Image Processing of NDT data

Krishna Mohan Reddy
Lucid Software Ltd.

Speaker

- Krishna Mohan Reddy
  - B.Tech Mechanical Engineering
  - M.Tech Machine Design
  - Doctoral Candidate
  - 6 patents in the domain of Sampling phased array approved and 2 further patents applied for
  - Promoted Lucid Software Limited
  - CEO of Lucid Software Limited since Apr 2005
  - Promoted QNET, India

Topics

- Imaging (Sampling Phased Array)
- Image processing
- Assisted defect recognition (ADR)

Motivation

- What does NDT engineer wants?

Dream for generations

Better resolution

Better SNR

Recent dreams

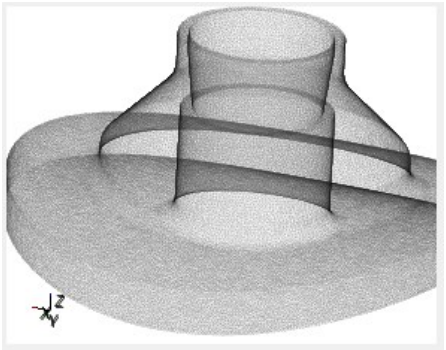
fast and easy

Motivation

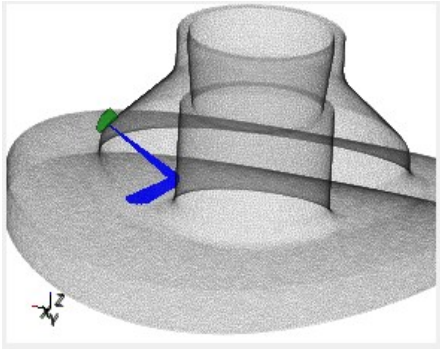
- What does customers want from NDT engineers?
  - Answers
    - We are sure we do not have them

Work flow for Nozzle assessment

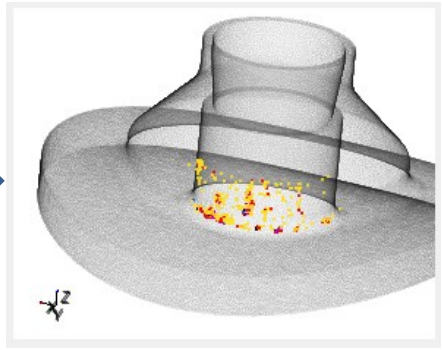
Nozzle model

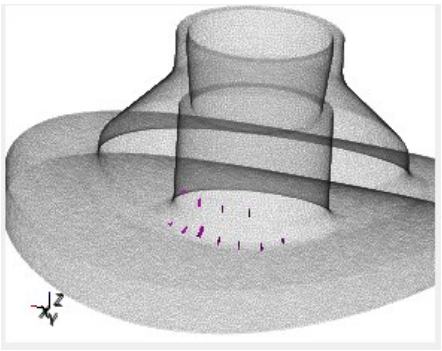


Ultrasound simulation



Ultrasound test data



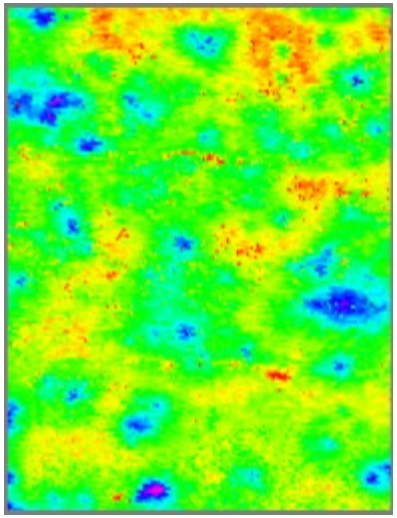


Inversion FEM model

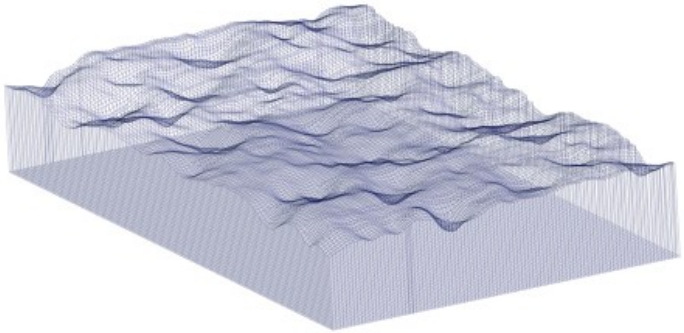
Risk assessment
Remaining life estimation

Corrosion mapping

Ultrasonic Thickness data



Input for FEM analysis



Risk Assessment
Remaining life estimation

Image Processing

- What is it?
- Where can we apply it?
- Does standards support it?

Image processing

- Representation and modeling
- Enhancement
- Restoration
- Analysis
- Reconstruction

3d Ultrasound

- What is 1D, 2D, 3D, 4D in Ultrasound?

