



Improved AUT of Girth Welds - Batam Round Robin Weld #4

Draft UT Scan Results, Images
and Metallographic Verification



THE MATERIALS JOINING EXPERTS

General View of DB-30 and Weld #4



THE MATERIALS JOINING EXPERTS

Overview

- Wall thickness 0.54-inch (13.8-mm)
- 24-inch (610-mm)diameter X-65 Pipe
- J-bevel, 12 Real Fabrication Flaws
- Weld was tested by several vendors using multi-probe and phased array AUT systems
- Weld was tested at EWI (3rd party) using Focus phased array system with 4 MHz and 7.5 MHz PA probes and sectorial scans for detection, imaging and sizing



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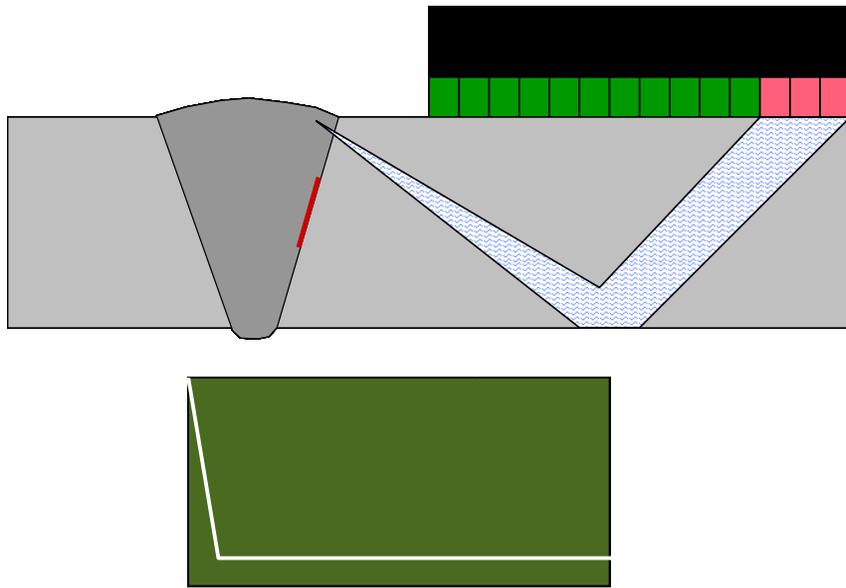
3rd Party

- Objectives:
 - reduce inherent detection and sizing inaccuracies of the current single focused beam zonal approach by using better techniques
 - identify potentially missed by vendors critical flaws and verify the presents of the flaws



THE MATERIALS JOINING EXPERTS

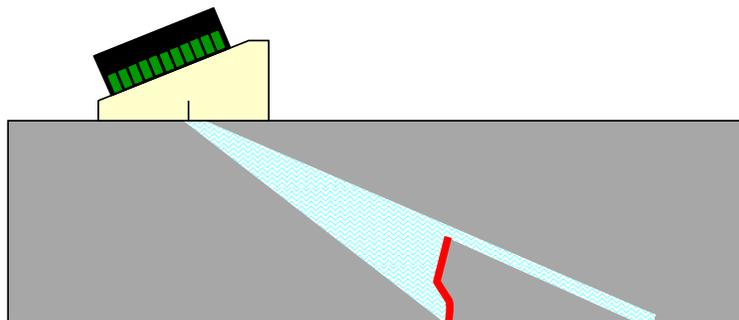
Phased Array – Weld Inspection



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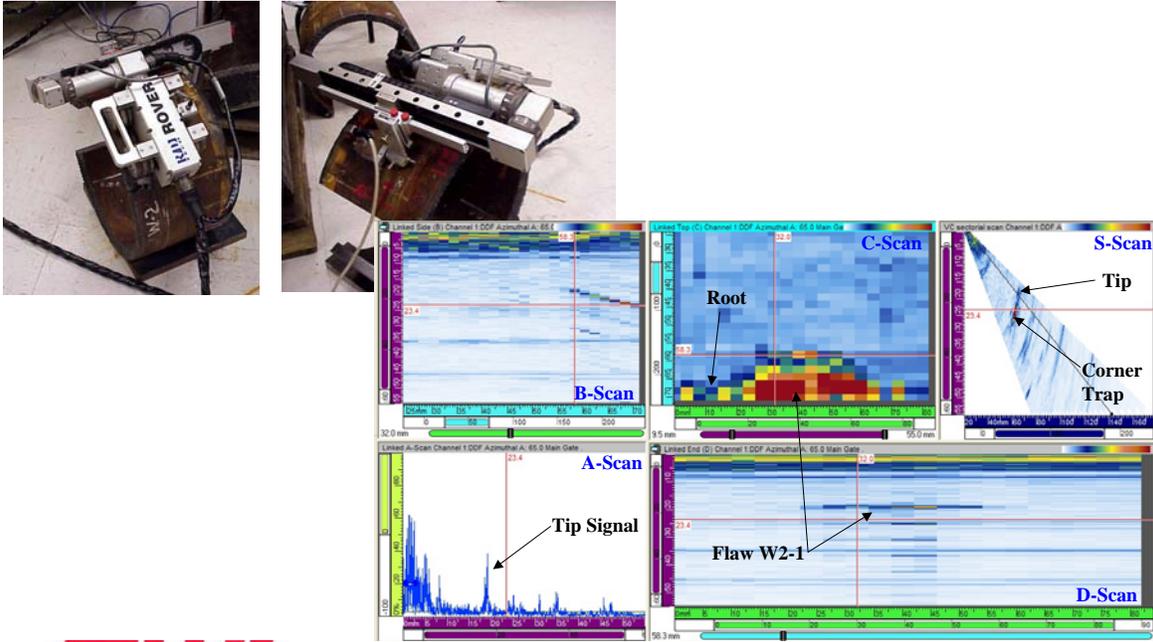
Phased Array - Angle Sweep



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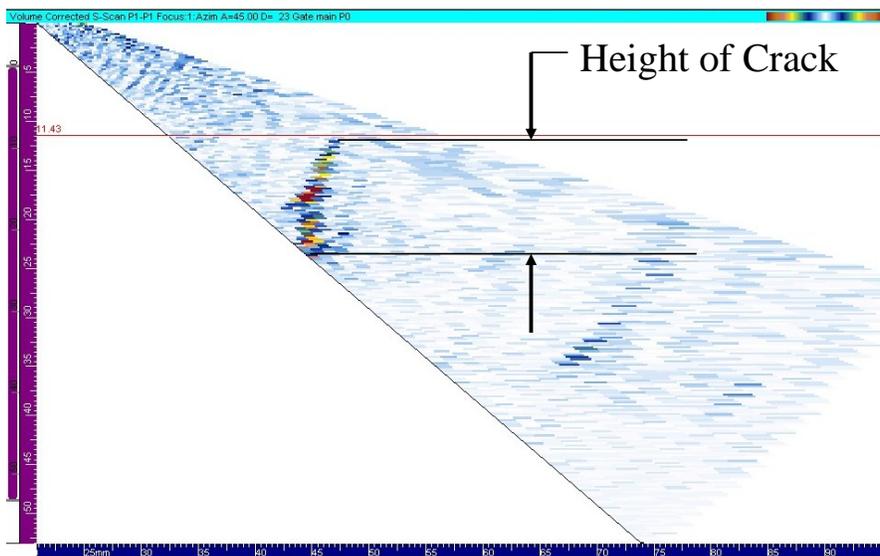
THE MATERIALS JOINING EXPERTS

Improved PA – Detection, Imaging, and Sizing



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Phased Array: Sector Scan of Cracked Weld



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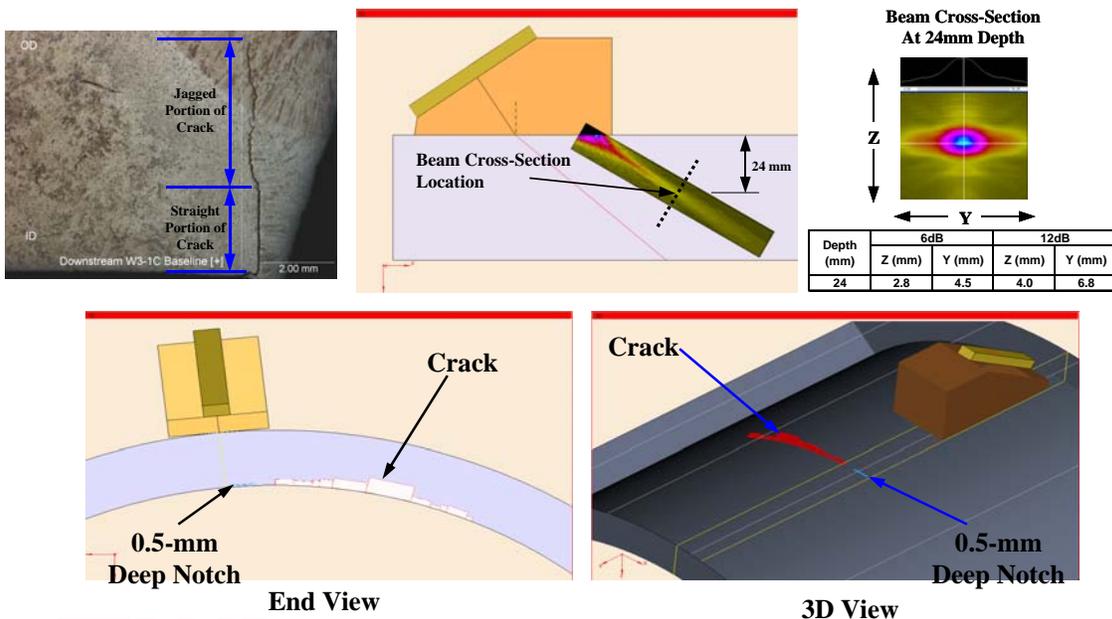
3rd Party

- Scanning gain for the PA 4 MHz probe was 6 dB above the calibration gain
- Scanning gain for the PA 7.5 MHz probe was 10 dB above the calibration gain
- Weld was scanned from both the upstream (US) and downstream (DS) sides
- Images captured with probe centered on flaw location stamped on pipe prior to metallographic cross-sectioning



THE MATERIALS JOINING EXPERTS

Improved AUT – Optimization via Modeling and Simulations (cont.)



