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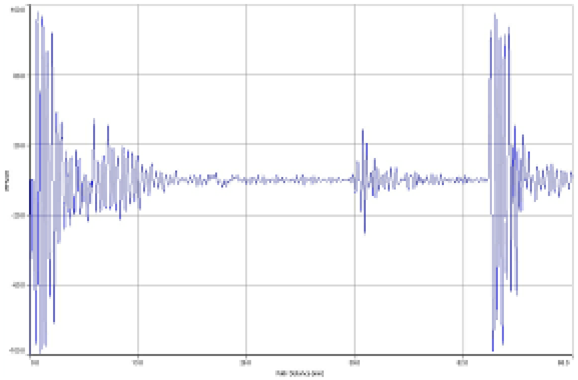
R&D Laboratory on Industrial Demand

UT, μ-NDT, NDT Systems

Michael Kröning

RF A-SCAN



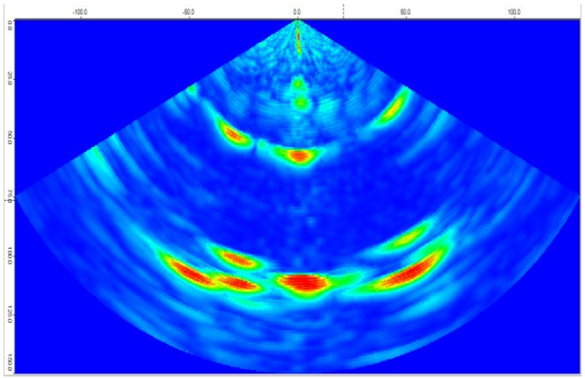
DEFINITIONS

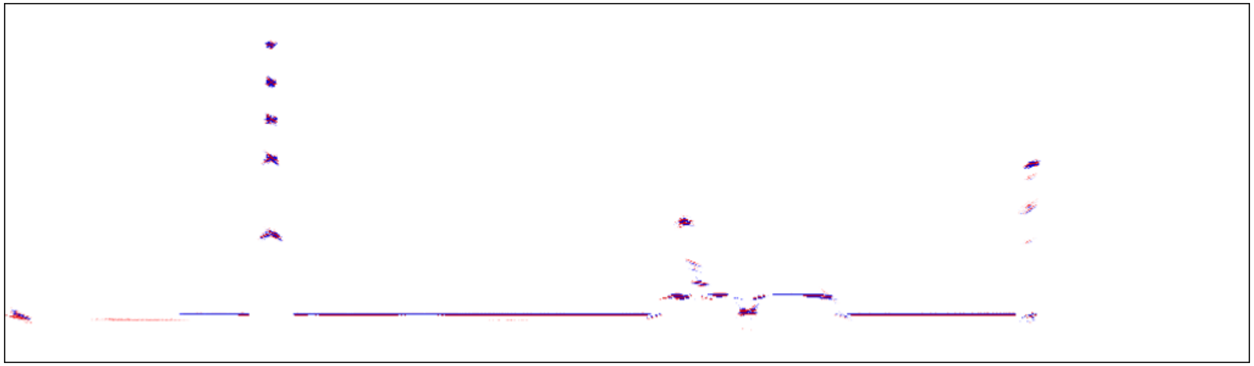
APPLICATIONS

BASICS

CASE STUDIES

PA SECTOR-SCAN





ADVANCED REAL-TIME IMAGING

Method	Main Application	Relevance	Remarks
Pulse-Echo	Flaw Detection Geometry Measurement	★★★★★	Standard
Guided Waves	Long Range Inspection	★★	Pipe Systems
Continuous Waves	Elastic Properties; Distance Measurement	★ (Research)	Specific Use (Time Reversal)
Velocity	Stress State Material Characterization	★ (Research)	Specific Use
Frequency Response	Adhesive Strength Material Degradation	★ (Research)	Specific Use (Aerospace Materials)
Ultrasonic Microscopy	Microscopy; SAW Micro Structure Characterization	★ (Laboratory)	Specific Use (Electronic Structures)

ULTRASONIC TESTING

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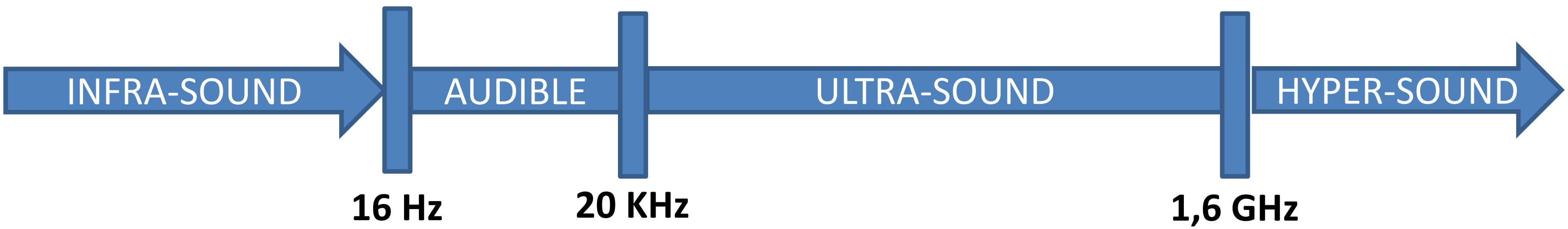
Acoustic Resonance Analysis
Mass Production



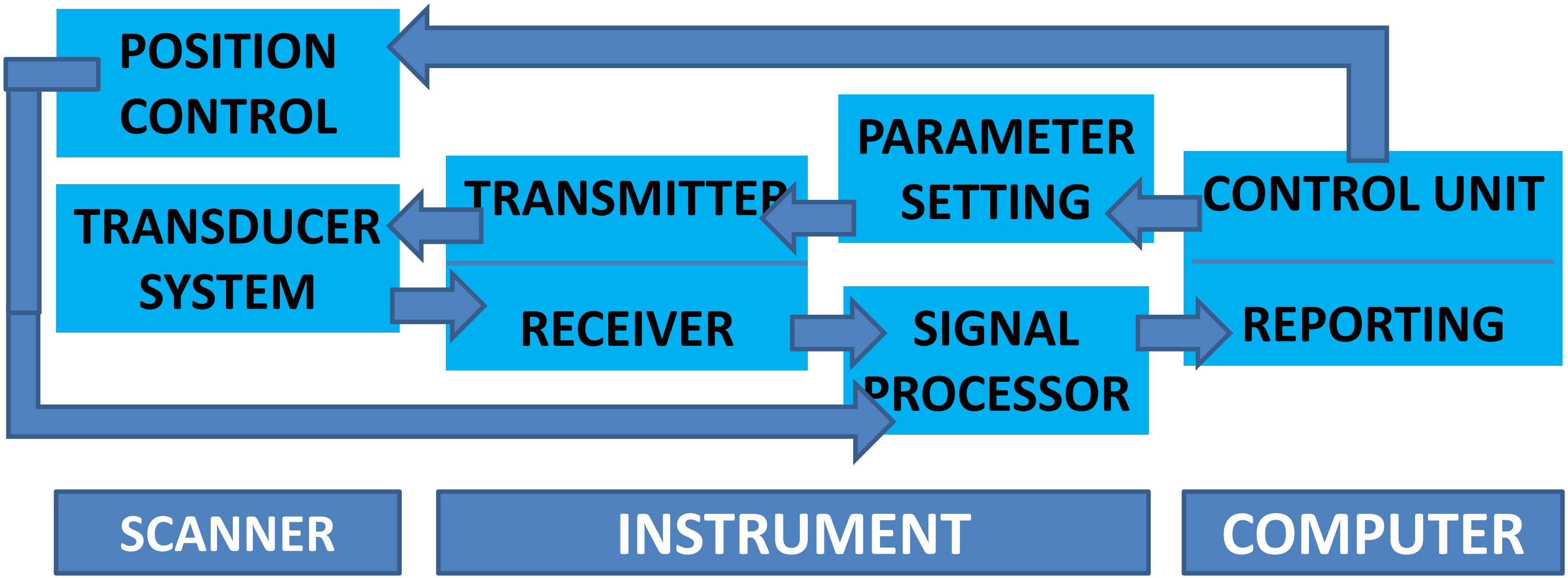
Ultrasonic Inspection
Structural Integrity

