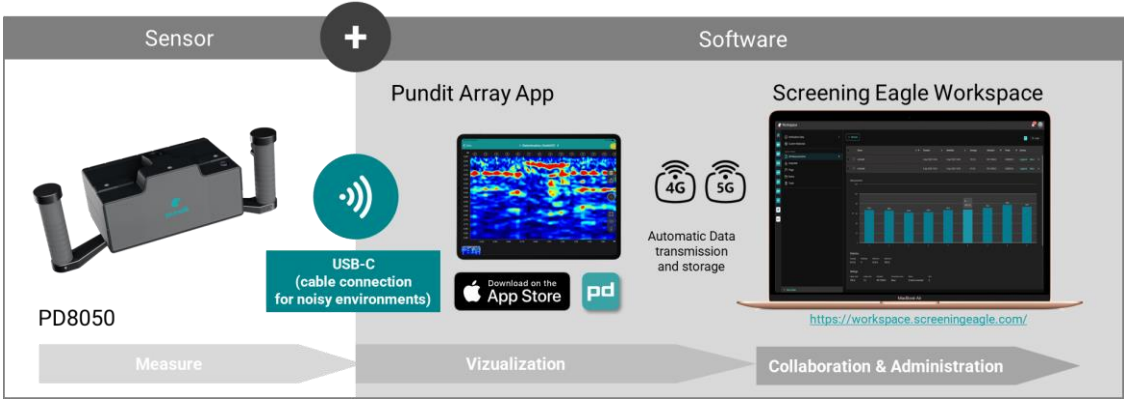
Pundit

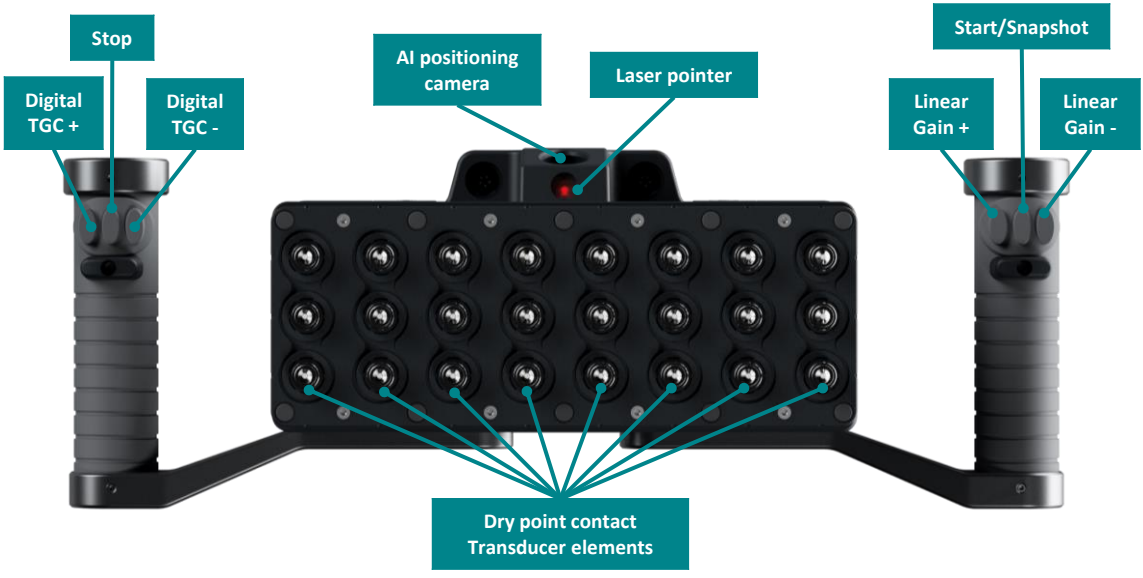
PD8050

Quick Reference

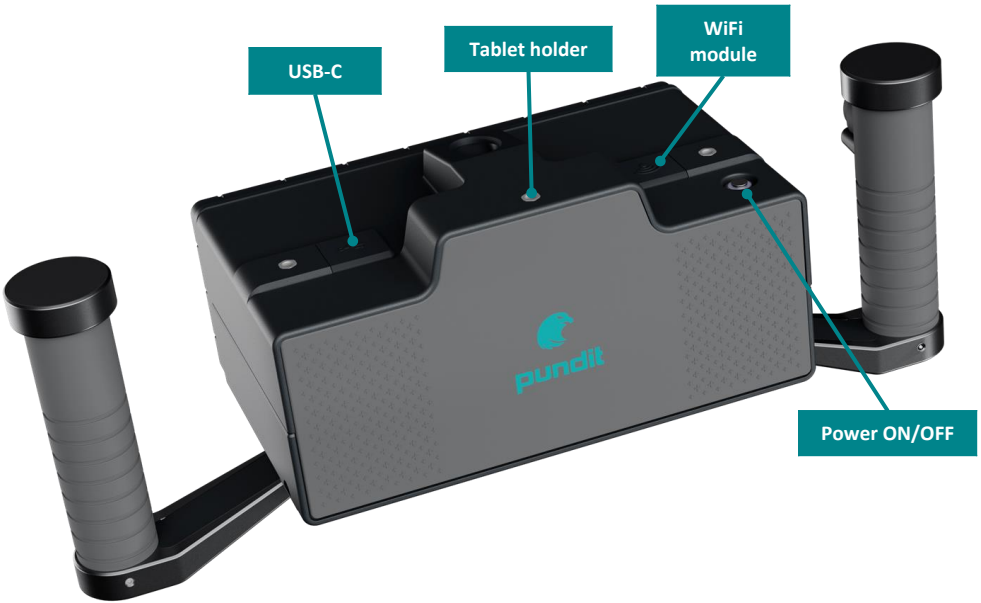
PD8050 System



Instrument Overview



Instrument Overview



Modularity

Single handle

8 channel

16 channel

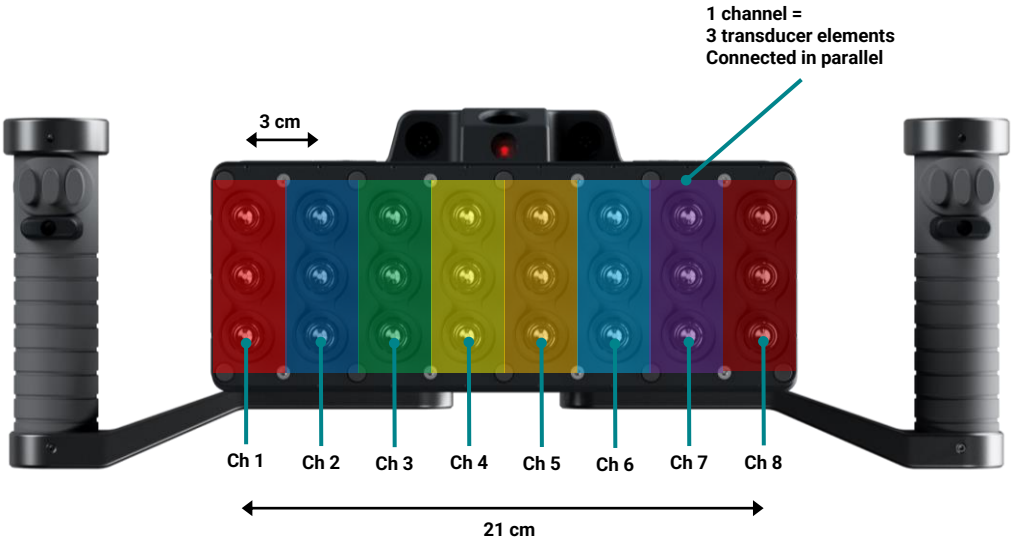
79330235

UTH100 Universal tablet holder for Pundit PD

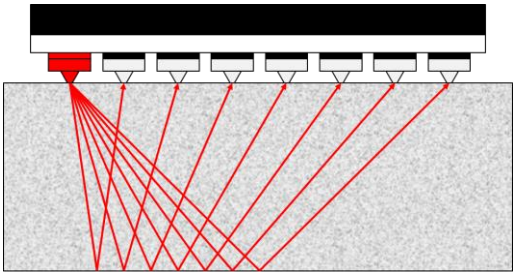
79330345

UHA100 Universal tablet holder with chest harness
Can also be used as an iPad stand

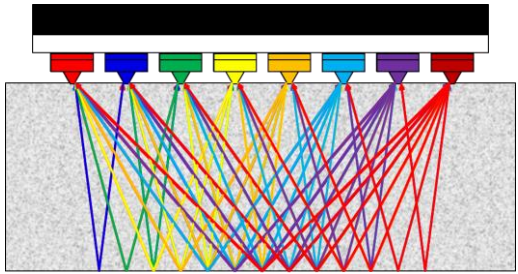
Technology - 8 channels



Technology - Operating principle



One channel transmits
The signal is received on the other 7 channels



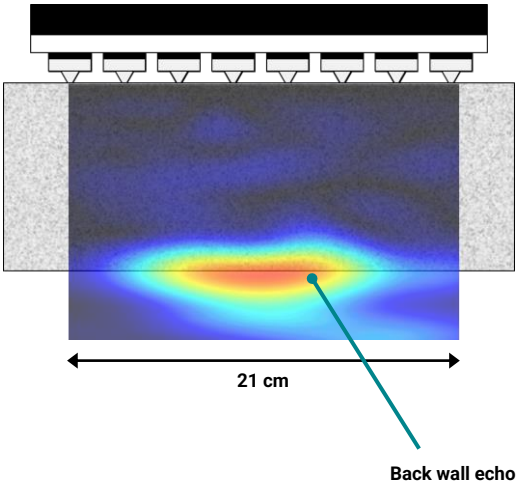
Each channel transmits in turn

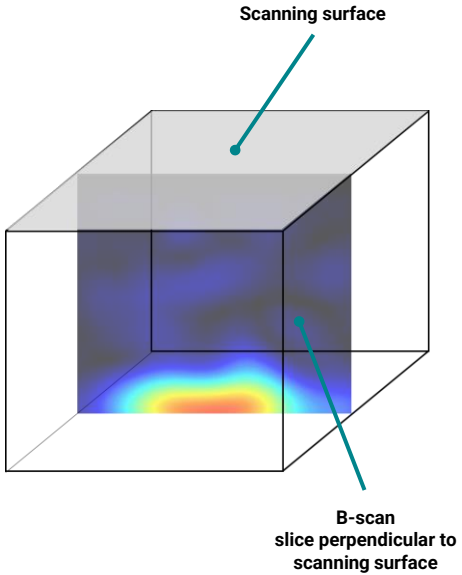
A complete cycle is completed in ms

The individual signals are used to create a B-scan image in real time

Technology - B-scan

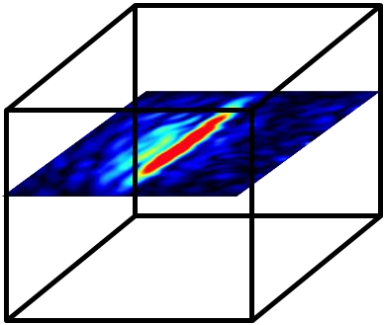
Real time imaging



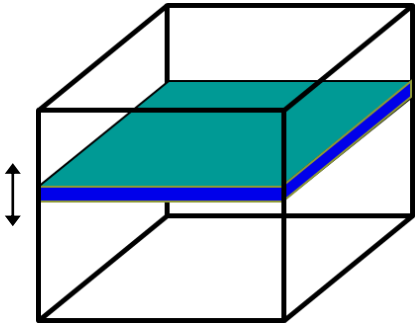


Technology - C-scan or Time Slice

Real time imaging



A time slice or C-scan shows the amplitude of the signal at a chosen depth



We can adjust the thickness of the slice and move it to any depth

Tips on structural assessment.