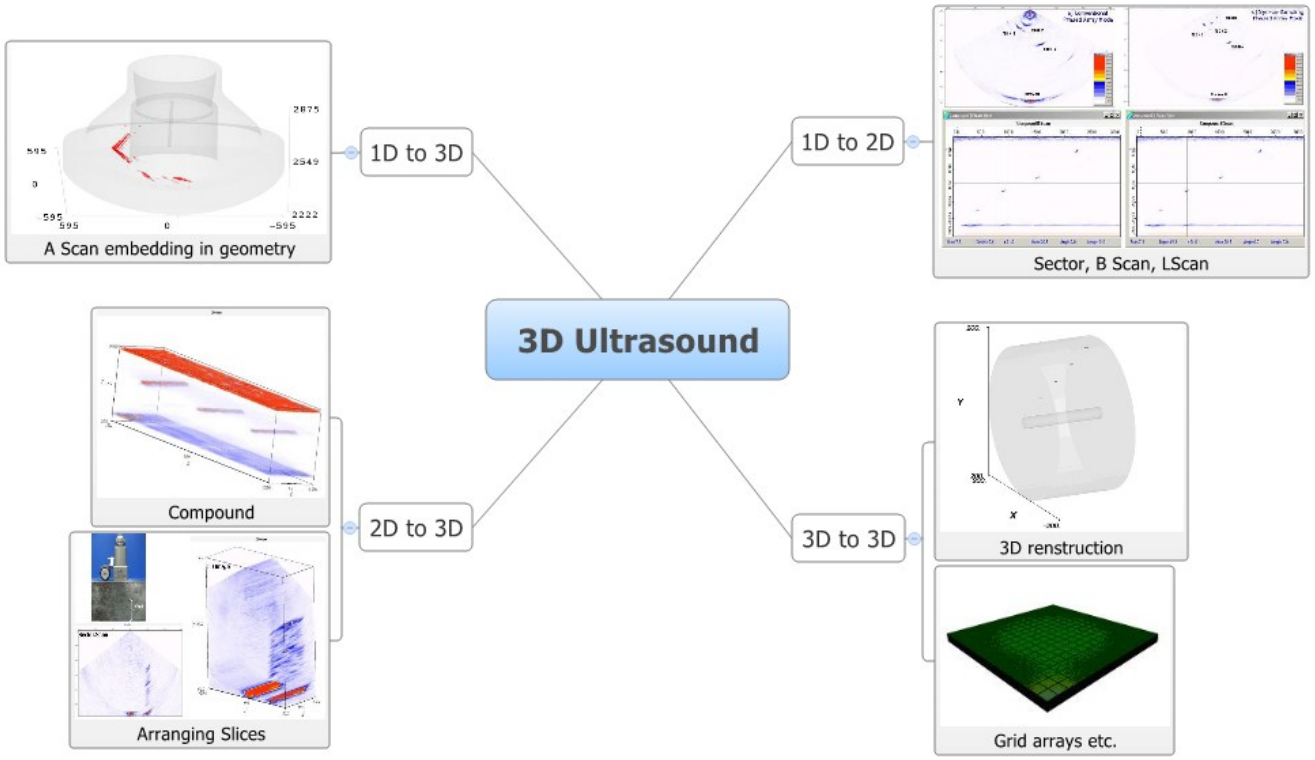


Image Enhancement - example

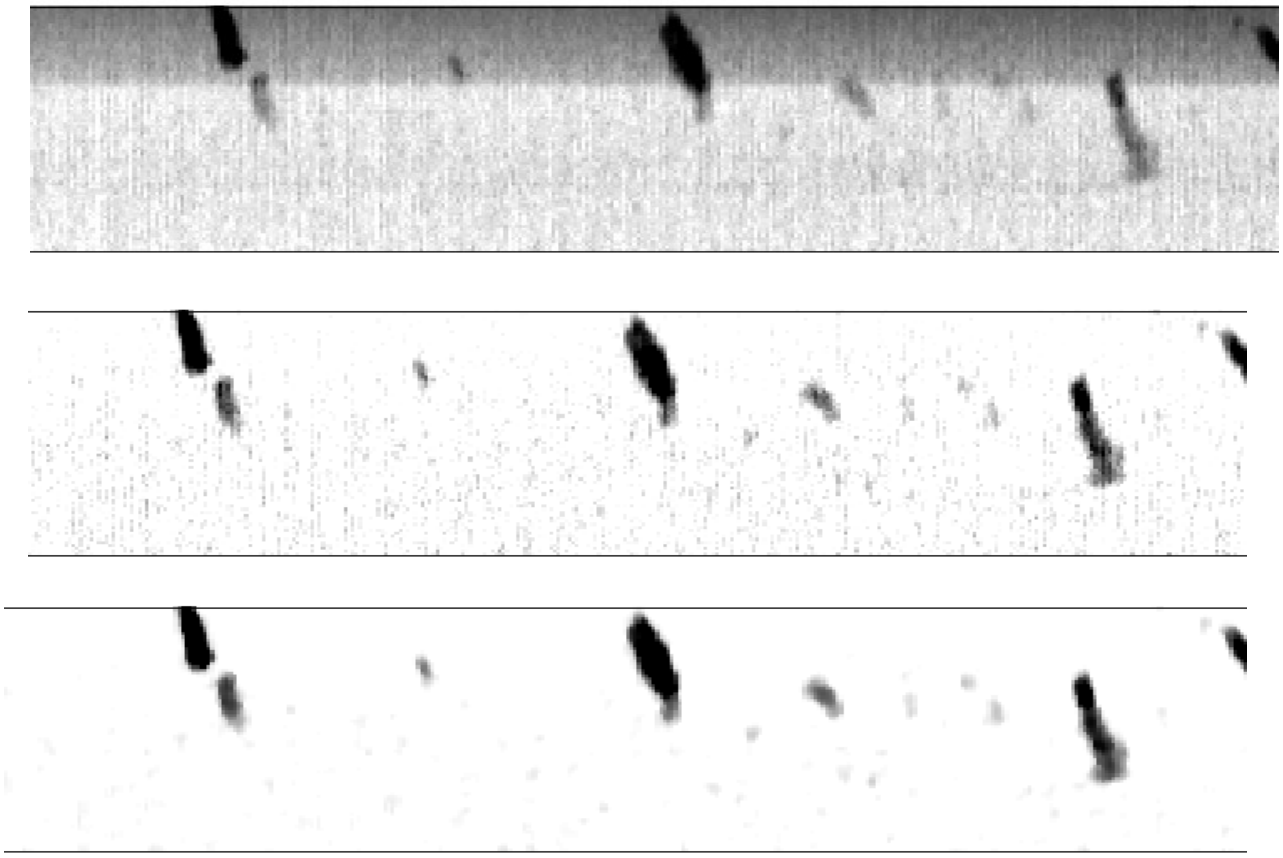


Image Analysis

- Feature extraction
  - Spatial features
  - Transform features
  - Edges and boundaries etc.
- Segmentation
  - Template matching
  - Thresholding
  - Boundary detection
- Classification
  - Statistical
  - Similarity measures etc.

ADR is our image analysis

ADR (Assisted Defect Recognition)