THE MATERIALS JOINING EXPERTS

Improved AUT of Piping Welds



THE MATERIALS JOINING EXPERTS

Locations for Cross Sectioning of Flaws Detected/Missed by AUT- Weld #4

Location (mm)	3rd Party		Vendor 1		Vendor 2	Vendor 3	Vendor 4	Metallography Location Selected By:
	PA-4 MHz	PA-7 MHz	PA	Multi-Probe	PA	Multi-Probe	Multi-Probe	
181	US & DS	US & DS	US	missed	US	US	missed	Vendor 1
232	US & DS	US & DS	missed	missed	missed	missed	missed	3rd Party
469	US	US	US	missed	missed	missed	missed	Vendor 1
769	US & DS	US & DS	US	missed	missed	missed	US	Vendor 1
797	US & DS	US & DS	missed	missed	missed	missed	missed	3rd Party
824	US & DS	US & DS	missed	missed	missed	missed	missed	3rd Party
863	US	US	missed	missed	missed	missed	US	3rd Party
953	US & DS	US & DS	US	TOFD	US	US	missed	Vendor 1
1213	DS	DS	US	missed	missed	missed	missed	Vendor 1
1269	US & DS	US & DS	DS	DS	US & DS	US & DS	DS	Vendor 1
1445	US & DS	US & DS	US & DS	TOFD	US	US & DS	missed	3rd Party
1555	No Flaw	No Flaw	No Flaw	No Flaw	No Flaw	No Flaw	No Flaw	Vendor 1
1901	US & DS	US & DS	US & DS	DS	US & DS	US & DS	US & DS	Vendor 1



THE MATERIALS JOINING EXPERTS

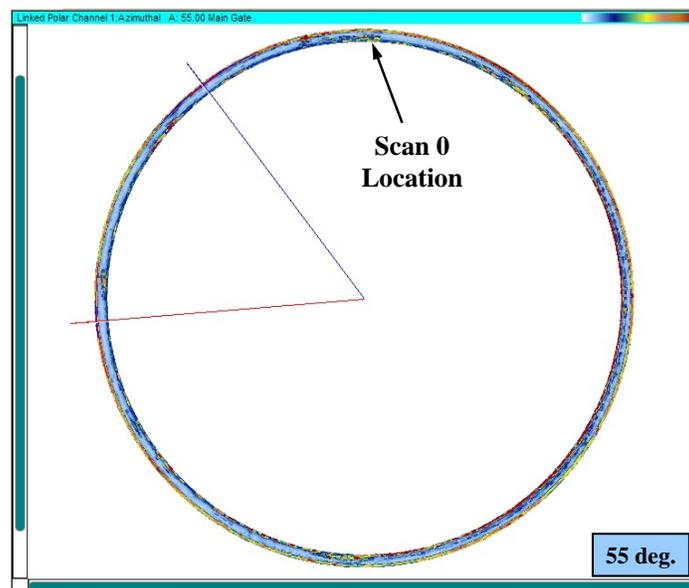
AUT Height Sizing vs. Destructive Sizing for Flaws Detected/Missed by AUT- Weld #4

Location (mm)	3rd Party		Vendor 1		Vendor 2	Vendor 3	Vendor 4	Metallography Flaw Hgt. (mm)
	PA-4 MHz	PA-7 MHz	PA-4 MHz	Multi-Probe	PA-7 MHz	Multi-Probe	Multi-Probe	
181	1.8	1.9	2.1	missed	3.7	2.8	missed	LOF - 1.7
232	2.2	1.9	missed	missed	missed	missed	missed	Lap at cap, crack
469	2.5	2.2	0.8	missed	missed	missed	missed	Lap at cap, crack
769	2.2	1.5	2.6	missed	missed	missed	NR	Root - 1.2
797	1.8	1.5	missed	missed	missed	missed	missed	Root - 1.0
824	1.3	1.7	missed	missed	missed	missed	missed	Root - 1.0
863	1.7	1.0	missed	missed	missed	missed	NR	Root - 1.0
953	2.4	2.7	3.4	2.3	2.5	4.3	missed	LOF - 2.6
1213	1.3	0.6	1.4	missed	missed	missed	missed	Root - 0.5
1269	7.0	6.7	5.0	4.1	6.8	6.3	NR	Cluster - 6.6
1445	4.5	4.5	2.5	1.8	7.7	6	missed	LOF/Crks - 4.8
1555	No Flaw	No Flaw	No Flaw	No Flaw	No Flaw	No Flaw	No Flaw	No Flaw
1901	2.6	2.5	2.5	2.8	5.5	6.3	NR	LOF - 2.4



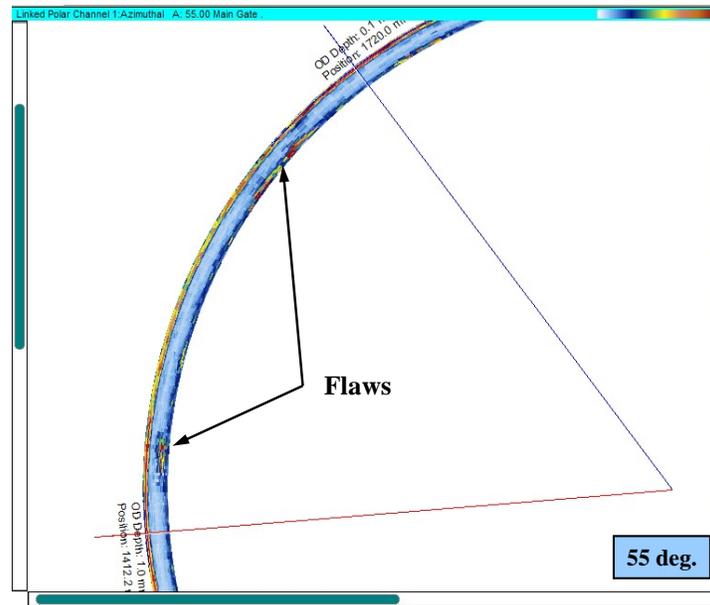
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PA 7 MHz DS Scan – Polar View



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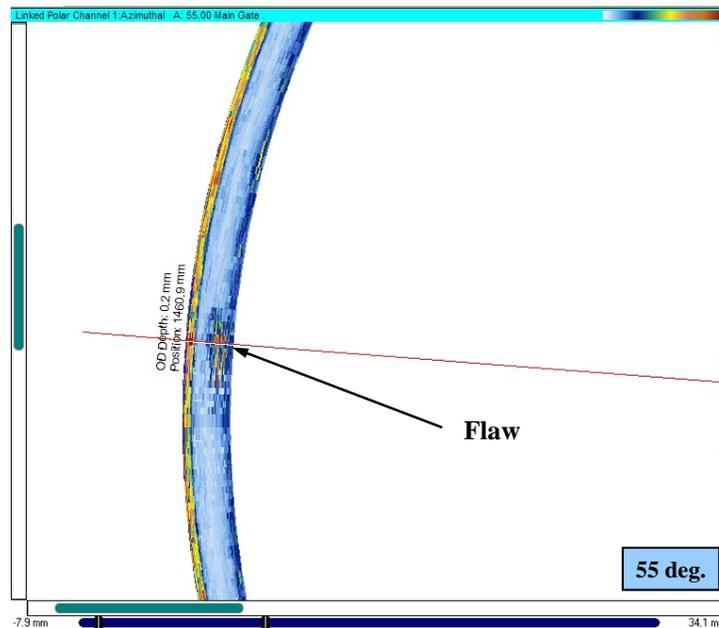
PA 7 MHz DS Scan – Polar View Location 1412 to 1720



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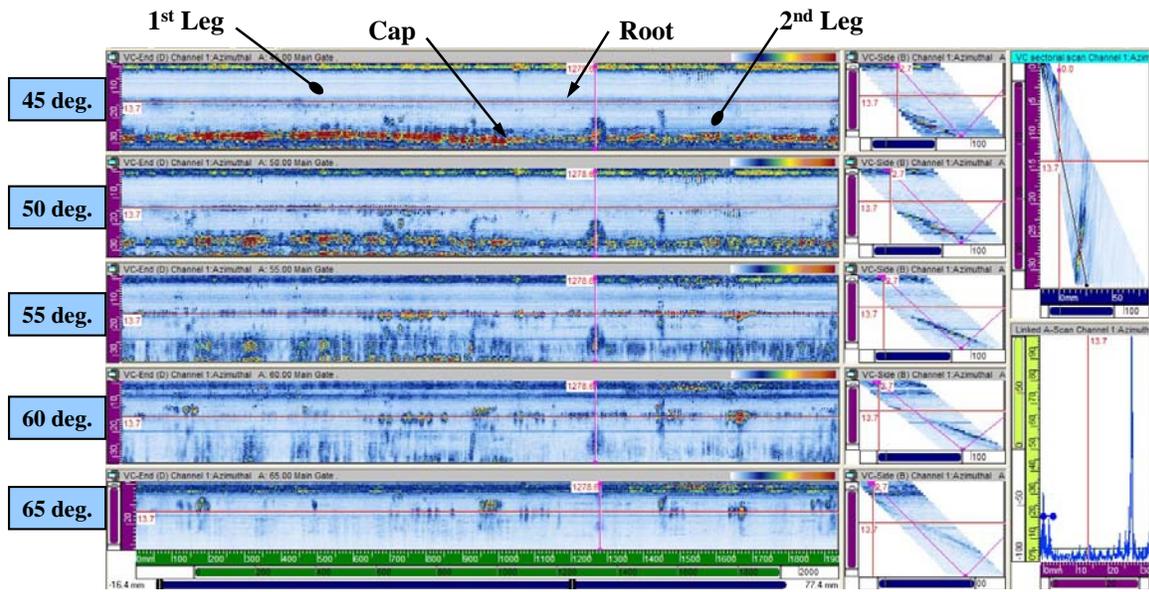
PA 7 MHz DS Scan – Polar View Location 1412 to 1720