Structural assessment with the PD8050 is typically done for the following cases:-

1. Thickness measurement – e.g. tunnel lining thickness
2. Concrete quality assessment by means of ultrasonic pulse velocity measurements
3. Verification of the presence or absence of structural defects, in particular voids, delaminations and honeycombs.
4. Verification of the presence or absence of voids inside tendon ducts.

In all cases a good starting point is the recommended measurement settings

Case 1 – It is important to know the expected thickness of the tunnel and select the appropriate depth of field. This will usually be the intermediate range. Because of the large amount of reinforcement used in tunnels, it is typically not advisable to use the near field setting as this has a reduced transmission voltage.

Case 2 – In this case it is necessary to know the thickness of the element being tested and to set the appropriate depth of field.

Case 3 – For this investigation it is necessary to find out as much information as possible on the suspected default. Are there drawings of the structure available? How thick is the structure? What kind of defect is suspected? (e.g. a void caused by concrete not flowing freely due to dense reinforcement). Is the approximate depth of the suspected defect known? Have any destructive tests been carried out to confirm the presence of a defect? Once this is known, the starting point is to try and locate a position on the structure where there is a back wall echo clearly visible and then to compare this with the images taken at the suspected defect locations.

Case 4 – This technique involves locating the tendon duct with a GPR instrument and then carrying out a full 3D matrix scan along the duct to look for variations in amplitude which indicates the likely presence of voids. There are a number of guidelines available on this technique that the user is advised to consult for further information.

Other than case 4, the best way to proceed is to try and detect a clean back wall image at some point on the structure.

Tips on obtaining a good back wall image.

- Perform a provisional investigation. Without saving any data, move the sensor around the surface to try to locate a back wall echo.

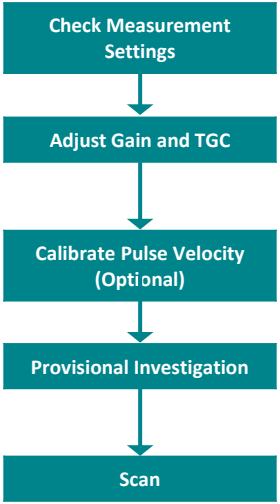
If no back wall is immediately visible, try the following:-

- Try rotating the probe diagonally to reduce the influence of reinforcement.
- Try increasing the linear gain and digital TGC if no back wall echo is immediately visible.
  (Note: in order to do this the auto gain function must be switched off.)
- If this fails, try increasing the analog gain and TGC.
- If this still does not work, then it may be necessary to use a lower frequency, either by setting the depth of field to far field, or by manually adjusting,

Reasons why a back wall image may not be visible:

- Coating on the surface with de-bonding to the concrete. Typically results in a totally red reflection from the top of the scan.
- Near to surface defect. Typically results in a totally red reflection from near the top of the scan.
- The element is too thick. Typically, the scan will be completely blue if there are no objects present.
- There is too much reinforcement or poor concrete quality causes too much attenuation.
- There are voids or honeycombs in the path. Typically, the objects will be visible as significant red, orange, yellow echoes.
- There are delaminations not visible due to destructive interference which block the path to the back wall. This occurs when the delaminations or voids have very rough surfaces which scatter the reflections. The scan may appear totally blue in this case, even though there may be large defects visible. This has been known to occur in steel fibre reinforced concrete and verified by destructive testing.

Recommended Workflow



Recommend Measurement Settings

Initial settings recommended to give a reasonable image on concrete without the need to calibrate the pulse velocity on the test object.

Measuring Presets		Variation
Measuring mode	Line scan	Full matrix 3D for 3D imaging Grid scan for large area heat maps
Depth of field	Intermediate field	Near field for objects < 30 cm thick Far field for objects > 1m thick
A.I. Positioning	Off	ON (Requires AI measurement tape)
X-spacing	21	
Image Stabilizer	1	
Units	Metric or Imperial depending on region	

Advanced Measuring Presets		Variation
Half Cycle	Off	
Analog Gain	36 dB	
Analog TGC	0 dB	10 dB for objects thick objects (ca. 1m)
Pulse Delay	8 ms	

Recommend Measurement Settings

Initial settings recommended to give a reasonable image on concrete without the need to calibrate the pulse velocity on the test object.

Image Processing	
Auto Gain	ON
Global Pulse Velocity	2600
Ascan	Signal and Envelope

Variation
If auto gain is off, then set Linear Gain and Digital TGC to default values (0, 0)

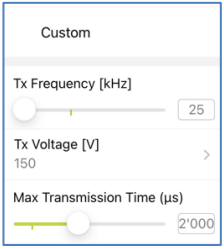
Advanced Image Processing	
Surface Wave Cancellation	OFF
Raw Data Offset (µs)	-30

Variation
Removes noise caused by surface waves
Only change this if it can be calibrated with 1st and 2nd back wall echoes

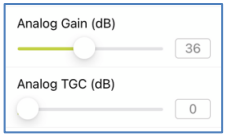
Depth of Field – Custom Settings

If desired the depth of field settings can be individually adjusted

Settings	
Tx Frequency (kHZ)	Low frequency – reduces resolution close to surface, increases penetration depth High frequency – increased resolution close to surface, decreases penetration depth
Tx Voltage (V)	Adjust transmission signal strength (Note! – On adjusting the voltage there is a short delay until it reaches the new voltage level)
Max Transmission Time (µs)	Adjusts the maximum transmission range



Analog Gain and TGC

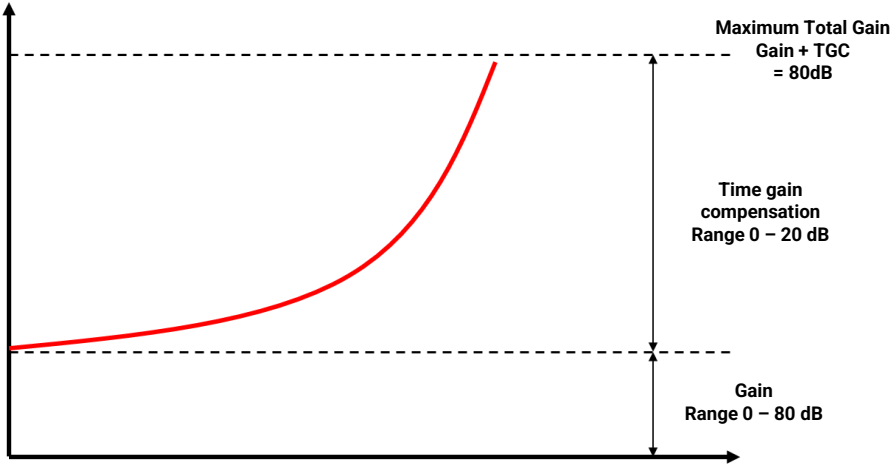


For most test objects it is recommended to leave the Analog Gain and TGC at the default values and to use the digital gain and TGC in Image Processing to obtain a good image.

TIP – double tap on the slider to reset to the defaults (36, 0)

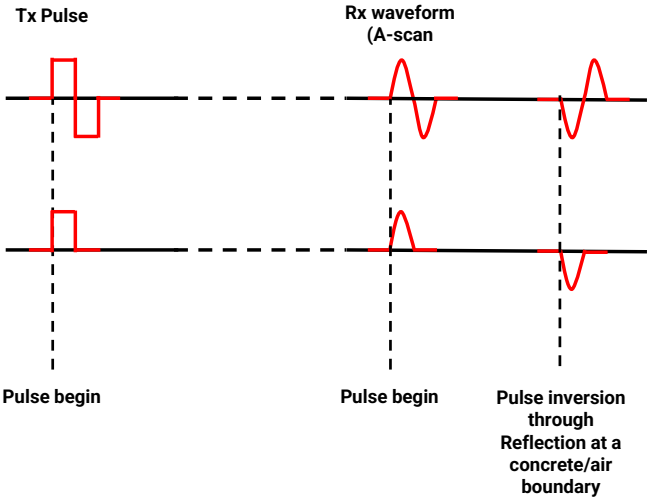
However, particularly for deep objects it may be desirable to increase the analog gain and TGC. In total there is 80 dB of gain available.

NOTE! If analogue gain and TGC are adjusted, remember to reset to the default values on completion of the test.



Advanced Settings – Half Cycle

Can help to distinguish near surface objects that are close to each other.



Advanced Settings – Image Stabilizer

Used to reduce flicker on the real time B-scan image

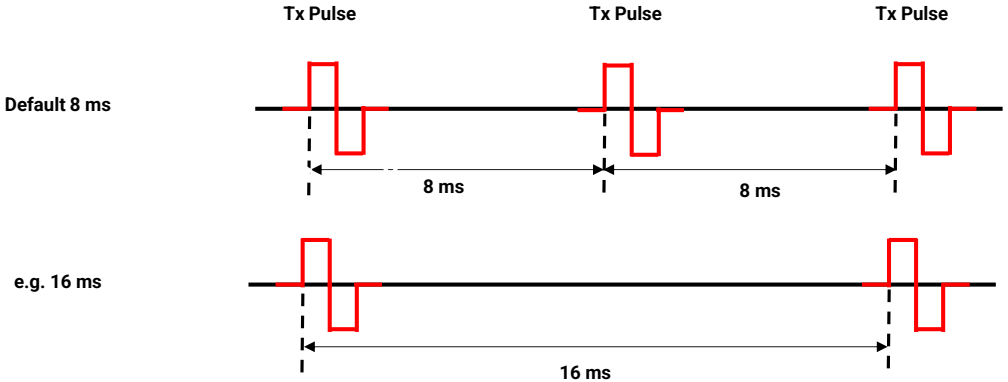
The image displayed on screen is a combination of the latest real-time image data combined with a percentage of the previous image data. The percentage is determined by the slider.

Slider set to 1 = no stabilization – Image presentation is immediate but it flickers

Slider set to 8 = maximum stabilization – Image takes longer to build up, but there is no flicker

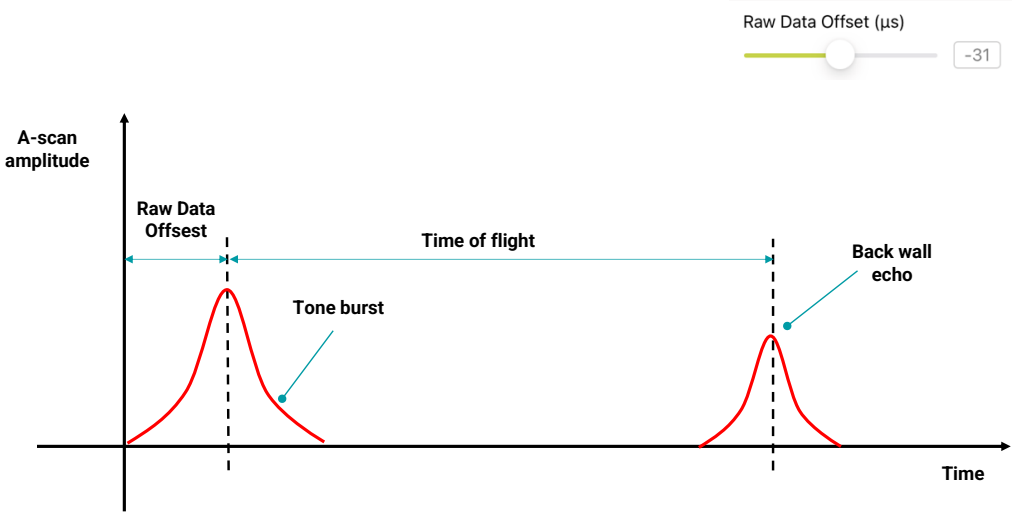
Advanced Settings – Pulse Delay

Introduces a delay between transmission pulses.
Functionality used for research.



