WOLAXIM –

DESIGN OF AROTATING PHASED ARRAY SYSTEM FOR THE INSPECTION OF HOLLOW AXLES

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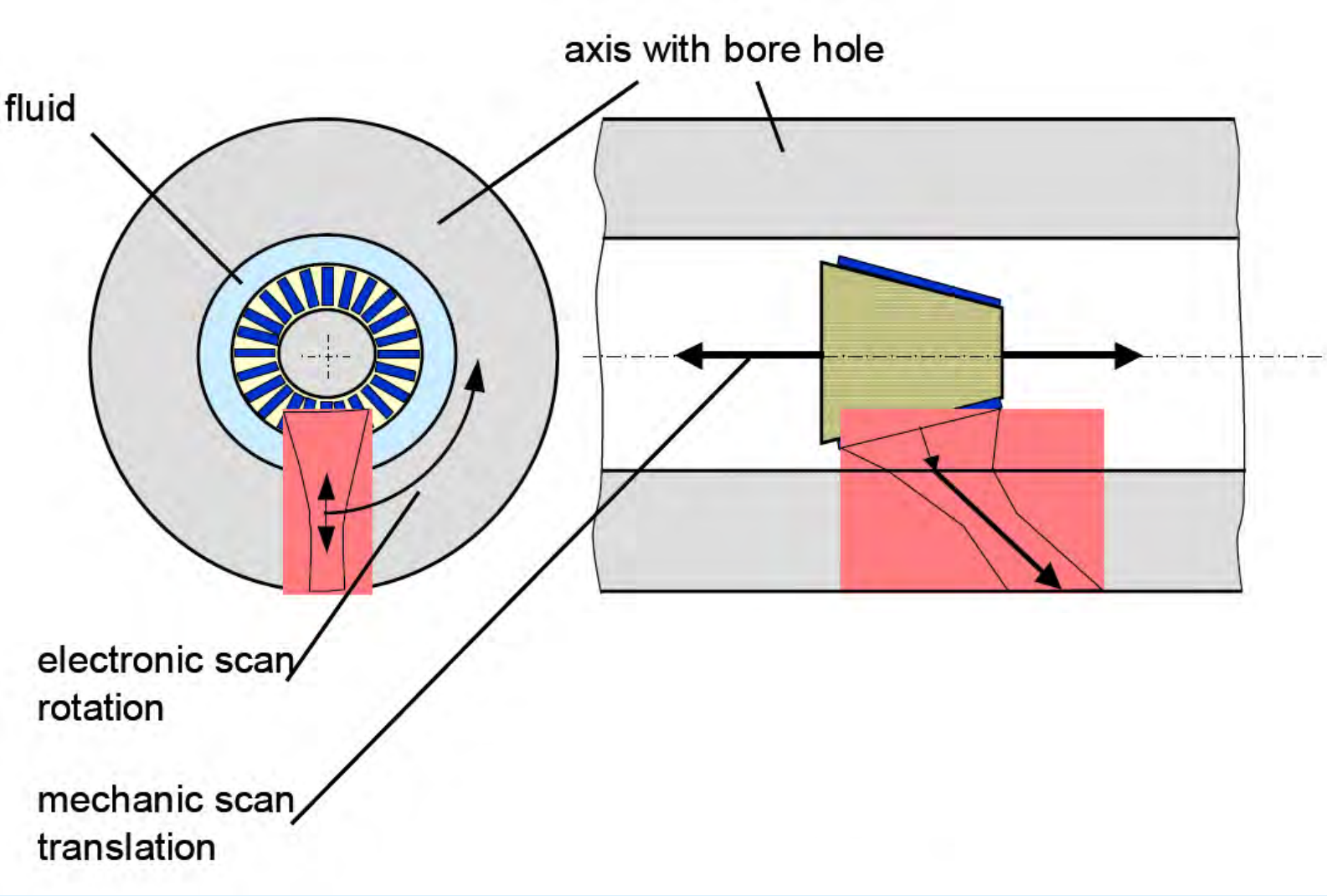
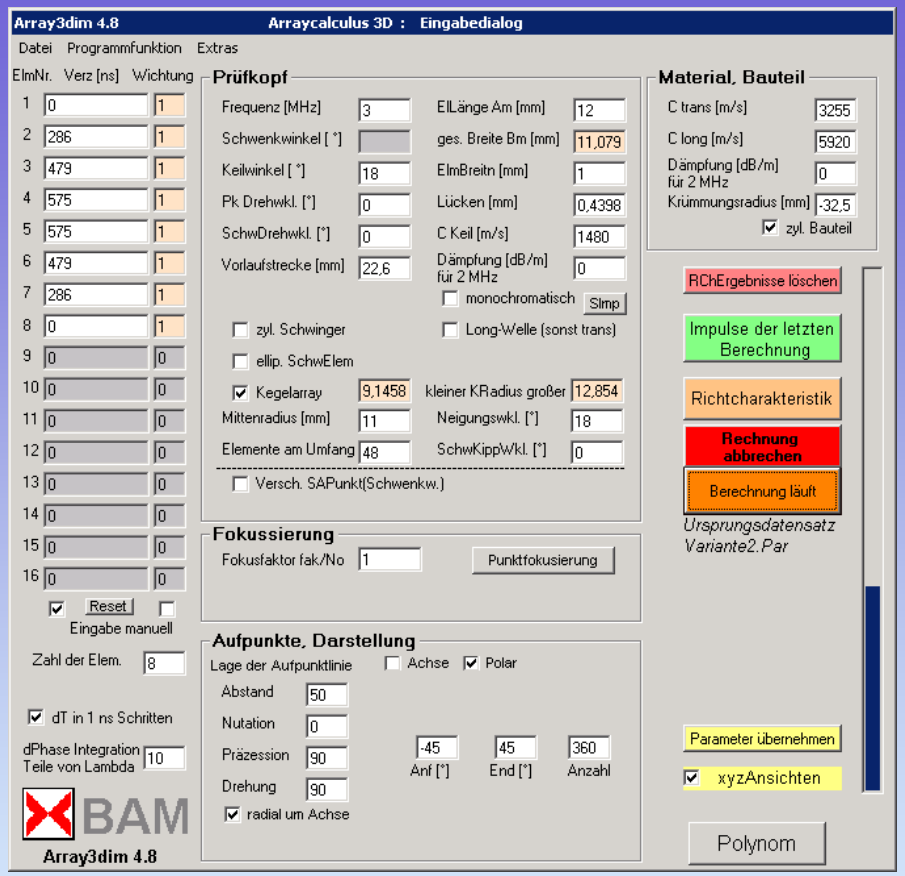
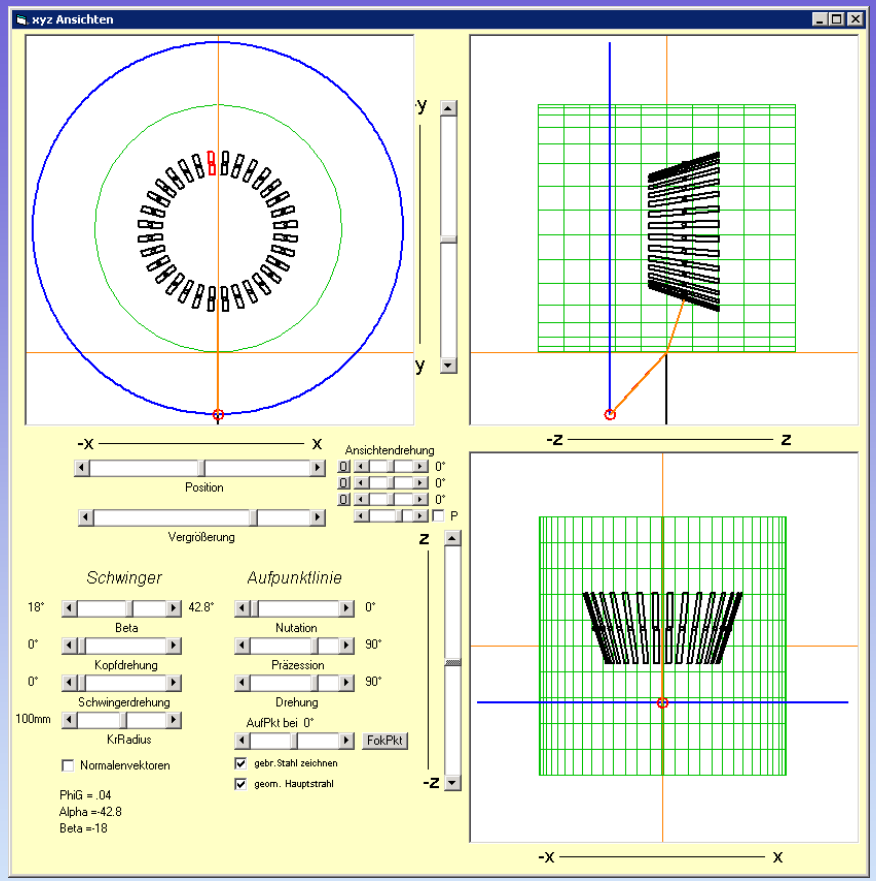
Motivation

