Improved Automated Ultrasonic Inspection of Girth Welds

Mark Lozev
Engineering & NDE

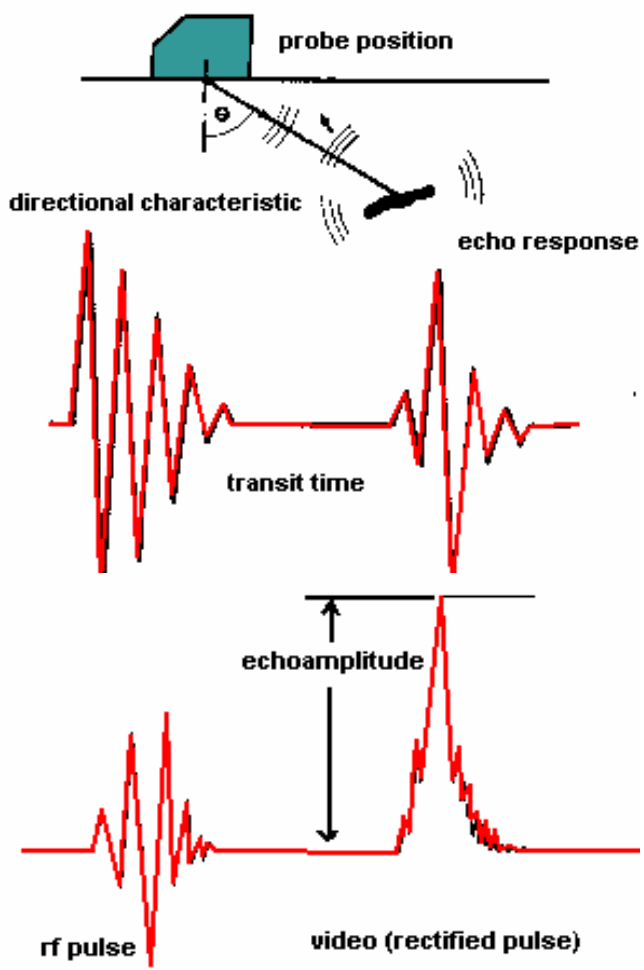
THE MATERIALS JOINING EXPERTS

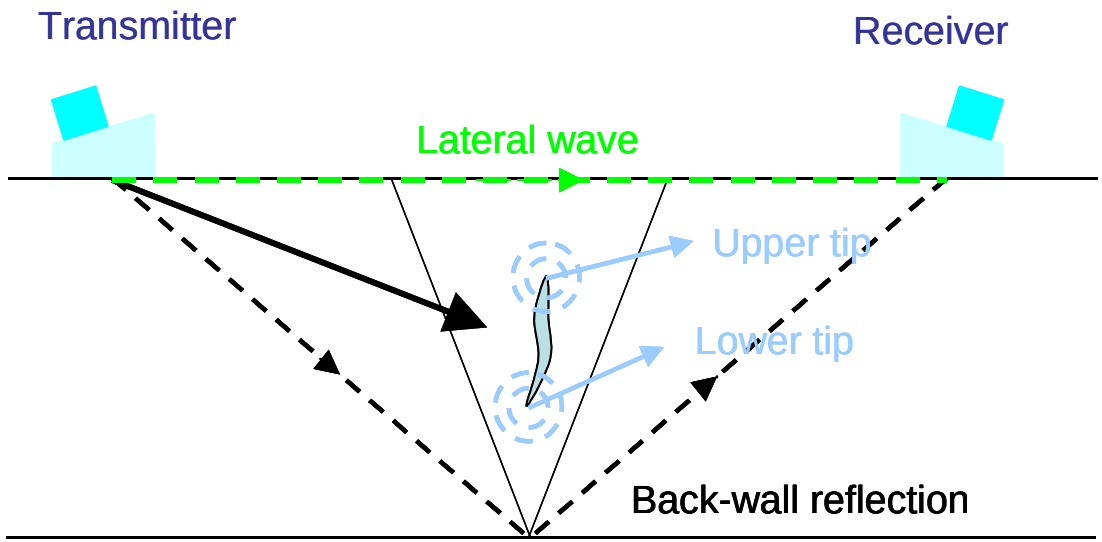
Overview

- Benchmark the performance of current state-of-the-art amplitude based AUT and phased-array UT inspection systems for pipeline girth welds flaw detection and sizing.
- Improved time-based phased-array AUT and defect imaging.
- Performance of the proposed improvements
- Discussion and questions.

