Sonatest

Application Note Title: **Using the veo with the Phoenix Bracelet Scanner**

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Typical Application

The Pheonix Bracelet Scanner has been developed for inspecting welds on small bore tubes, as found in refineries. It Is particularly useful for situations where tubes are stacked close together providing little access between or behind them.

This Application Note provides guidance for using the Sonatest veo with the Bracelet Scanner. Specific operating instructions for the scanner are available from Phoenix.

This document should be used in conjunction with the specific NDT standards describing the inspection and evaluation of weld defects for boiler tubes.

Introduction

The Phoenix Bracelet Scanner supports special low profile array probes and wedges supplied by Olympus NDE and GE Sensing Technologies:

Olympus:

7.5CCEV35-16-8X10-A15-P-2.5OM	7.5MHz 16 element low profile array
10CCEV35-32-8X7-A15-P-2.5OM	10MHz 32 element low profile array
SA15-N60-IH	Wedge for either of the above arrays

GE:

115-000-861	10MHz 32 element low profile array 5mm elevation
115-000-683	10MHz 32 element low profile array 11mm elevation

Phoenix wedges supplied for above

Setting up the veo

The following setup files have been provided to allow the scanner to be setup with the veo. This application note refers to measurements taken with this setup, but similar results will be obtained using alternative arrays and wedges as available.

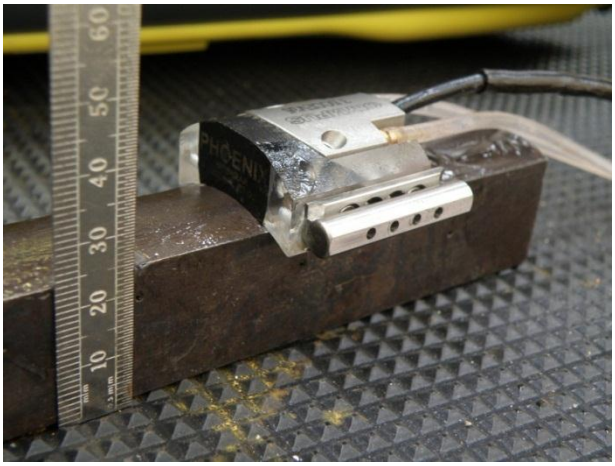
PHOENIX BRACELET ONDT.utcfg

This configuration file applies to the following setup: (full list of settings in Appendix A)

Array Probe	Olympus 7.5MHz 16 element array (7.5CCEV35-16-8X10-A15-P-2.5OM)
Scan type	Sectorial, constant depth.
Tube diameter	2.5” (60mm approx)
Tube thickness	4.5mm
Encoder Resolution	38clicks/mm
Weld preparation	Single V, 12mm weld cap, 1mm gap
Wedge offset from weld centre	9mm

Calibrating the inspection

Before you begin the inspection, a calibration can be performed on a standard boiler tube calibration block. Remove the probe and wedge from the scanner, as shown below. Note that test blocks are available with different radii to match the diameter of pipe to be inspected. Small side drilled holes are machined at depths of 1mm, 3mm, 5mm, 8mm and 10mm.



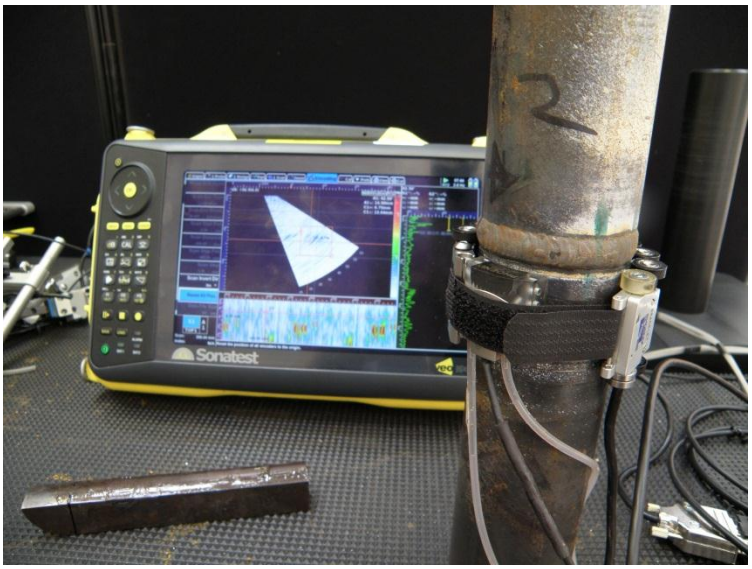
A velocity and probe zero calibration can be performed using this test block if desired, although bear in mind that an accurate velocity calibration must be done on the same material as the test piece. It may be more accurate to obtain a velocity for the test material, than to do a calibration on this small calibration block.