No manual rotation, Fast scanning,
High sensitivity, 100% inspection



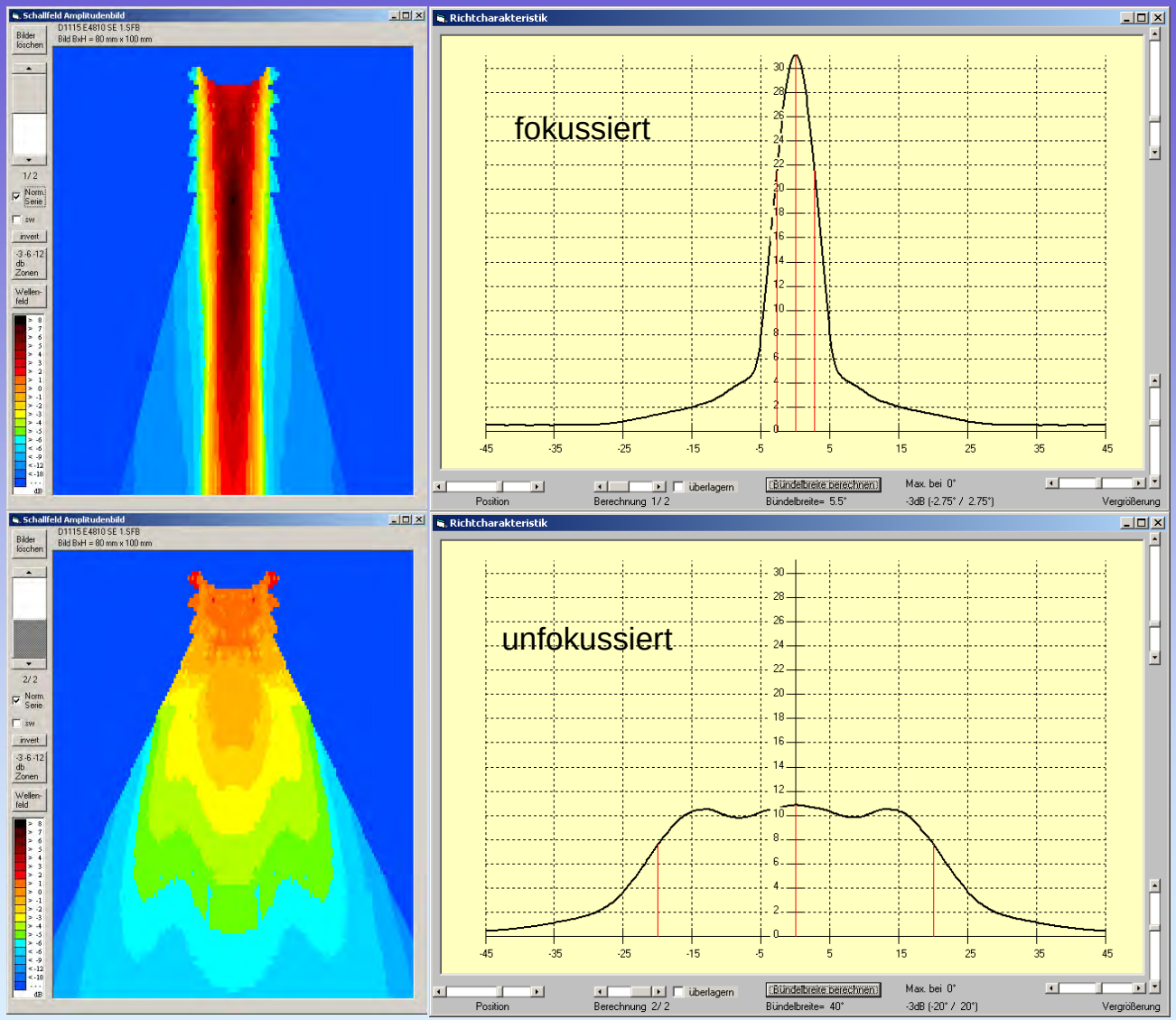
Modeling the sound field





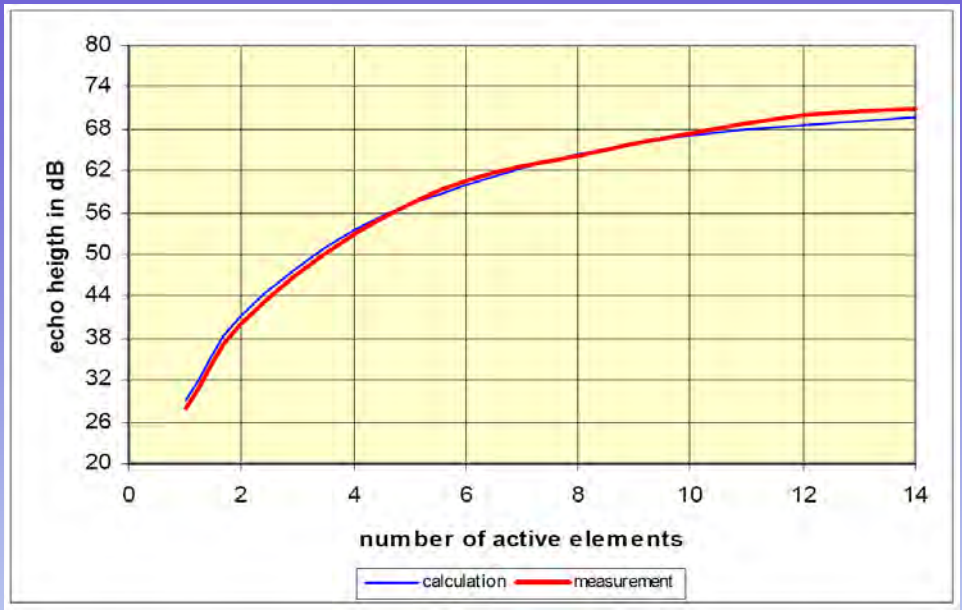
Modelling parameters, left: numerical, right: geometric