FOCUS ON ULTRASONIC INSPECTION UT

UT, µ-NDT, NDT Systems

BASICS of UT

FOREIGN CODES: ASME Section 5, EN 583 and others



STRUCTURE OF ULTRASONIC SYSTEMS

BASICS of UT

SYSTEM ENGINEERING
with
Advanced Modular Architecture

- **INSPECTION PROBLEM**
  (Specification, Procedures, Constraints)
- **MEASUREMENT PHYSICS**
  (Nondestructive Methods, Sensor Physics)
- **ELECTRONICS**
  (Instruments, Computer Hardware)
- **INFORMATION TECHNOLOGIES**
  (System Programming, Signal Processing, System Control & Reporting, Asset Management)
- **HANDLING TECHNOLOGIES**
  (Robots, Automation Technologies)

BASICS of UT

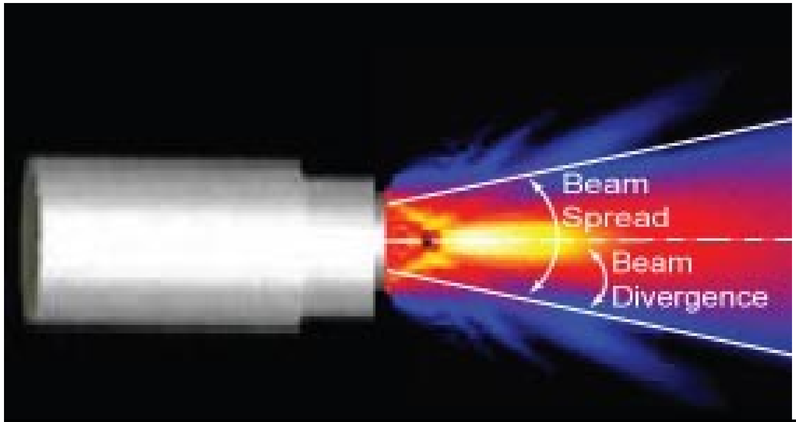
TRANSDUCER TECHNOLOGIES

MECHANICAL IMPACT

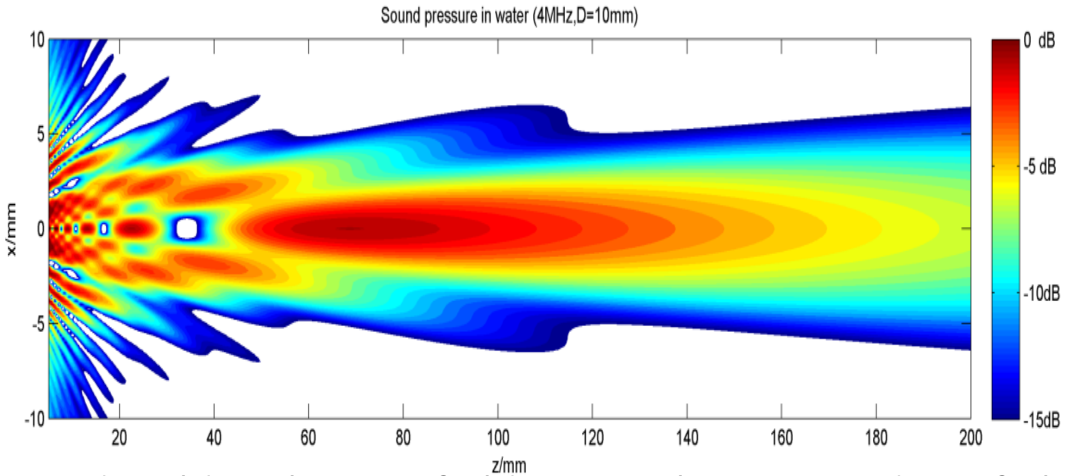
PIEZO EFFECT

EMAT ELECTRO MAGNETIC

LASER IMPACT

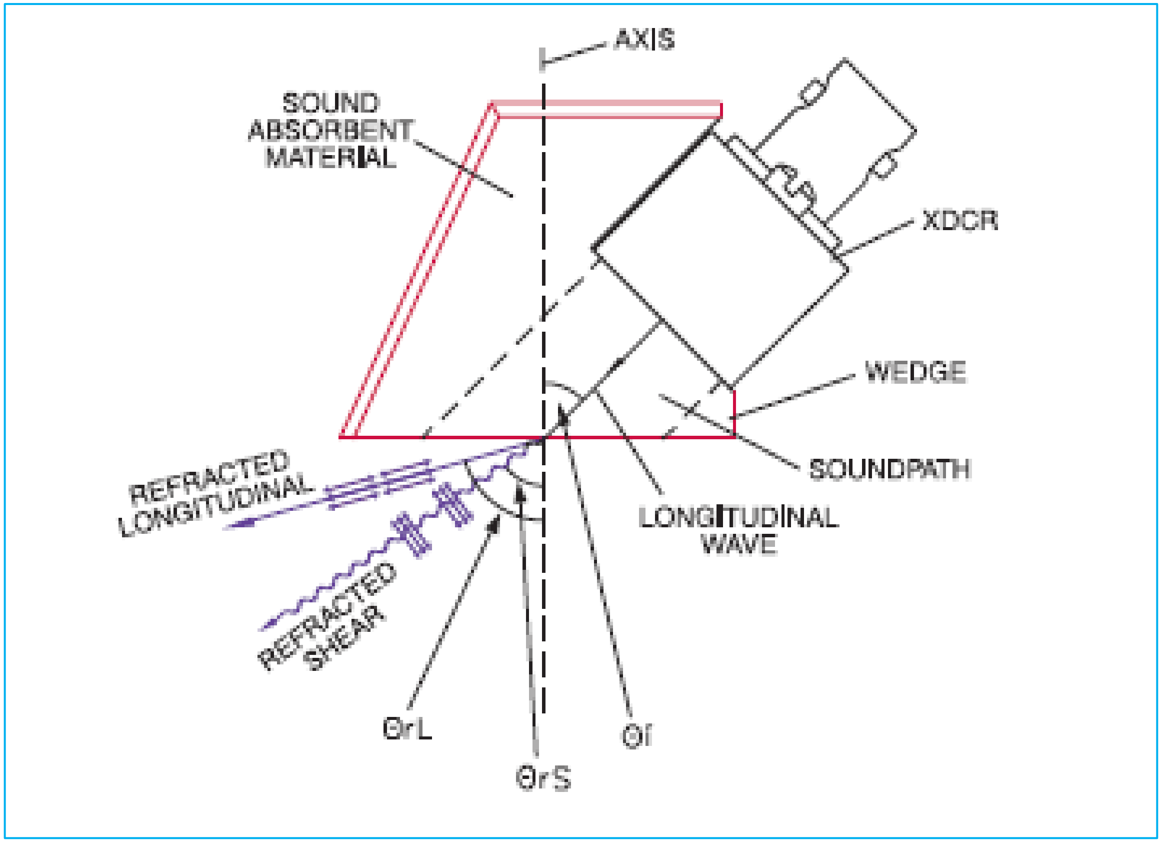


Typical Ultrasonic Sound Field (Larson, 2011)



Harmonic Sound Field with Near-field, Natural Focus, and Far-field

BASICS of UT



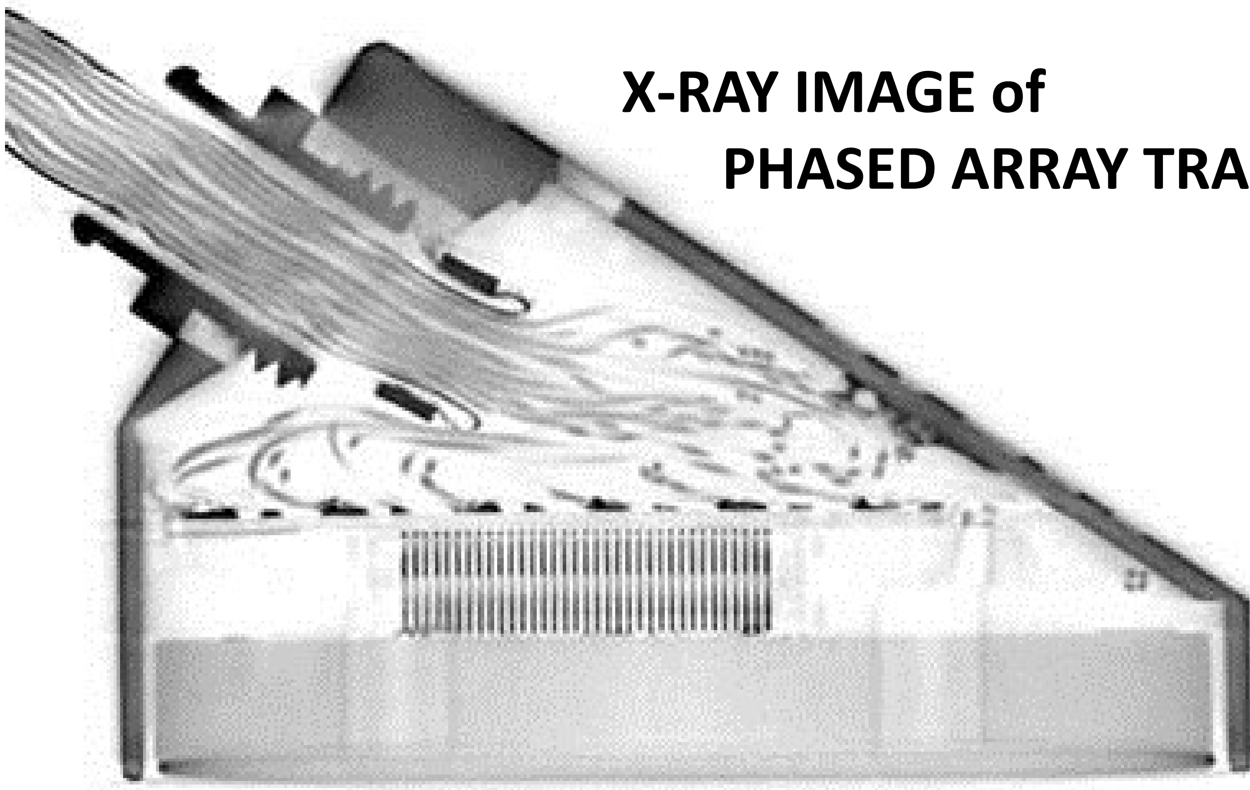
Typical Design of an Angular Beam Transducer (Olympus, 2011)