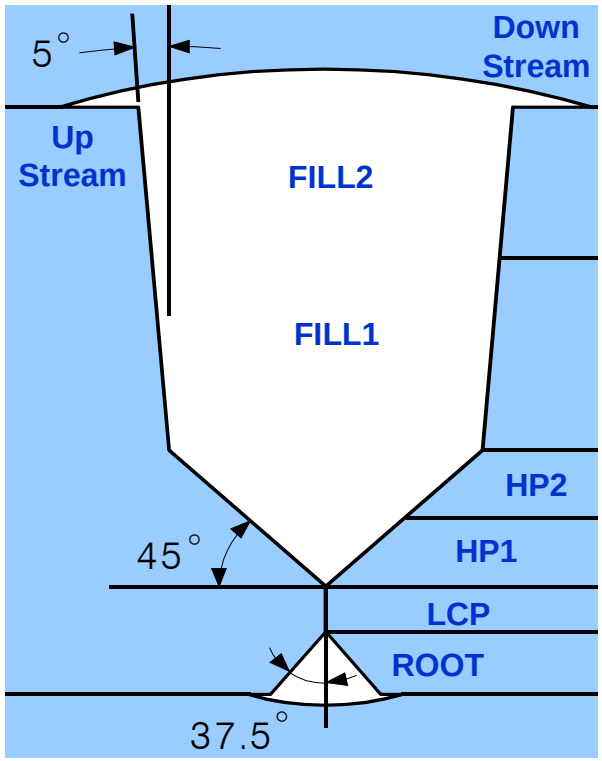
AUT Instrumentation

Pulse Echo and TOFD Basics



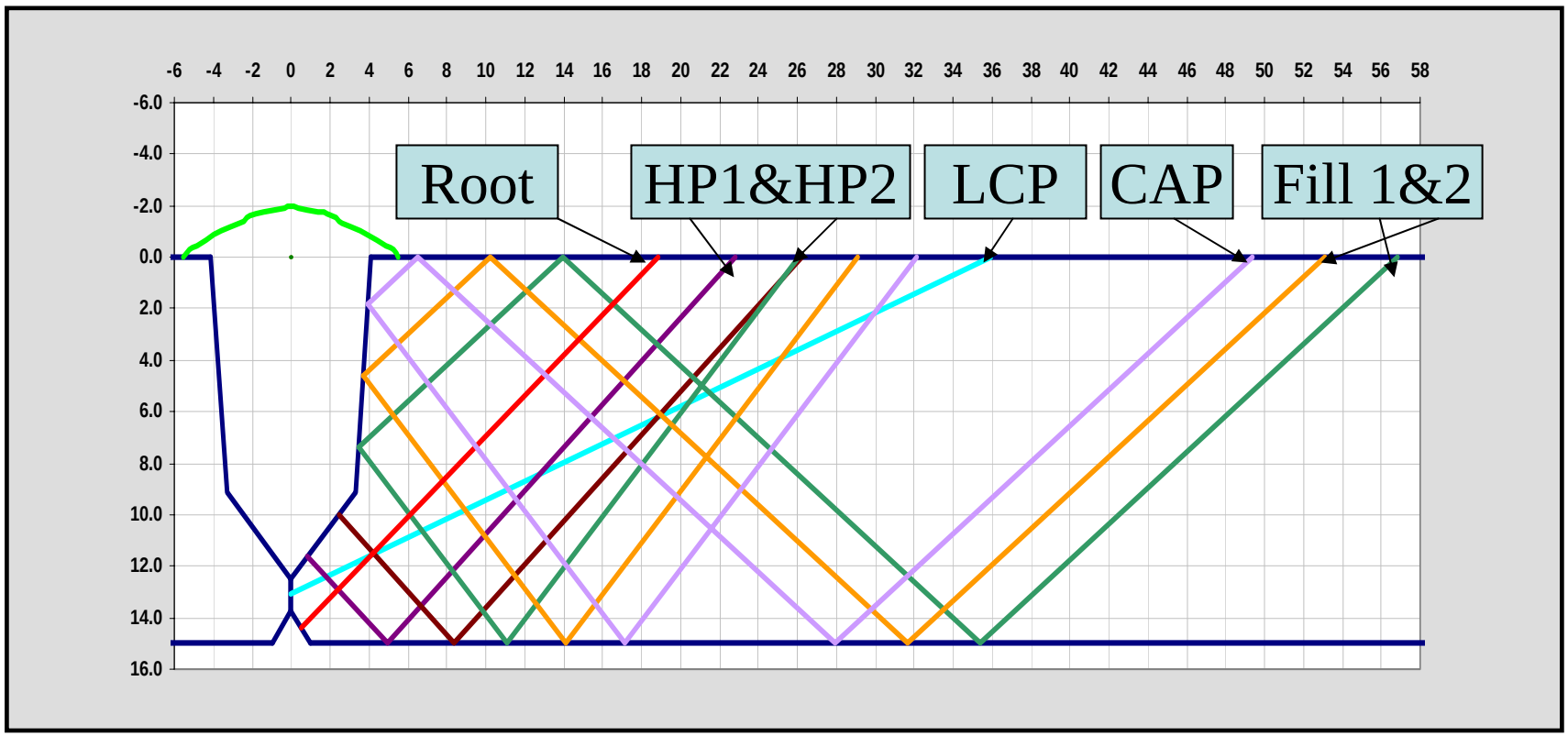


AUT – Zone Discrimination Basic

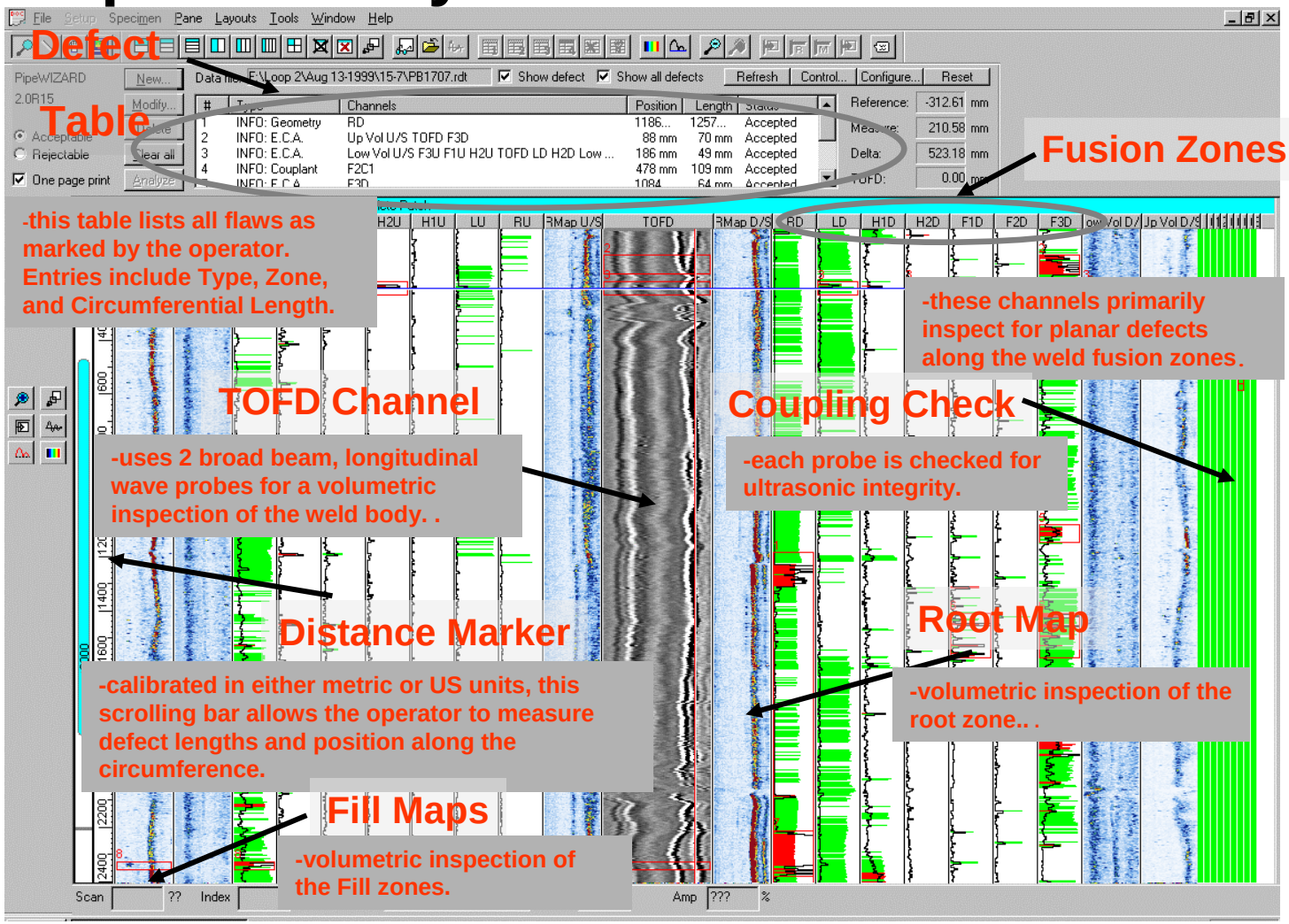


- The weld volume is divided into vertical “zones”.
- The Mechanized weld is divided in two halves – up and downstream.
- Each zone has an individual ultrasonic inspection channel.
- The number of zones is dependant on the material thickness, bevel type, and welding procedure.
- Optimization of beam profile through variation of radius of curvature (lenses or curved element, or PA), element size, frequency and sizing algorithms