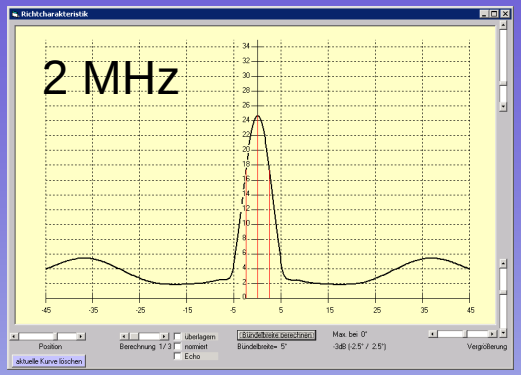
Modeling the sound field

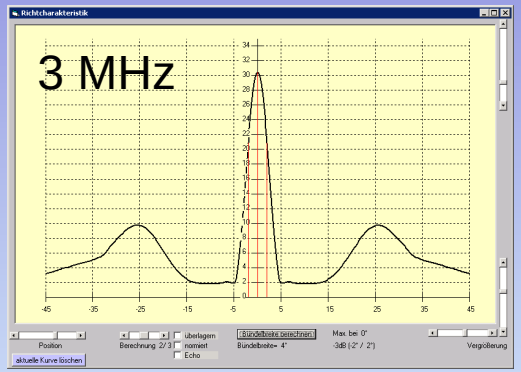


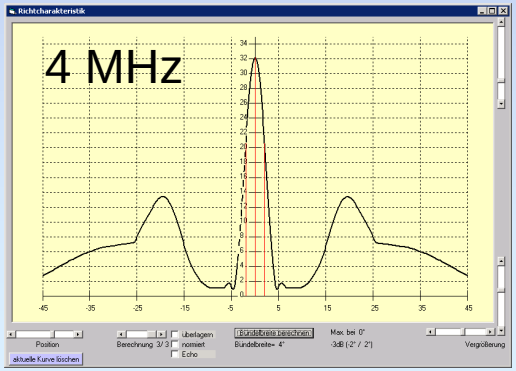
Modelling of the circumferential sound field, top: focused, bottom: non focused, left: sound field with color coded amplitudes, right: circumferential directivity pattern

Modeling the sound field







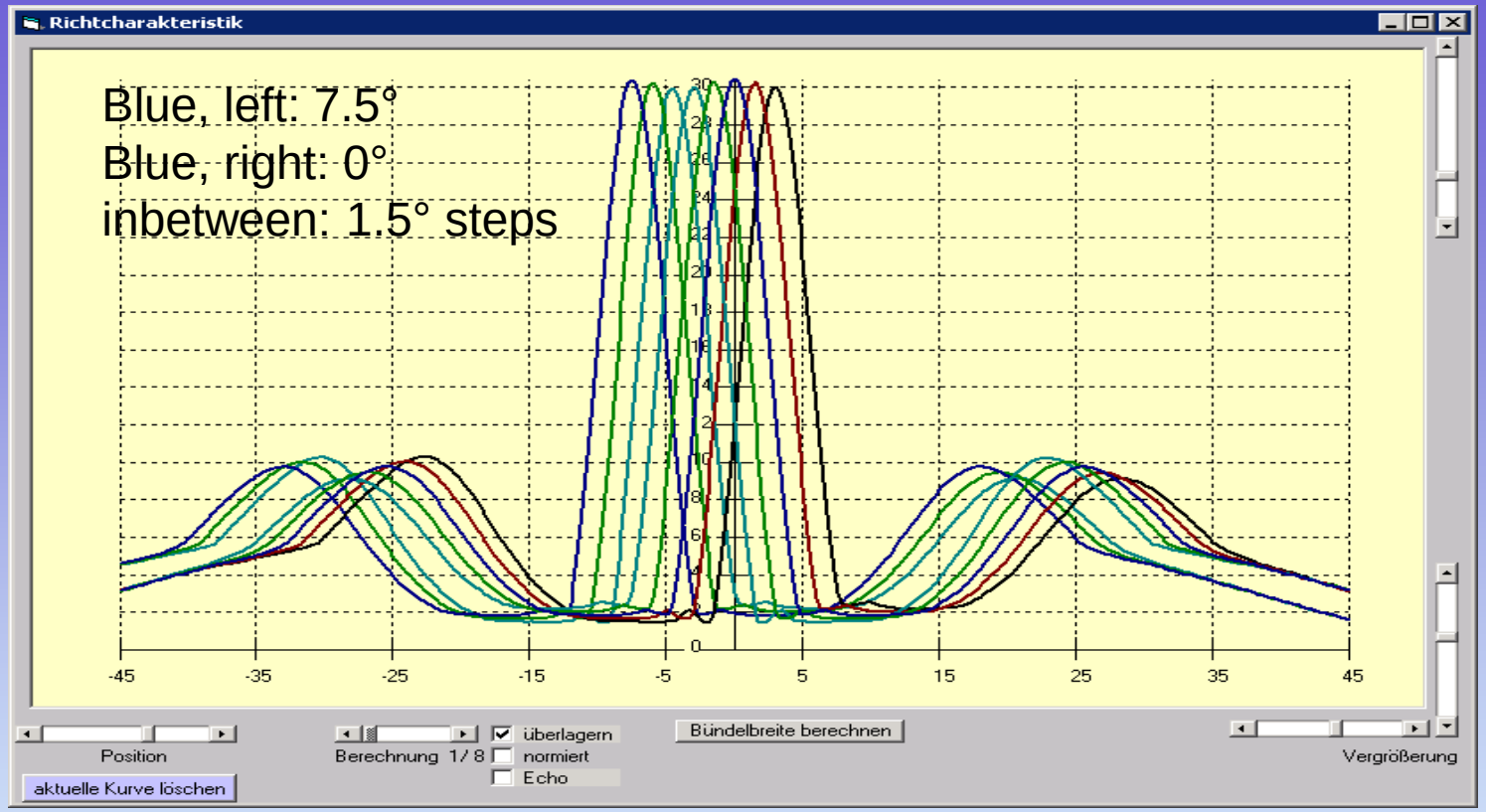


Reasonable numbers of elements in the PA system: 8

No significant increase in SNR for larger amount of elements simultaneously operated