PIEZO TRANSDUCER

UT, μ-NDT, NDT Systems

BASICS of UT

X-RAY IMAGE of PHASED ARRAY TRANSDUCER



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BASICS of UT

Near field distance: **N = $(A^2 - \lambda^2)/4\lambda$**

Transducer aperture: **A**

Wave length: **λ**

Focus diameter : **ϑ ~ .26 A**

Focal length: **Λ**

TECHNICAL ESTIMATES of TRANSDUCER PARAMETERS

PIEZO TRANSDUCER

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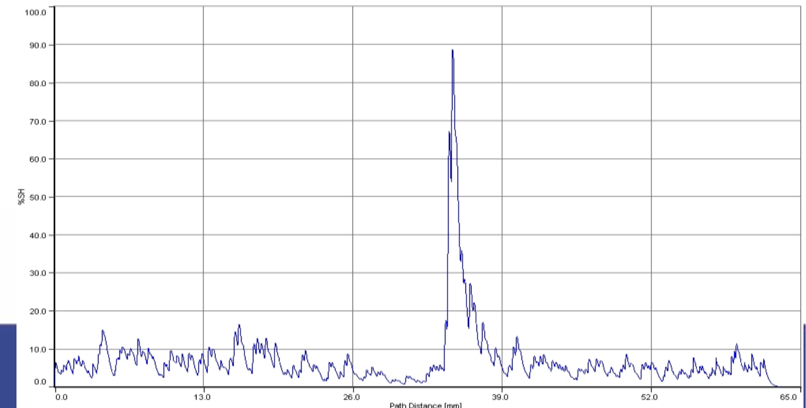
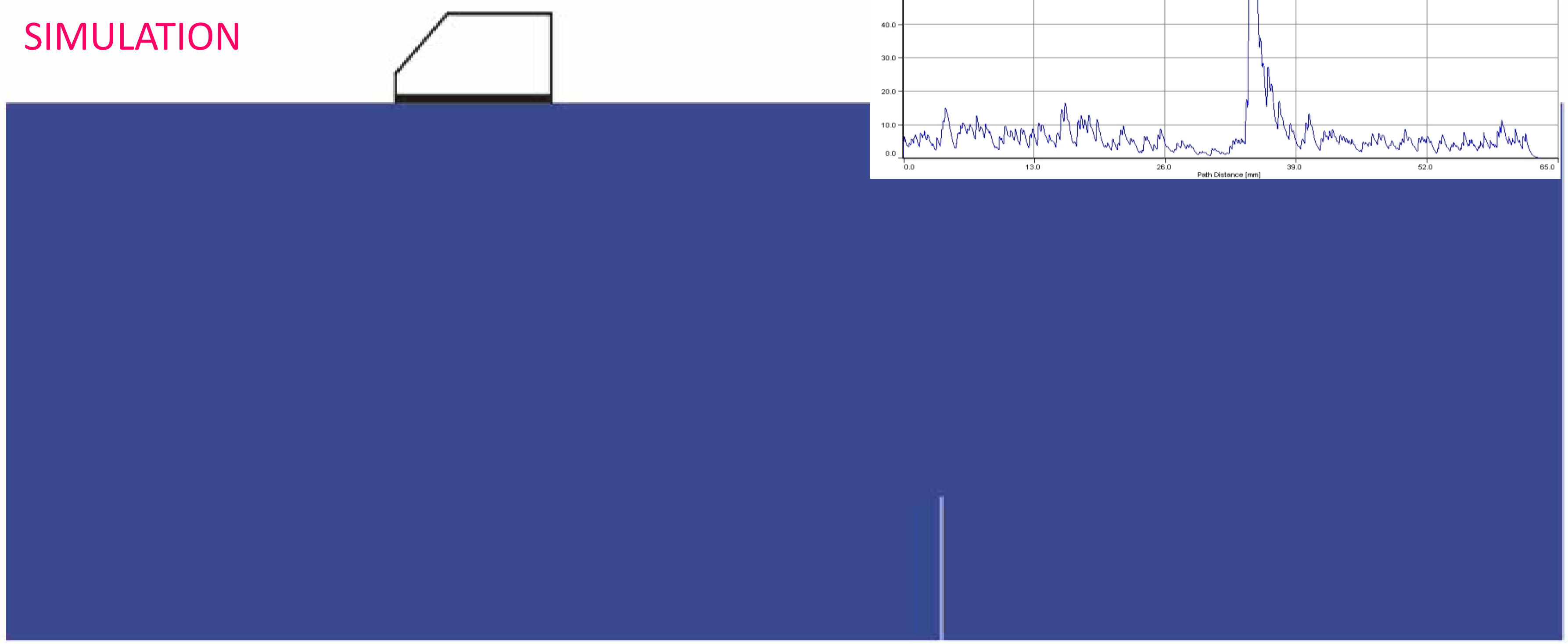
BASICS of UT



Impulse – Echo Technique

SIMULATION



PIEZO TRANSDUCER

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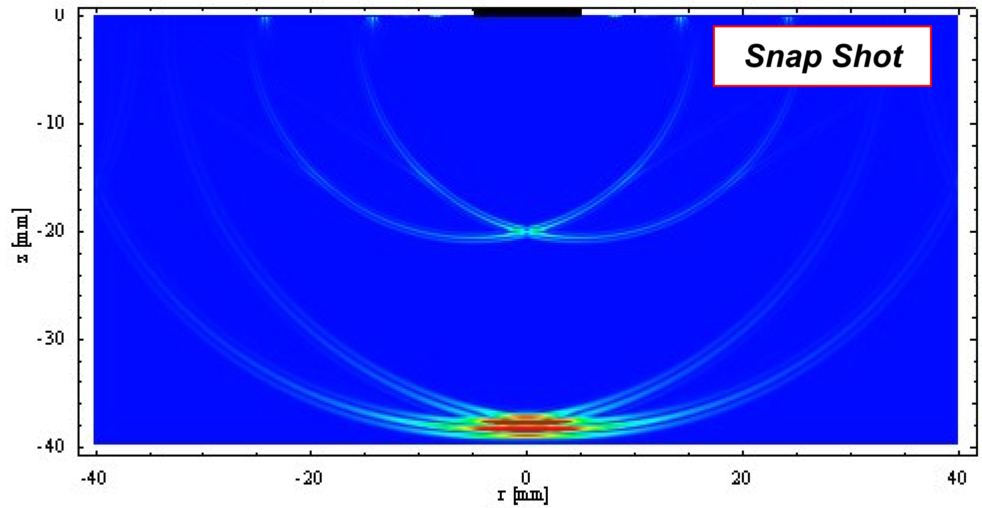
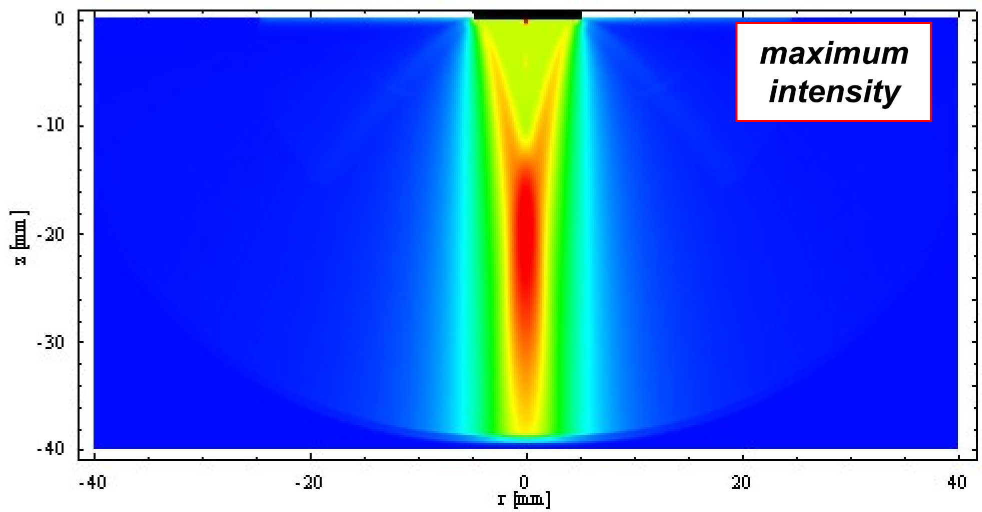
Case Studies: Surfaces