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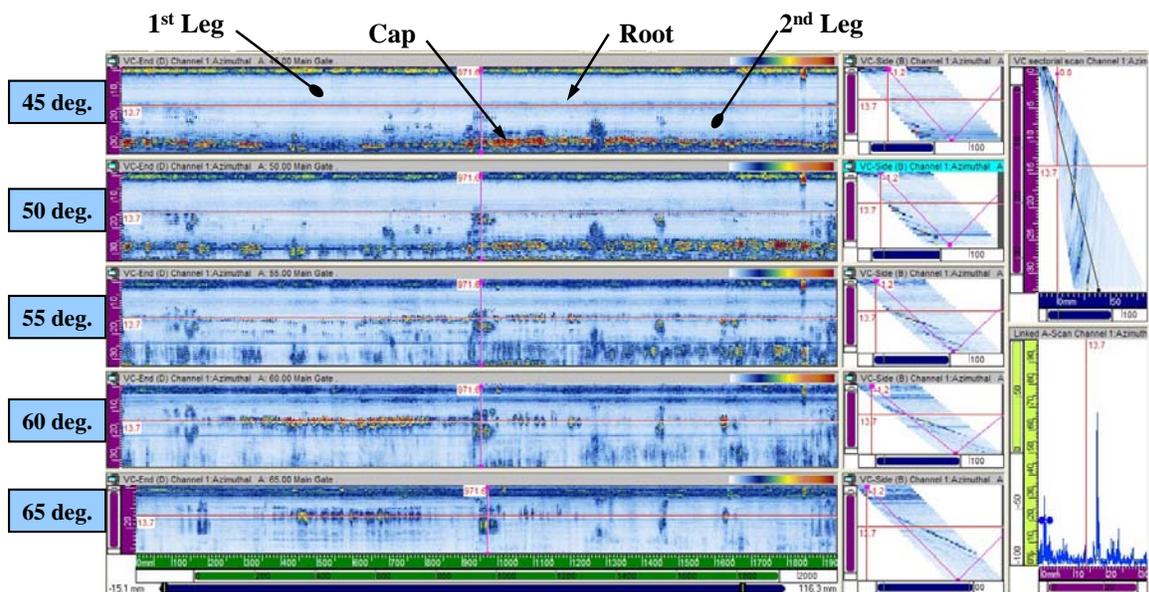
THE MATERIALS JOINING EXPERTS

PA 4 MHz US Scan



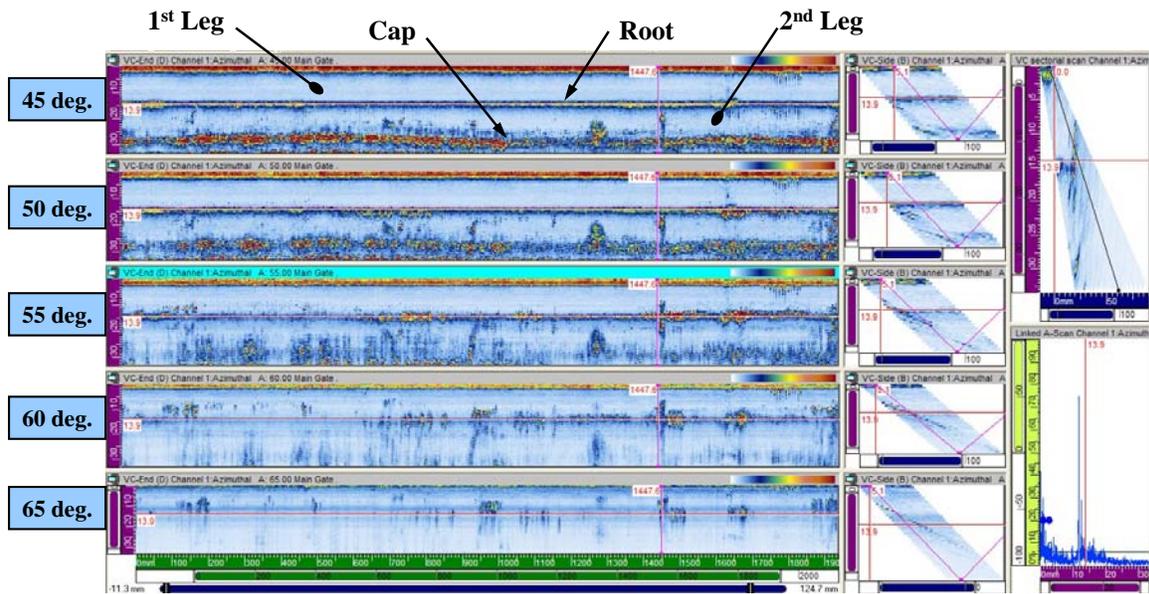
THE MATERIALS JOINING EXPERTS

PA 4 MHz DS Scan



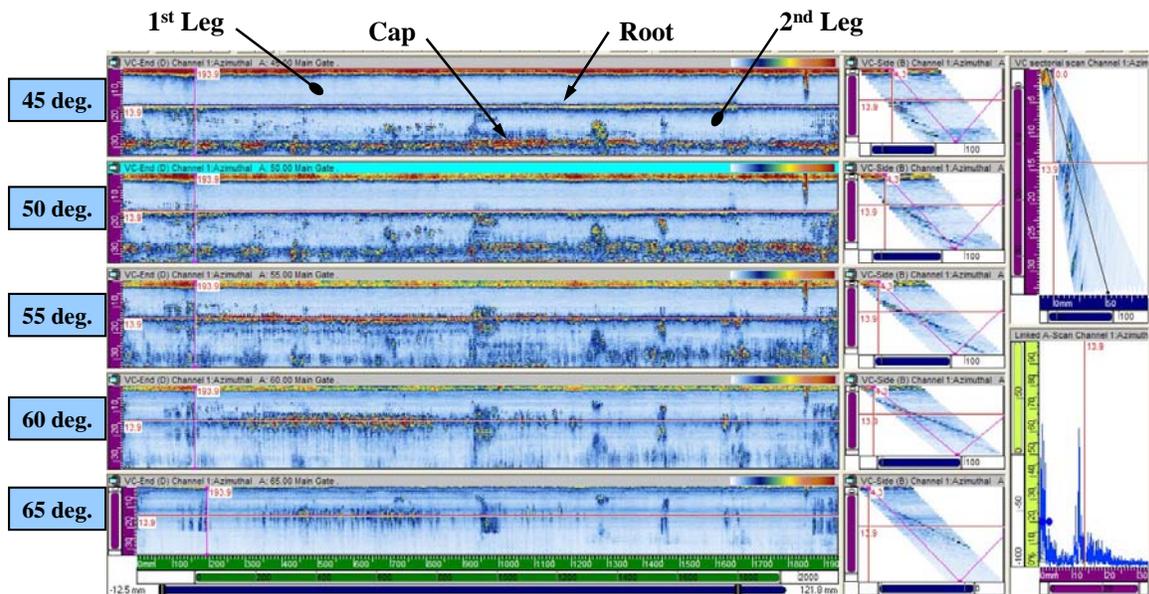
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PA 7 MHz US Scan