Advanced Settings – Raw Data Offset

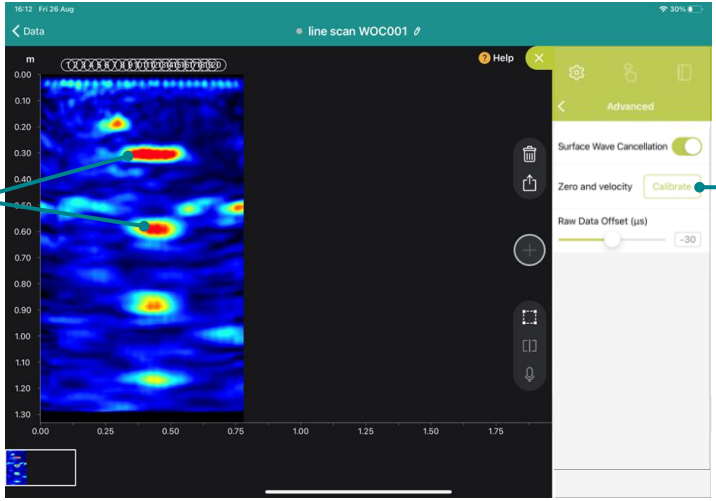
Used for accurate depth estimations



Pulse Velocity Calibration – 1st and 2nd Back Wall Echo

This method provides the most accurate depth information. It requires two clear back wall echoes and must be carried out at a location of known depth

1st and 2nd back wall echoes are required for the calibration

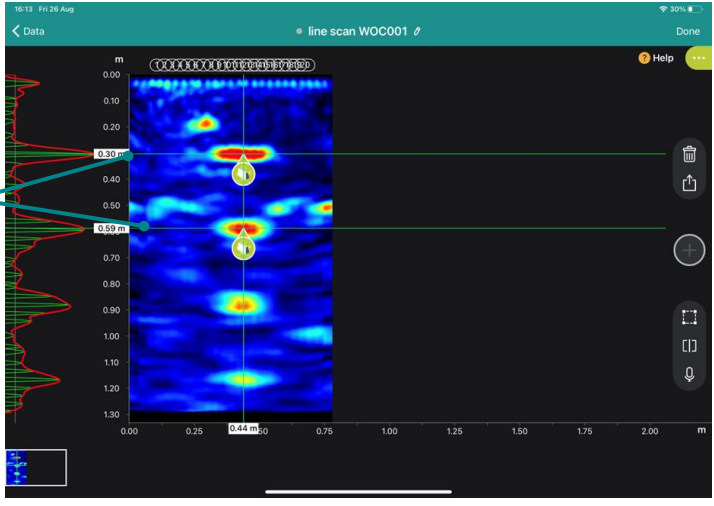


Calibrates both raw data offset and global pulse velocity

Pulse Velocity Calibration – 1st and 2nd Back Wall Echo

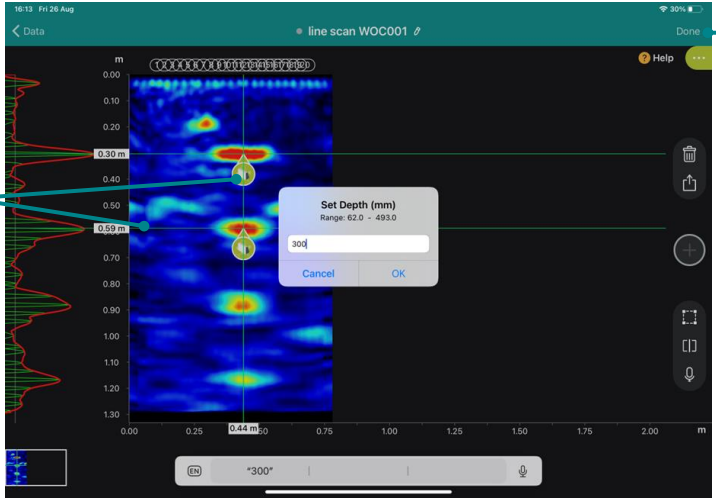
Swipe in from the left with one finger to show the A-scan

Align the cursors to the peaks of the 1st and 2nd back wall echoes



Pulse Velocity Calibration – 1st and 2nd Back Wall Echo

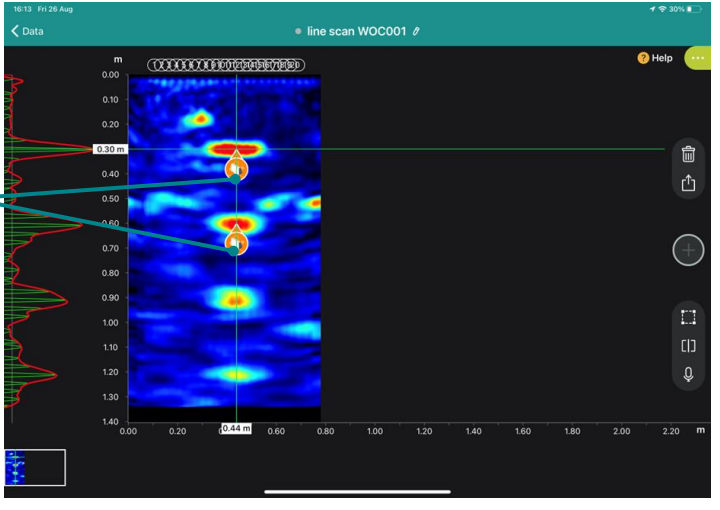
Tap on the 1st back wall echo tag to enter the known depth of the test object



Tap on “Done” to complete the calibration

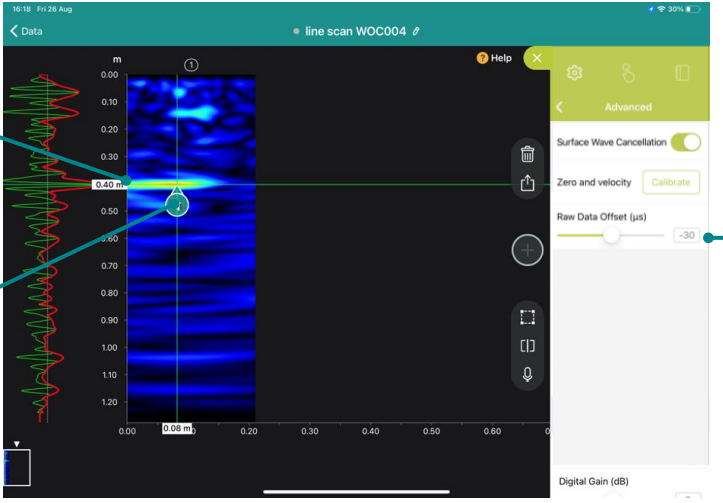
Pulse Velocity Calibration – 1st and 2nd Back Wall Echo

Orange colour indicates that the tag is being used to calibrate the pulse velocity

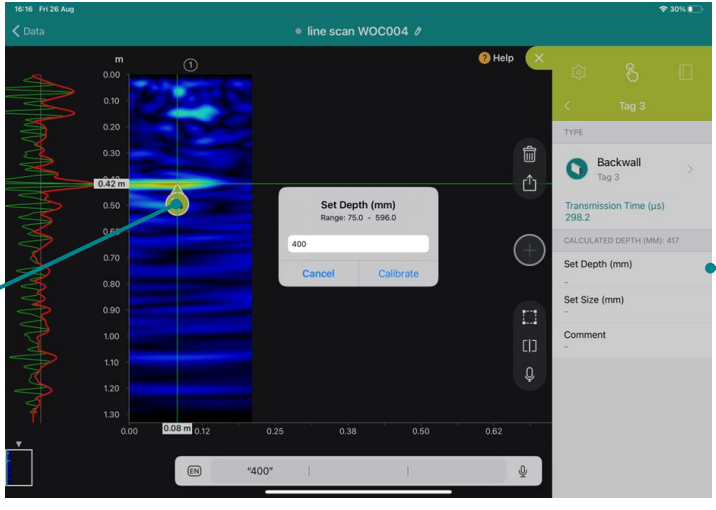


Pulse Velocity Calibration – Only One Back Wall Echo

A 2nd back wall echo is not always available. If only one back wall echo is available, then this method is recommended.



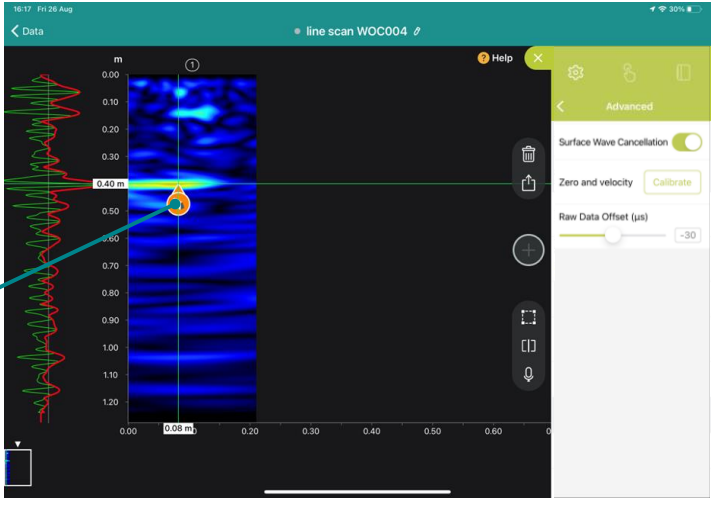
Pulse Velocity Calibration – Only One Back Wall Echo



Tap on the tag to open the information panel

Tap on “Set depth” to enter the known depth, which calibrates the global pulse velocity

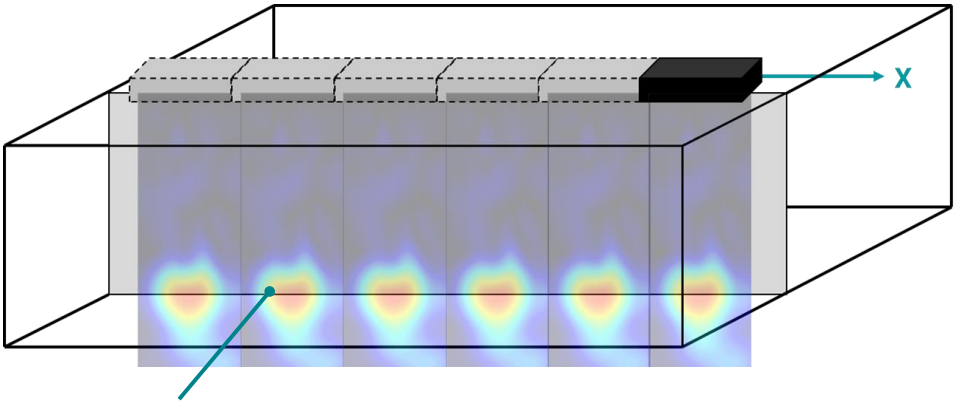
Pulse Velocity Calibration – Only One Back Wall Echo



Orange colour indicates that the tag is being used to calibrate the pulse velocity

Workflow - Line Scan – Data Collection

Scan parallel to the long axis of the sensor. Combine B-scans with or without an overlap to create a line scan.