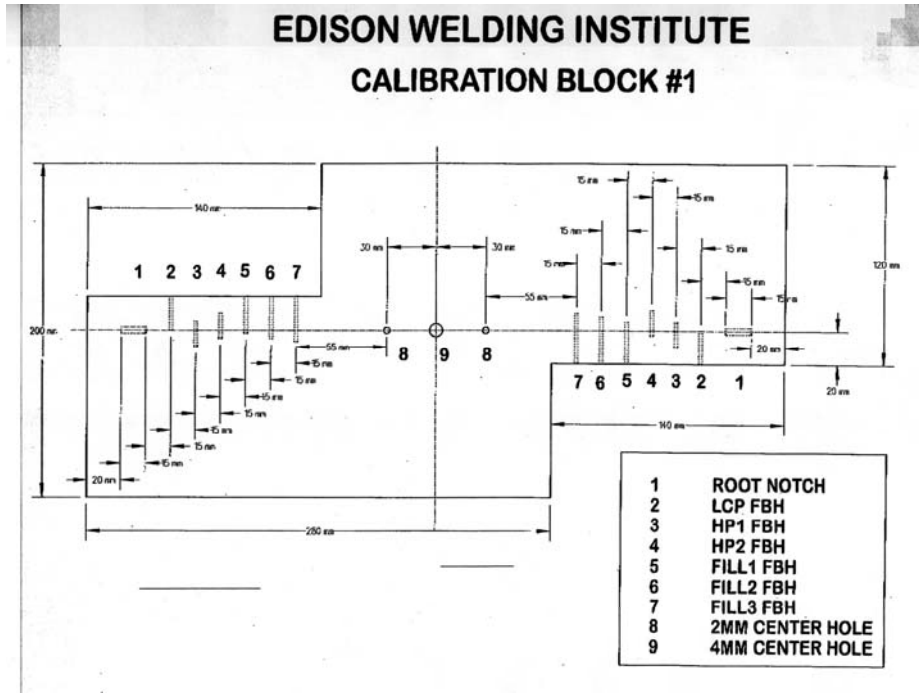
AUT – Zone Discrimination Basic (cont.)

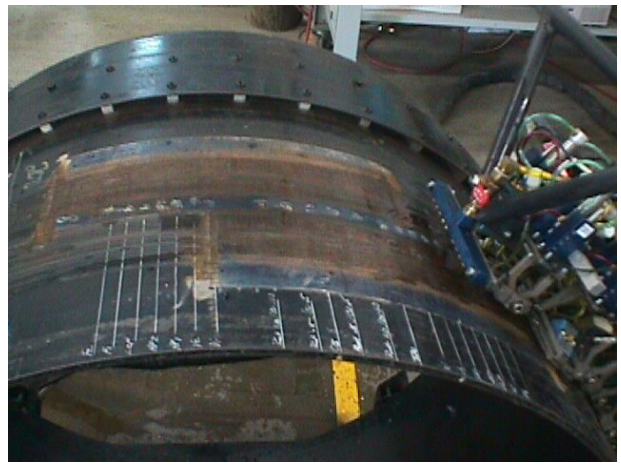


AUT – Strip Chart Layout



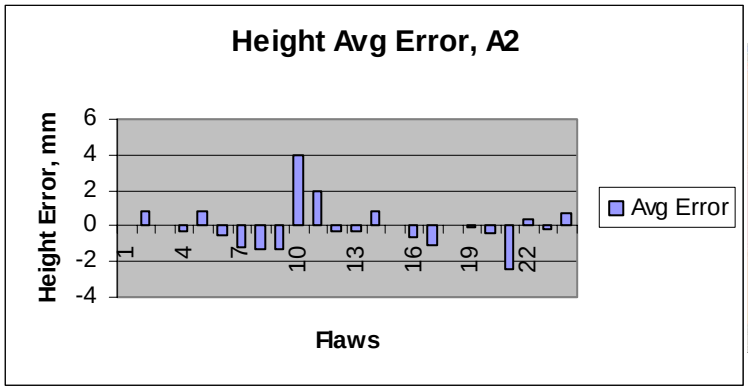
Calibration Blocks – ASTM 1961-98

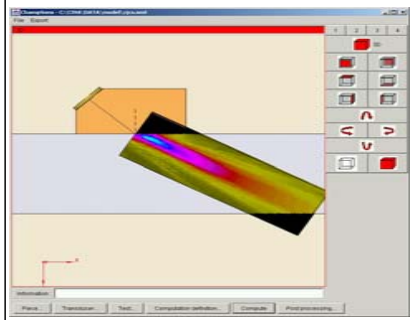


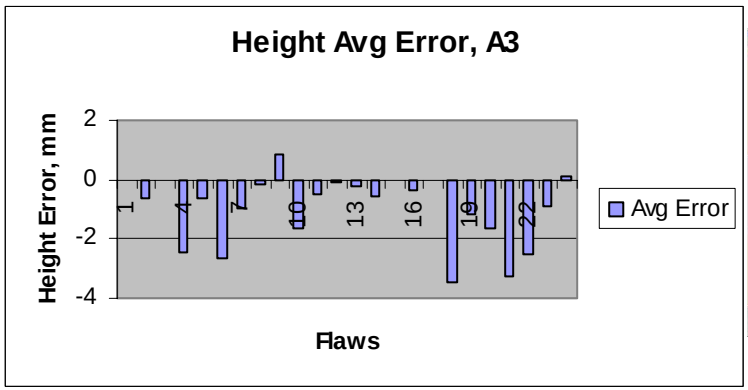


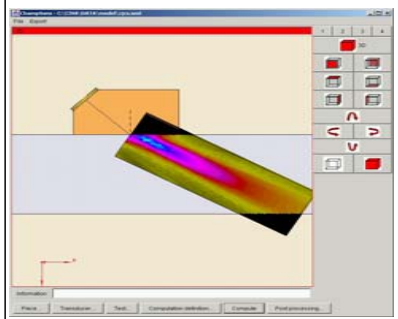
AUT Capabilities - Statistical Analysis

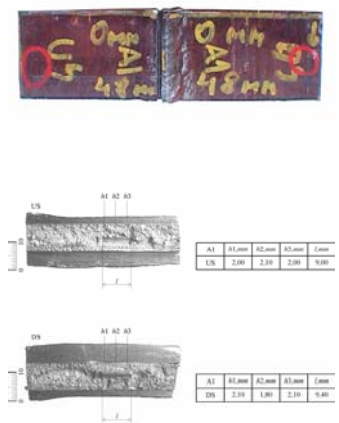
Typical focal spot size 2.6 mm - Focused