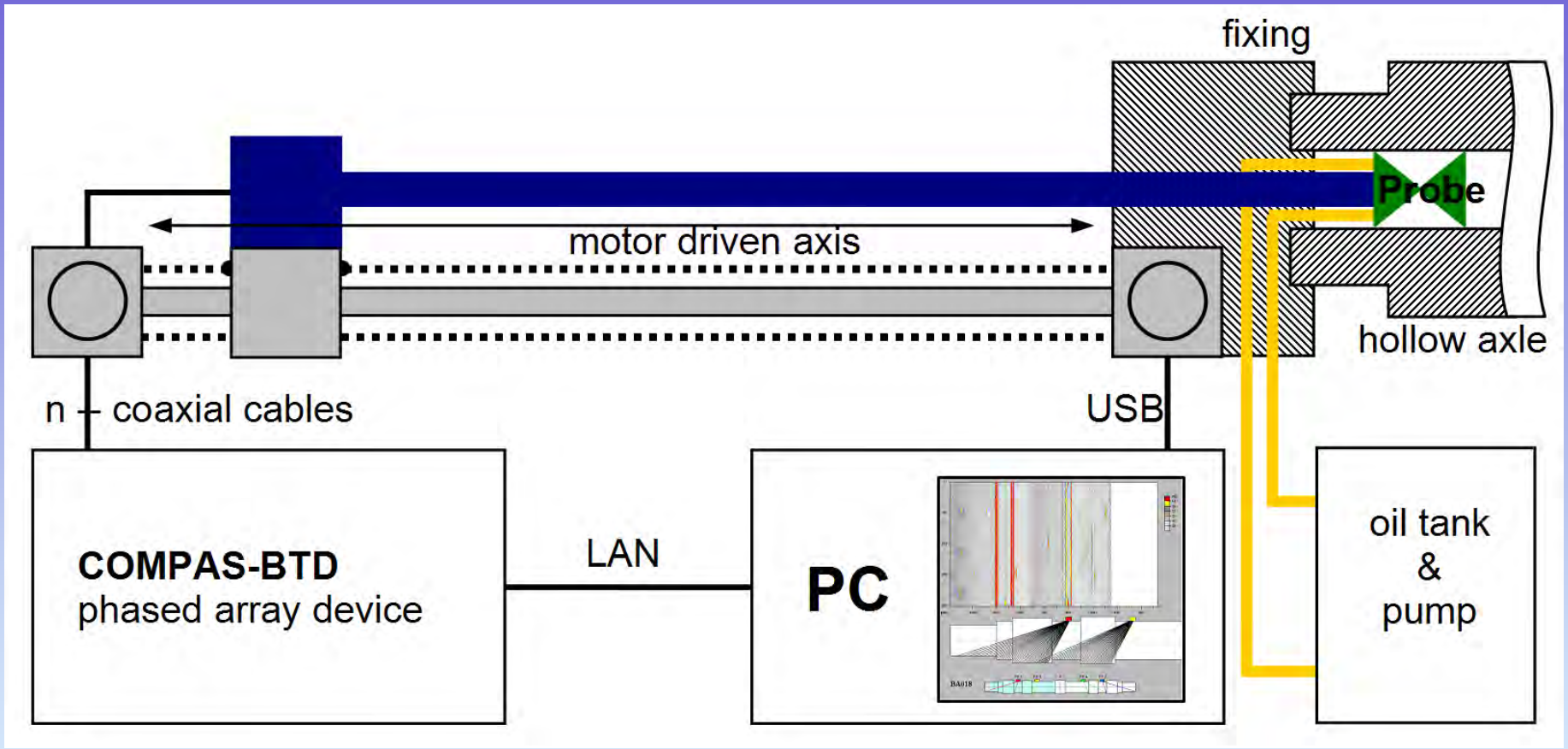
Grating lobes are tolerable for f= 3 MHz (see fig. Right)

Modeling the sound field –changing the steering angle



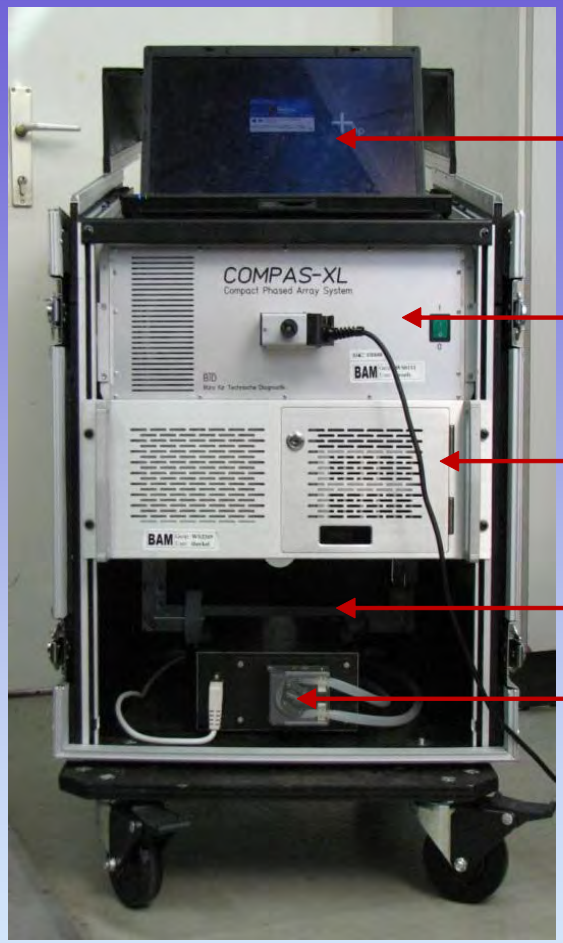
- 48 elements / cone corresponds to 7.5°/element along the circumferential Resolution of better 2° is required
- Therefore it is necessary to steer the sound field electronically in 1.5° steps by using the Phased Array
- Delay times for each single element to steer the sound field are calculated
- We observe a constant amplitude for different steering angles