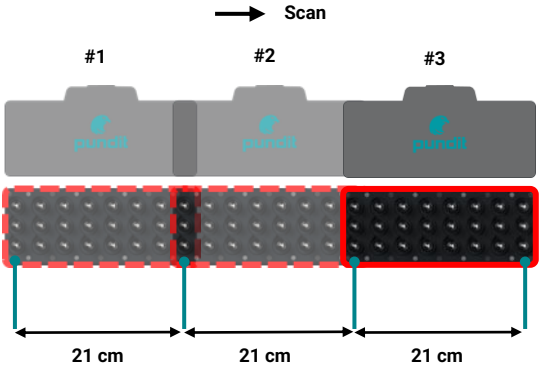


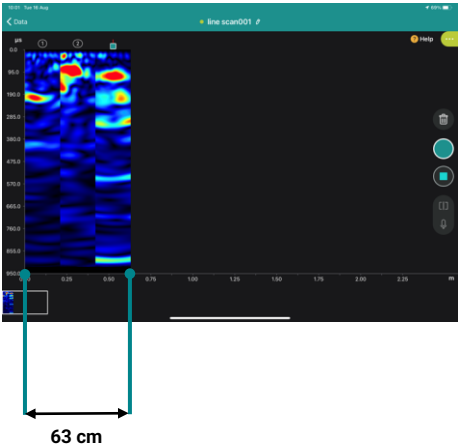
Analog gain and TGC can only be adjusted before saving the first B-scan
After that the controls are blocked

Digital gain and TGC can be adjusted at any time and also on the completed scan

Workflow – Line Scan – Default Spacing

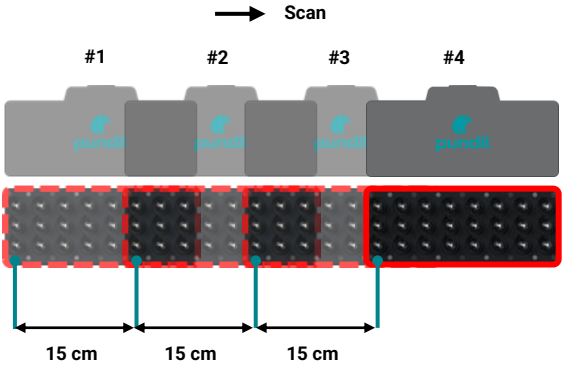
Unless AI positioning is being used, it is necessary to set the X spacing, i.e. how far you wish to move the sensor between snapshots.

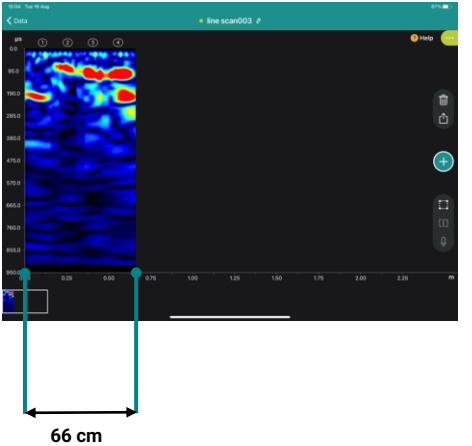


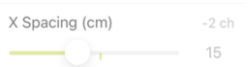


Workflow – Line Scan – X Spacing Overlap

Smoother images can be achieved by overlapping B-scans. In this case it is necessary to set the number of channels you wish to overlap.

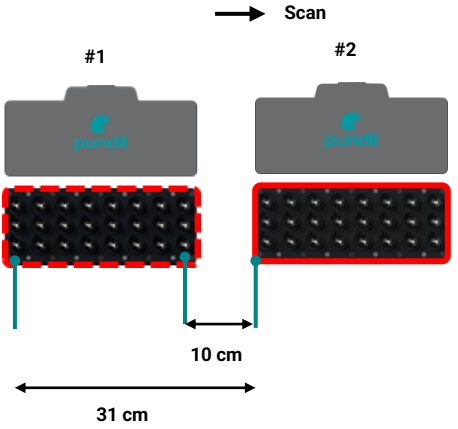


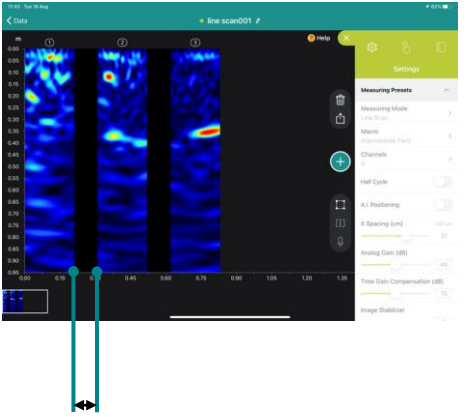


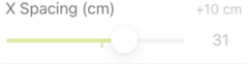


Workflow – Line Scan – X Spacing > 21 cm

For quicker scans over greater distances it is possible to leave a gap between B-scans. Particularly useful when scanning over large distances when looking for larger defects.

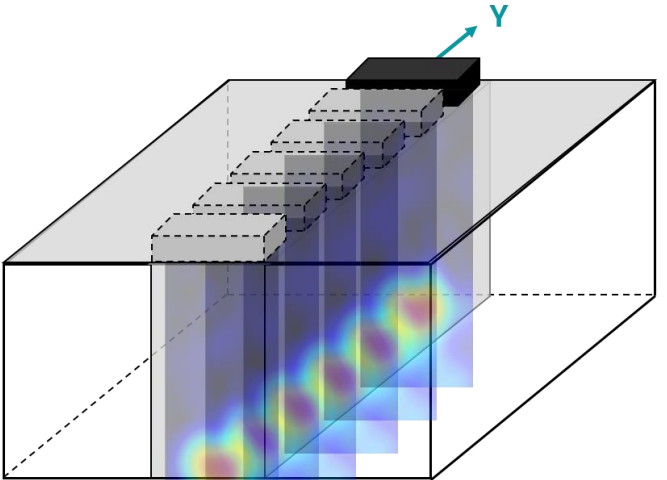






Workflow – Full 3D Matrix – Data Collection

Scan parallel to the short axis of the sensor.

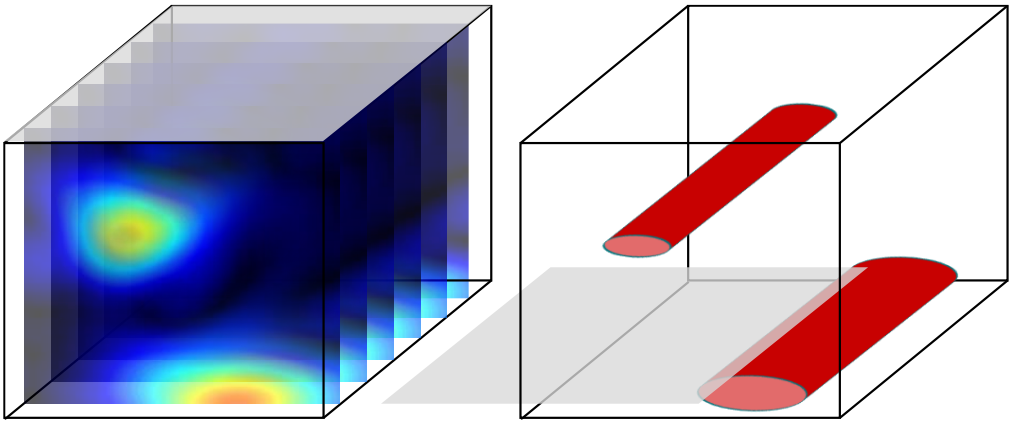


Analog gain and TGC can only be adjusted before saving the first B-scan
After that the controls are blocked

Digital gain and TGC can be adjusted at any time and also on the completed scan

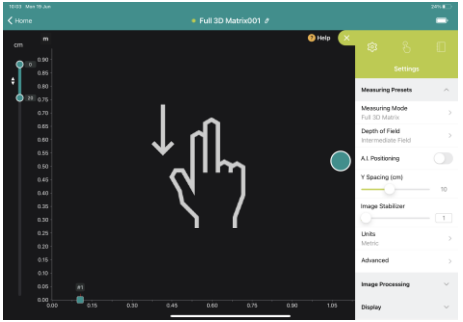
Workflow – Full 3D Matrix – Image Creation

B-scans are interpolated to create 3D images up to 1.5m in length.



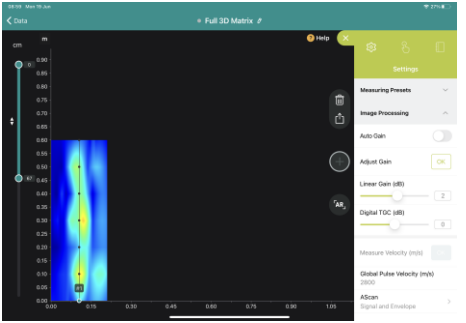
Workflow – Full 3D Matrix – First Snapshot

Gain and TGC can be adjusted before the first snapshot is taken. Switch to the B-scan view to adjust the transmission parameters as required before commencing with the scan.



Time Slice View

Swipe down with two fingers to view B-scan



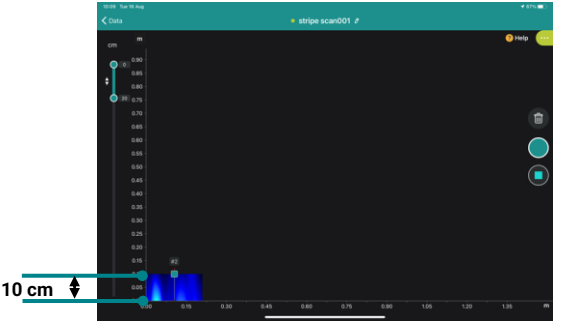
B-scan View

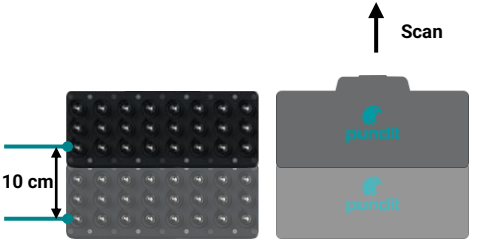
Adjust gain and TGC

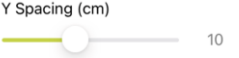
Swipe down with two fingers to revert to time slice view

Workflow – Full 3D Matrix– 2nd Snapshot

Unless AI positioning is being used, it is necessary to set the Y spacing, i.e. how far you wish to move the sensor between snapshots.