Simulation by Dr. Schubert
Fraunhofer IZFP-D

Transducer:	normal probe f = 4 MHz
Aperture:	A = 10 mm
Surface:	flat





COUPLING

UT, µ-NDT, NDT Systems

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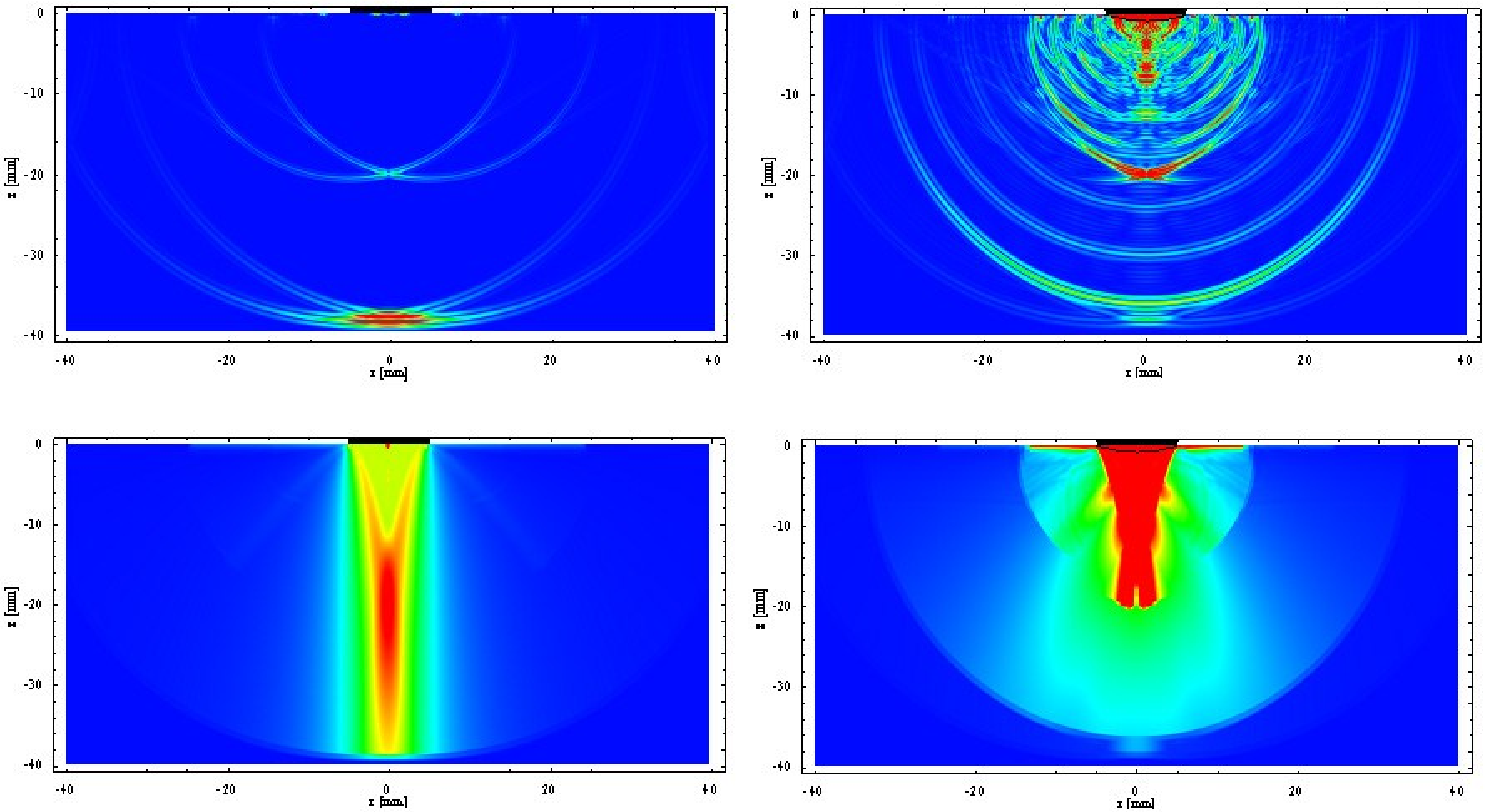
Water gap depth (lense shaped): 0.74 mm (λ/2 in steel, 2λ in water)



COUPLING

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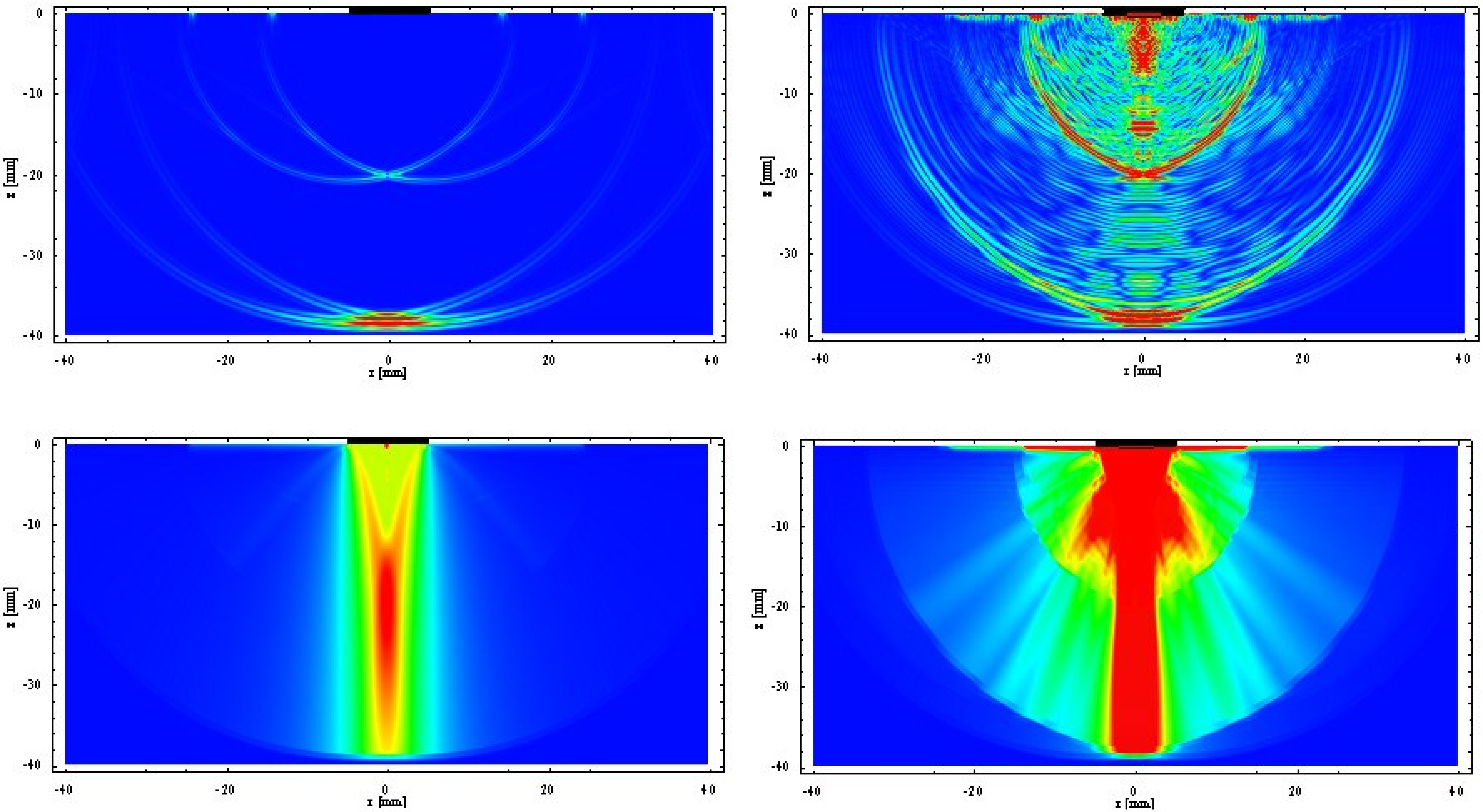
Water gap depth (lense shaped): 0.18 mm (λ/8 in steel, λ/2 in water)