Concept of the ultrasonic testing system



Concept of the ultrasonic testing system


Test bench for hollow axles



PC with user interface

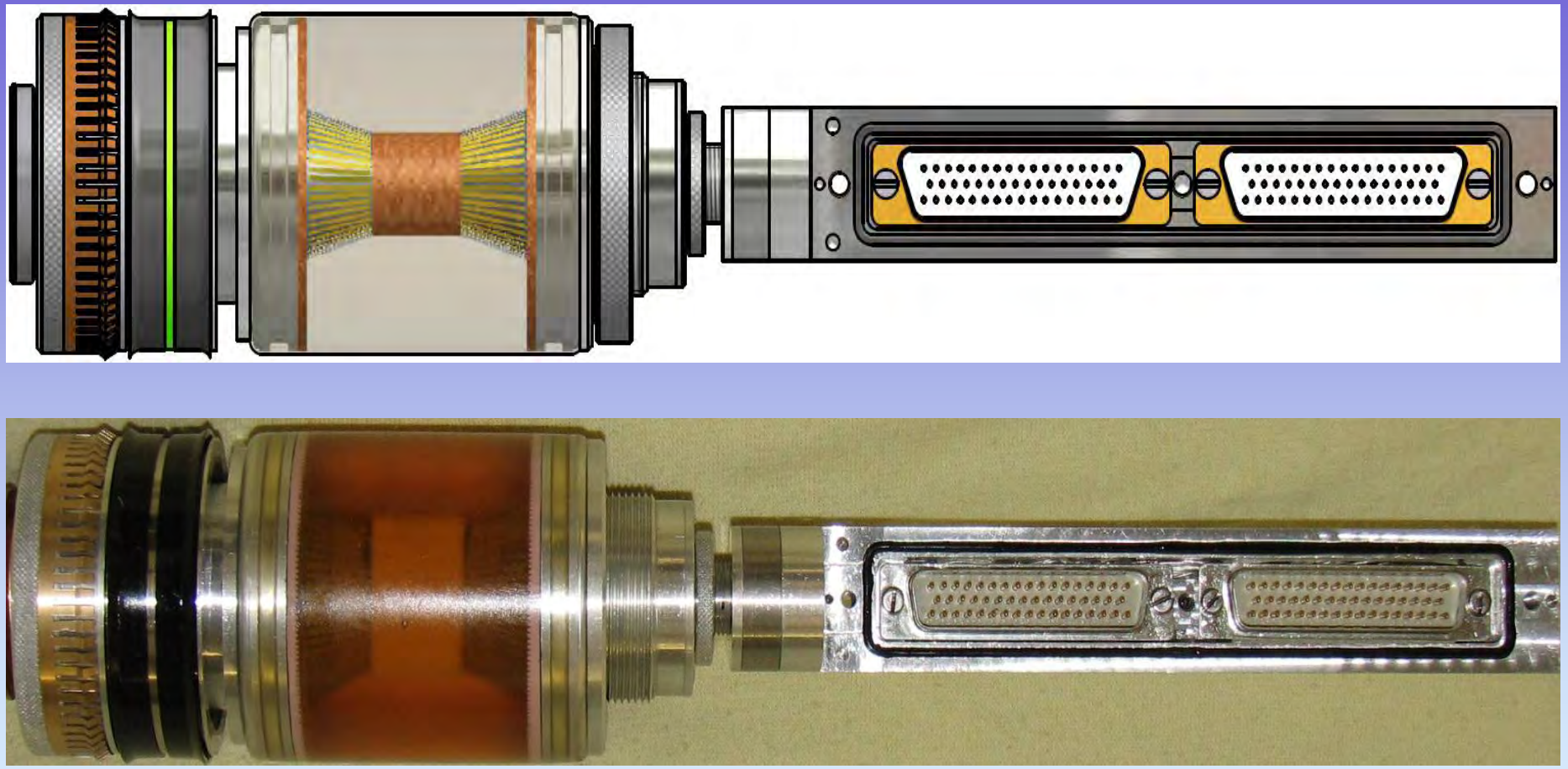
COMPAS device

motor control device

oil tank

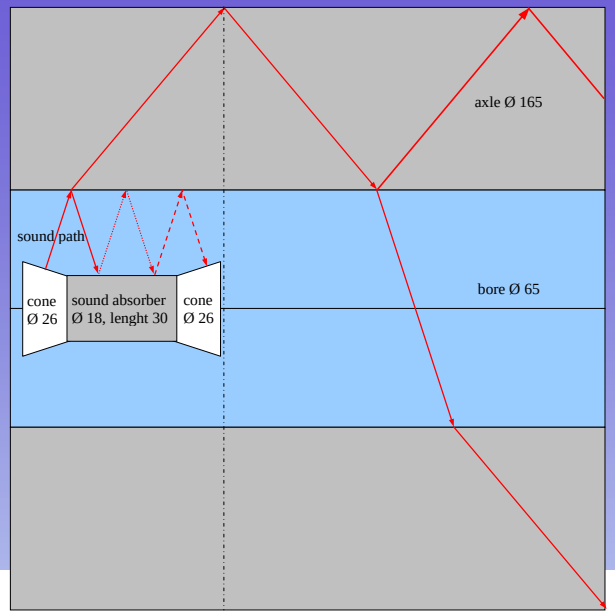
oil pump

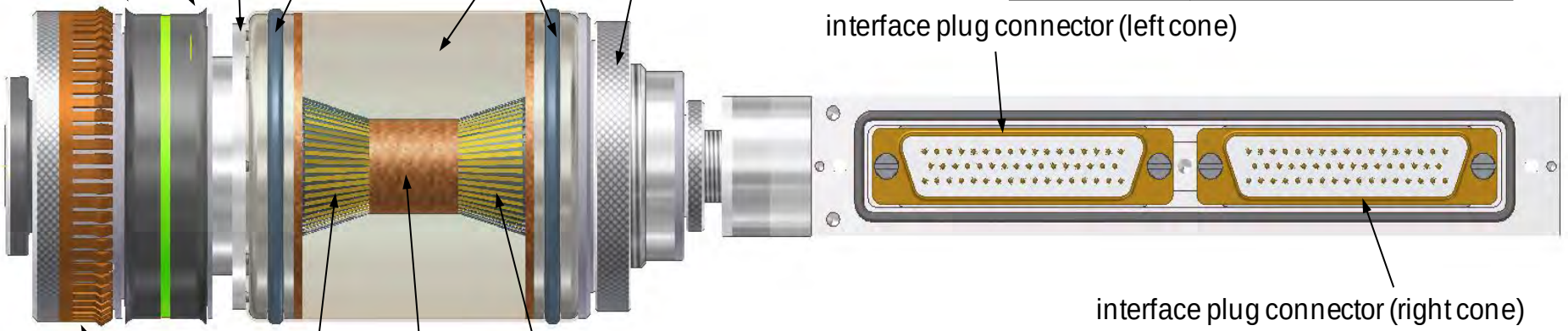
Concept of the ultrasonic testing system – Transducer system



Phased array probe; top: design drawing; bottom: picture

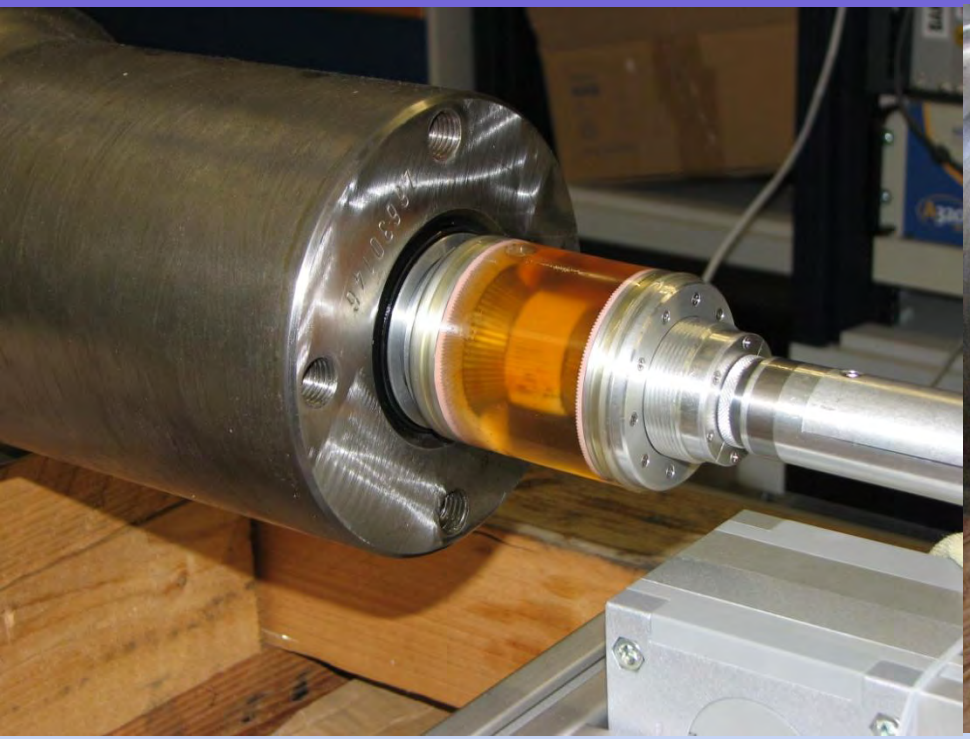
Concept of the ultrasonic testing system – Transducer system