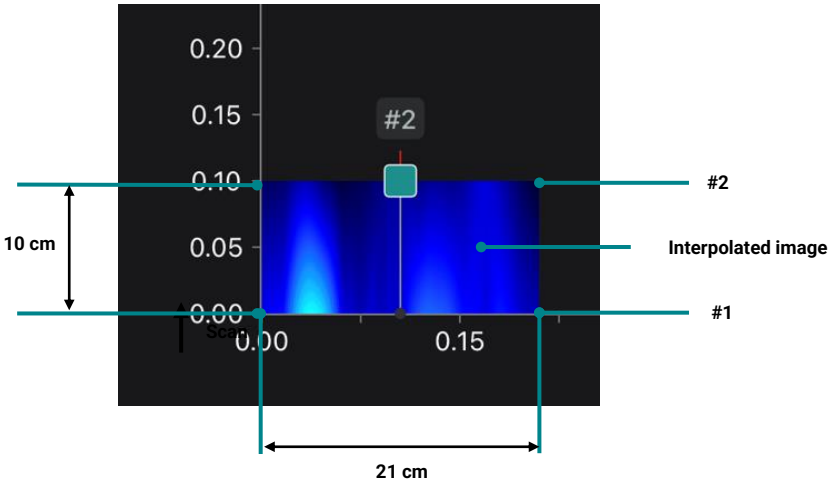






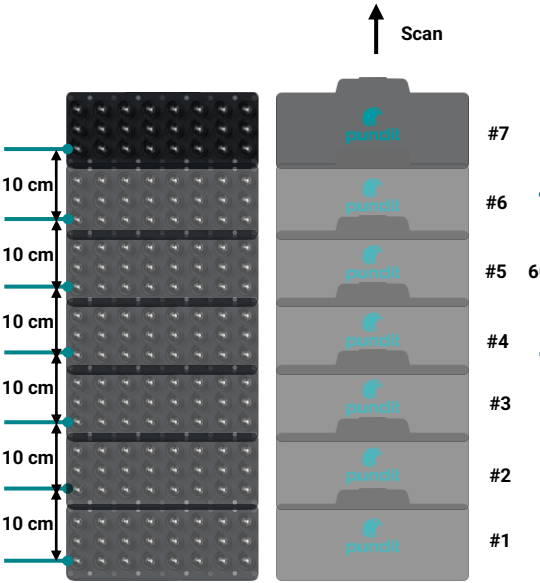
Workflow – Time Slice View - Detail

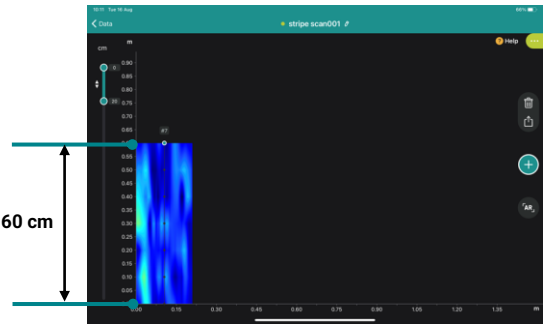
Unless AI positioning is being used, it is necessary to set the Y spacing, i.e. how far you wish to move the sensor between snapshots.



Workflow – Full 3D Matrix– 2nd Snapshot

The maximum length of a Full 3D Matrix scan is 1.5m.



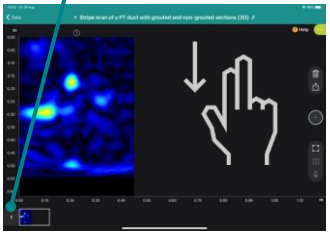


Y Spacing (cm)

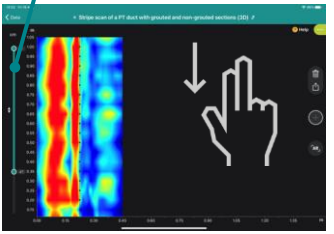
10

Workflow – Full 3D Matrix – Review Mode

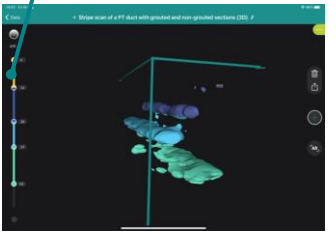
Tap to select B-scan



Slider sets slice thickness for both Time Slice View and 3D View



Slider sets break points for colour layers



B-scan View

Swipe down with two fingers to view Time Slice

Time Slice View

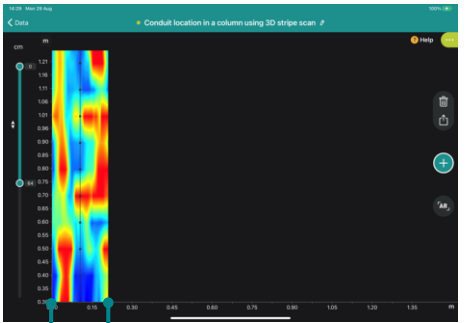
Swipe down with two fingers to view 3D

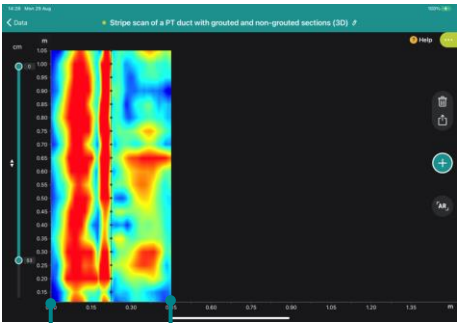
3D View

Swipe down with two fingers to view B-scan

Workflow – Full 3D Matrix – 8 channel / 16 channel

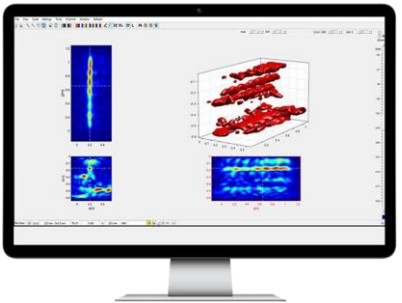
Multiple 3D Matrix scans can be combined to create larger volume scans using the optional Pundit Vision Software.





Workflow – Post-processing and Analytics Software

Advanced visualization and analysis of ultrasonic pulse-echo data.



Pundit Vision

Phase evaluation

Obtain more information about material composition based on phase evaluation

Combine your data

By combining 3D Matrix scans or line scans you can create larger volume 3D images.

Combine orthogonal 3D scans for maximum information

Workflow – AI Positioning

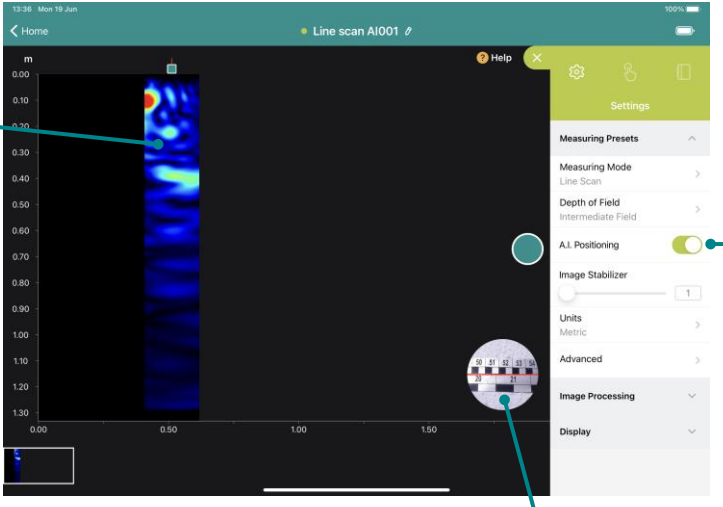
Enables faster and more precise data acquisition.

- **Can be used both with Line scan and Full 3D Matrix scan**
- **Up to 10 tapes can be connected in series for longer line scans up to 15 m.**

AI positioning tape accessory
32730418S
(Set of 10x 1.5 m tapes)

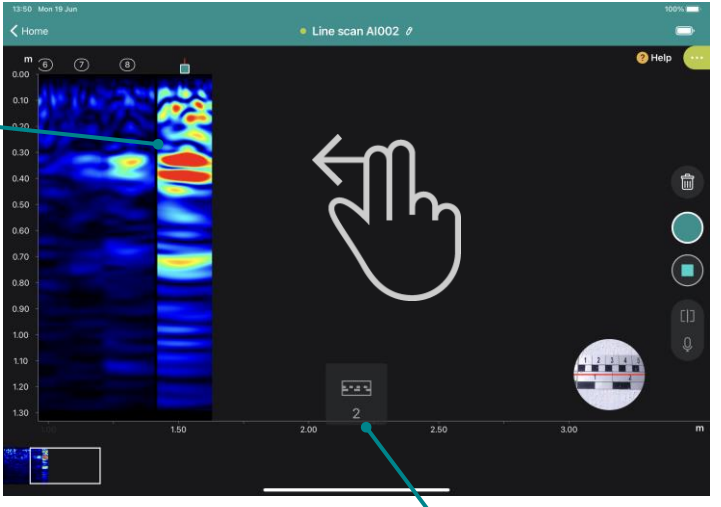
Workflow – AI Positioning

Faster scans – does not require constant spacing or careful placement of the sensor. As long as the tape is visible in the camera window, the B-scan will be placed in the correct position.



Workflow – AI Positioning – Multiple Tapes

When working with multiple tapes it is necessary to inform the system which tape is being used.
E.g. Swipe left with two fingers to move to the next tape

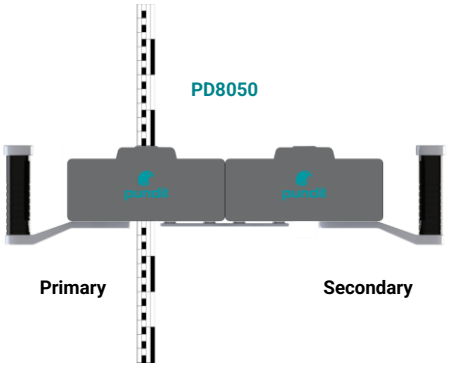


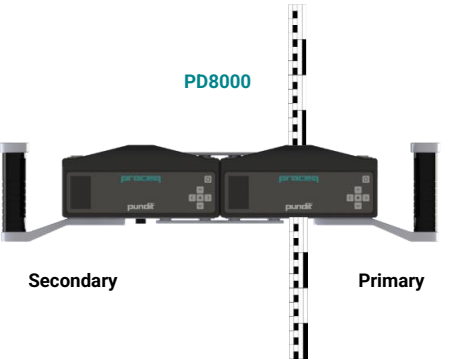
Current B-scan is positioned correctly

The tape number appears here

Workflow – AI Positioning – 16 channel tape position

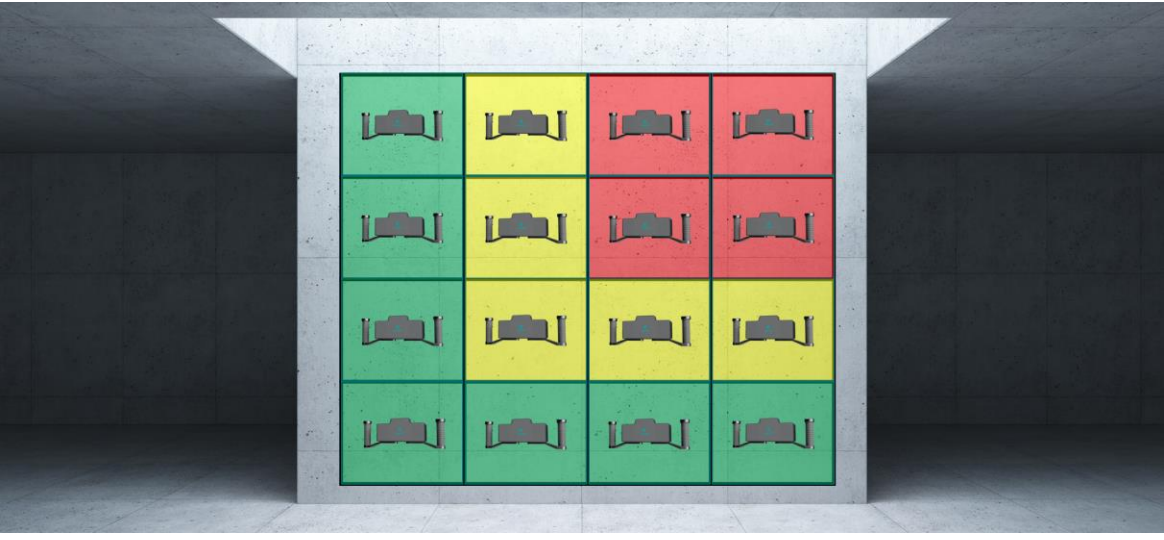
When using AI positioning for Full 3D Matrix scans with the 16 channel instrument, there is a difference between the PD8000 and PD8050 versions