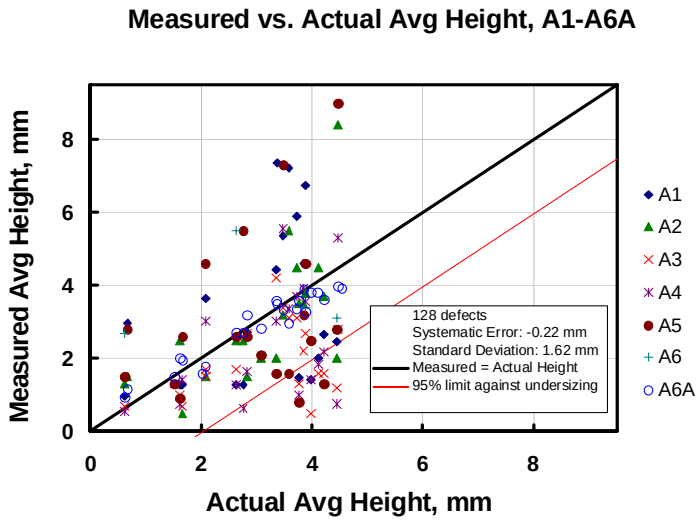






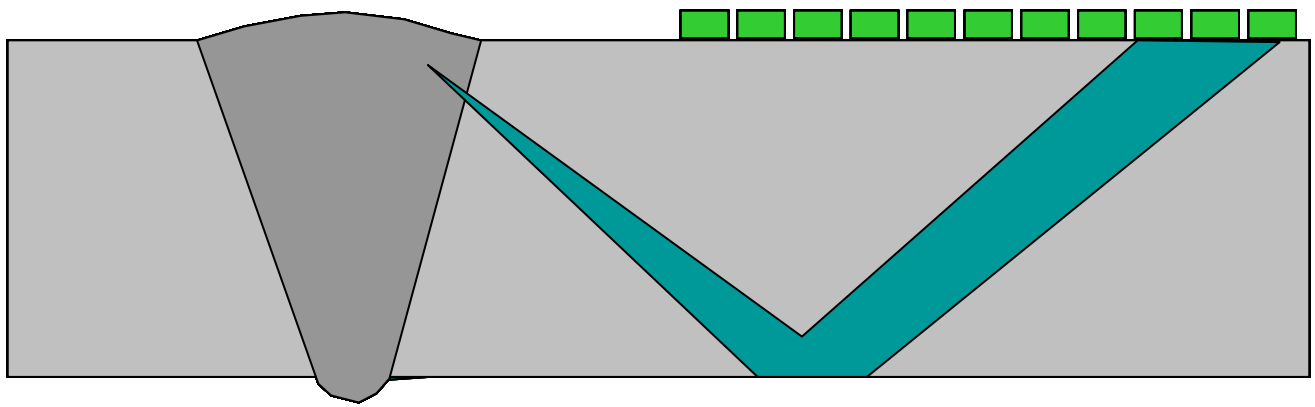






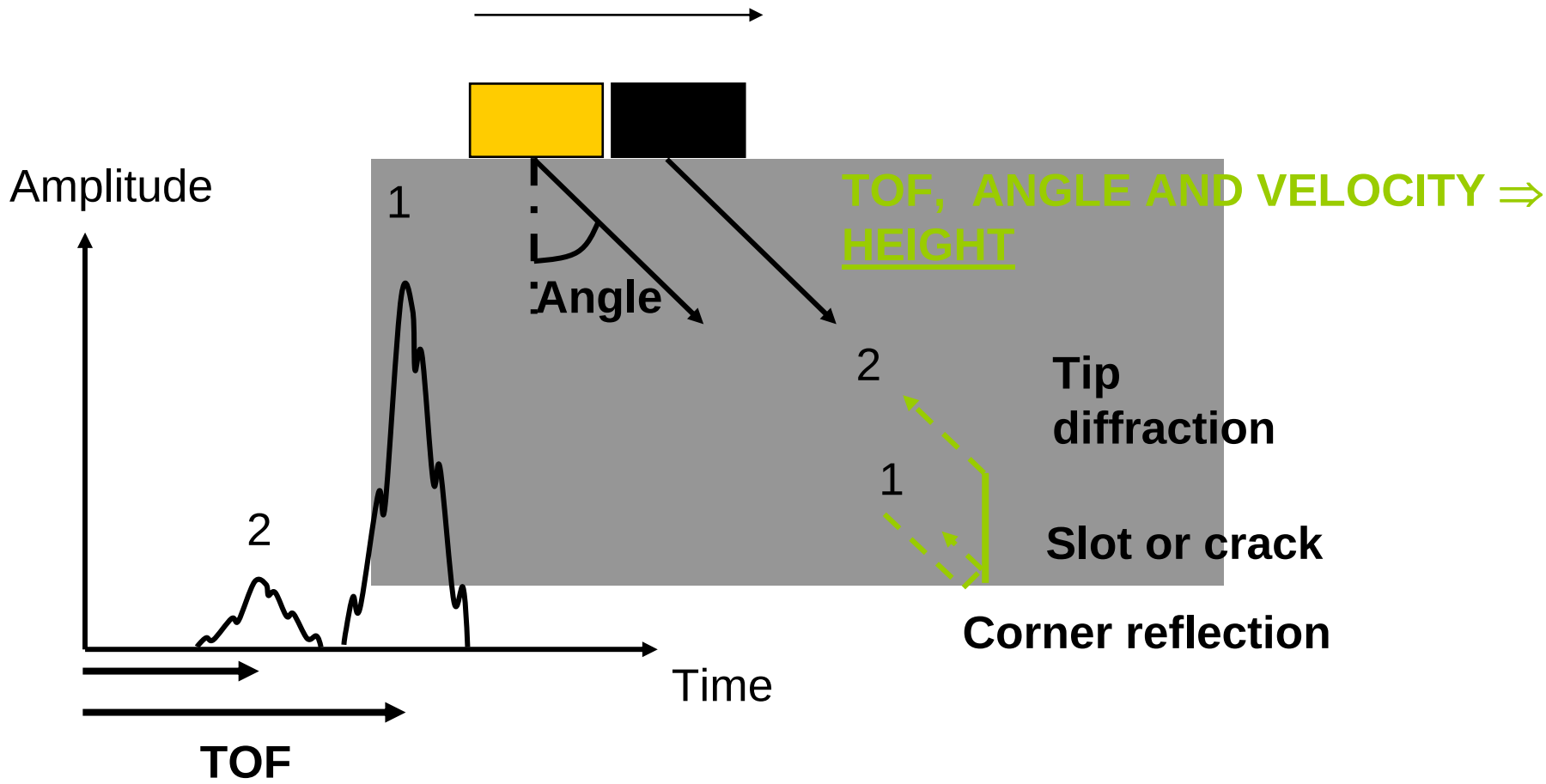
Typical focal spot size 3.2 mm – Non-focused