- Is it possible and reliable?
- Everybody say so, but nobody want to use it

ADR - example

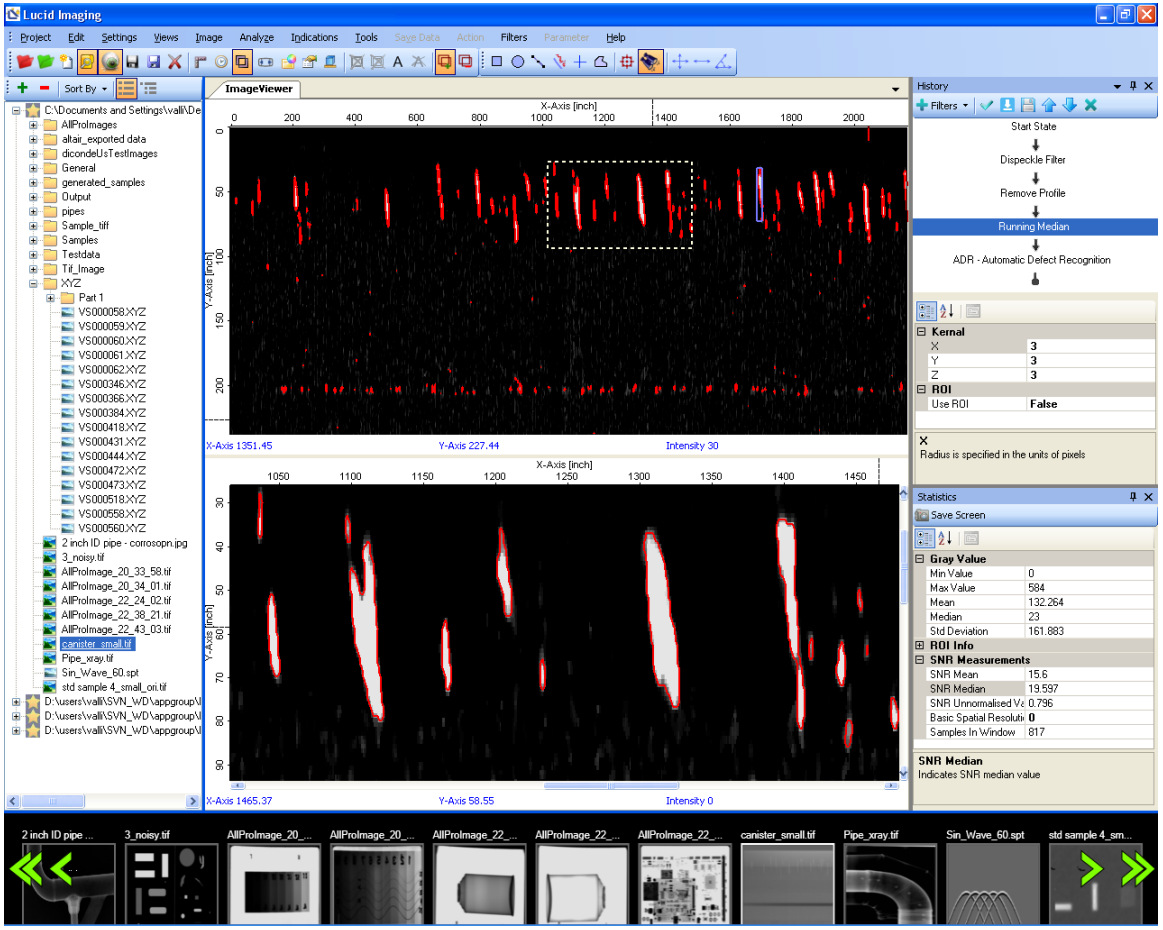
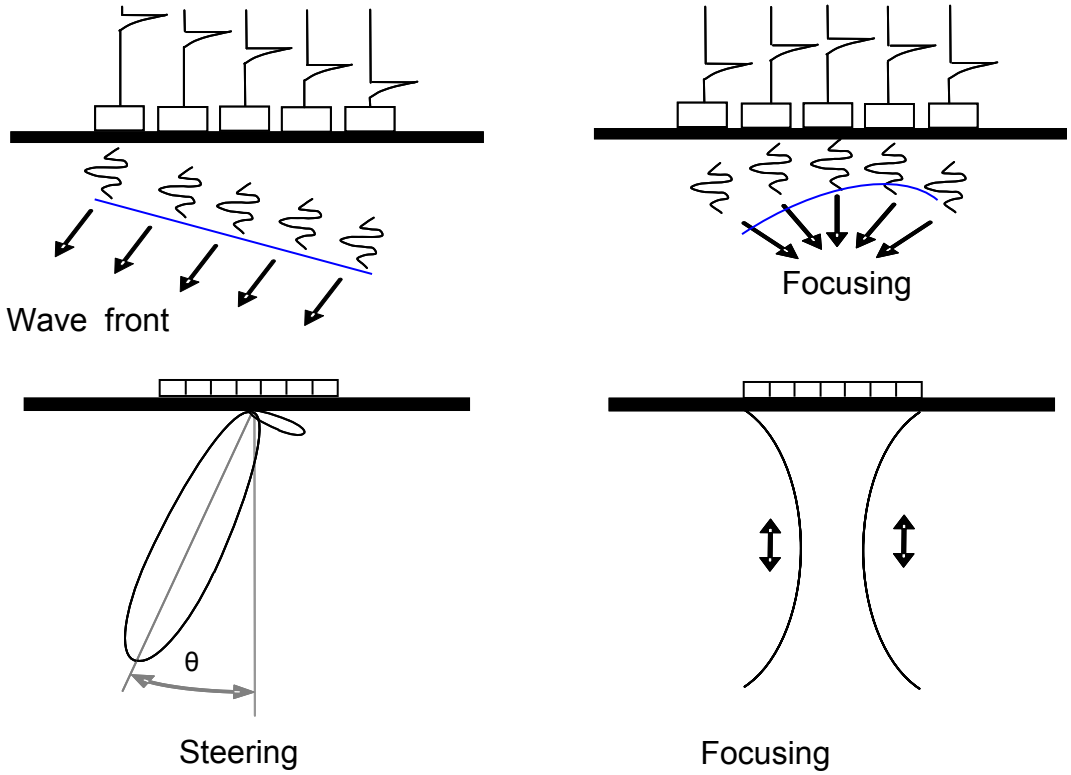

Lucid Imaging
Project Edit Settings Views Image Analyze Indications Tools Save Data Action Filters Parameter Help
ImageViewer
X-Axis [inch]
Y-Axis [inch]
X-Axis 1351.45
Y-Axis 227.44
Intensity 30
X-Axis 1465.37
Y-Axis 58.55
Intensity 0
History
Start State
Dispeckle Filter
Remove Profile
Running Median
ADR - Automatic Defect Recognition
Kernal
ROI
Use ROI False
Radius is specified in the units of pixels
Statistics
Save Screen
Gray Value
Min Value 0
Max Value 584
Mean 132.264
Median 23
Std Deviation 161.883
ROI Info
SNR Measurements
SNR Mean 15.6
SNR Median 19.597
Samples In Window 817
SNR Median
Indicates SNR median value
2 inch ID pipe ...
3_noisy.tif
AllProImage_20_...
AllProImage_20_...
AllProImage_22_...
AllProImage_22_...
AllProImage_22_...
canister_small.tif
Pipe_xray.tif
Sin_Wave_60.spt
std sample 4_sm...

Image reconstruction

- Sampling Phased Array
  - Is it new or old?
  - Does it help?
  - Let us see in work