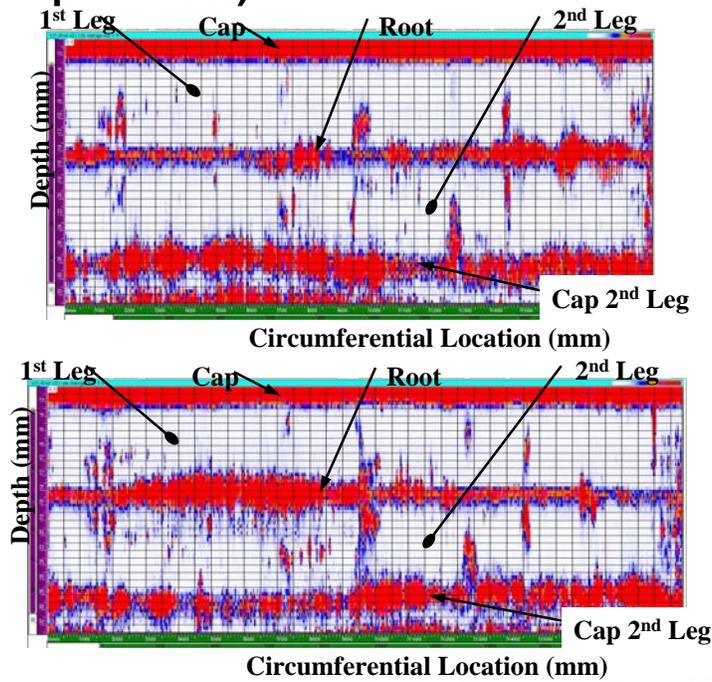
THE MATERIALS JOINING EXPERTS

PA 7 MHz DS Scan



THE MATERIALS JOINING EXPERTS

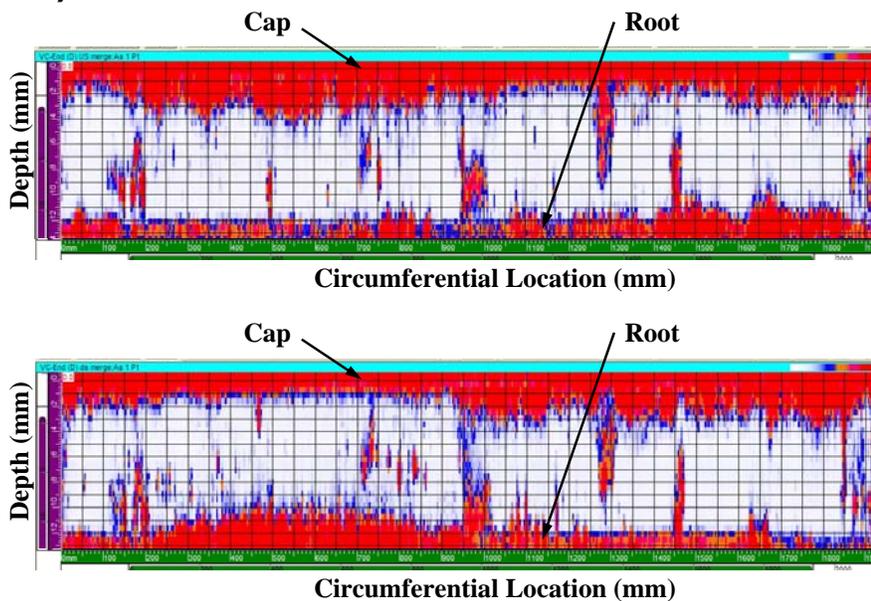
PA 7 MHz US (top) and DS (bottom) 45 to 70 Deg. Scan Data Merged; (Amp. $\geq 40\%$)



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THE MATERIALS JOINING EXPERTS

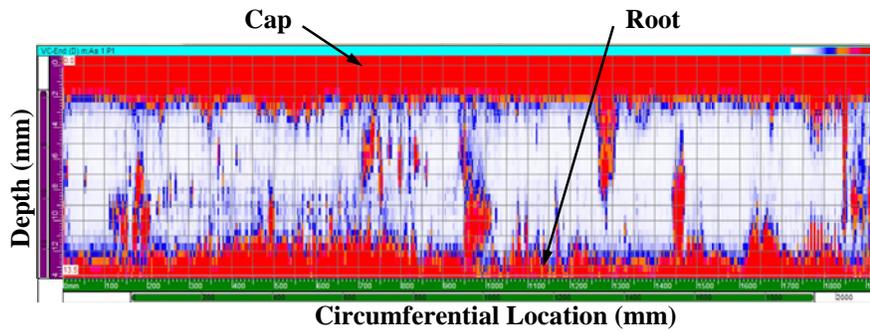
PA 7 MHz US (top) and DS (bottom) 45 to 70 Deg. Scan Data Merged with 2nd Leg Folded Up On 1st Leg; (Amp. $\geq 40\%$)



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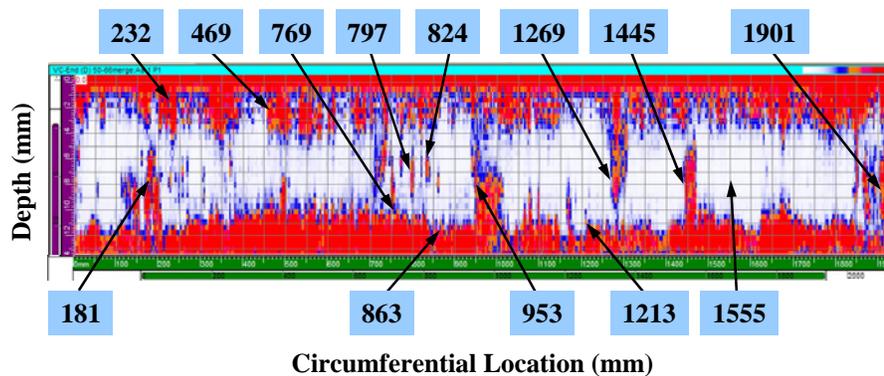
THE MATERIALS JOINING EXPERTS

PA 7 MHz US & DS 45 to 70 Deg. Scan Data Combined & Merged with 2nd Leg Folded Up On 1st Leg; (Amp. >= 40%)



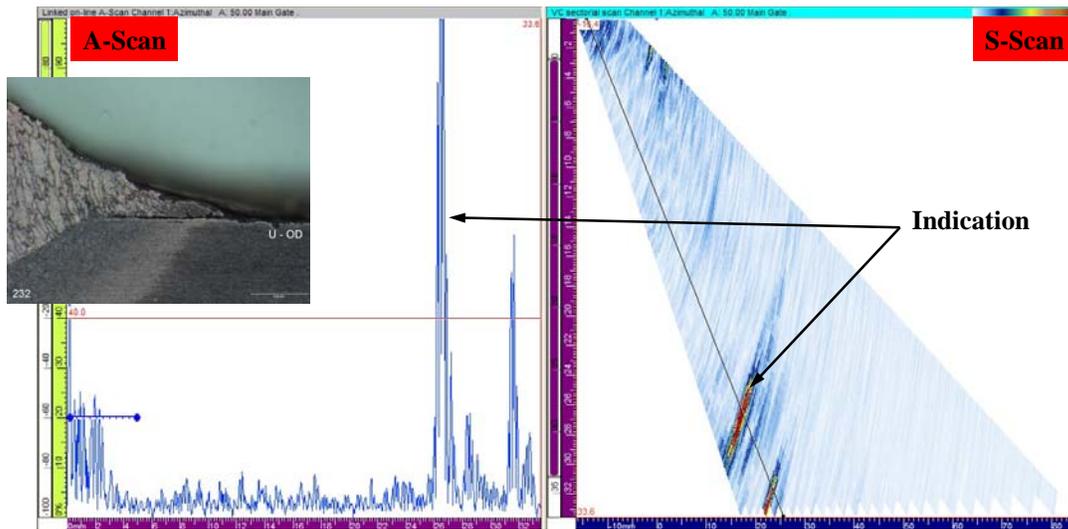
THE MATERIALS JOINING EXPERTS

Flaw Locations Identified For Metallographic Cross-Sectioning



THE MATERIALS JOINING EXPERTS

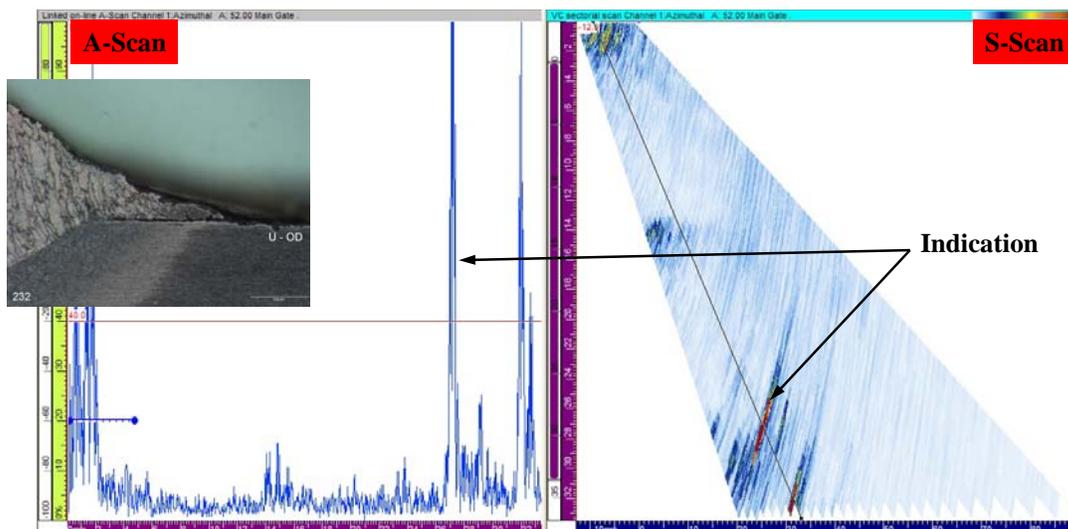
Location 232 US – PA4 64/21, FD 20



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THE MATERIALS JOINING EXPERTS

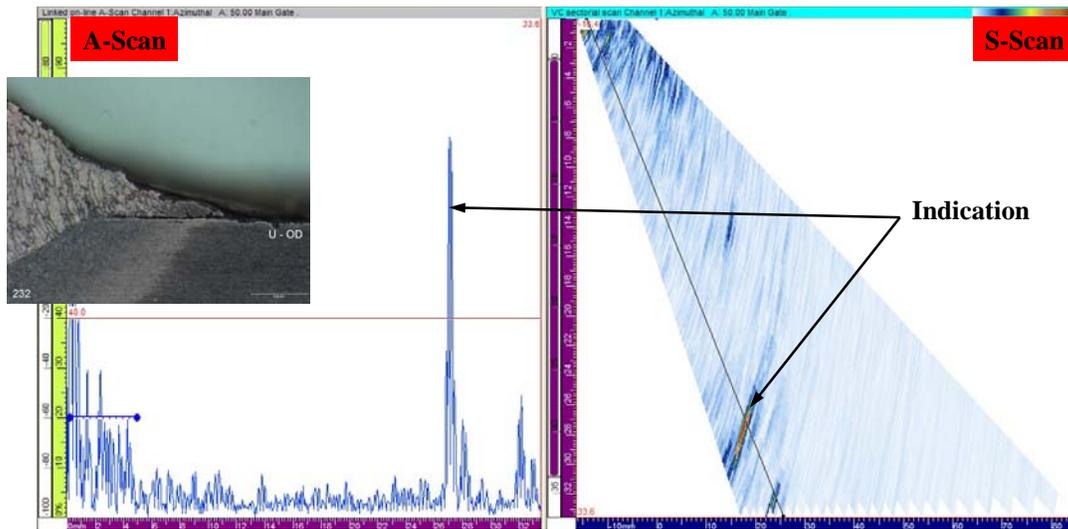
Location 232 US – PA7 60/16, FD 20



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THE MATERIALS JOINING EXPERTS