A wedge delay calibration can easily be performed on a single SDH, and is recommended.

A TCG calibration is not essential for a thin walled tube, although the SDH in this block provide for this. Refer to the relevant inspection procedure for guidance as required.

Setting up the scanner on the pipe

The Bracelet scanner can easily be setup on the pipe, ensure that the scanner wheels are just under the weld cap, and that the Velcro strap is pulled tight. It is important that the wedge profile is a good match for the tube diameter, otherwise extra coupling will be required in order to achieve good results. You may find that better results are achieved scanning in one direction or another, as the wedge may tend to lift off the part surface. Also pay attention to the encoder wheels, as these can slip if the Velcro strap is loose. Water irrigation is preferred, but coupling gel can be used.

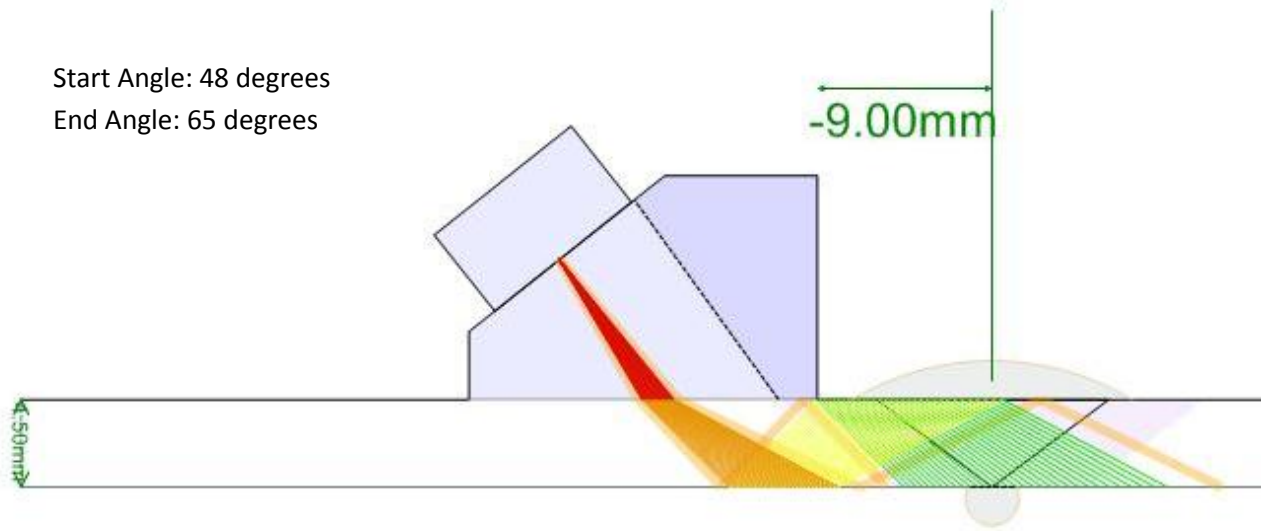


Measure the offset from the weld centre line to the front of the wedge, it is recommended that this is set to approximately 9mm. You can adjust the vertical position of the array on the scanner by slackening off the hex grub screw which clamps it in position.