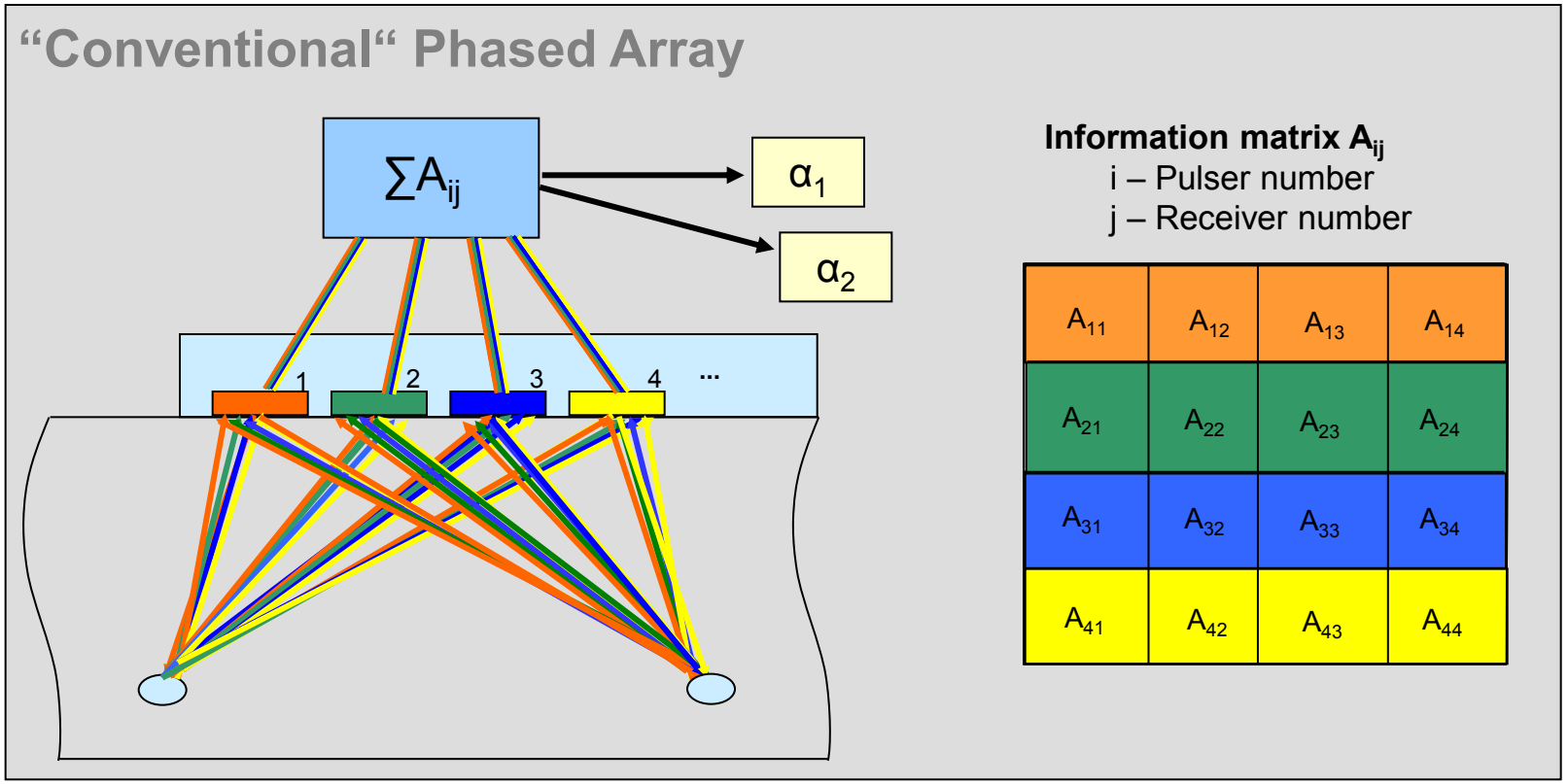
Phased Array principle



Steering and focusing of the sound beam

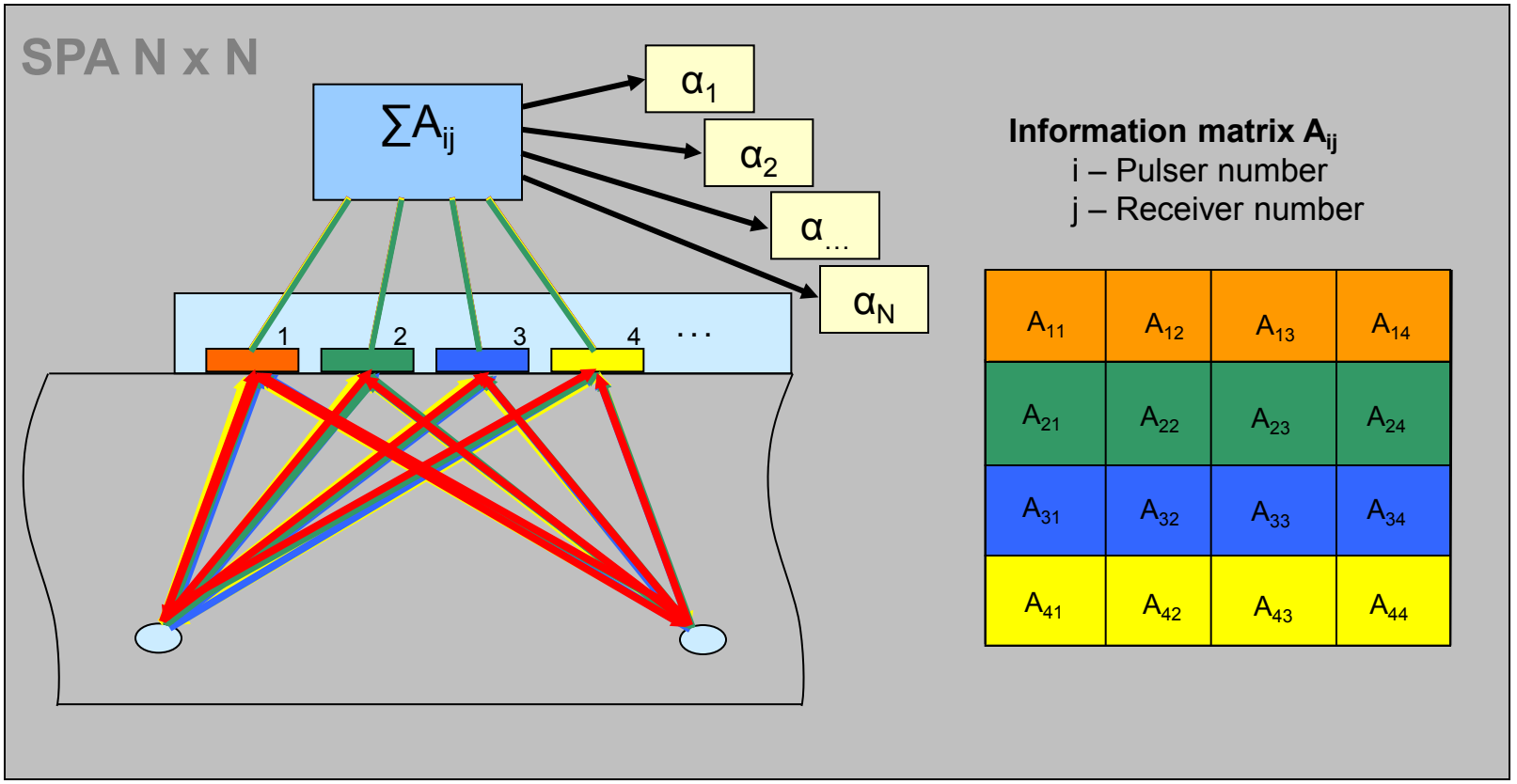
Principles of phased array inspection

Informational content



Sampling Phased Array: allgemenine Prinzipien

Sampling Phased Array N x N: SPA “COMPLETE”



Information matrix A_{ij}
i – Pulser number
j – Receiver number

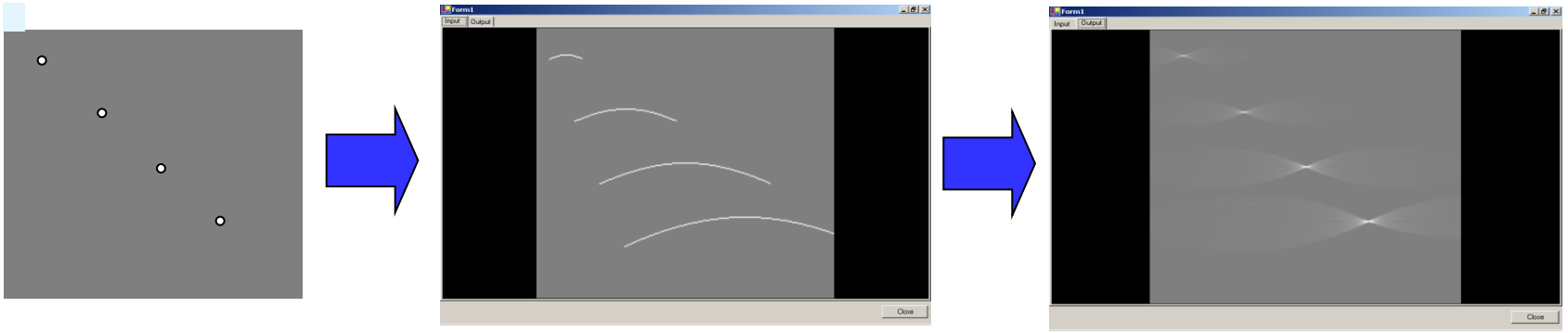
A_{11}	A_{12}	A_{13}	A_{14}
A_{21}	A_{22}	A_{23}	A_{24}
A_{31}	A_{32}	A_{33}	A_{34}
A_{41}	A_{42}	A_{43}	A_{44}

