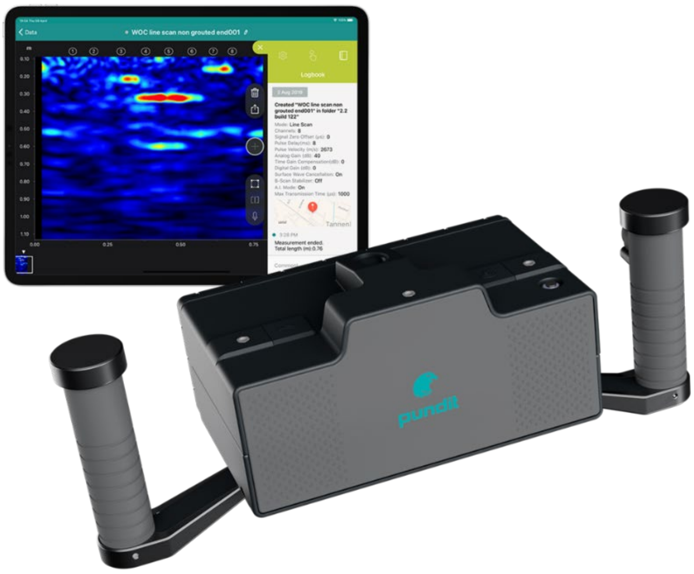
PD8050

Pundit Ultrasound Pulse Echo

User Manual



Document Information

Document Revision:	1.0
Revision Date:	Feb 26, 2024
Document State:	Draft
Company:	Proceq SA Ringstrasse 2 CH-8603 Schwerzenbach Switzerland
Classification:	Technical Manual

Revision History

Rev	Date	Author, Comments
0.0	Jan 17, 2024	DFER, 1st Draft Version
0.1	Jan 23, 2024	DCOR comments
0.2	Jan 24, 2024	DFER 2nd revision
0.3	Jan 26, 2024	EGEO Proofreading
0.4	Jan 31, 2024	DFER and USA team 3rd revision
0.5	Feb 23, 2024	MDEN revision
1.0	Feb 26, 2024	DFER Final Revision

Content

Legal Notice

This document contains important information on the safety, use and maintenance of Proceq products. Read through this document carefully before the first use of the instrument. Observe the safety and warning notes in this documentation and on the product. This is a prerequisite for safe working and trouble-free operation.

Symbols used

- This icon signals important information, specifications, proper working procedures and to avoid data loss, damage, or destruction of the instrument.
- This note signifies a warning about dangers to life and limb if the apparatus is handled improperly. Observe these notes and be particularly careful in these cases. Also, inform other users of all safety notes. Besides the notes in this instruction manual, the generally applicable safety instructions and regulations for the prevention of accidents must be observed.

Limitation of use

The instrument is only to be used for its designated purpose as described herein.

- Replace faulty components only with original replacement parts from Proceq.
- Accessories should only be installed or connected to the instrument if they are expressly authorized by Proceq. If other accessories are installed or connected to the instrument, then Proceq will accept no liability and the product guarantee is forfeited.

Liability

Our “General Terms and Conditions of Sales and Delivery” apply in all cases. Warranty and liability claims arising from personal injury and damage to property cannot be upheld if they are due to one or more of the following causes:

- Failure to use the instrument in accordance with its designated use as described in the product documentation.
- Incorrect performance check for operation and maintenance of the instrument and its components.
- Failure to adhere to the instructions dealing with the performance check, operation, and maintenance of the instrument and its components.
- Unauthorized modifications to the instrument and its components.
- Serious damage resulting from the effects of foreign bodies, accidents, vandalism, and force majeure. All information contained in this documentation is presented in good faith and believed to be correct. Proceq AG makes no warranties and excludes all liability as to the completeness and/or accuracy of the information.

Safety Instructions

The equipment is not allowed to be operated by children or anyone under the influence of alcohol, drugs, or pharmaceutical preparations. Anyone who is not familiar with the instrument must be supervised when using the equipment.

Reserved Rights

The content of this document is the intellectual property of Proceq SA and is prohibited to be copied neither in a photomechanical or electronic way, nor in excerpts, saved, and/or passed on to other persons and institutions. This document can be changed at any time and without any prenotification or announcement.

- Unauthorized modifications and changes to the product are not permitted.

Damages during carriage

On receipt of the goods, check for any visible damage to the packaging. If it is undamaged, you may sign the receipt of the goods. If you do suspect by visual inspection that damage has occurred, make a note of the visible damage on the delivery receipt and request the courier to countersign it. Moreover, the courier service must be held responsible for the damage in writing.
If hidden damage is discovered while unpacking, you have to inform and hold the courier liable immediately in the following way: "When opening the parcel we had to notice that … etc. "This superficial checking of the goods has to be done within the time limit set by the carrier, which is normally 7 days. However, the period could vary depending on the courier. Hence, it is recommended to check the exact time limit when receiving the goods.