Setting up the inspection for sectorial scan

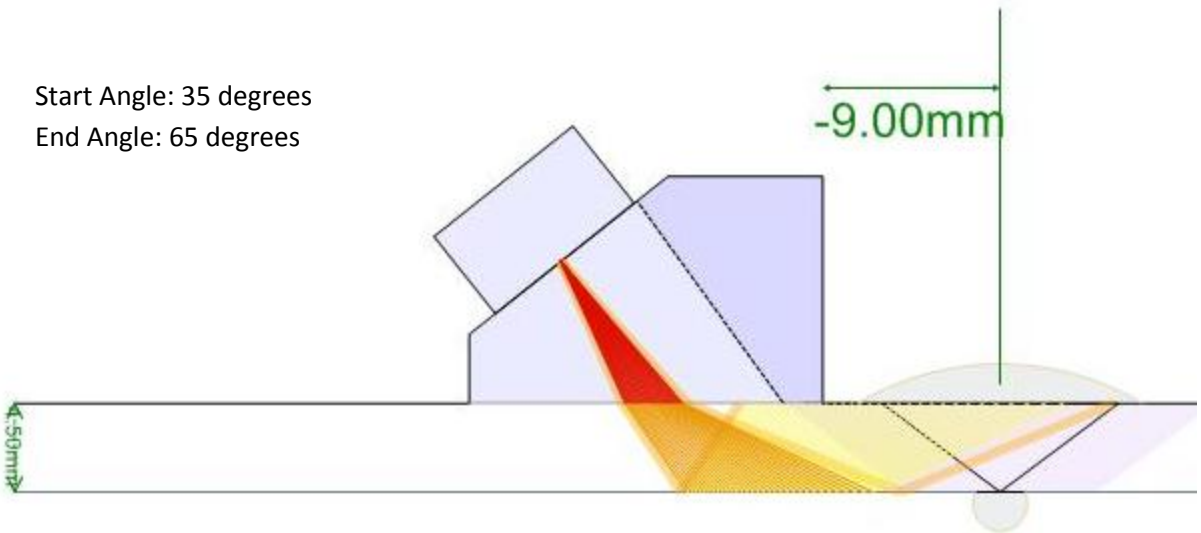
Below is a typical setup for the weld inspection. It should be noted that in the case of thin tube walls, the minimum sweep angle should be chosen with care to avoid reflections from the tube back wall back into the wedge. The veo will also limit the maximum sweep angle to around 60 degrees to prevent the beam from firing into the front of the wedge. Three or four skips will be required to obtain full coverage of the weld.

Start Angle: 48 degrees
End Angle: 65 degrees



If the start angle is set too low, then back wall reflections will enter the wedge, the beam setup does not cover the volume of the weld correctly and this could cause confusing results.

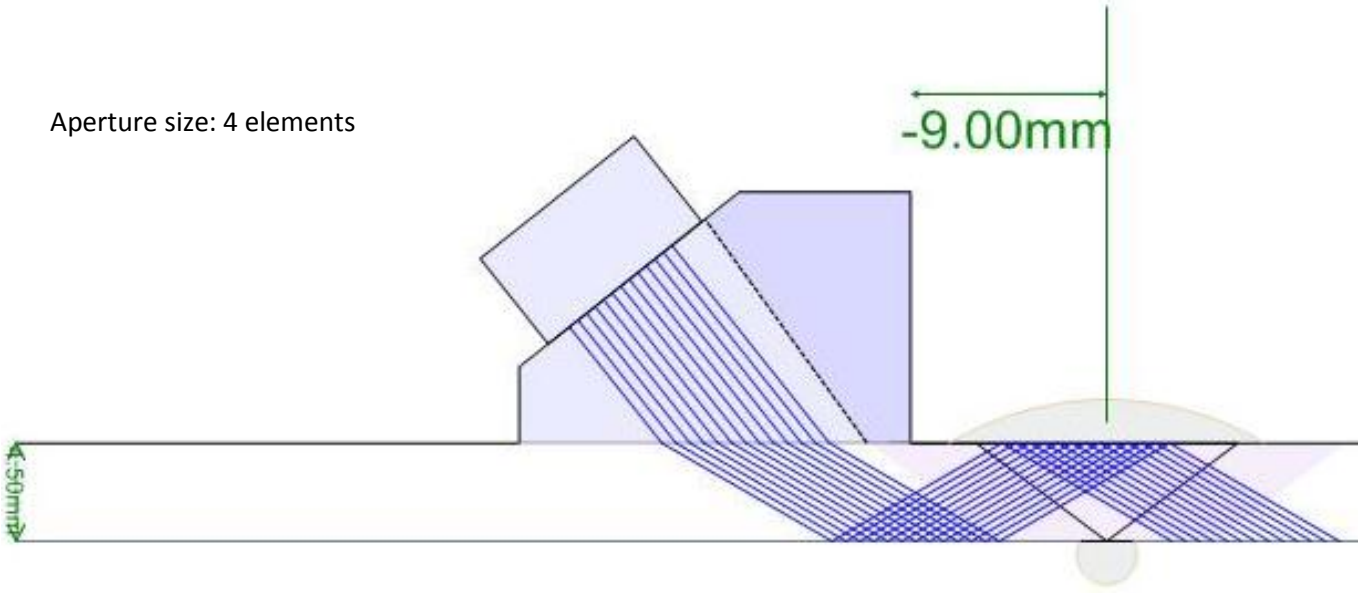
Start Angle: 35 degrees
End Angle: 65 degrees