PA Technology – Focusing, Steering and Electronic Scanning

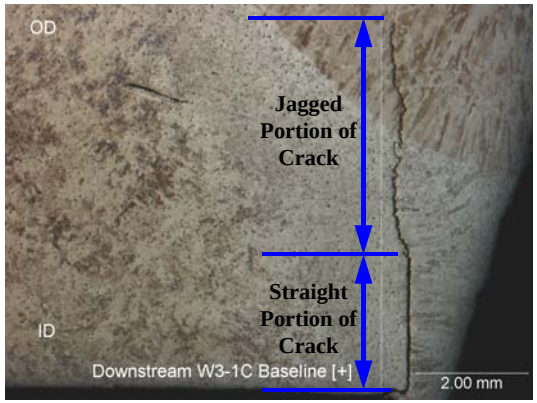


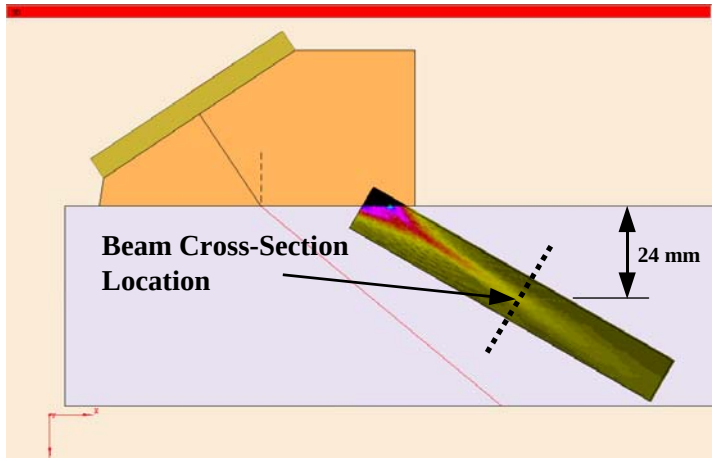
- Elements are fired in a programmed sequence from both sides of the weld.
- Entire weld volume is covered.
- No mechanical movement required perpendicular to the weld axis.

Time-of-Flight (Tip Diffraction)

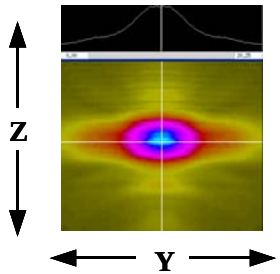


AUT Optimization – Modeling and Simulations

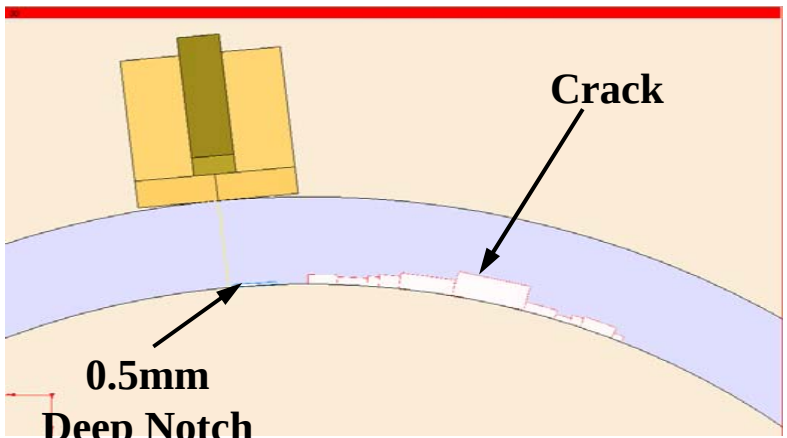




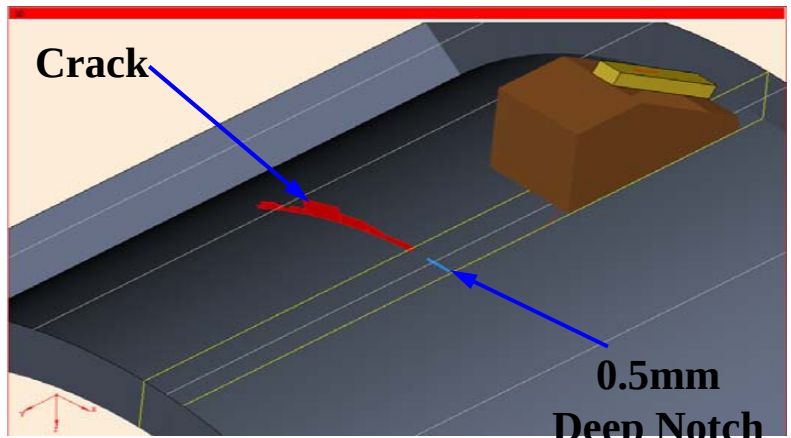
Beam Cross-Section At 24mm Depth



Depth (mm)	6dB		12dB	
	Z (mm)	Y (mm)	Z (mm)	Y (mm)
24	2.8	4.5	4.0	6.8



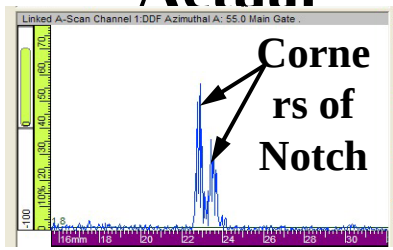
End View



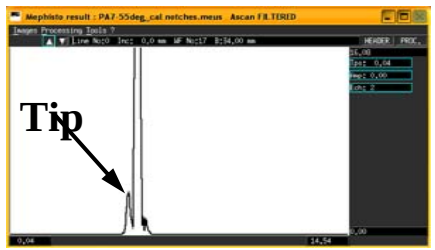
3D View

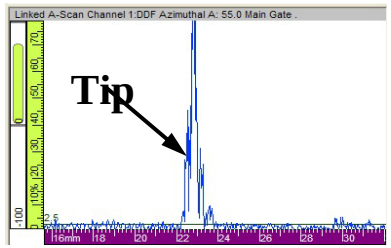
Simulation vs Actual - PA 7.5 MHz, 60 Element Using 17, 55 Deg., 20 FD