If there are any damages also inform your authorized Proceq agent or **Proceq SA** immediately.

Shipment

Should the device be transported again, it must be packaged properly. Preferably use the original packaging for later shipments. Additionally, use filling material in the package to protect the device from any shock during carriage.

Safety notes and hints

- All maintenance and repair work that is not explicitly permitted and described in the present manual shall only be carried out by **Proceq SA** or your authorized service center, failure to comply voids the warranty.
- **Proceq SA** refuses all warranty and liability claims for damages caused by usage of the product in combination with **non-original accessories**, or accessories from 3rd party suppliers.
- Never immerse the device in water or other liquids: **Danger of short circuit!**
- Never leave the product under direct sun exposure. Always store the product in its carrying case.

For the operation of the product, all local safety regulations apply.

1 Introduction

The Pundit PD8050 Ultrasound Pulse Echo is a high-quality solution for structural imaging, object, and defect detection, using the technology of Ultrasound Pulse Echo. The most common applications are:

- Location of subsurface defects in concrete elements
- Measurement of thickness
- Determination of concrete pulse velocity for homogeneity and strength estimation
- Inspection of prestressed and post stressed ducts.
- Structural imaging and defect detection.

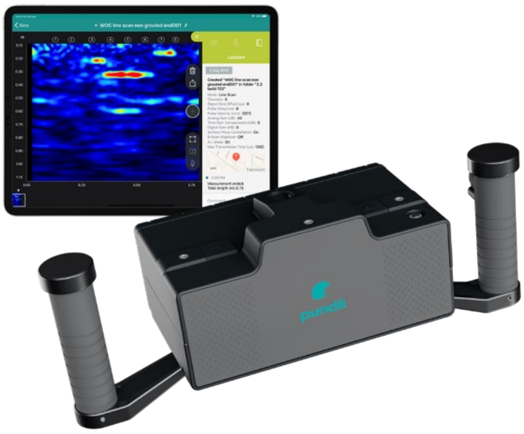


Figure 1: PD8050 System

The product consists of:

- PD8050 high-performance sensor
- iOS app
- Screening Eagle Workspace platform.

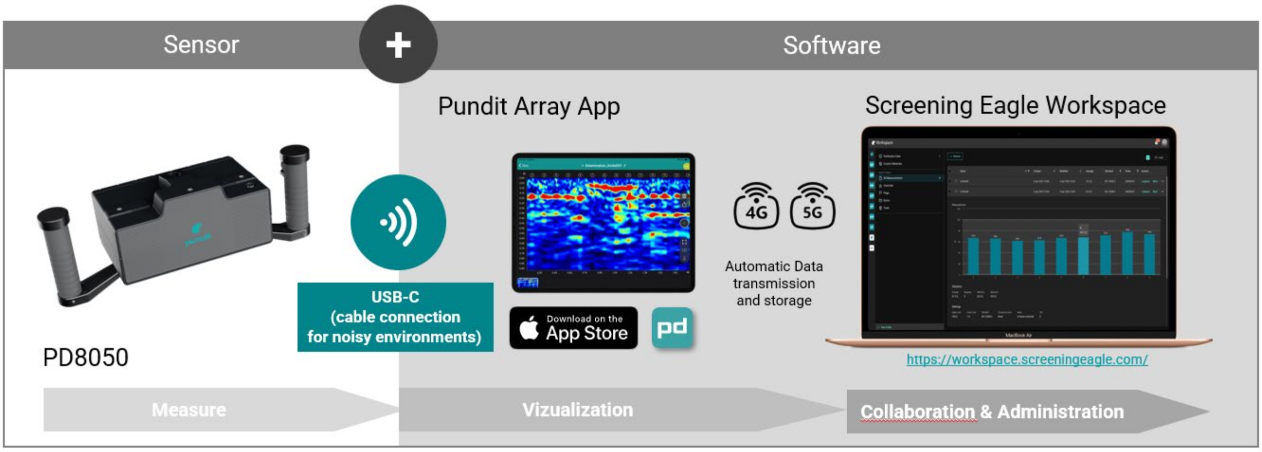


Figure 2: PD8050 System

1.1 Scope of this document

This document is the user manual for all products of the PD8050 Product family. The functionality provided by the Pundit Array app and described herein also applies to the PD8000 model. Therefore, some pictures or functional descriptions may differ from your model.

This manual contains important information about the correct and safe use of the device. Read this manual carefully before using the device for the first time and use the device only in the intended manner.

1.2 Important information

Check that the firmware and the app is always updated to the latest available version.