Sampling Phased Array Technology: basic principles

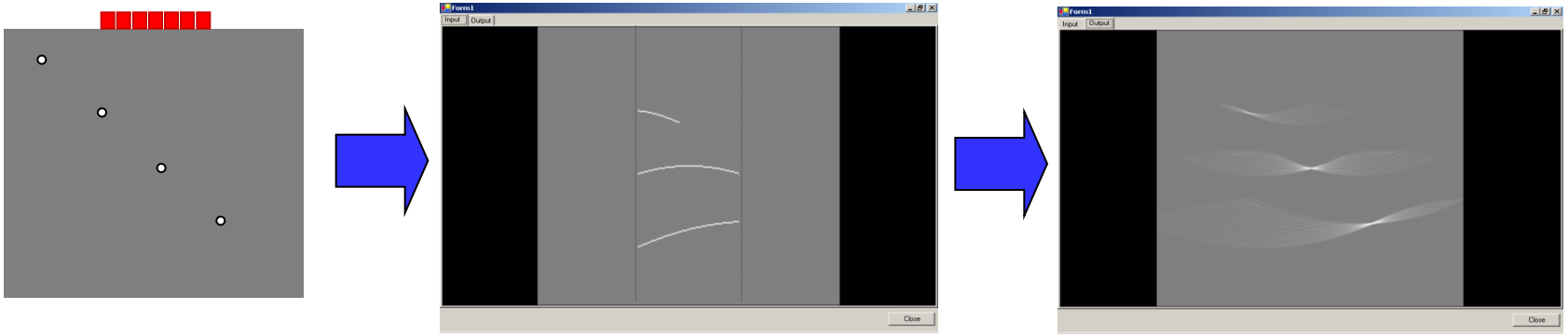
Principles of Sampling Reconstruction

SynFo-Sampling Phased Array: Sector-Scan Reconstruction with Synthetic Focusing

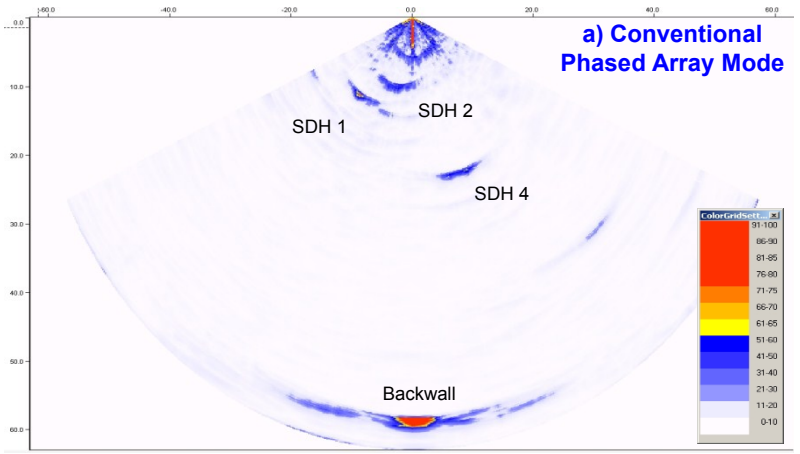
SAFT-Reconstruction

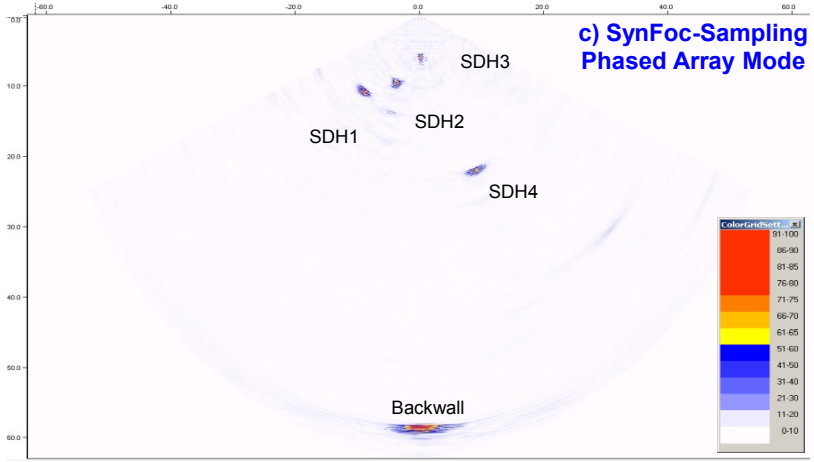


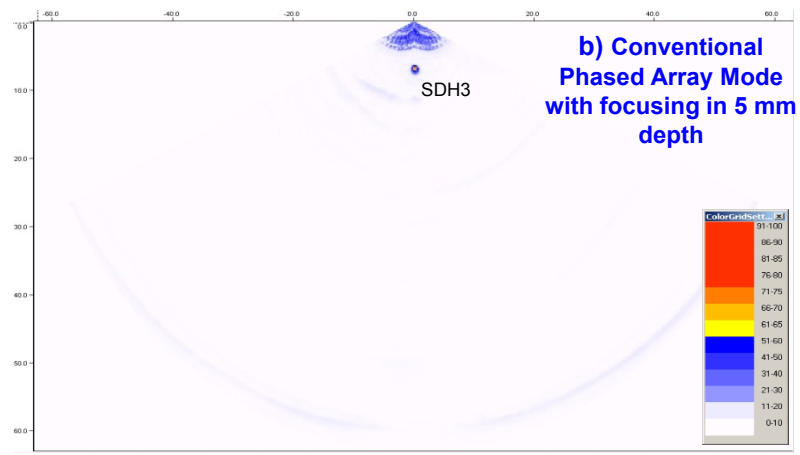
Migration Technique for Sampling Phased Array Image Reconstruction