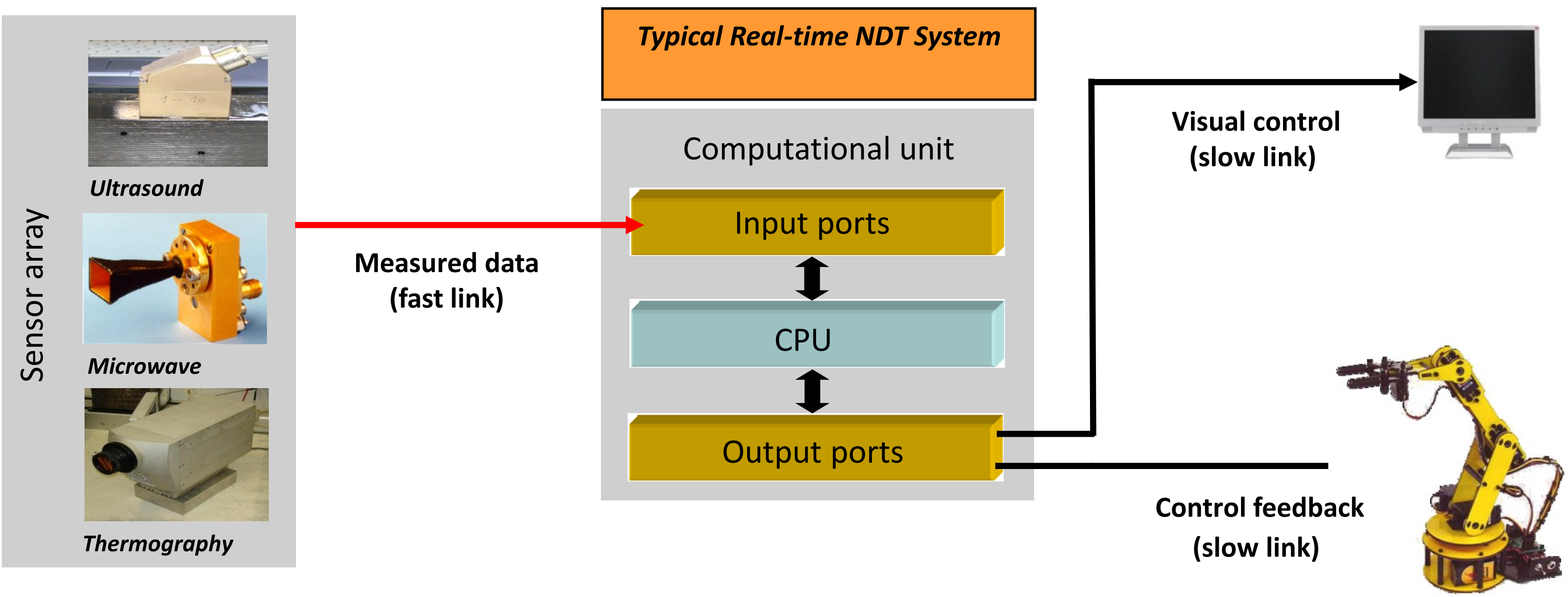
COUPLING

UT, μ-NDT, NDT Systems

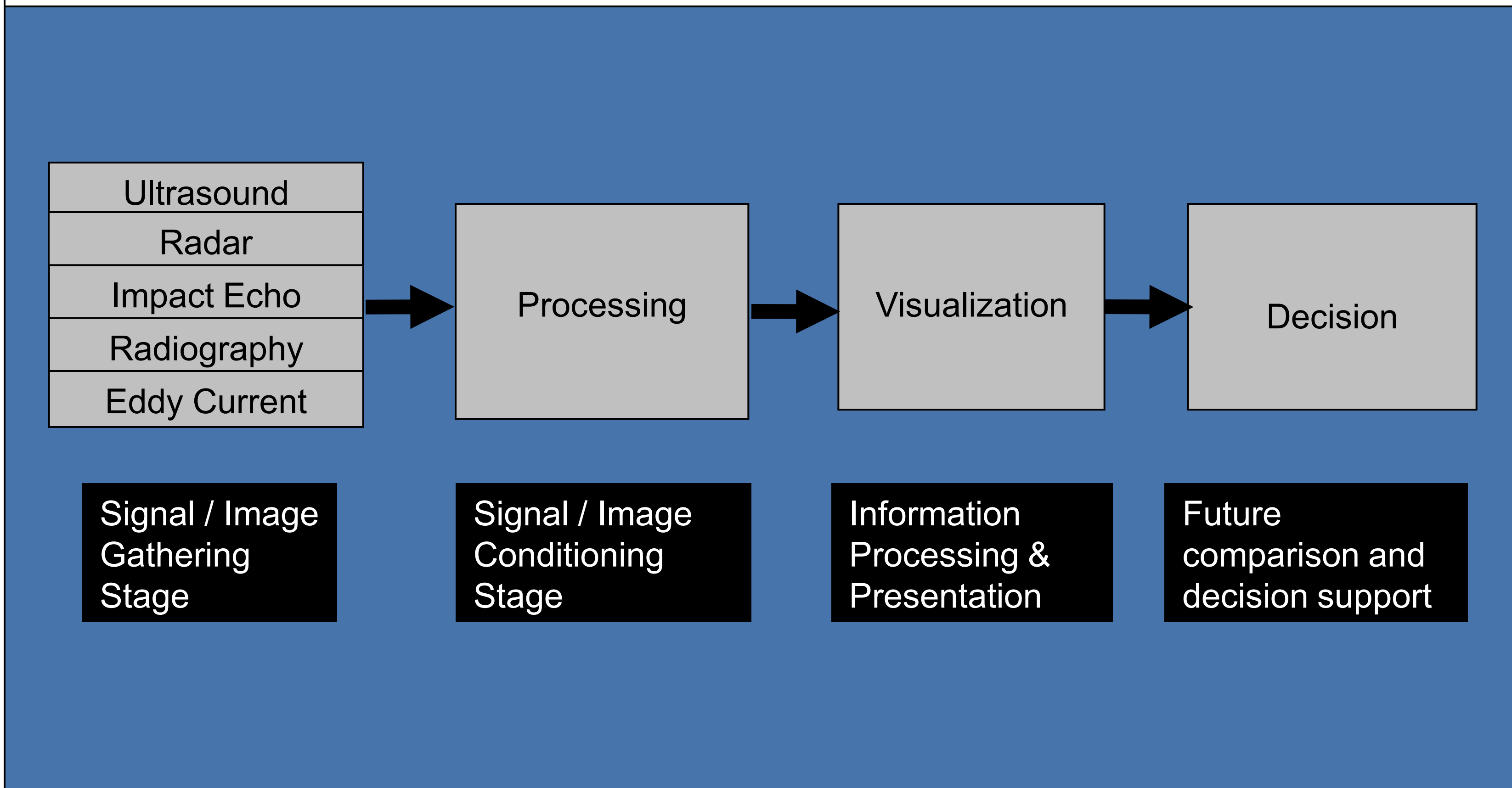
Information Flow in NDT Systems

The complexity of data processing in modern NDT requires…

- Fast data links of several Gbit / sec (data transfer towards computational unit)
- Computational unit performance of hundreds of GFlop / sec (reconstruction process)