With every firmware and app version update, the functionalities of the device might vary. It is possible that formerly described functions are not available anymore, new functions added or pictograms and / or procedures change. The online version of the manual available on the website should be the most up-to-date document.

The PD8050 is intended for the ultrasonic inspection of constructions made of concrete, reinforced concrete, stone, or bricks with one-sided access. The design is for manual operation.

Please review the Quick Start Guide for more information about Declaration of Conformity and the Swiss Made Declaration.

1.3 Type of license

To be able to use the functionality of the Pundit Array app, a software license is required.

The following license is available and offers the following functionalities:

- Pundit Pro License (for PD8050).

Please refer to the table below for the supported features of this license:

MODES	FEATURES
Acquisition modes	• Line scan – 2D scan • Full Matrix 3D scan • Grid scan – depth and pulse velocity uniformity
Depth of field	• Near • Intermediate • Far • Custom
View modes	• A-scan view • Line view • Time slice view • 3D view • Heat map view • AR view
Advanced Presets	• Half Cycle • Analog Gain • Analog Time Gain Compensation • Pulse Delay
Image processing	• Auto gain • Digital Linear Gain • Digital Time Gain Compensation • Surface wave cancellation • Zero and Velocity calibration • Raw data offset
Data acquisition	• AI positioning
On-site annotations	• Markers • Tagging • Photos • Notes • Voice Notes • GPS positioning
Data options	• Cloud storage & sharing • HTML export • Share via URL • Raw data export

1.4 Product applications

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

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

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 – For this investigation it is necessary to find out as much information as possible on the suspected defect. 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 backwall echo clearly visible and then compare this with the images taken at the suspected defect locations.

Case 3 – 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 several guidelines available on this technique that the user is advised to consult for further information.

Other than case 3, the best way to proceed is to try and detect a clean backwall image at some point on the structure.

Case 4 – In this case it is necessary to know the thickness of the element being tested and to set the appropriate depth of field.

2 Scope of Delivery

Please refer to the Quick Start Guide and the Quick Reference Guide provided in the standard delivery and available in the download section of the product webpage:

[Quick Start Guide PD8050 - ScreeningEagle.com]

[Quick Reference Guide PD8050 - ScreeningEagle.com]

	Pundit PD8050
A	●
B	●
C	●
D	●
E	● (x3)
F	●
G	●
H	●
I	●
J	○
K	○
L	○
M	○

● Included / inbegriffen / inclus/ incluso / incluido / incluído / включены / 含まれる / 包括 / 포함 된

○ Optional / optional / optionnel / opzionale / opcional / opcional / необязательный / オプション / 可选的 / 선택 과목

Figure 3: PD8050 Scope of delivery.

Figure 4: PD8050 Scope of delivery.

3 Measurement Principle

The measuring principle of the ultrasonic method is based on the evaluation of changes that an ultrasonic wave undergoes in a component due to scattering or reflecting from internal objects.

The ultrasonic wave is generated on the component surface, in this instrument by piezoelectric excitation, and propagates as an elastic wave in the component.

When propagating through the material, the wave interacts with the material structure whenever it encounters a boundary to a material with a different acoustic impedance and is scattered along it. For example, in the case of concrete, this occurs at the layer boundaries of the aggregate to the concrete matrix.

On parts of the inner structure, for example, reinforcing bars or cladding pipes, parts of the switched-on energy are backscattered and reach the surface again. A large proportion of the energy is reflected on the backwall of a component (e.g. at a concrete/air boundary).

To create and record the sound energy, transducer elements of various types are used as transmitters and receivers, which are connected to ultrasound devices for measurement and presentation of results. Transmitters and receivers are arranged differently depending on the method used.

Depending on the accessibility of the component, the transmitter and receiver are placed on the same side of the component, which is referred to as a reflection arrangement. Procedures that are used using this method are referred to as pulse-echo procedures. If access from both sides is possible, this is referred to as a transmission arrangement or through-sound transmission.

The speed of sound can be determined very easily using transmission. This can be experimentally related to material parameters such as concrete compressive strength or the solidification process of fresh concrete.

If amplitudes recorded in a pulse-echo arrangement are plotted over time, the depth of objects and the thickness of the component can be determined if the speed of sound is known.

PD8050 uses ultrasound pulse echo technology, in which both the transducers and receivers are placed on the same side of the component. This is used to detect objects with a different acoustic impedance, such as air voids (cracks, delaminations), rebars, honeycombs, etc.

The Pundit has 3 rows of 8 transducers for a total of 24 transducers. A channel is a group of transducers operating together.

The Pundit has 8 channels: the 3 transducers in the same column are connected in parallel. One channel transmits and the echoes are received by the other seven channels. Each channel transmits in turn.