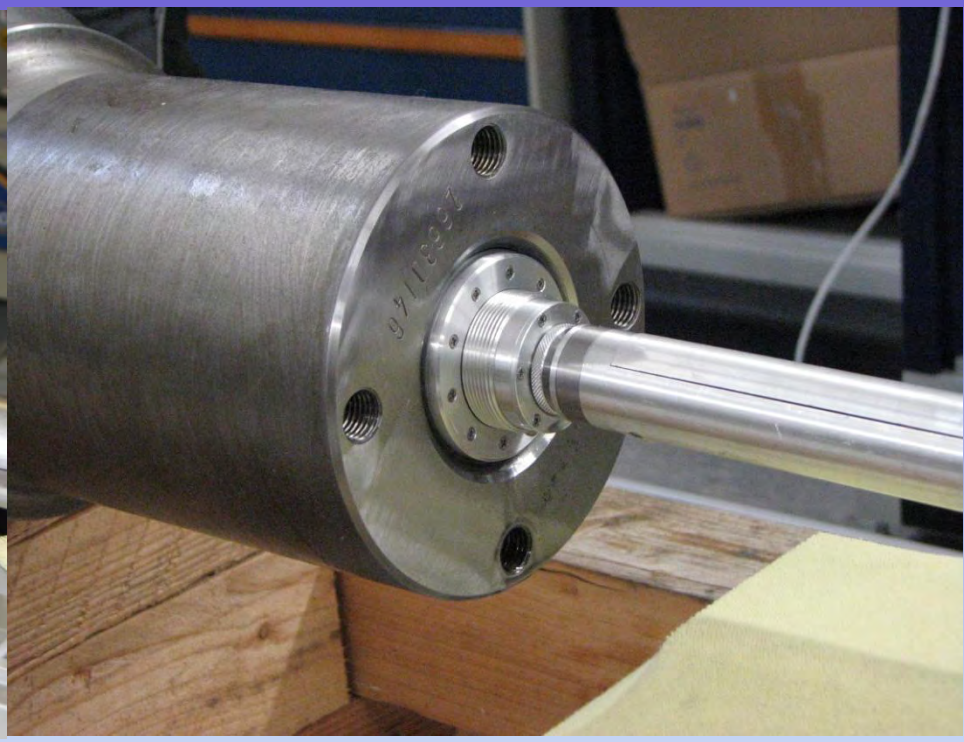




(including a pressure-balance system for a counterforce lower than 4 Newton by air-pressure in a hermetically sealed bore)