Paradigm Shift – Data Centric



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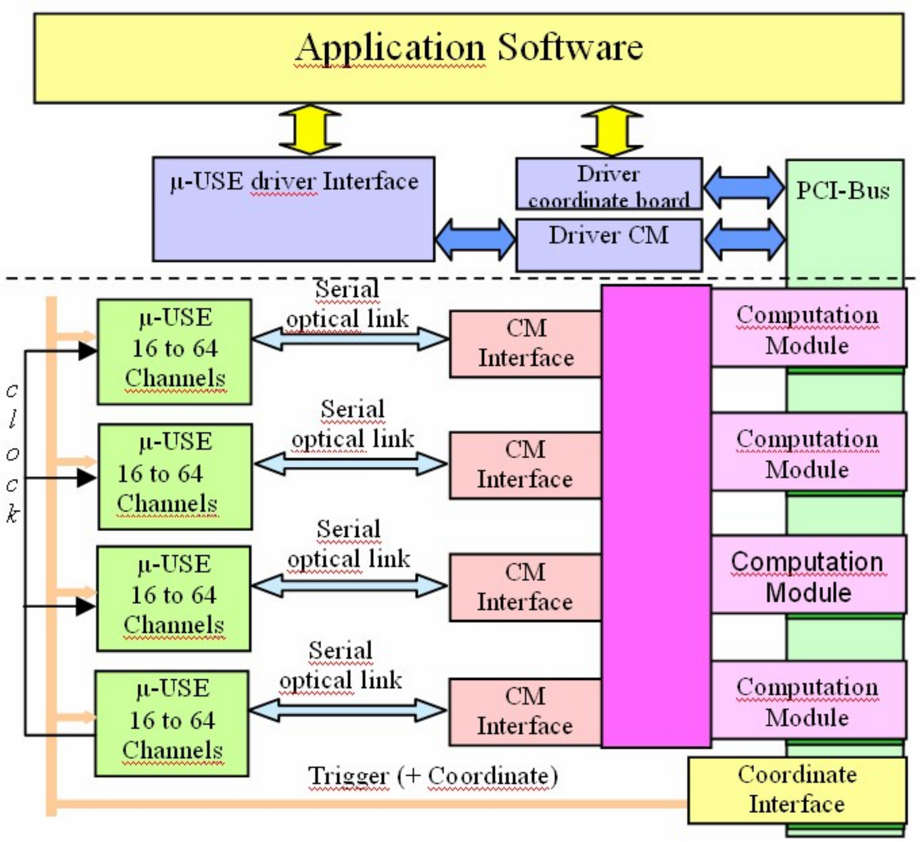
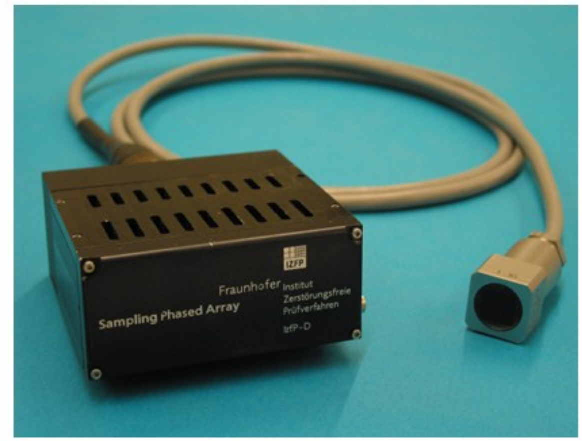
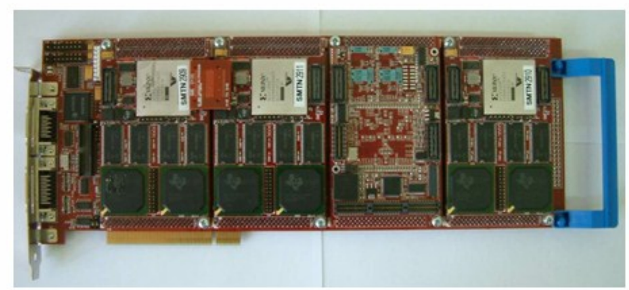


16-Channel μ-USE UT Front End



Multi-DSP Computation Module



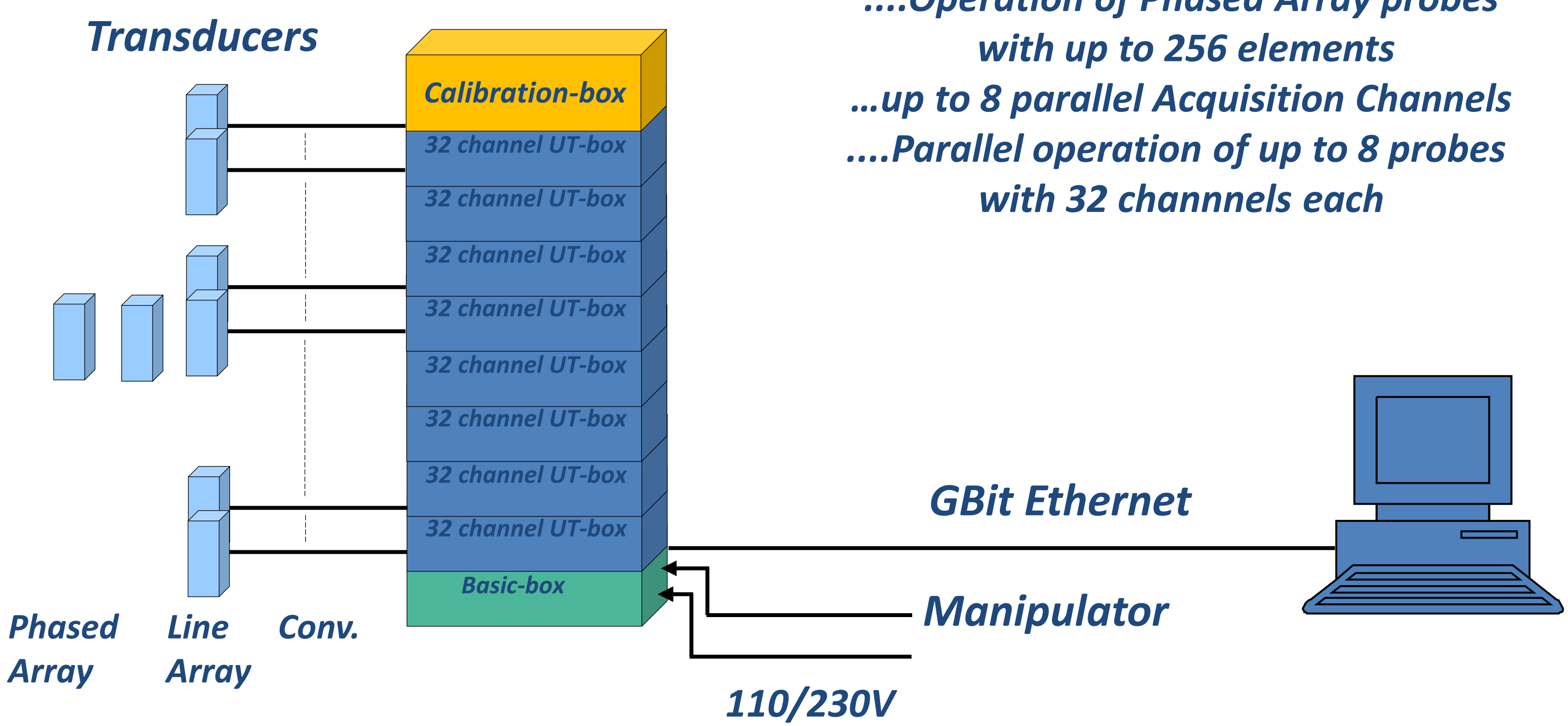
Parallel architecture of A-scan recording and processing

UT, μ-NDT, NDT Systems

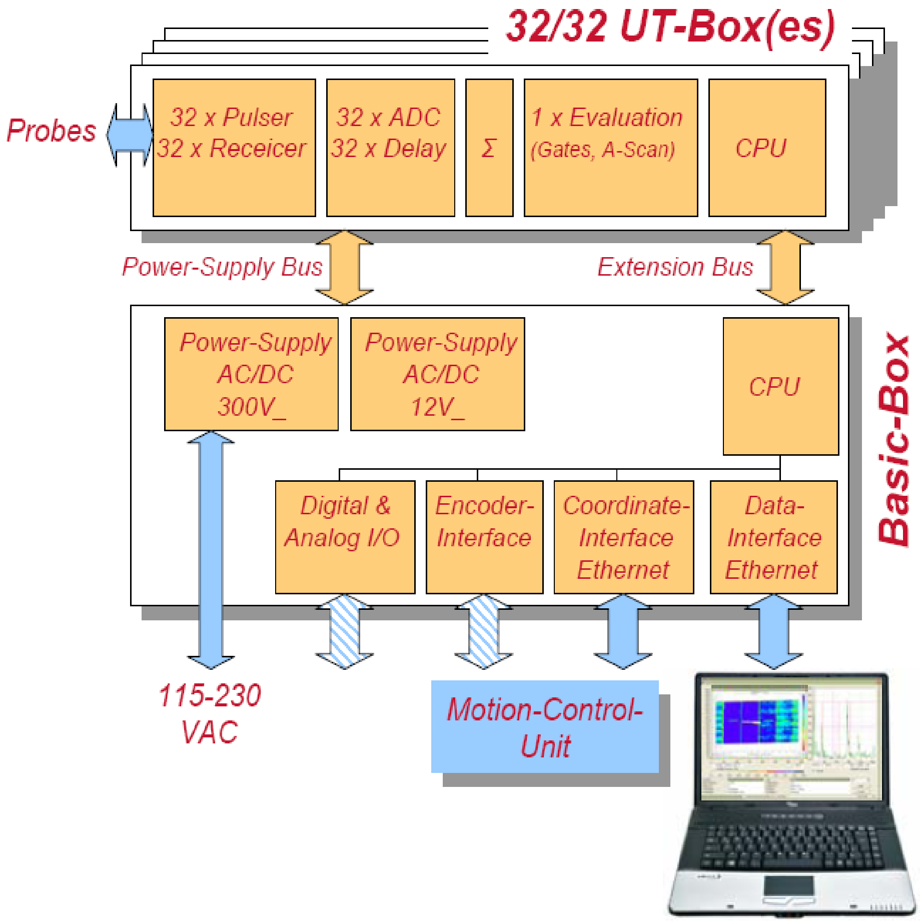
SAPHIR^{quantum} Multiple Boxes Configuration