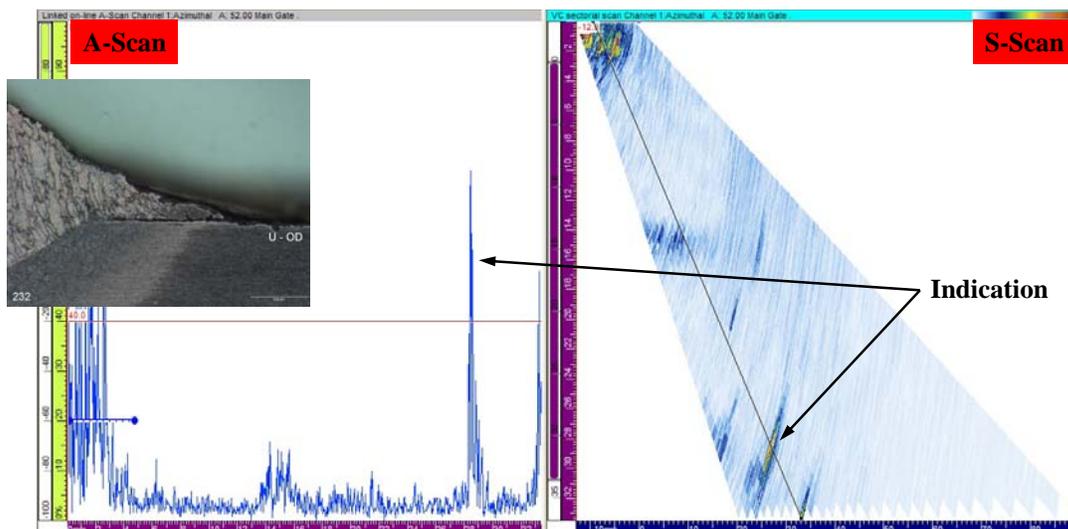
Location 232 DS – PA4 64/21, FD 20



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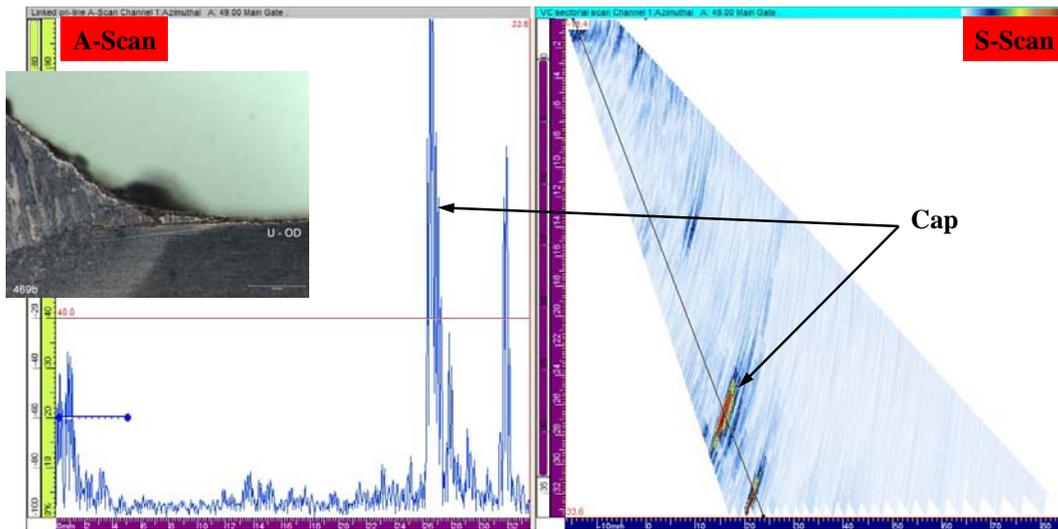
Location 232 DS – PA7 60/16, FD 20



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THE MATERIALS JOINING EXPERTS

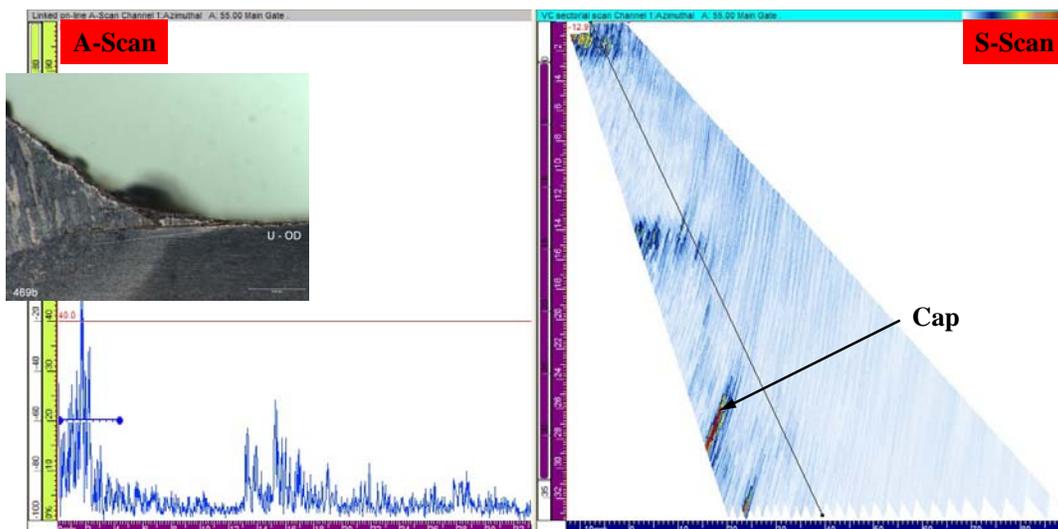
Location 469 US – PA4 64/21, FD 20



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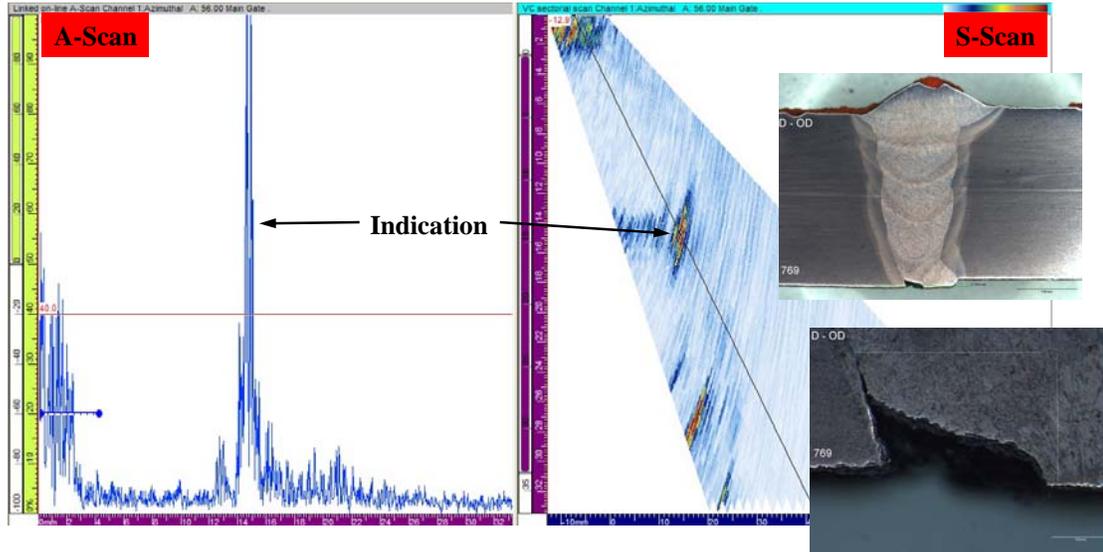
Location 469 US – PA7 60/16, FD 20



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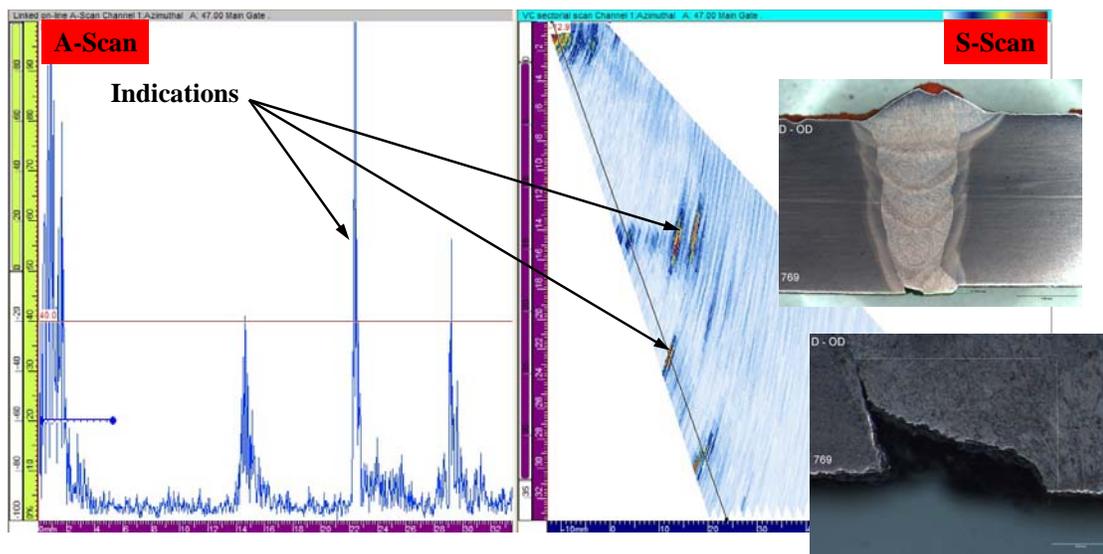
Location 769 US – PA7 60/16, FD 20