Setting up the inspection for linear scan

For linear scanning, better results would be obtained with the 32 element probes that are available with this scanner. However due to the small size of the arrays, it is not possible to cover the entire volume of the weld on even quite a thin tube using this method. Linear scanning for this inspection is not recommended.

Aperture size: 4 elements

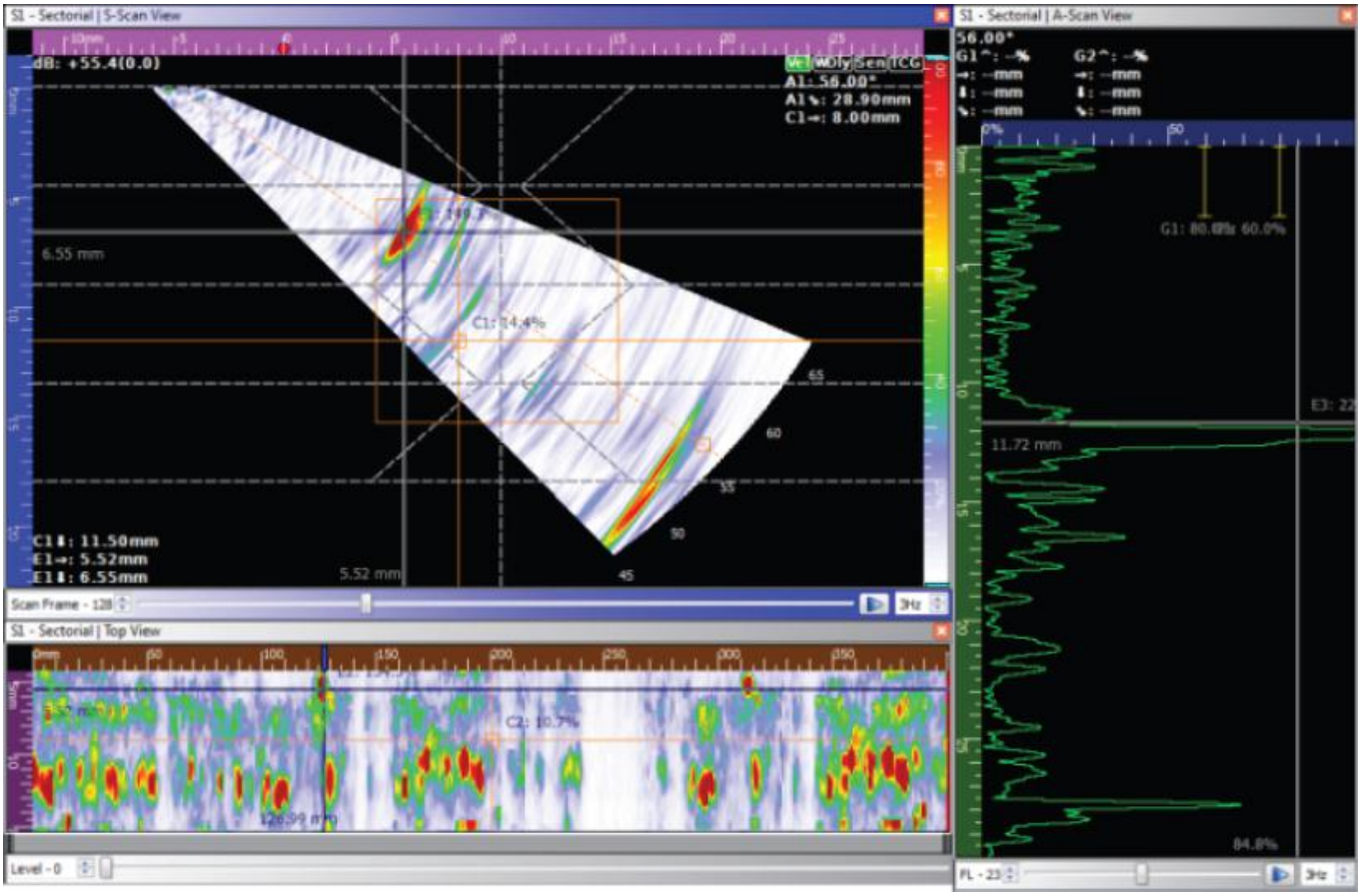


Settings files available

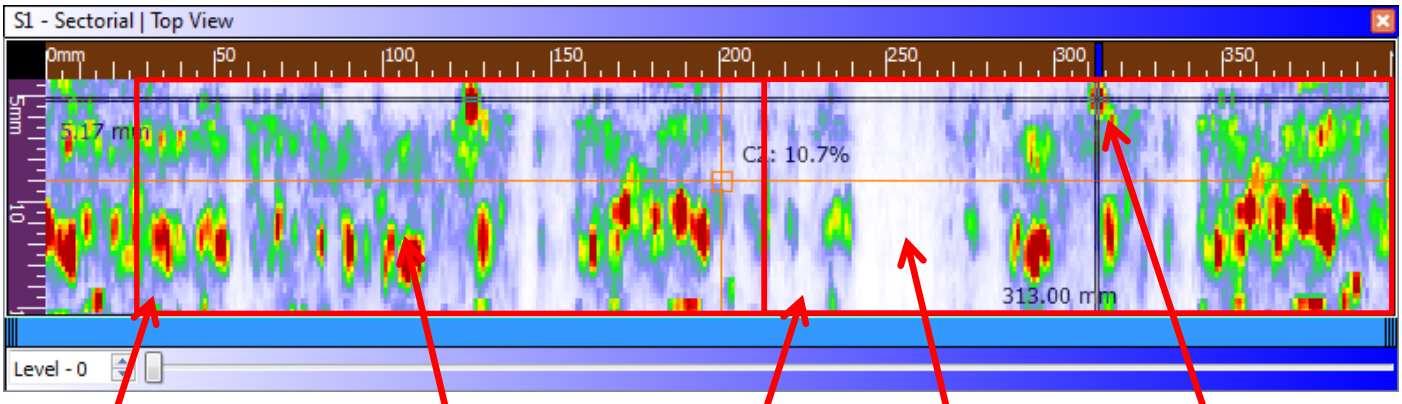
Phoenix Bracelet ONDT.utcfg	Settings file used in this Application Note
GEIT 115-000-683	Probe definition file
GEUT 115-000-861	Probe definition file
Olympus 7.5CCEV35-16-8X10-A15-P-2.5OM	Probe definition file
Olympus 10CCEV35-32-8X7-A15-P-2.5-OM	Probe definition file
SA15-N60S-IH	Wedge definition file for Olympus / GE Probes all radii.

Typical results

A number of scans were performed on example tubes with unknown weld defects, results are presented below. The scan length was set to 400mm, in order to scan around the pipe twice to observe repeatability of data and consistency of coupling. In the example below, there is a large amount of weld root noise possibly from an uneven weld root profile, and a fusion face defect under the Cartesian cursor at 125mm and again repeated at 315mm.



White areas in the Top view are a result of inconsistent coupling around the back of the tube where access is more difficult.