Performance of Sampling Phased Array in Comparison to Conventional Phased Array

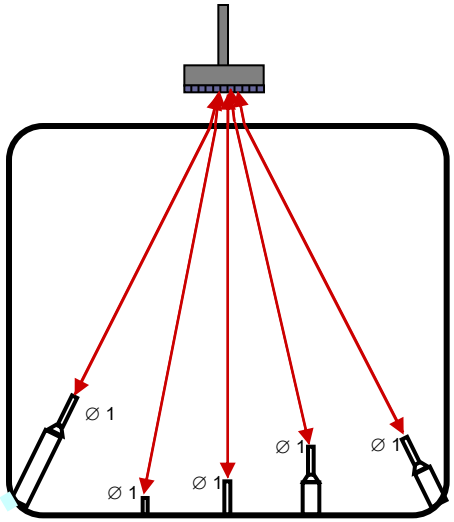


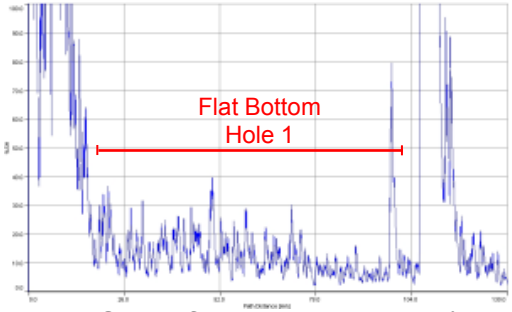




Sampling Phased Array Technology: Applications

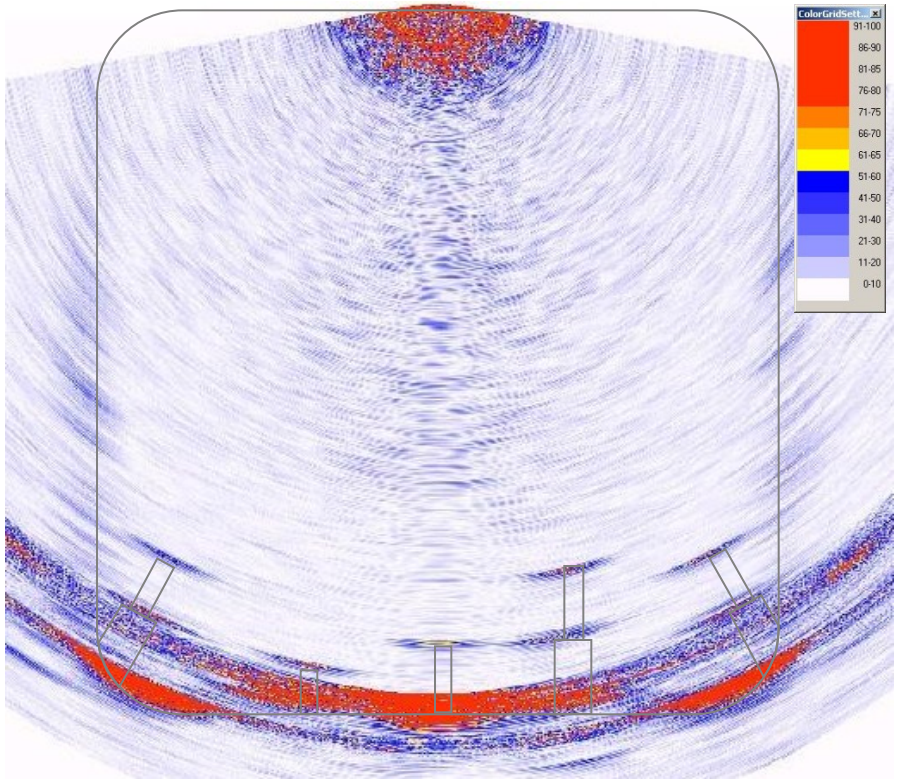
State of the Art



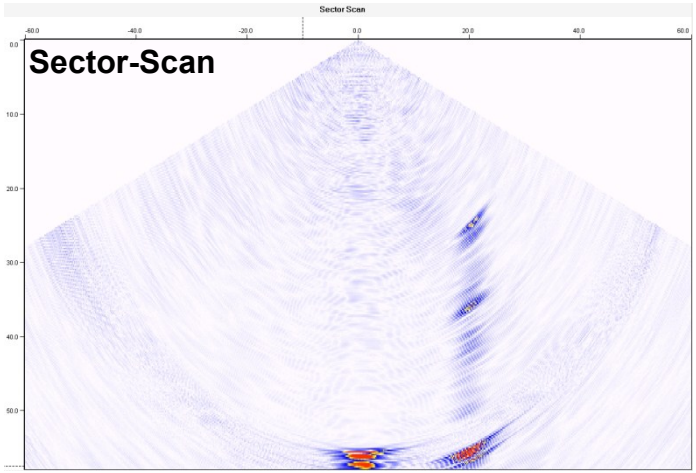


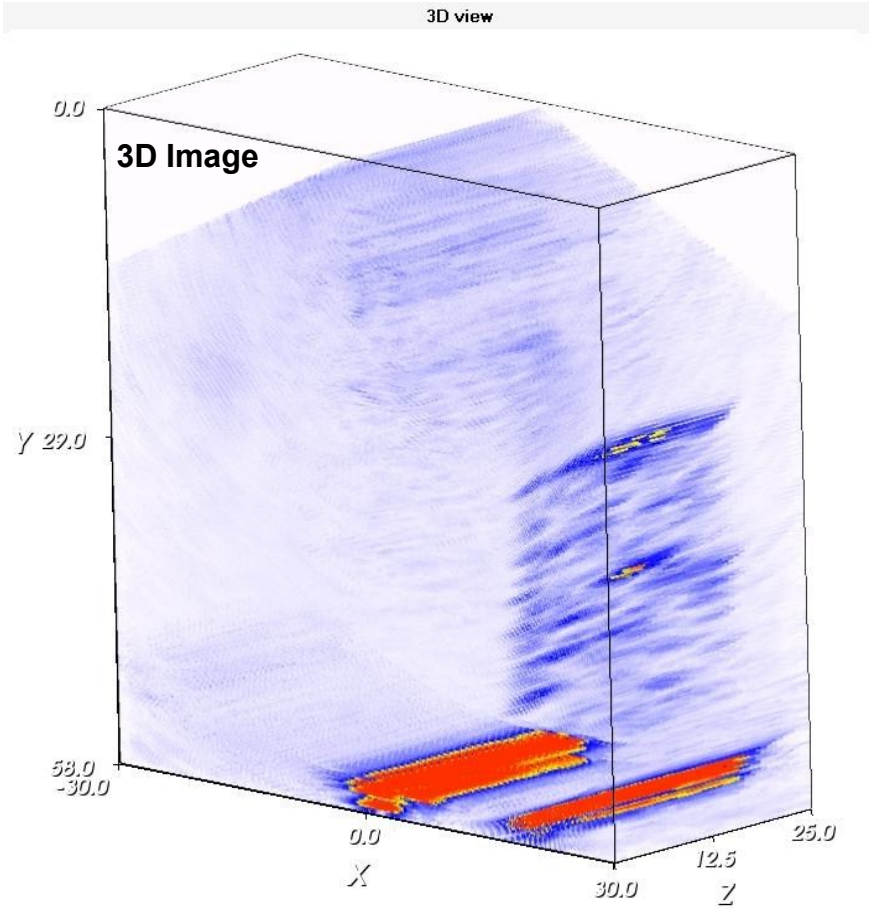
A-Scan for angle beam 0˚

Fast Imaging

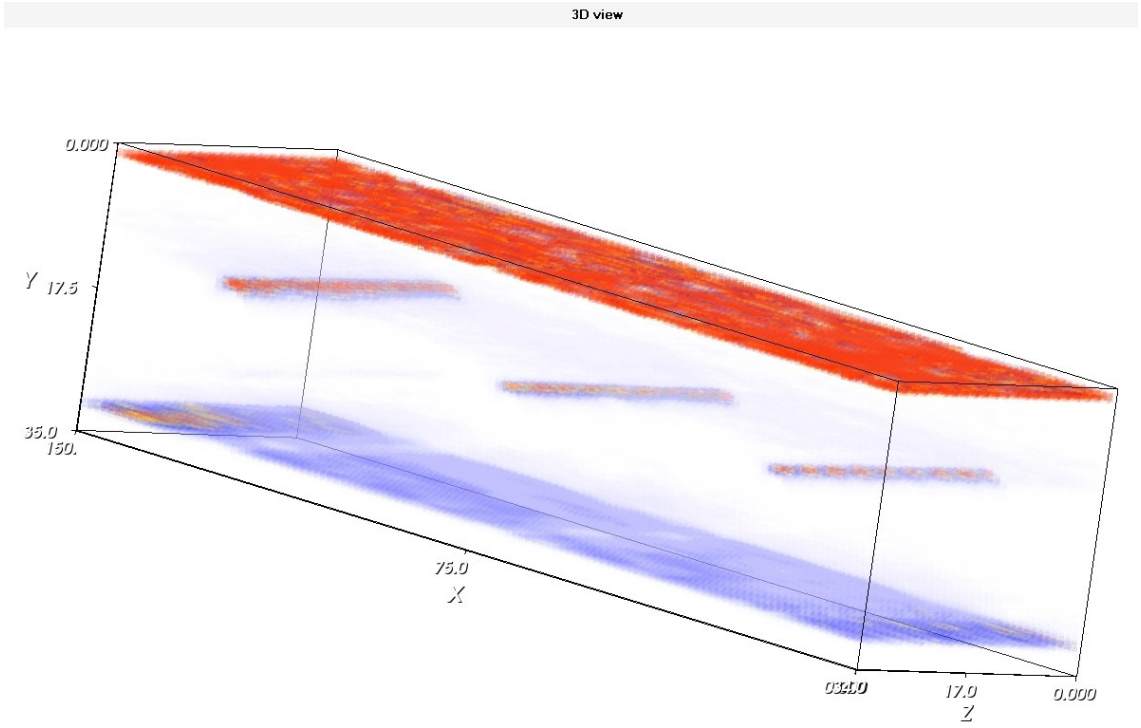