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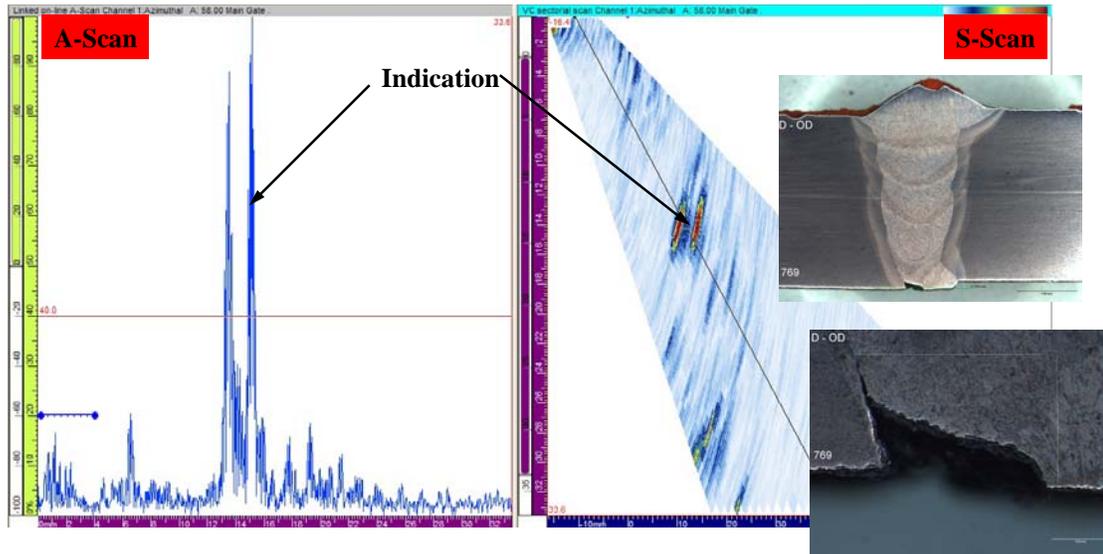
Location 769 DS – PA7 60/16, FD 20



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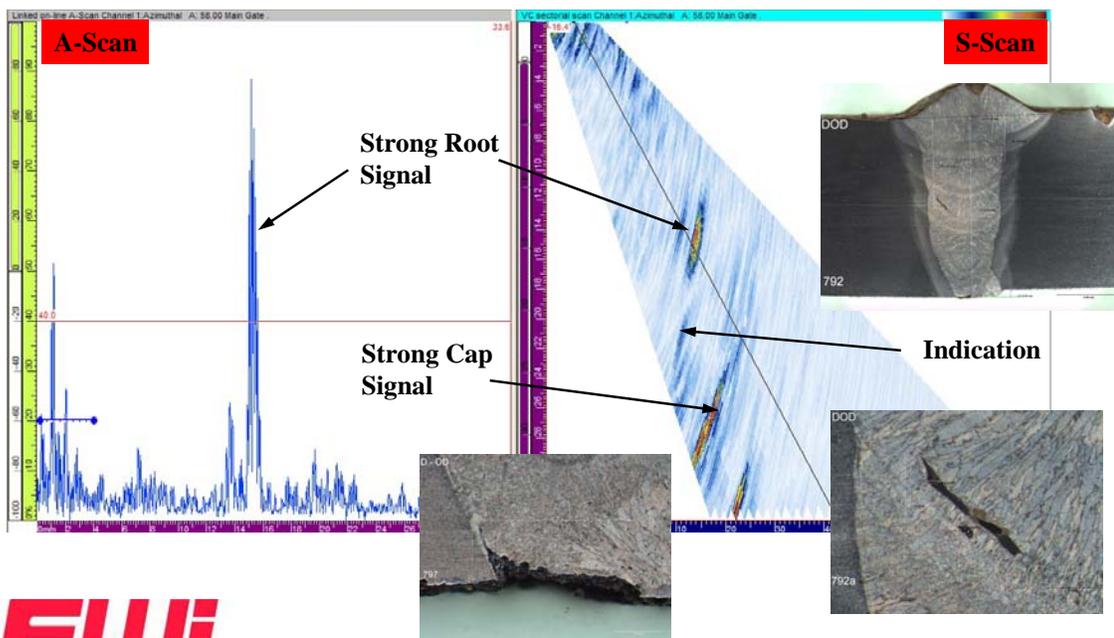
Location 769 DS – PA4 64/21, FD 20



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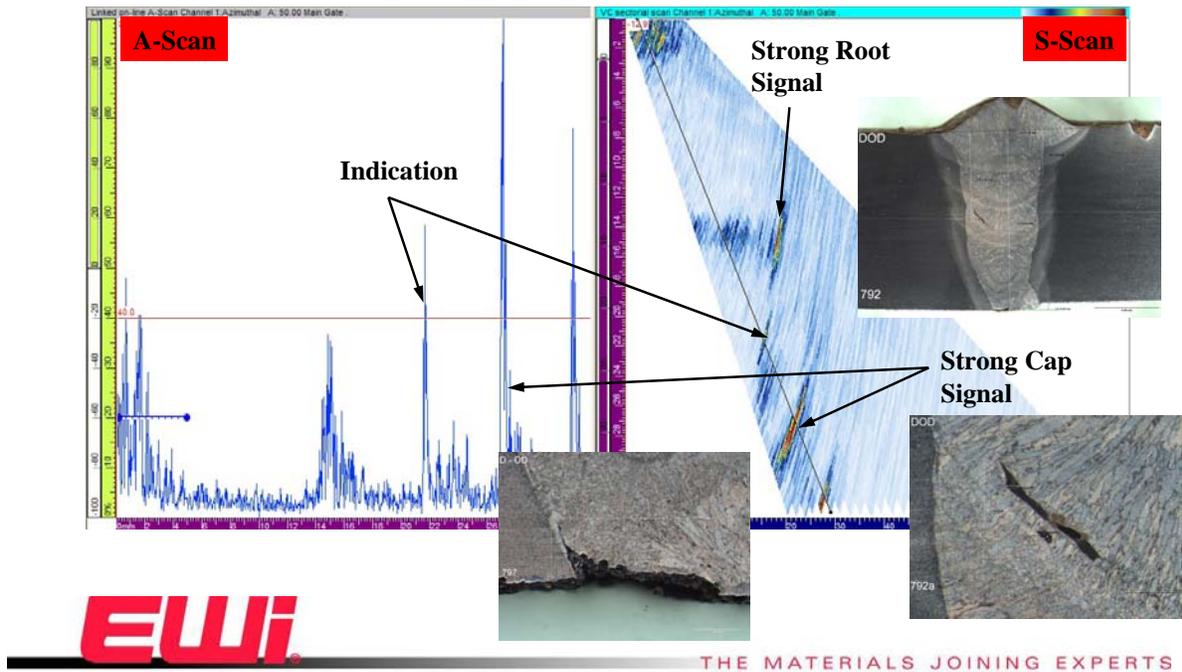
Location 797 US – PA4 64/21, FD 20