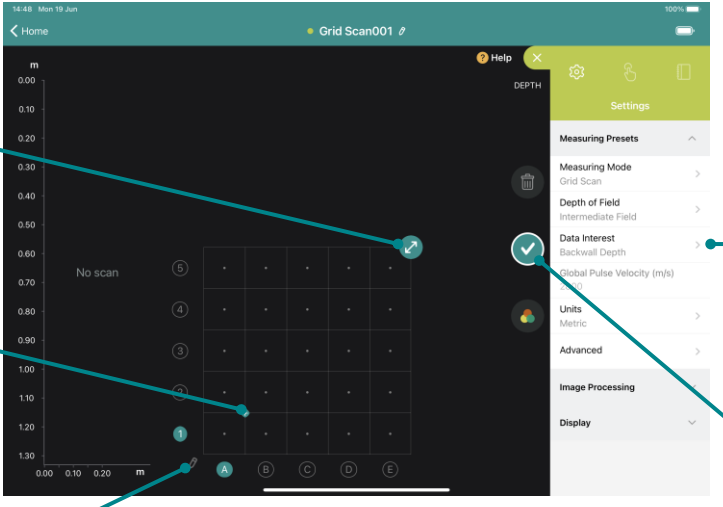
Workflow – Grid Scan– Data Collection

One measurement is made in each cell to create a colour-coded heat map of back wall depth or pulse velocity
Useful for uniformity testing and for identifying weak or suspect areas



Workflow – Grid Scan – Set-up

The grid that you set up here corresponds to a real grid defined on the structure



Drag or long press to type in grid size (max 338 cells e.g. 18 x 18)

Tap to set cell size 10 cm to 200 cm

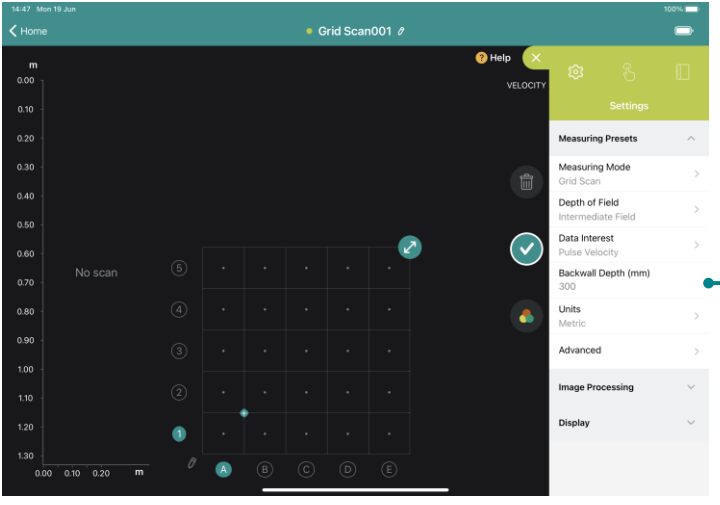
Set starting co-ordinates for grid

Select Backwall Depth or Pulse Velocity

Tap when ready

Workflow – Grid Scan – Additional Set-up Pulse Velocity

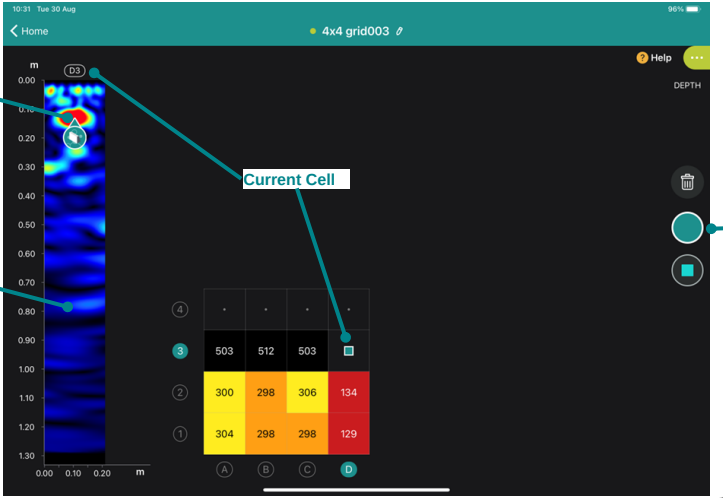
In order to calculate the pulse velocity, it is necessary to enter the known back wall depth.
Note; for structures of varying depth it is possible to adjust individual cells later.



Set known backwall depth

Workflow – Grid Scan – Measurement Screen

The grid scan relies on an AI function to automatically detect the back wall echo. If it is unable to detect the back wall, the user may set the tag manually.



Back wall is detected automatically by AI and a tag is created

Current Cell

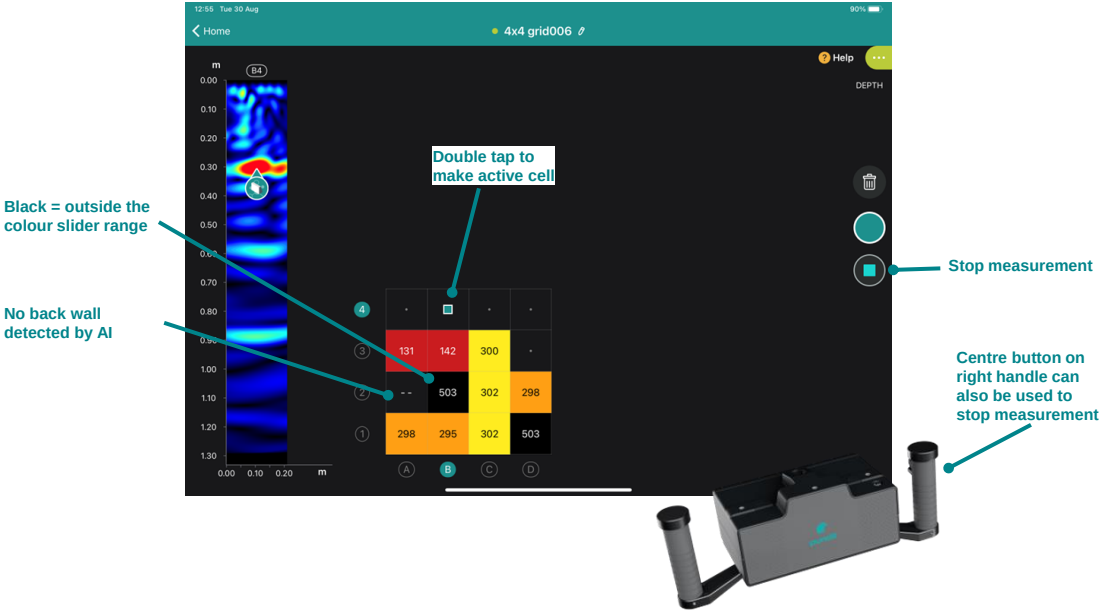
B-scan of current cell

Record measurement for the current cell

Centre button on left handle can also be used to record measurement for the current cell

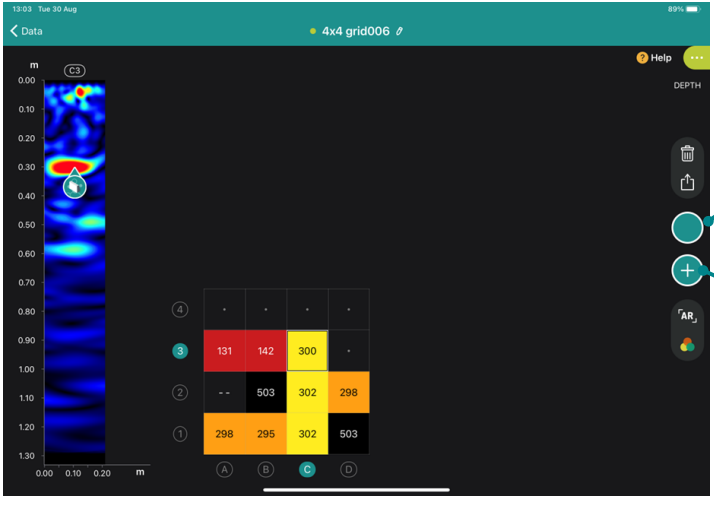
Workflow – Grid Scan – Measurement Screen Actions

When a measurement is taken, the next cell automatically becomes the active cell unless the user wishes to change this manually.

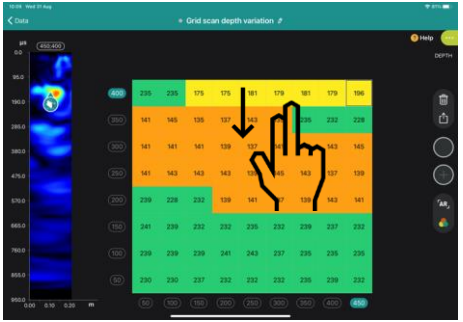


Workflow – Grid Scan – Re-open a saved file

Grid scans can cover very large areas. It is possible to take a break from scanning, then re-open the file and continue where you left off.



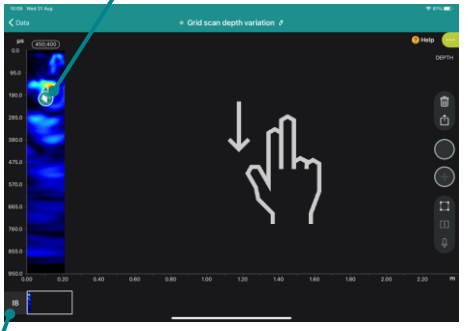
Workflow – Grid Scan – Review Modes



Grid Scan View

Swipe down with two fingers to view B-scan of active cell

Long press to delete tag
Tap to edit tag information
Drag to reposition

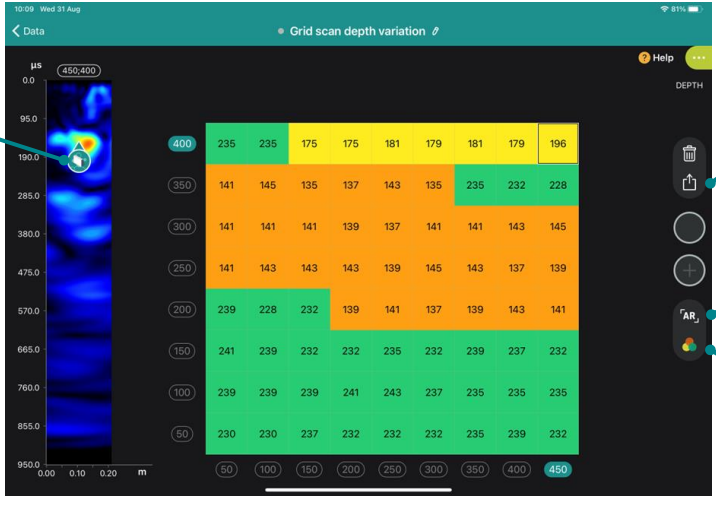


Tap to select B-scan

B-scan View

Swipe down with two fingers to revert to Grid Scan View

Workflow – Grid Scan – Review Screen



Long press to delete tag
Tap to edit tag information
Drag to reposition

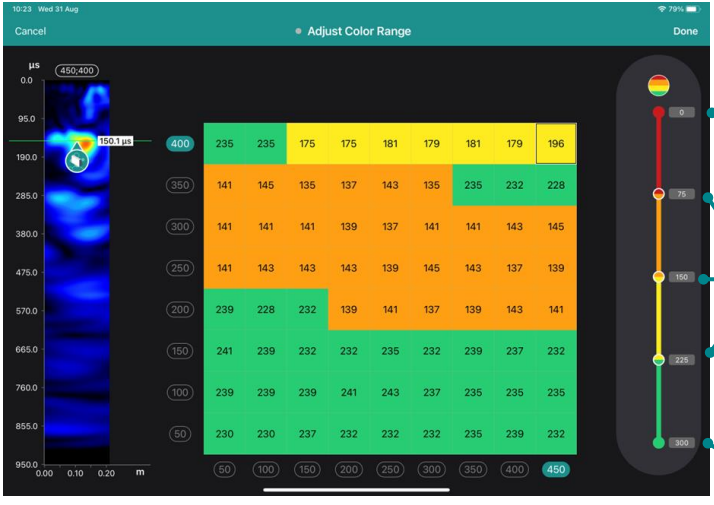
Export data

Activate augmented reality

Adjust colour slider

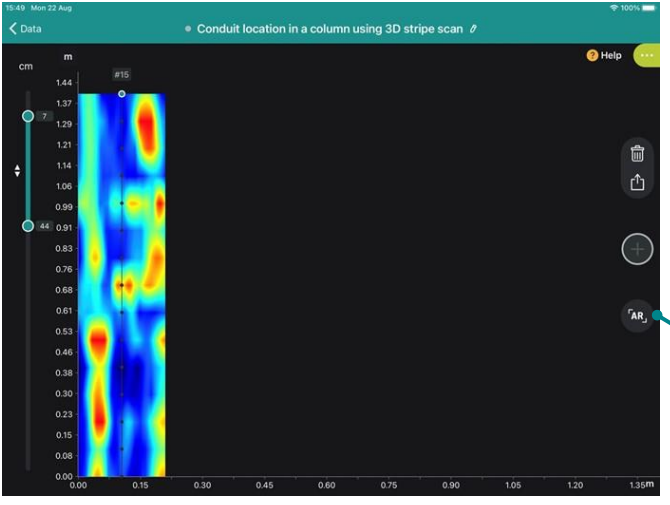
Workflow – Grid Scan – Adjust Colour Slider

