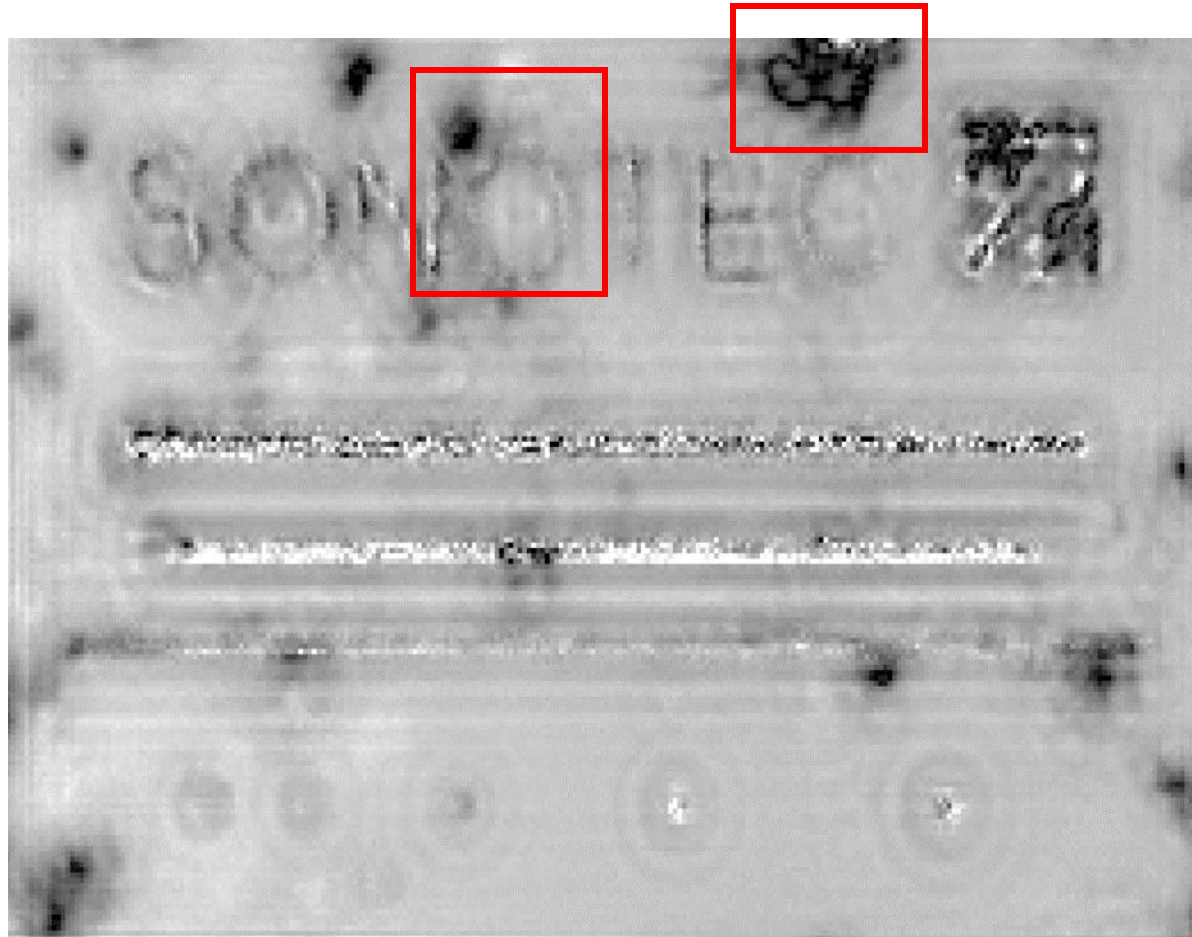
400 kHz



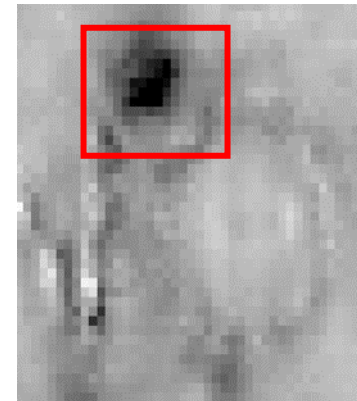
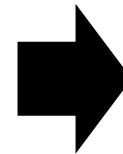
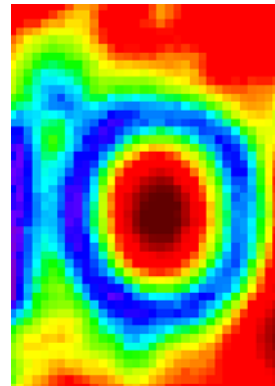
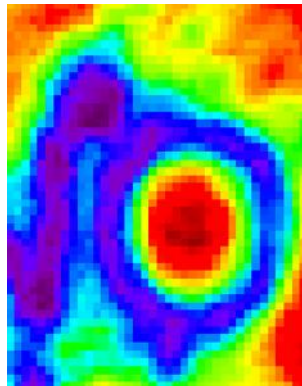
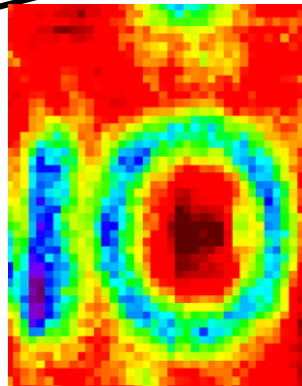
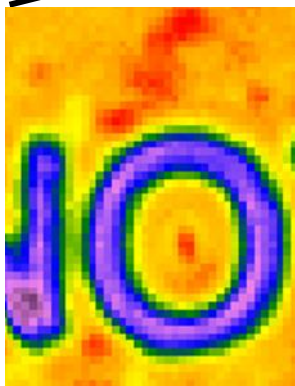
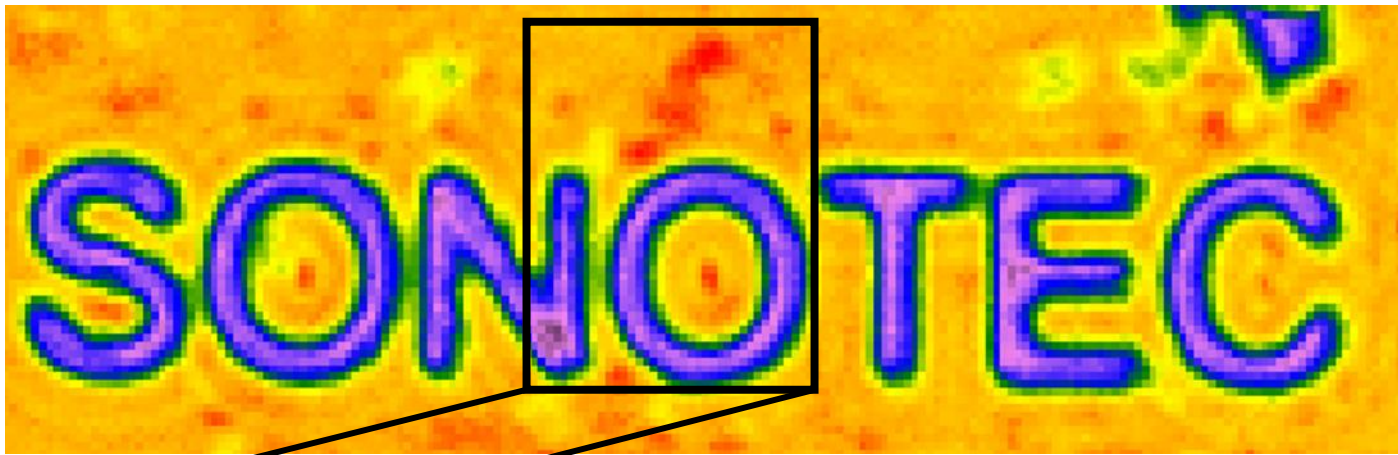
420 kHz

- ▀ Differences in Amplitude drop
- ▀ Differences in interference pattern
- ▀ Less focused than the reference scan

# Test Results – Spectral Analysis



# Test Results – Exemplary Analysis



# Conclusion

- ▶ A wider bandwidth can be achieved with dice and fill composites
- ▶ Spectral analysis can be used as a contrast mechanism with high bandwidth probes
- ▶ The detection and sizing of delamination and flaws in composites can be improved with this contrast mechanism



# Ultrasound is our strength.

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