Applications: 3D Imaging



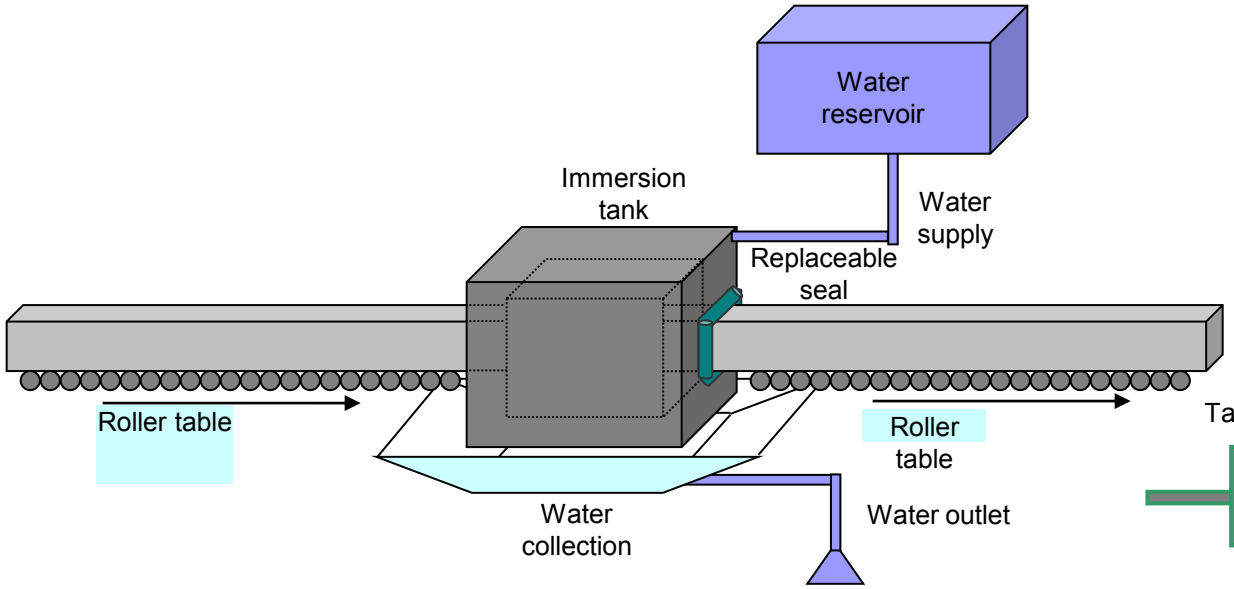


Applications: 3D Imaging

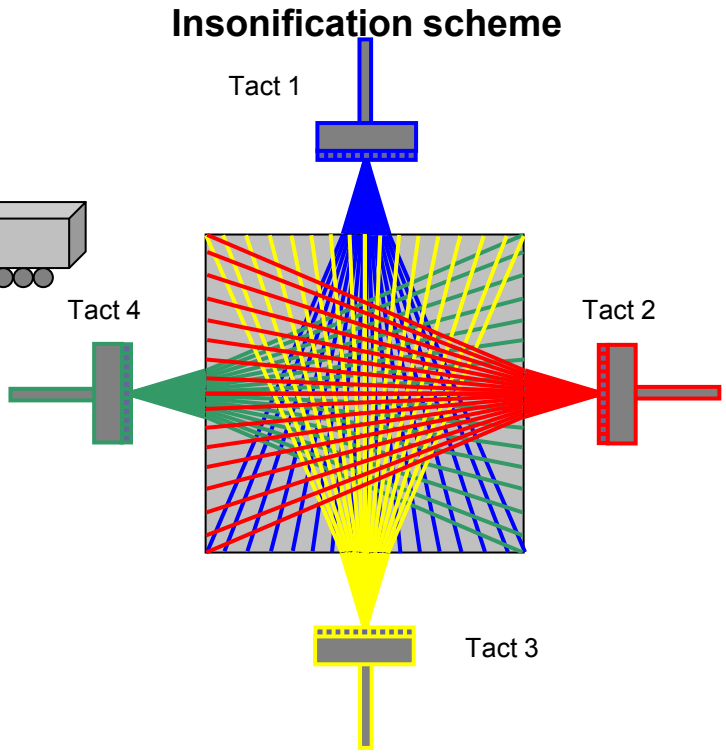


Applications: Steel billet inspection with Sampling Phased Array

Fast automatic inspection

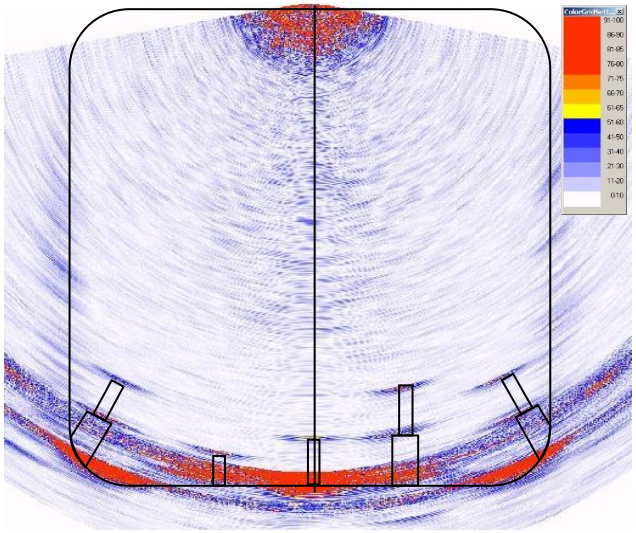


Overall system schematic

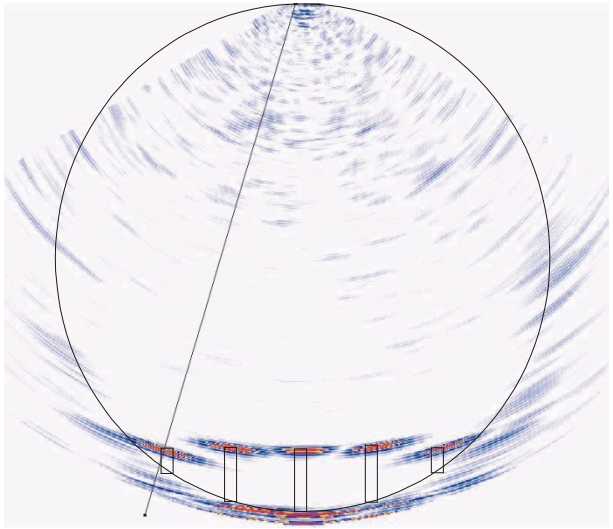


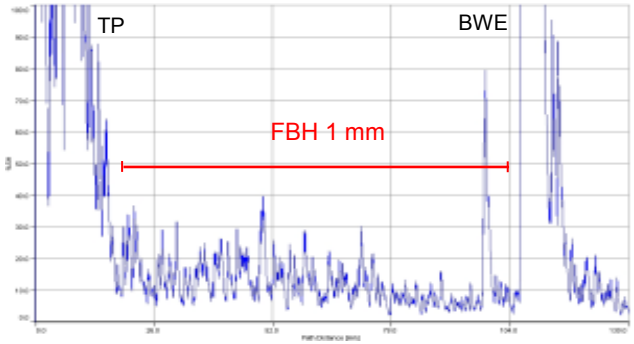
Applications: Steel billet inspection with Sampling Phased Array