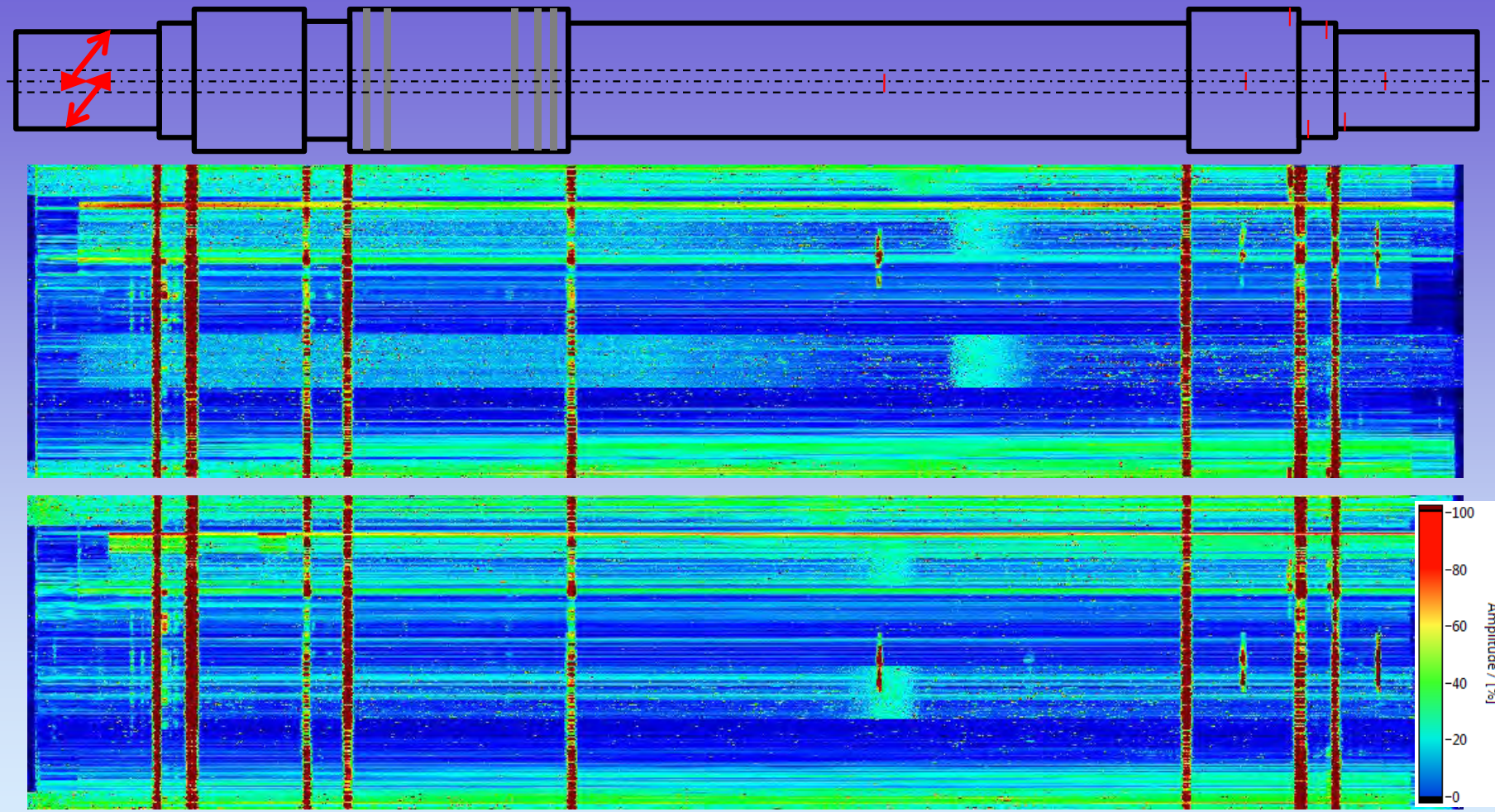
Probe in Action



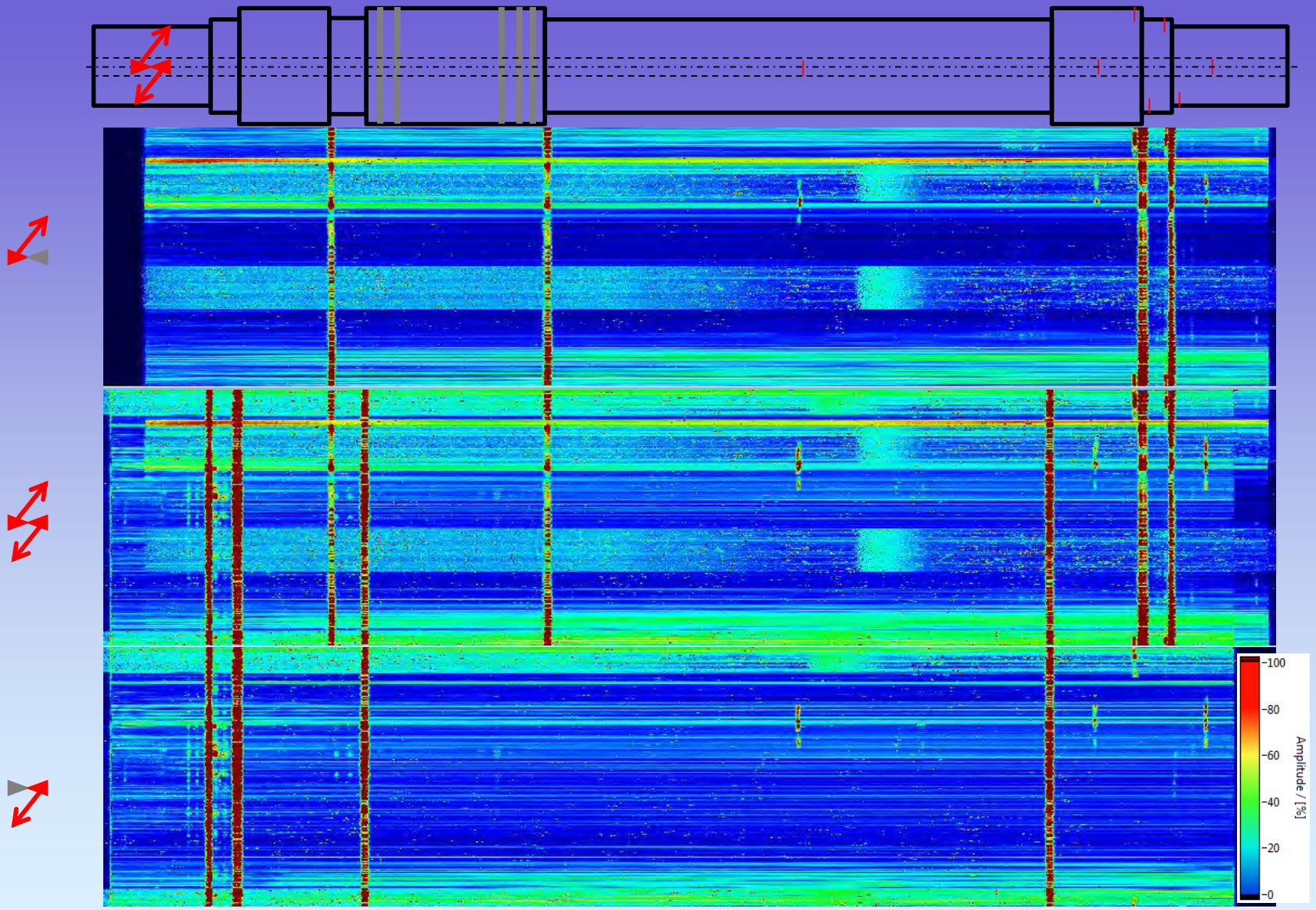


Pictures of the probe inside the bore;
left: before inserting;
right: starting position for the inspection procedure

Video

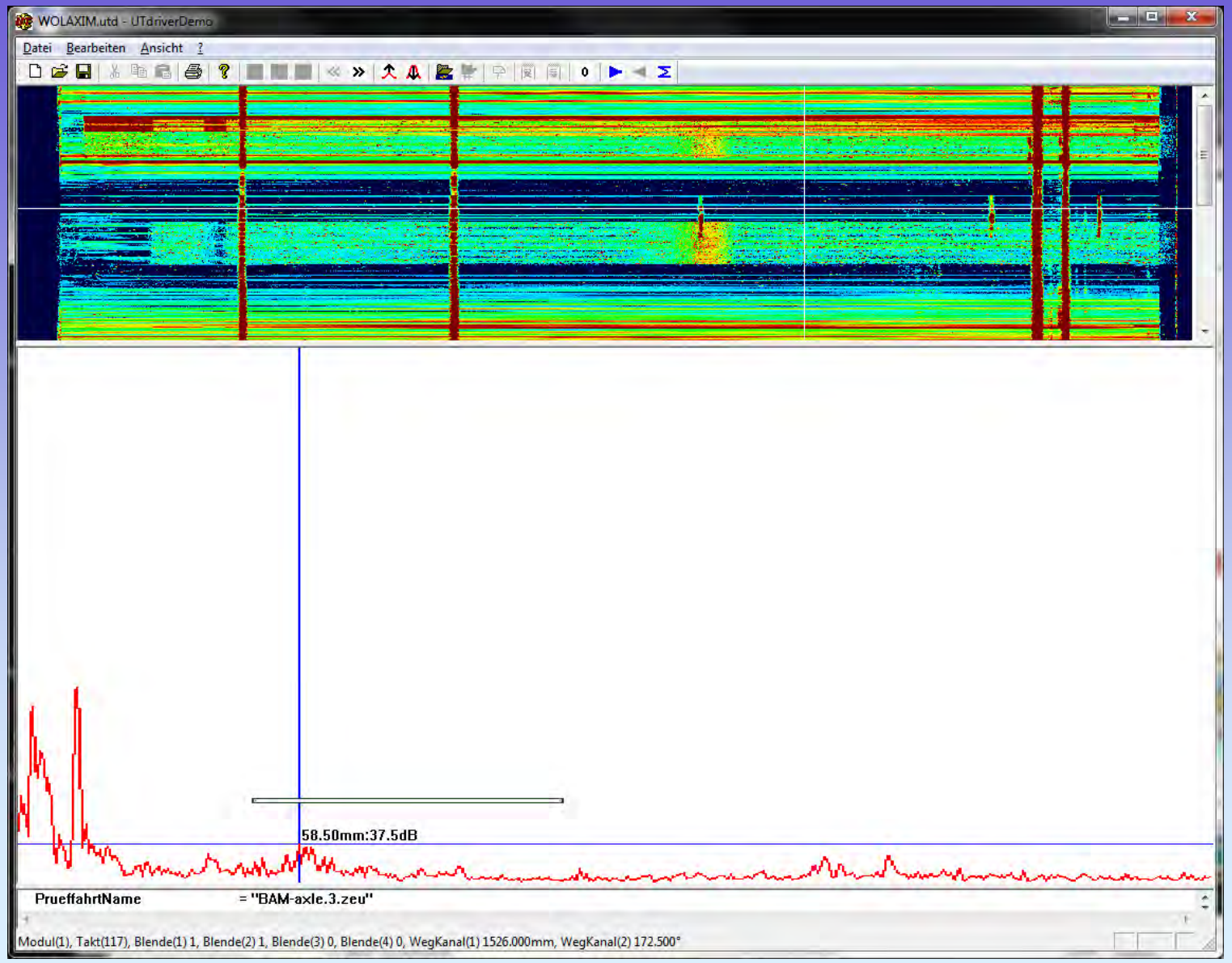


Comparison of the C-scans of the first test (top)
and the second test with the probe 90° rotated (bottom), 2mm deep saw cuts