Pass 1 | Weld root noise | Pass 2 | Loss of coupling | Fusion face defect

Appendix A – Instrument Settings

Software: 3.1.35 R1, Unit serial #: I005403

Scan S1 - Sectorial					
Type	Sectorial PE	Wave Mode	SW Velocity	First Elmt RX	1
Gain , Ref	56.9 dB, 0.0 dB	Travel Mode	Half Path	Last Elmt RX	16
Focalisation	Constant Path	PRF	3000 Hz	Beam Qty.	71
Focal Dist	10.00 mm	Sub-Sampling	1:1	Sample Qty.	1856
Resolution	0.50°	Smoothing	Yes	Path Res.	61.9 spl/mm
Start Angle	25.00°	Filter	5.0 MHz	Wedge Delay Cal Status	None
Stop Angle	60.00°	Signal Rectification	Full	Sensitivity Cal Status	None
Start Path	0.00 mm	Probe TX/RX	P1 - Phased-Array 1D	TCG Cal Status	None
Range Path	30.00 mm	Probe RX	P1 - Phased-Array 1D	Velocity Cal	Perfect
Stop Path	30.00 mm	First Elmt TX	1		
Delay	0.00 µs	Last Elmt TX	16		

Geometry					
W1 Index Off.	-9.50 mm	W1 Rotation	90.0°	Encoder Area CL Offset	0.00 mm
W1 Scan Off.	0.00 mm	Encoder Area CL Pos	0.00 mm	Encoder Area Rotation	0.00°

Encoder parameters					
Encoding Setup	Scan Axis Only	Scan Enc Resol.	38.000 ticks/mm	Scan Step	1.00 mm
Enc. Name	N/A	Scan Start Pos	0.00 mm	Scan Invert Dir	No
Scan Axis Name	N/A	Scan Distance	400.00 mm	Data File Size	100 MB
Scan Enc Type	Quadrature	Scan Stop Pos	400.00 mm	Max Phys. Enc. Speed	42.3 mm/s

S1 S-Scan	BPL	Depth	SD	Angle	Beam	Peak
Angular 1 (A1)	18.98 mm	12.94 mm	8.15 mm	47.00°	45	13.6%
Cartesian 1 (C1)	18.75 mm	13.64 mm	6.75 mm	---	---	10.4%
SQ1[Top, Left]	---	9.00 mm	4.00 mm	---	---	---
SQ1[Bot, Right]	---	17.83 mm	13.55 mm	---	---	---

Inspection					
Probe Qty	1	Alarms	Off	Qualification	None
Scan Qty	1	Encoded Axis Ref.	Wedge Reference	Procedure Ref	N/A
Voltage Phased Ar.	100 V	Job/Customer	N/A	Couplant	N/A
Acq. Freq.	100 MHz	Site	N/A	Trigger	Encoder
Max Frame Rate	20.0 Hz	Operator	N/A		

Probe P1 - Phased-Array 1D					
Type	Phased-Array 1D	Pulse Width	66.67 ns	Elmt Size Dim 2	10.00 mm
Manufacturer	Olympus	Nb Elmt Dim 1	16	Elmt Offset Dim 2	3.00 mm
Model #	7.5CCEV35-16-8X10-A15-P-2.5OM	Elmt Pitch Dim 1	0.50 mm	Element Layout	Bottom Left Row
Serial #	N/A	Elmt Size Dim 1	0.40 mm		
Frequency	7.50 MHz	Elmt Offset Dim 1	2.00 mm		

Wedge P1 - Phased-Array 1D					
Type	Angular	Back Height	3.52 mm	Roof Angle	0.00°
Manufacturer	Olympus	Front Height	11.51 mm	Probe Back Dist	1.84 mm
Model #	SA15-N60S-IH	Width	16.00 mm	Probe Side Dist	0.00 mm
Serial #	N/A	Length	17.00 mm	Probe Inset	0.00 mm
Contact Surface	Planar	Cut Angle	38.50°	Wedge Velocity LW	2.330 mm/µs

Part					
Material	Steel	Velocity SW	3.240 mm/µs	Weld Face Left	0.08 mm
Component	N/A	Cal. Block Serial #	N/A	Weld Top Left Width	6.00 mm
Serial #	N/A	Velocity SW	3.240 mm/µs	Weld Top Left Angle	48.50°
Location Ref	N/A	Weld	SingleV	Weld Top Left Height	4.42 mm
Thickness	4.50 mm	Weld Root Gap	2.00 mm		
Velocity LW	5.890 mm/µs	Weld Top Bevel Width	12.00 mm		