Simulation | **Actual**

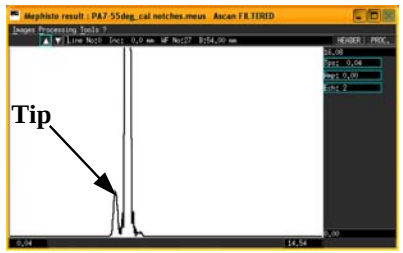


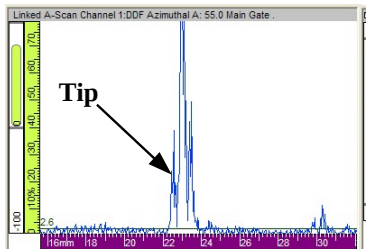
0.5mm Deep ID Notch



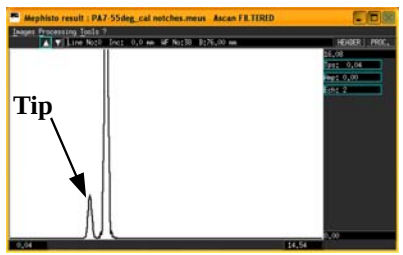


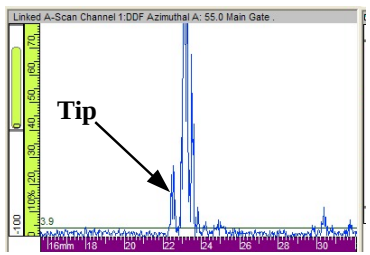
1.0mm Deep ID Notch





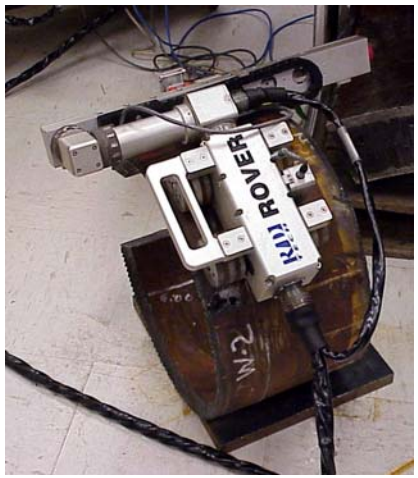
1.5mm Deep ID Notch

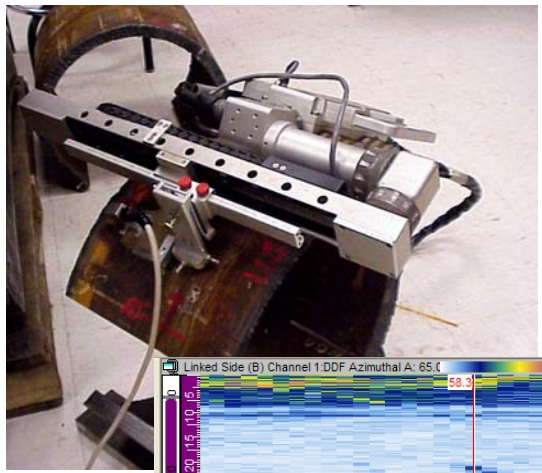