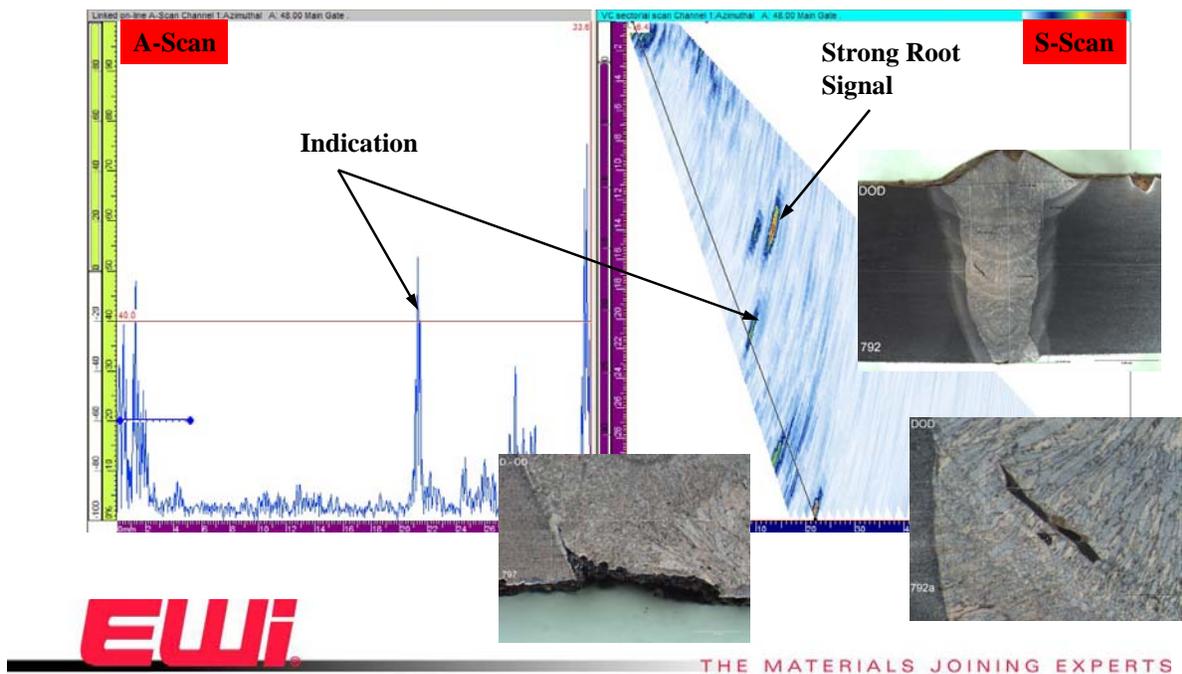
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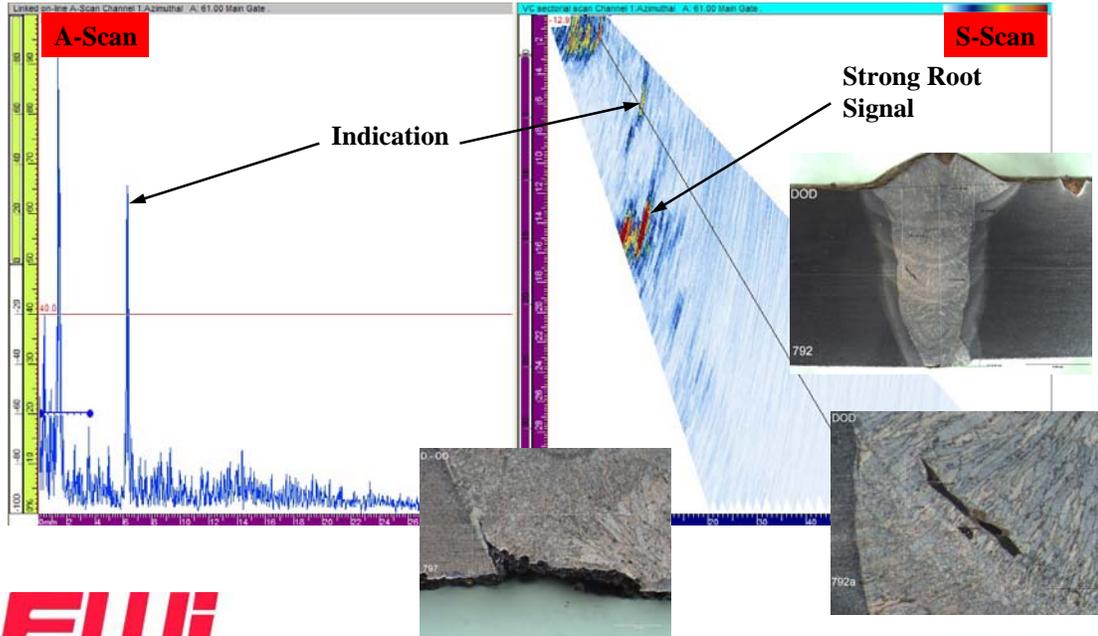
Location 797 US – PA7 60/16, FD 20



Location 797 DS – PA4 64/21, FD 20



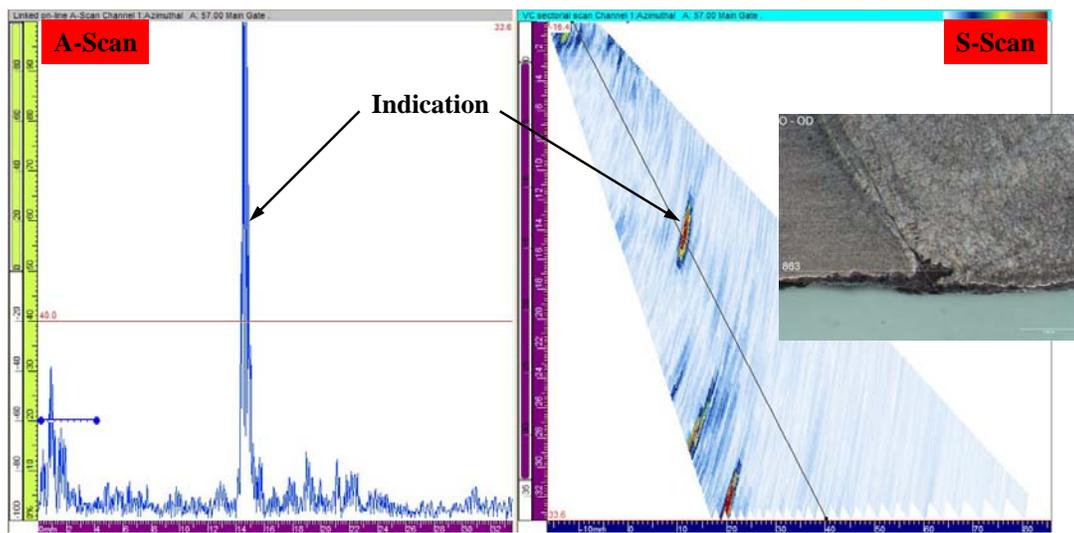
Location 797 DS – PA7 60/16, FD 20



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THE MATERIALS JOINING EXPERTS

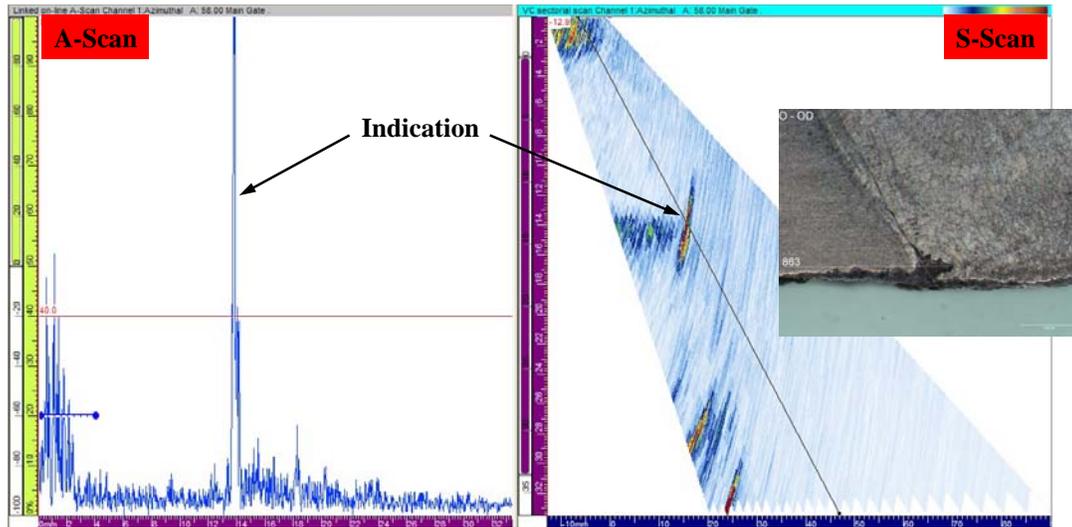
Location 863 US – PA4 64/21, FD 20



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THE MATERIALS JOINING EXPERTS

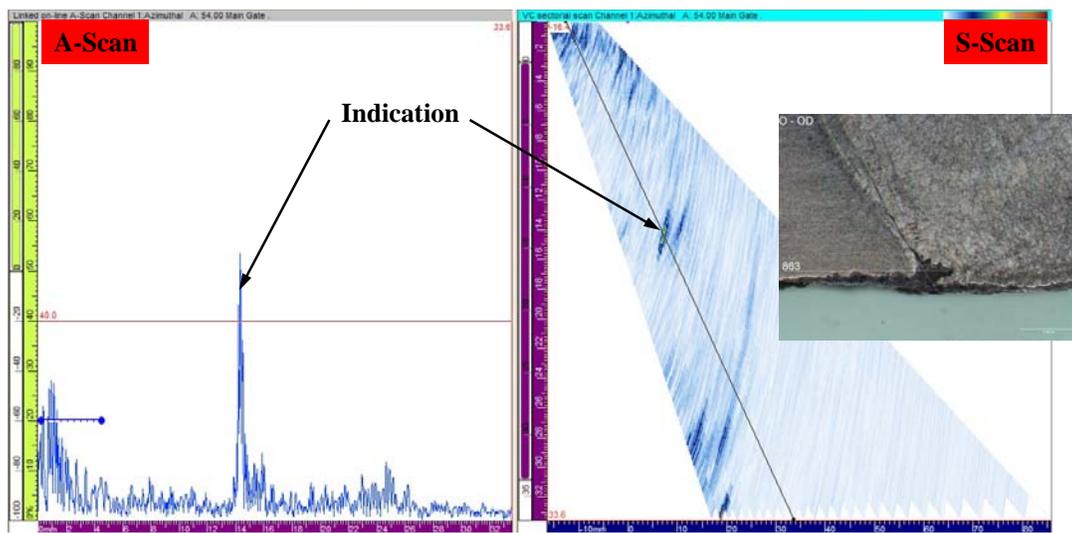
Location 863 US – PA7 60/16, FD 20



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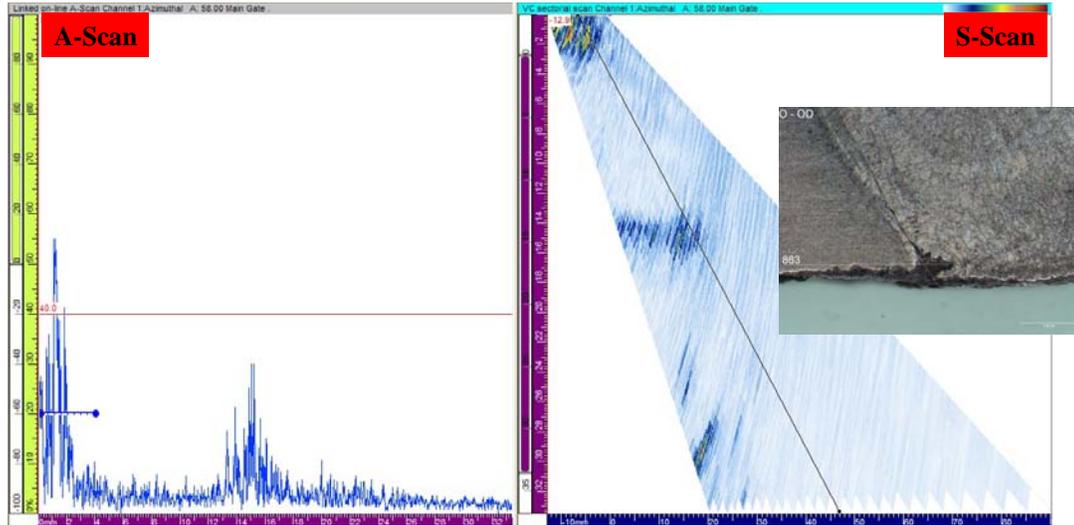
Location 863 DS – PA4 64/21, FD 20