The colour slider allows you to quickly highlight weak spots and suspect areas.
Useful for setting a minimum thickness or an acceptable pulse velocity.



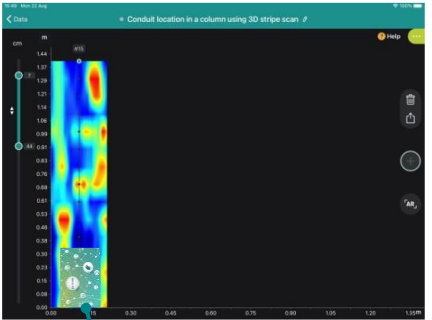
Workflow – Augmented Reality

Augmented reality allows the scan to be projected onto the surface of the test object

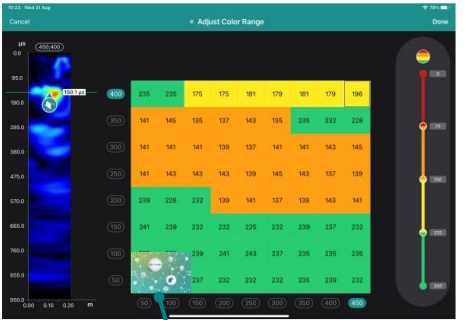


Activate AR to project the scan onto the surface of the test object

Workflow – Augmented Reality – Marker Position

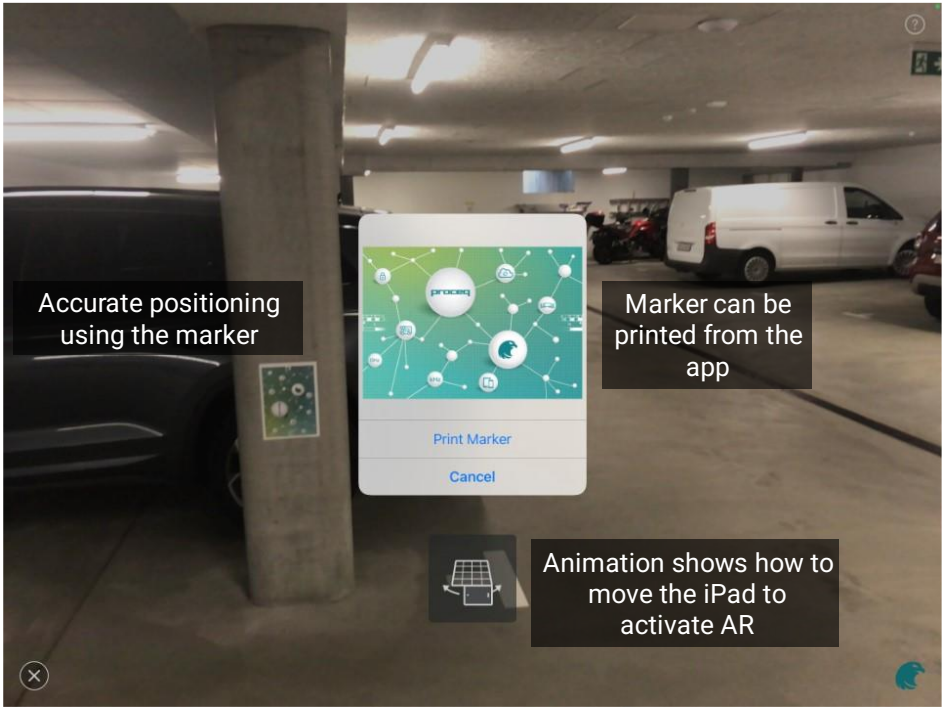


AR marker aligns with bottom center of a 3D scan

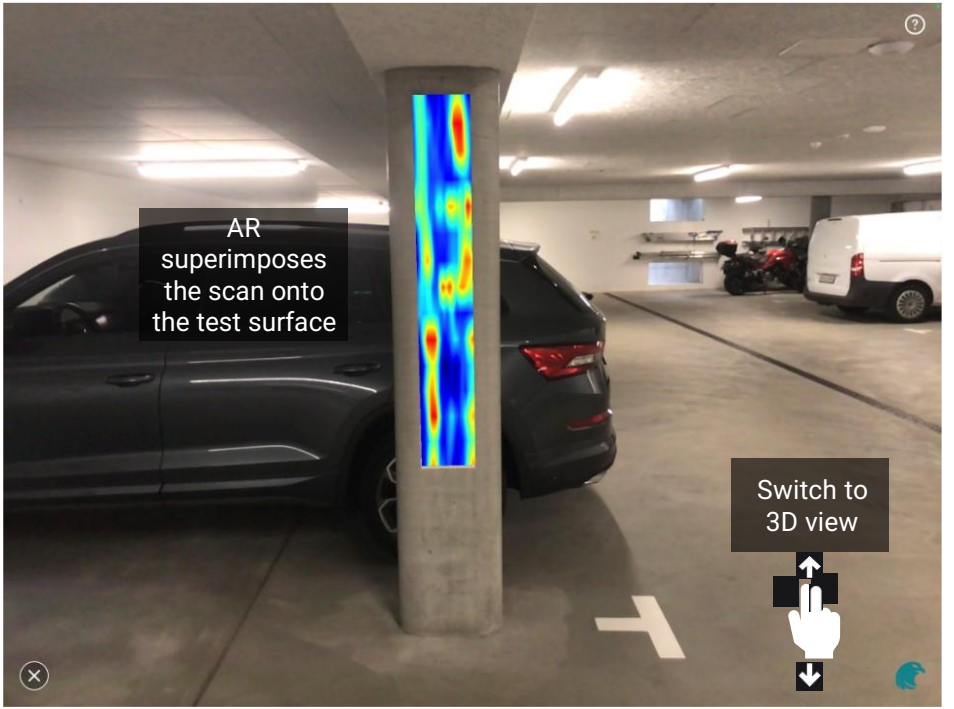


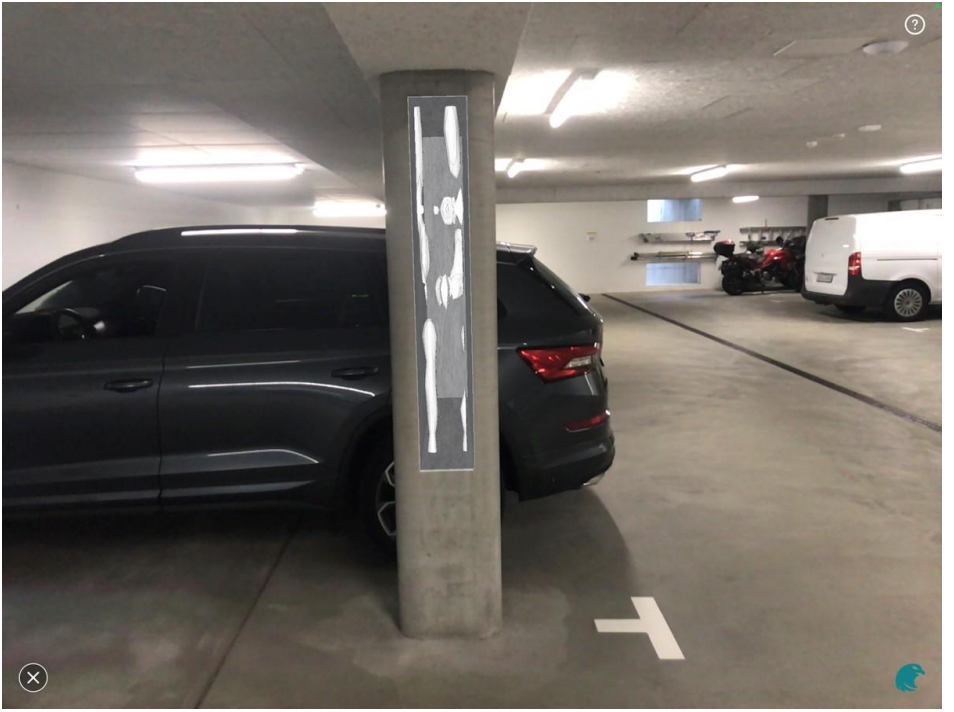
AR marker aligns with bottom left of a grid scan

Workflow – Augmented Reality



Workflow – Augmented Reality





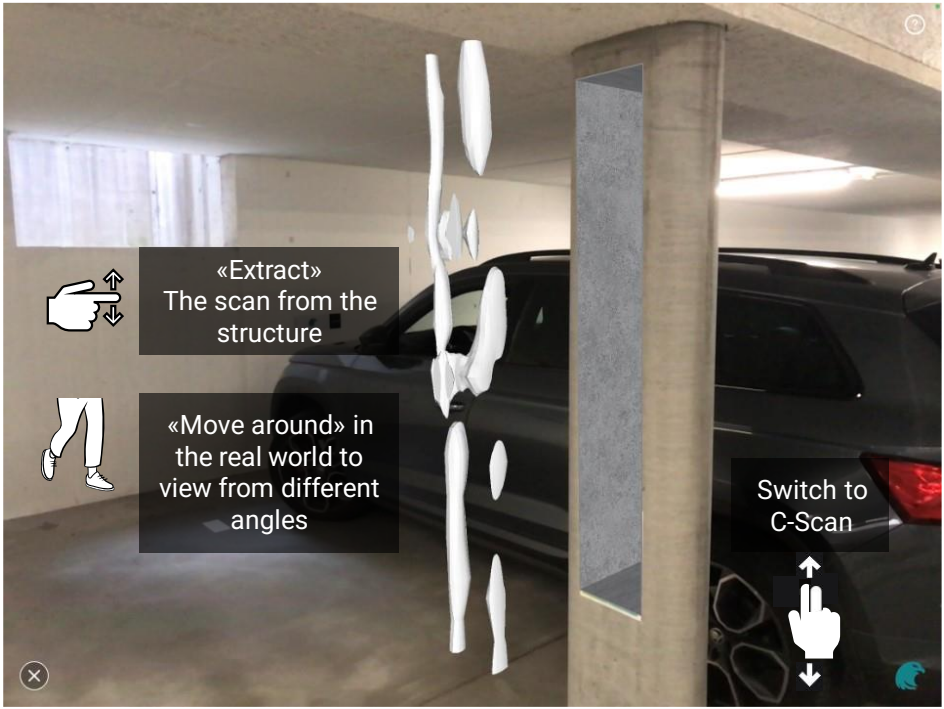
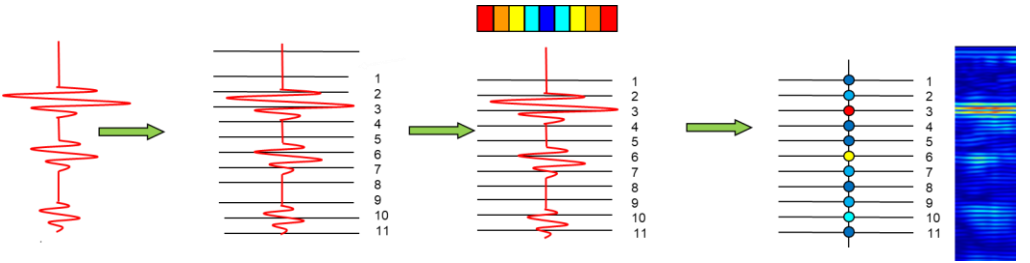

«Extract»
The scan from the structure
«Move around» in the real world to view from different angles
Switch to C-Scan

Image Interpretation – Understanding Echoes – Colour Coding

The echoes are colour coded to make image interpretation simpler.
Strong echoes occur when there is a boundary between two materials with differing acoustic impedances.
The strongest echoes are from a concrete / air boundary.