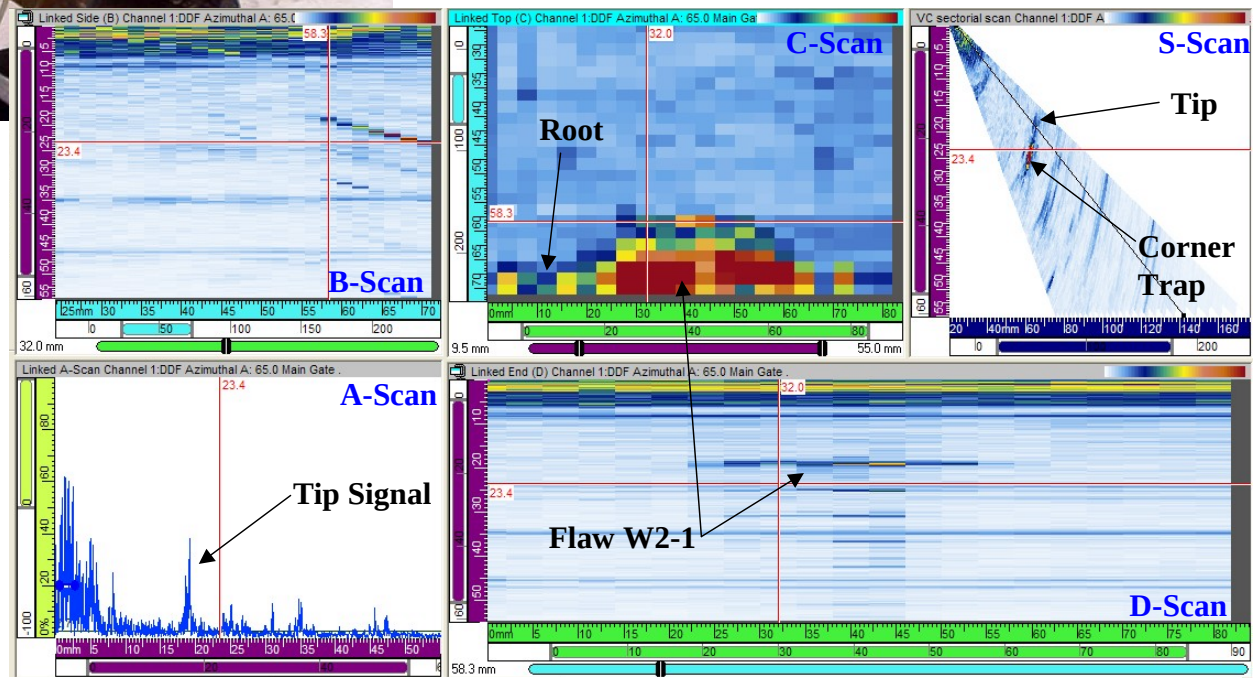


2.0mm Deep ID Notch

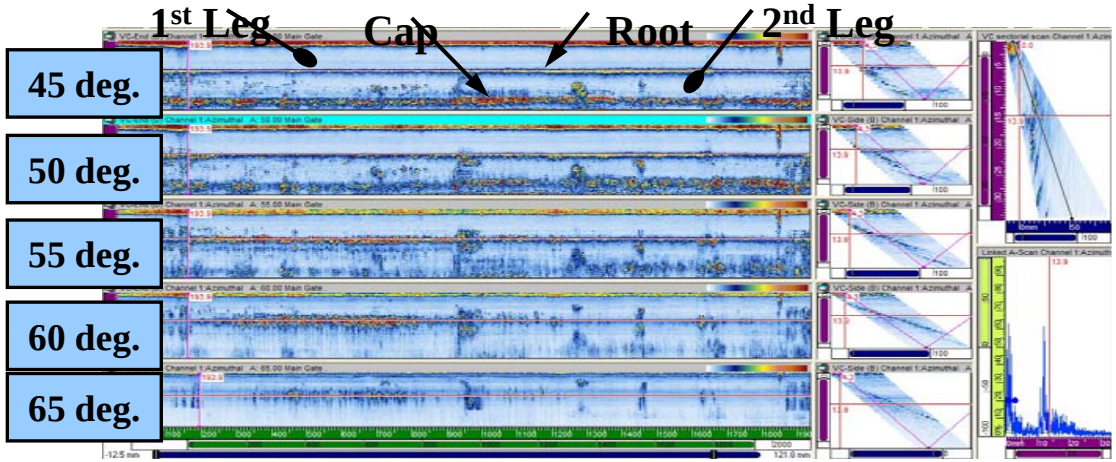
Improved PA Detection, Imaging, and Sizing

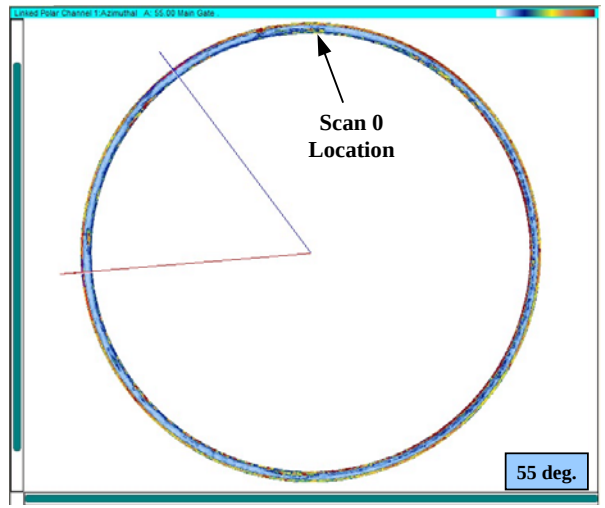


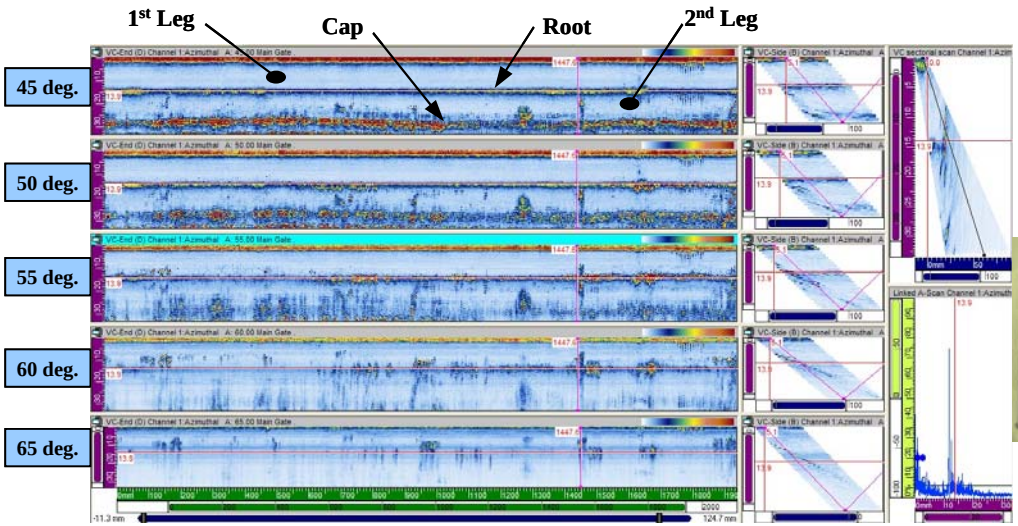


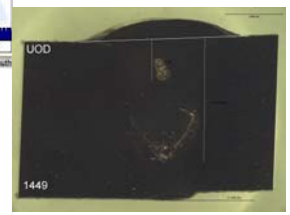


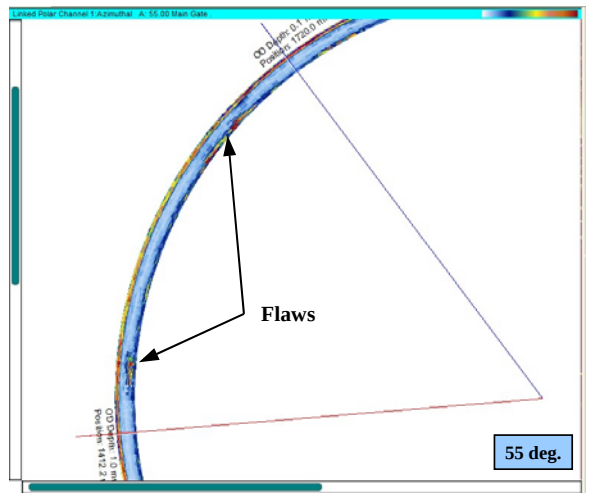
Merged DS vs. US Scans; Polar View - 1412 to 1720mm