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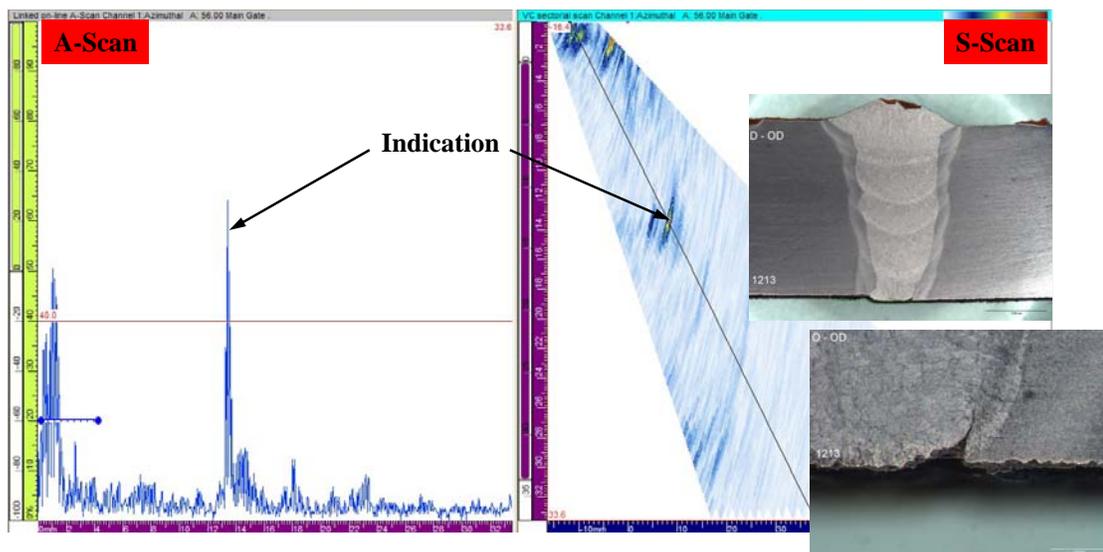
Location 863 DS – PA7 60/16, FD 20



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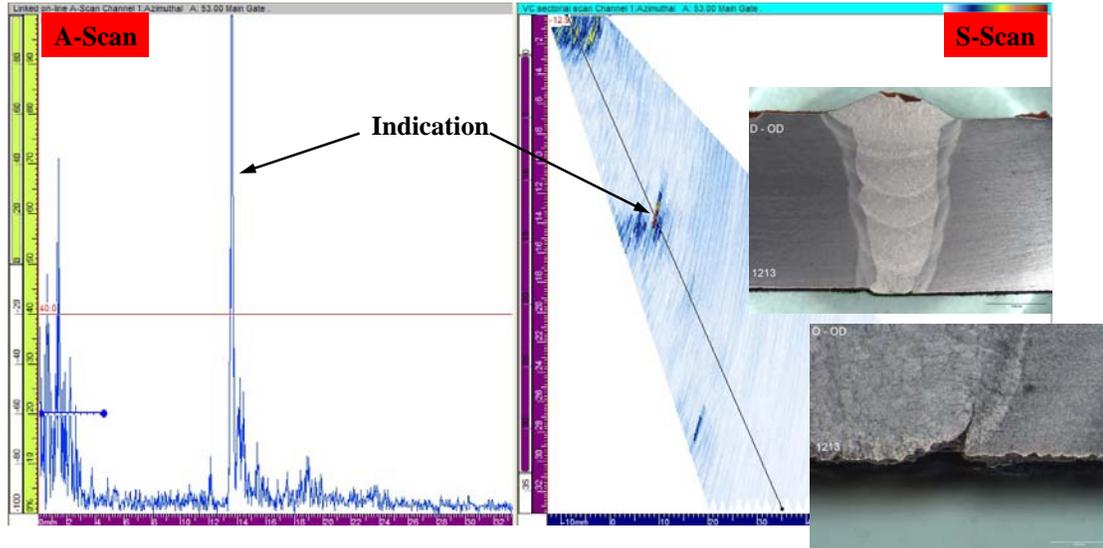
Location 1213 US – PA4 64/21, FD 20



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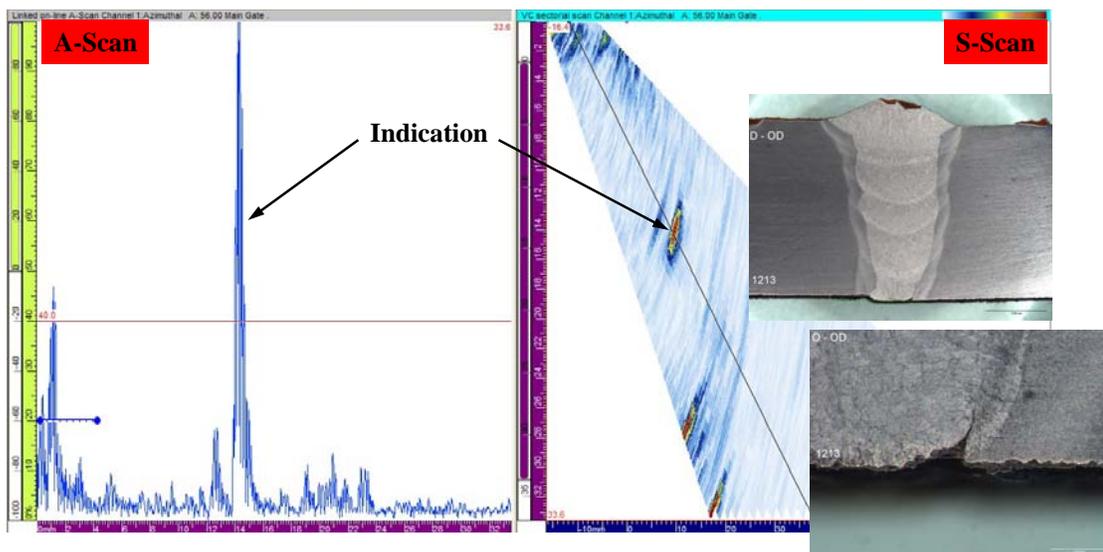
Location 1213 US – PA7 60/16, FD 20



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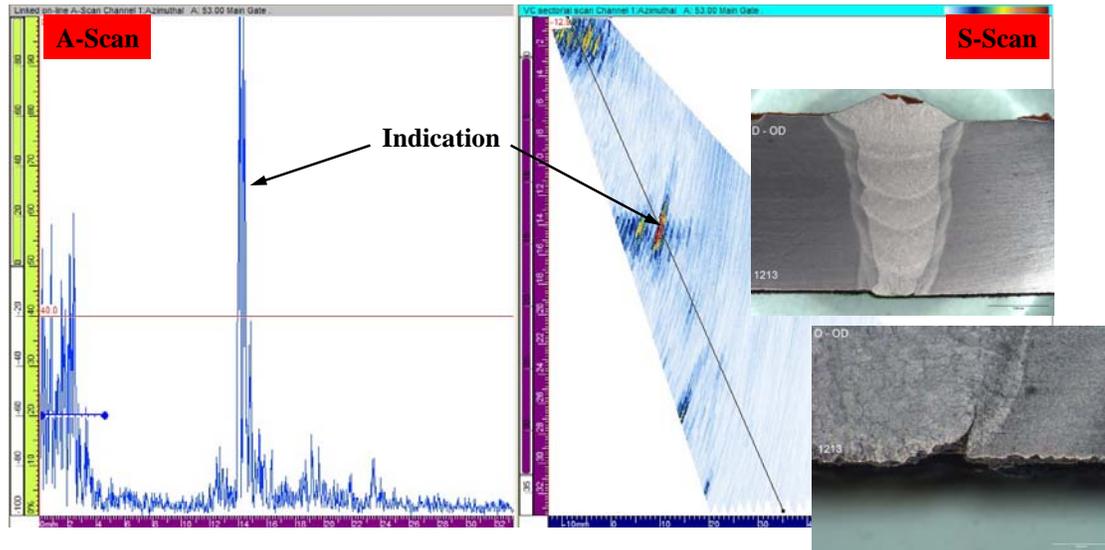
Location 1213 DS – PA4 64/21, FD 20



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Location 1213 DS – PA7 60/16, FD 20



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Questions?



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