Strongest echoes are yellow, orange and red.

Image Interpretation – Reflections at Boundaries

The main boundaries encountered in reinforced concrete are concrete / air and concrete / steel.
The strongest echoes are from the concrete / air boundary which occur at the back wall and at defects such as voids, honeycombs and delaminations.

Interface	Z_1	Z_2	R
Concrete - Metal	9.6	46.5	43%
Concrete - Air	9.6	.000429	99%

$$R = \frac{(z_2 - z_1)^2}{(z_2 + z_1)^2}$$

R = energy reflected
Z1 = acoustic impedance concrete
Z2 = acoustic impedance 2nd material

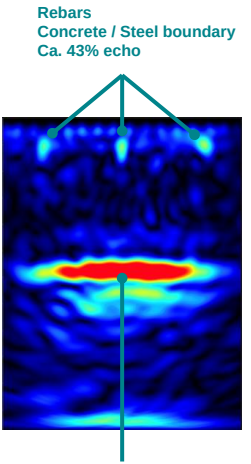


Image Interpretation – Multiple Echoes

The ultrasonic wave bounces backwards and forwards within an element. So particularly for thinner elements, it is quite common to see multiple echoes of the back wall and other large objects such as large voids and delaminations.

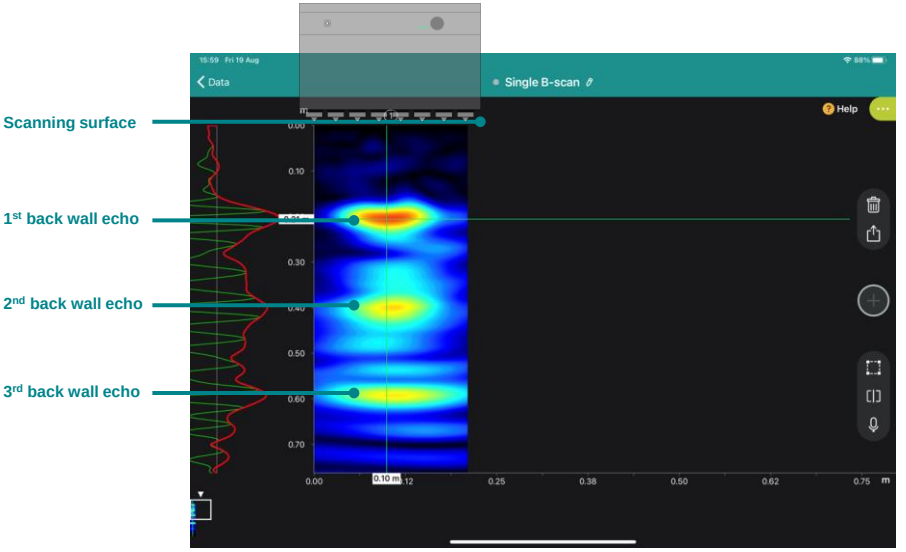
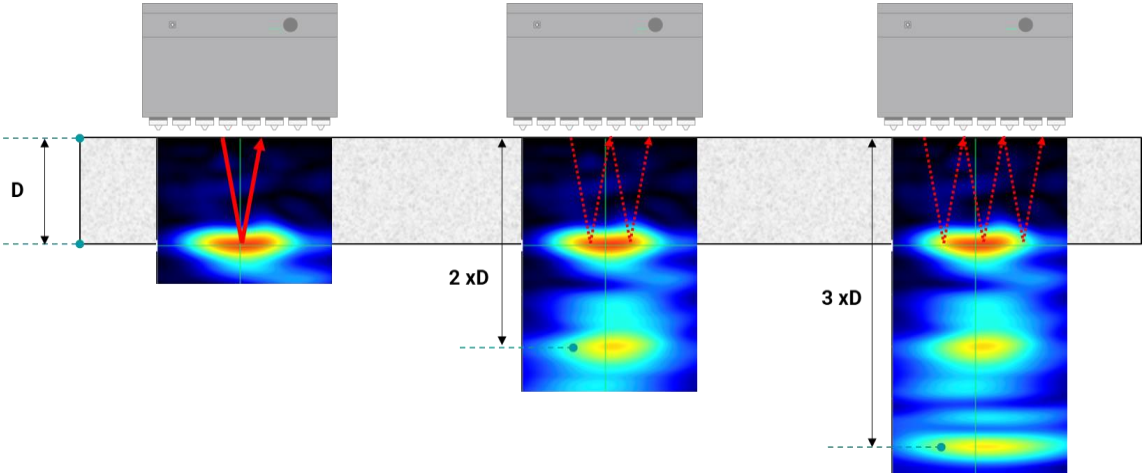


Image Interpretation – Multiple Echoes - Explanation

The image below shows the path travelled by the signal to create the 1st, 2nd and 3rd back wall echoes.



1st back wall echo

Signal reflects once and travels a distance 2x D

2nd back wall echo

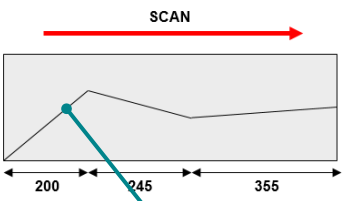
Signal reflects 3x and travels a distance 2x D

3rd back wall echo

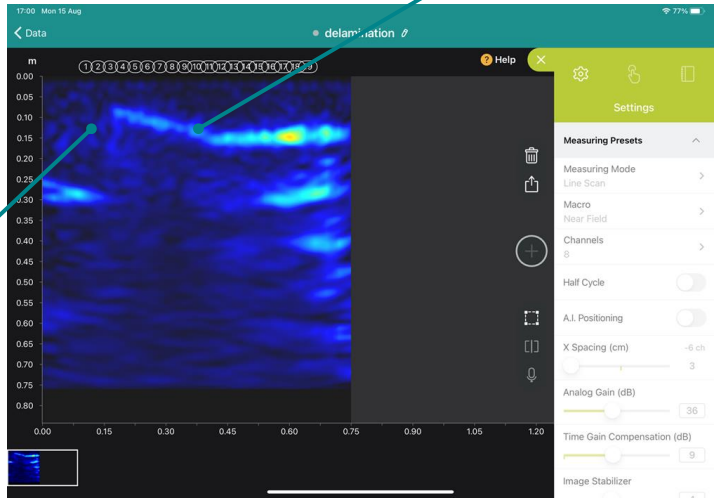
Signal reflects 5x and travels a distance 3x D

Image Interpretation – Crack Detection

Cracks or delaminations that run more or less parallel to the scanning surface can be detected.
Cracks that are vertical or at a steep angle cannot be detected.



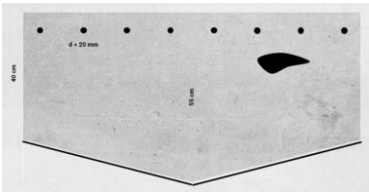
Delamination



In this location the angle of the crack is too steep. The echo is reflected away from the receiver.

Image Interpretation – Shadowing

Larger objects create shadows on the back wall. Likewise, a shadow on the back wall most likely indicates the presence of an object, even if it cannot be seen directly.



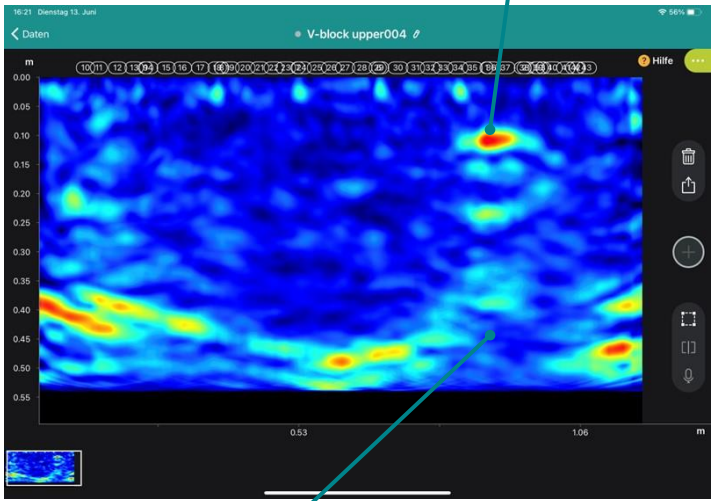
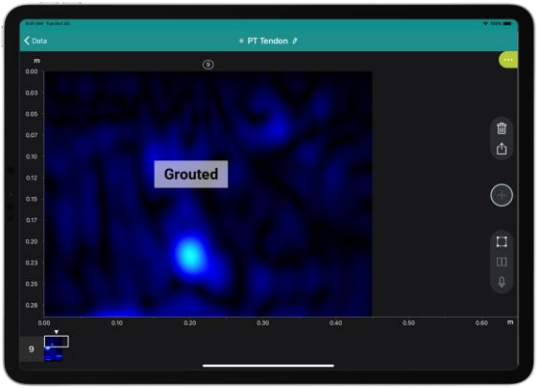
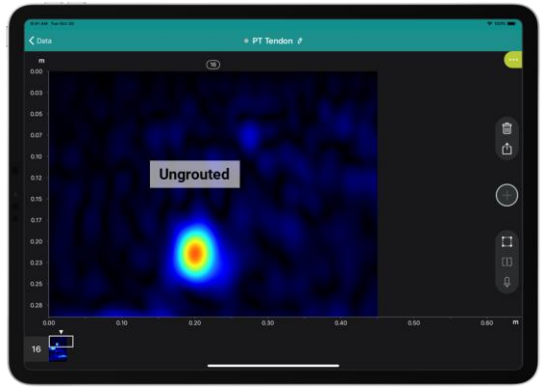


Image Interpretation – Grouting Defects

Voids inside tendon ducts due to grouting defects, cause stronger echoes than those from fully grouted ducts. This principle has been successfully used to locate grouting defects. (Note! It is always advisable to confirm by drilling and performing a visual inspection.





For more information on the product use of the product, please refer to the PD8050 documentation

It is available for download on

https://www.screeningeagle.com/en/products/pundit-pd8050

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