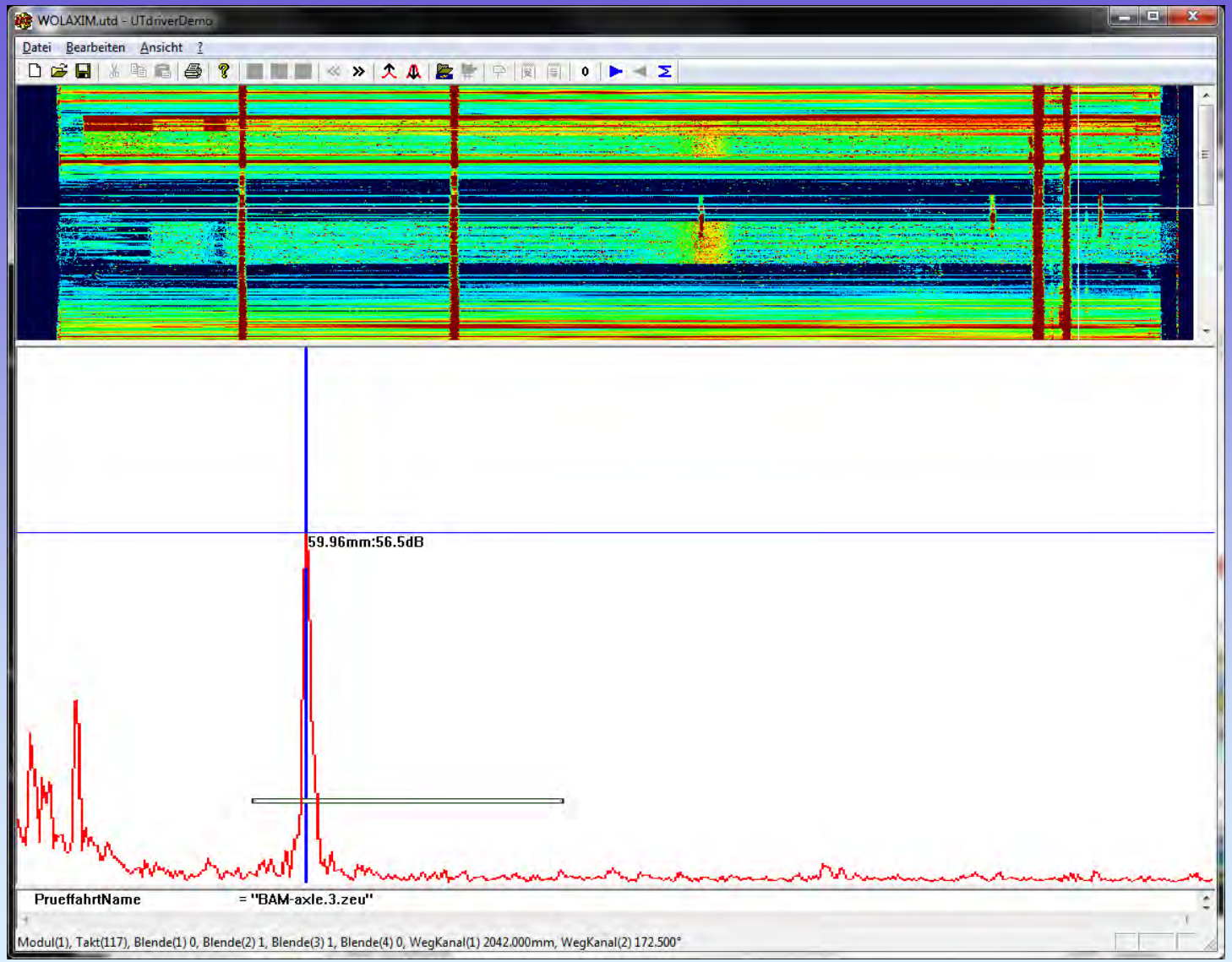


Comparison of the C-scans of cone 1 (top), cone 2 (bottom), and the fusion of both (middle)

Measurements –Noise Level

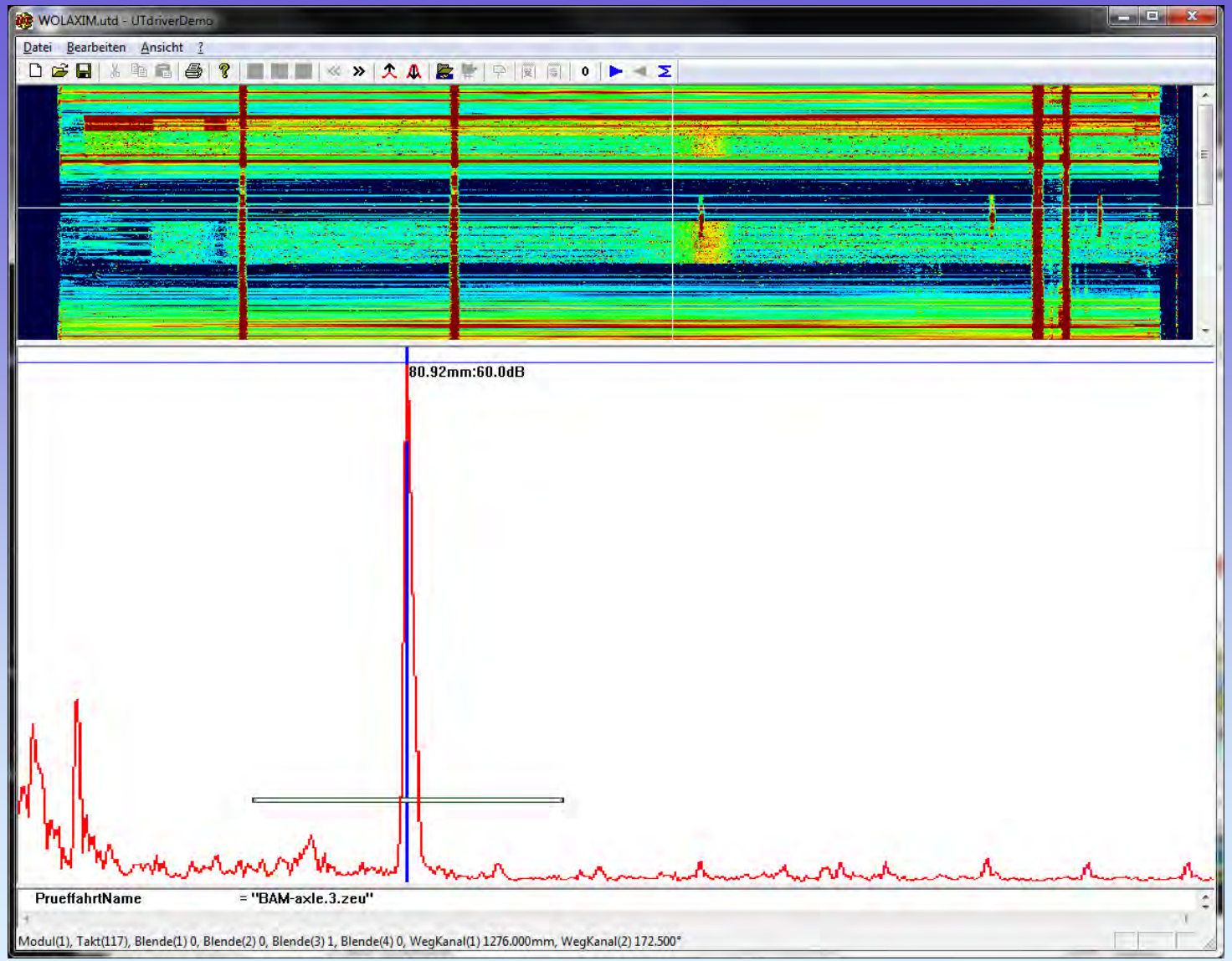


Measurements – Defect in Journal



A-scan of an element group without interference, reflection of the test flaw in the journal

Measurements – Defect in Shaft



A-scan of an element group without interference, reflection of the test flaw in the shaft

Conclusion

-Fast UT-inspection system based on an electronically rotated Phased Array system (measurement time of 60 seconds / axles)

-Resolution of 1.5° circumferential direction and 2mm in axial direction (resulting in 1000 x 240 A-scans)

-Signal-to-noise ratio of better than 17.5 dB
-In the shaft region about 22.5 dB for 2mm deep notches

- Further optimization is possible