Multiple Box Cascaded Version

...up to 256 UT-Channels simultaneously
....Operation of Phased Array probes with up to 256 elements
...up to 8 parallel Acquisition Channels
....Parallel operation of up to 8 probes with 32 channnels each



SAPHIR^{quantum} System-Architecture

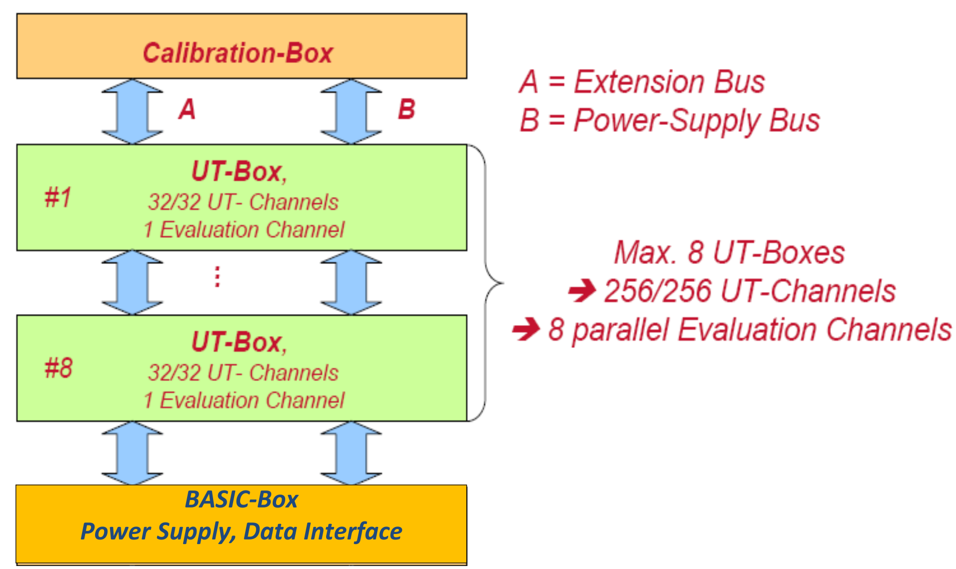


- ***Flexible architecture****…starting from a portable equipment with 32 channels up to a complex configuration with 256 channels (1..8 UT-Boxes)*
- ***Parallel structure*** *with full 256/256 channels means no limits for the user…Phased-Array probes with up to 256 active elements, or a mix of a number of Phased-array and conventional probes*
- *High productivity by up to* ***8 parallel firing probes*** *in conjunction with the possibilities of the different on-board data-reduction methods & the GBit-Data-Interface*

Calibration-Box
- Calibration for 32 Channels
- Cable-Channel-Check
- Extended Self-Check

32/32 UT-Box
-UT-Electronic with 32/32 channels
-Basic Self-check

Basic-Box
- Power-Supply for up to 8 Boxes
- Data- and Coordinate-Interfaces
- 110-230V Input