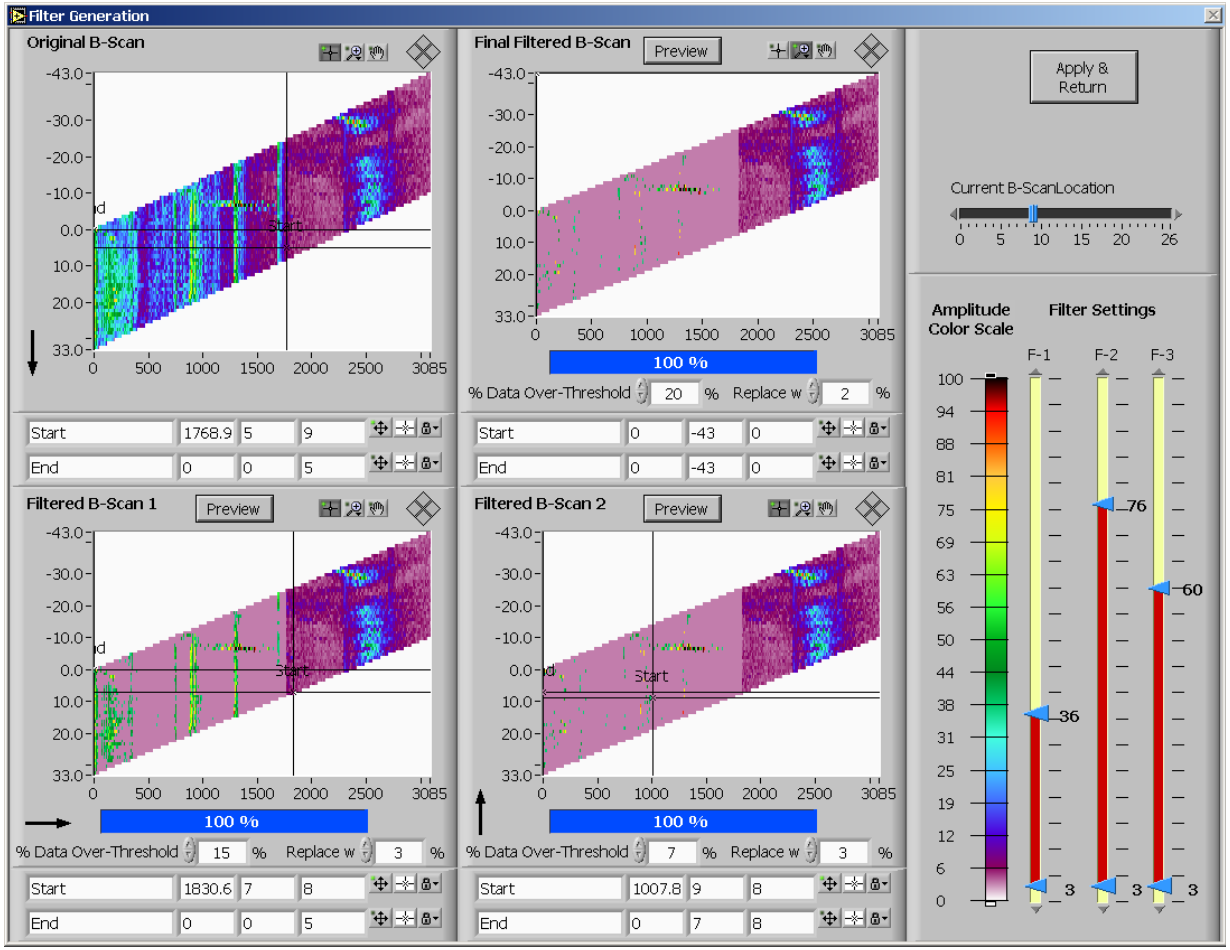




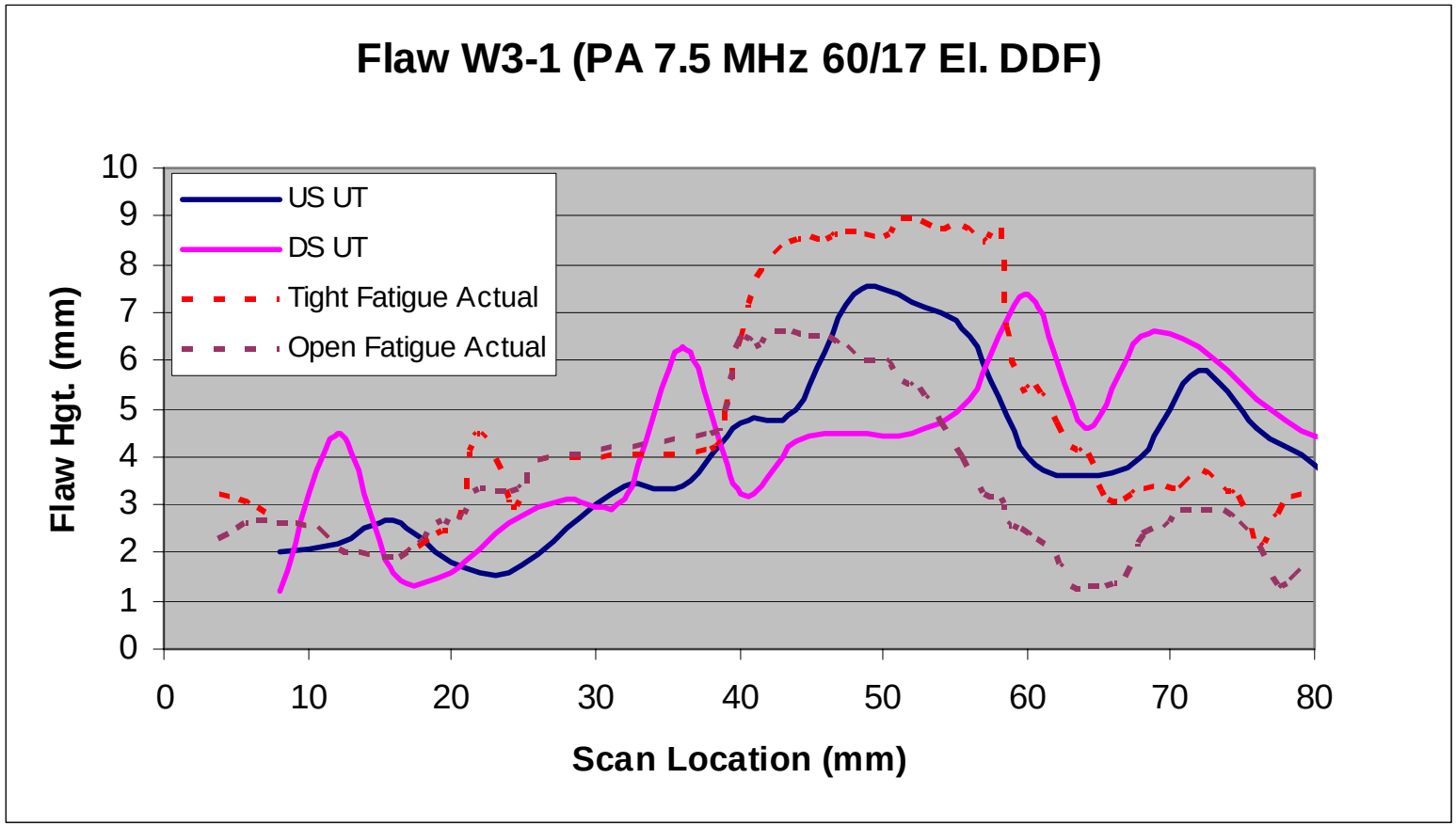




Improved PA Imaging – Wedge Noise Reduction



W3-1 Flaw Profile (PA60/17el. DDF)



Summary

- Typically using non-focused multiprobes flaw height was undersized
- In the past the best accuracy was achieved using shaped focused multiprobes
- Currently optimized PA technology with improved imaging and time-based sizing approach is demonstrating better detection and sizing accuracy