Steel billet, wall thickness 110 mm

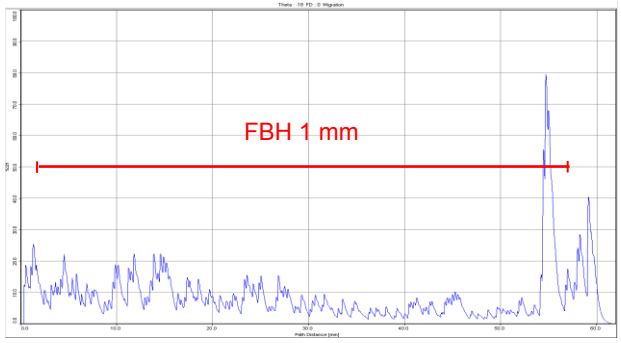


Rod ∅ 65 mm



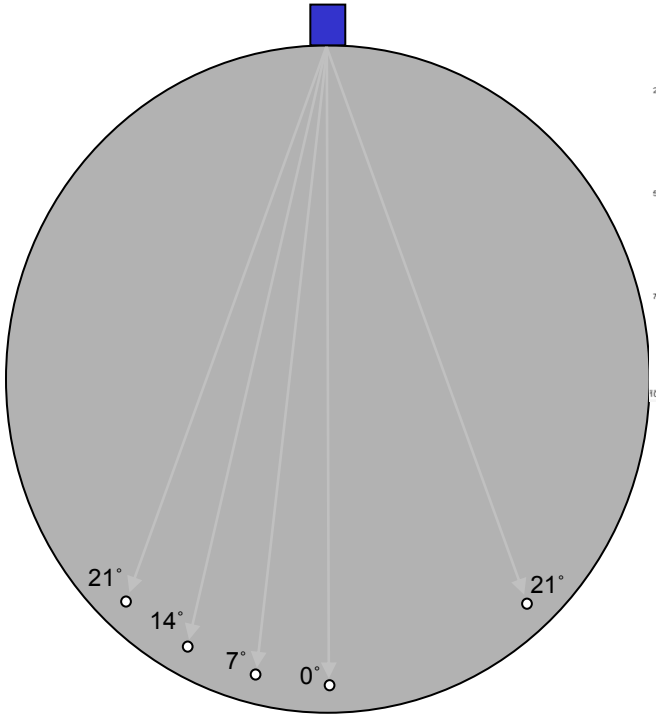


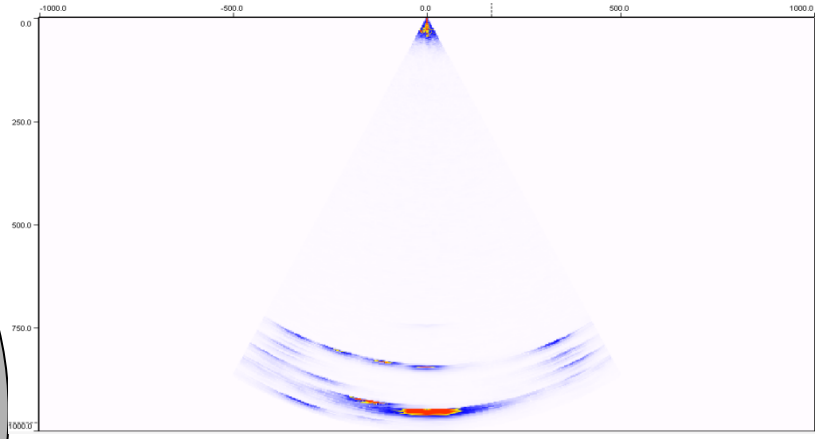
A-Scan for angle beam 0˚



A-Scan for angle beam 18˚

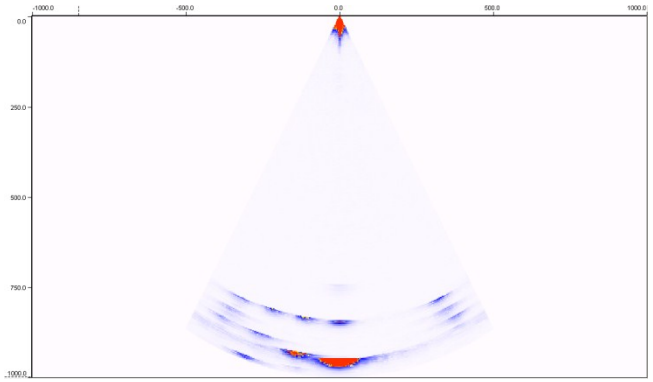
Applications: turbine shaft inspection





CPA

SPA



Shaft ø: 940 mm, side drilled holes ø 3.2 mm

Thank you very much for your attention !

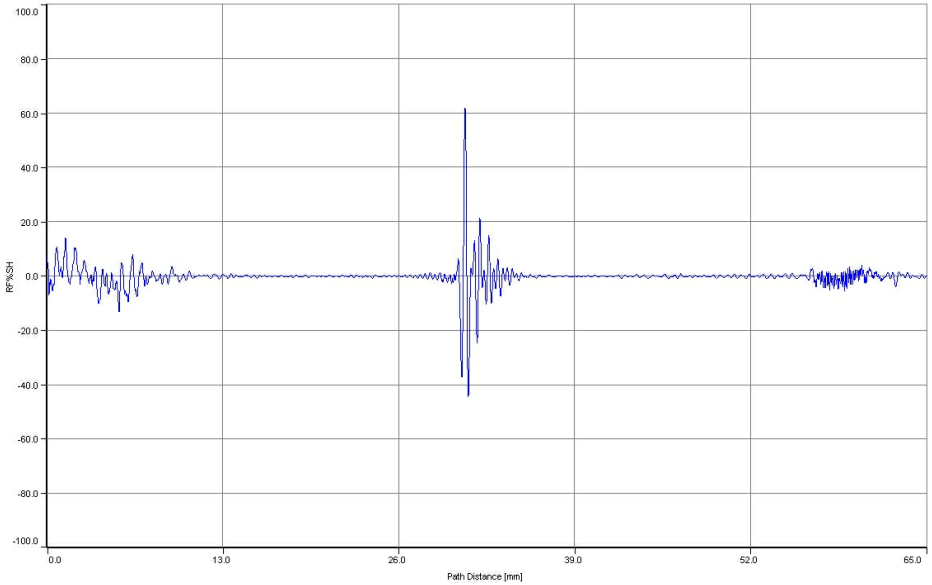


Abbildung des Kindes in Gebärmutter