SAPHIR*quantum* System-Architecture

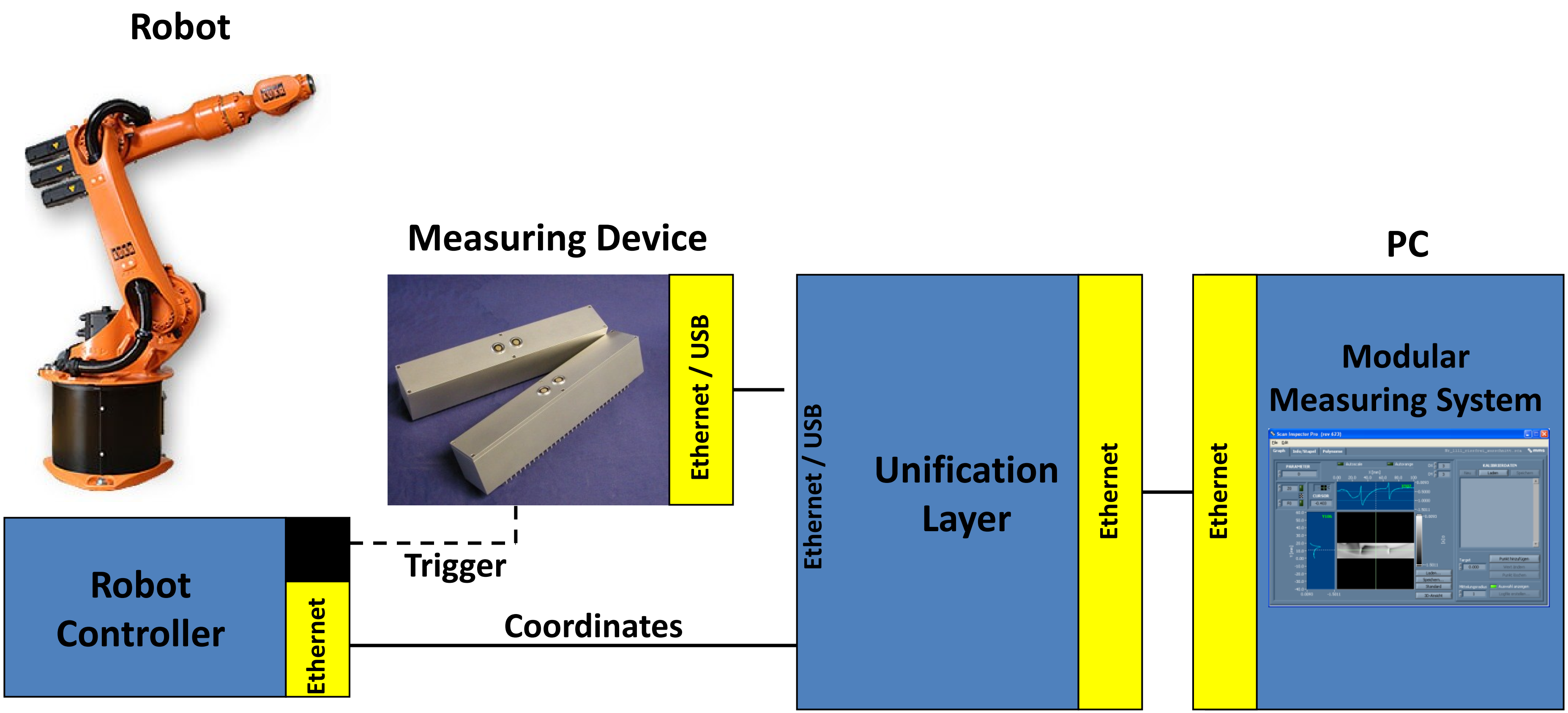
AUTOMATION FOR

REDUCTION OF HUMAN ERROR

ACCESS TO COMPONENT

SHORTER INSPECTION TIMES

LESS RADIATION EXPOSURE



Architecture of Robotic NDT Systems

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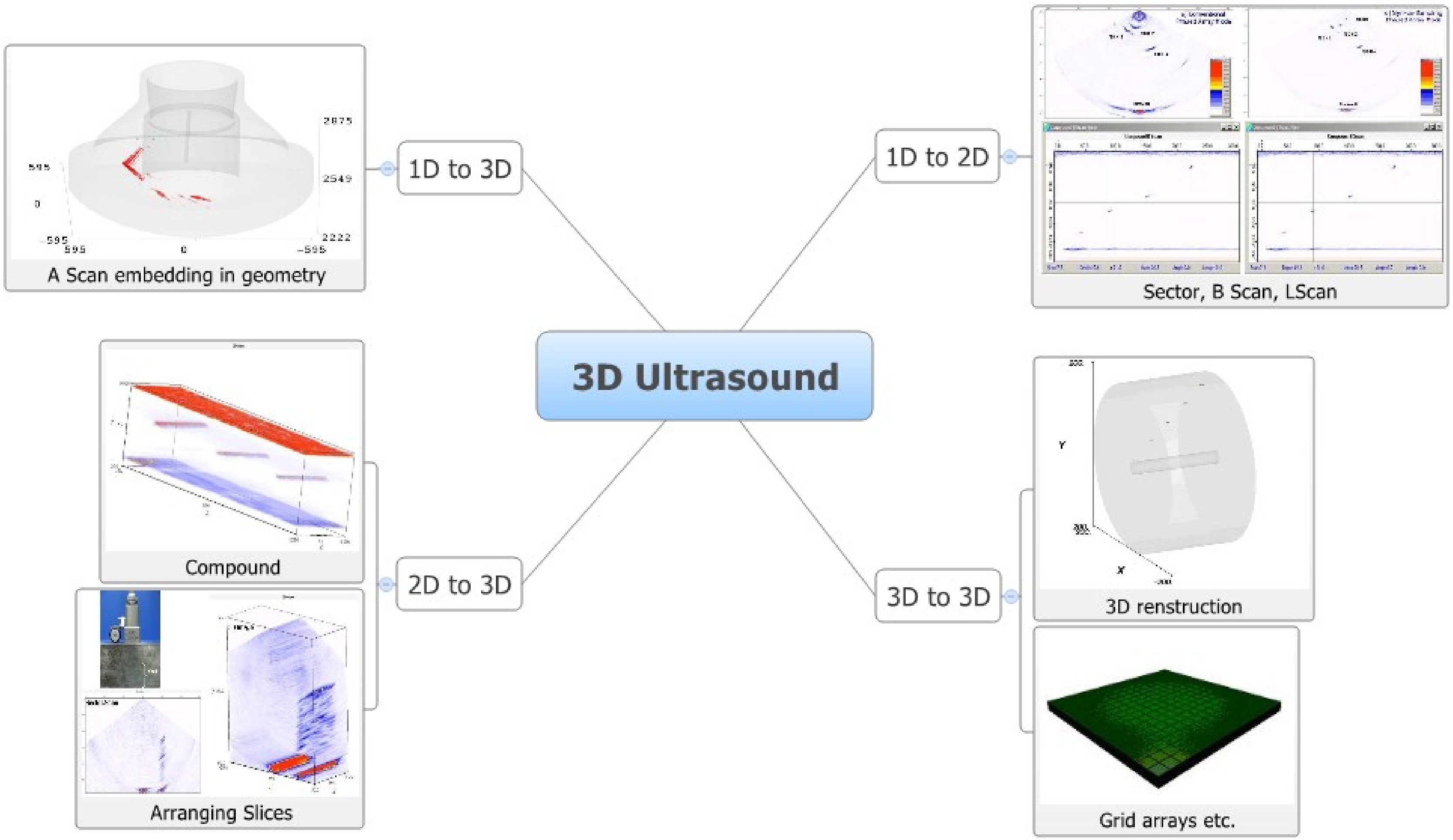
Case Studies: Ultrasonic Imaging



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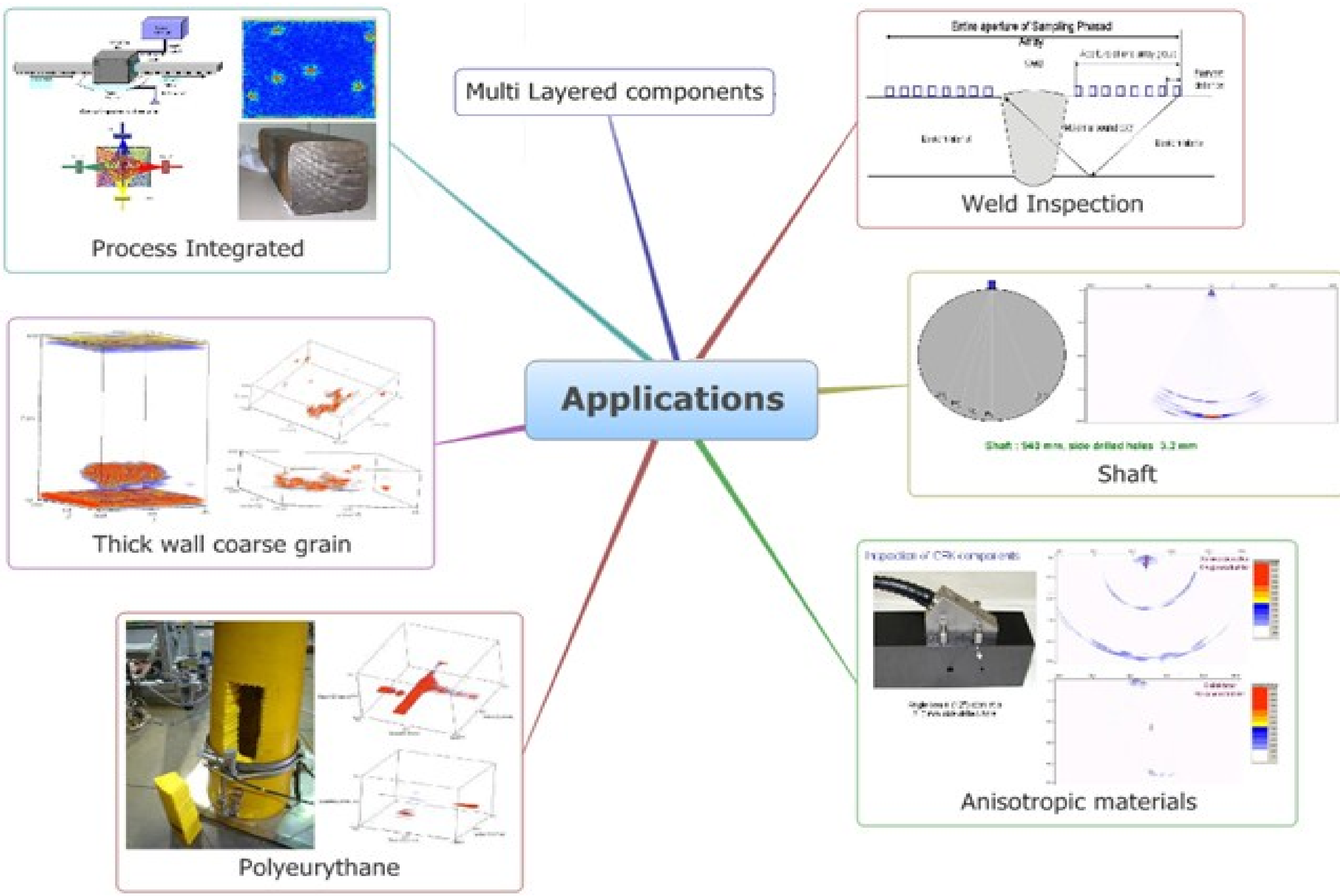
Case Studies: Ultrasonic Imaging



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COFFEE BREAK

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Day 2:	Organization and Networks	Speaker
9.00	Welcome Address with Minutes of Last Day	NN
9.30	Recommended Laboratory Structure of Activities	Kröning
10.00	Human Resources – Ethics, Responsibilities, Education, Training and Certification	Klimenov
10.30	Coffee Break	
11.00	Methods I - ET, MT, PT, TT, VT	Vavilov
11.30	X-ray, Betatron	Klimenov
12.00	UT, µ-NDT, NDT Systems	Kröning
12.30	Open Round Discussion (Questions)	all
13.00	Lunch Break	
14.00	Applied Technologies and Capability Networks	Kröning
14.30	Knowledge Strategies and Education	Klimenov
15.00	Coffee Break	
15.30	Added Value Chain in Applied Science	Vavilov
16.00	R&D Driven by Demand – a Project Analysis	Kröning
16.30	Concluding Minutes	to be appointed
17.00	End of Second Day	

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Day 3:	CASE STUDIES & NEXT STEPS	Speaker
9.00	Welcome Address with Minutes of Last Day	NN
9.30	Case Studies: Betatron for NDT	Klimenov
10.00	Advanced UT and New Instruments	Kröning
10.30	Coffee Break	
11.00	Thermography for Surface Characterization	Vavilov
11.30	NDT System for In-line NDT	Kröning
12.00	International Cooperation Practice	Klimenov
12.30	Open Round Discussion (Questions)	all
		NN
13.00	Lunch Break	
14.00	Next Steps and Seminar Evaluation	
16.00	End of Third Day	