In transmission, the transducers in the same channel will pulse simultaneously.

In reception, the signals recorded by the transducers in the same channel will be summed together.

8 channels

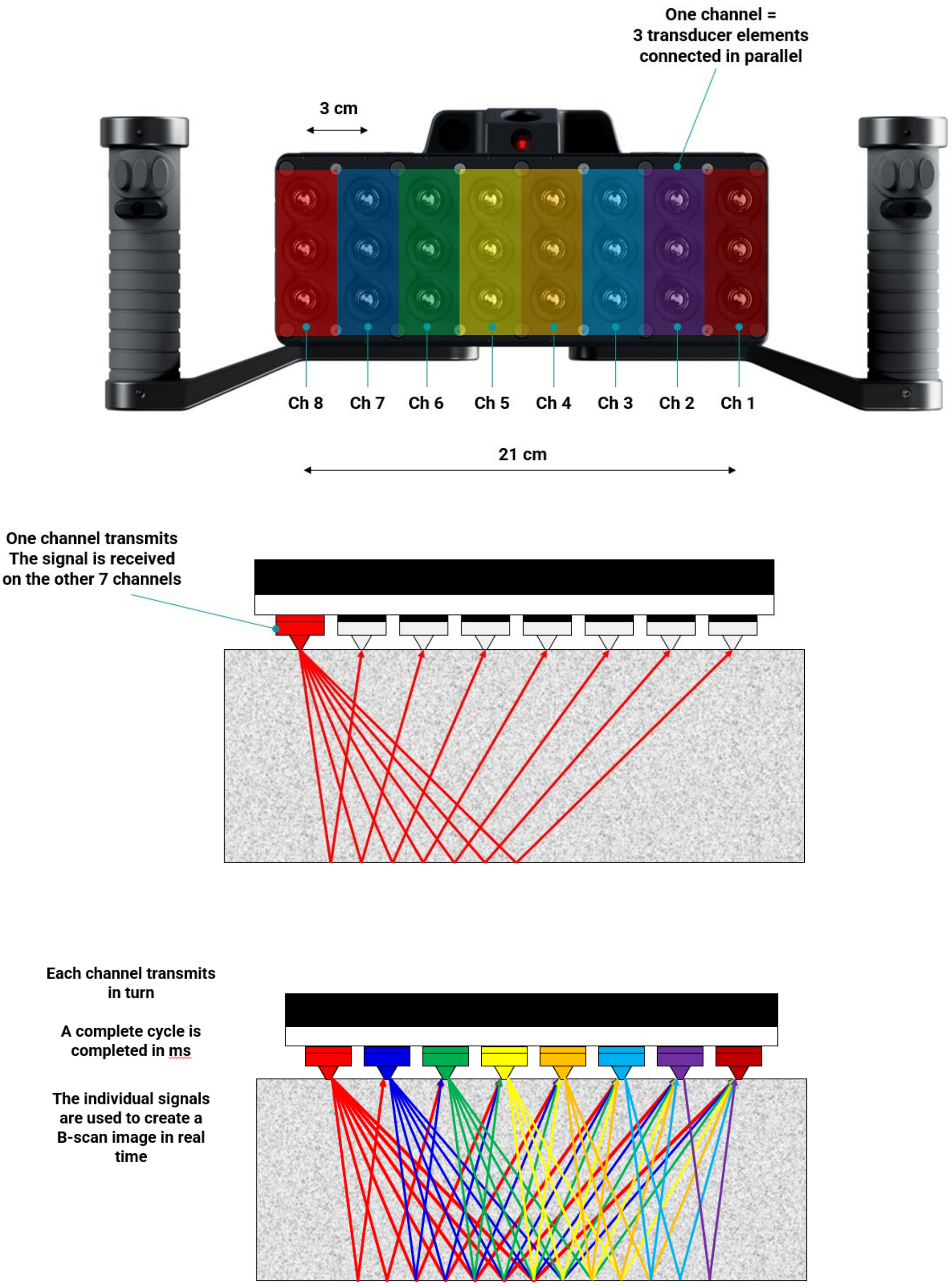


Figure 5: Ultrasound Pulse Echo Principle.

In its single-device configuration, the Pundit has 8 channels.

The acquisition scheme is as follows:

- 1st transmission: channel 1 (1st column of transducers) transmits, channels 2 to 8 (included) receive and record each an A-scan (7 A-scans recorded),
- 2nd transmission: channel 2 transmits, the channels 3 to 8 receive and record each an A-scan (6 A-scans recorded),
- ...
- 7th transmission: channel 7 transmits, channel 8 receives (1 A-scan recorded).

Total: 28 A-scans are recorded (7+6+5+4+3+2+1=7*8/2=28) per acquisition cycle. The table below illustrates this.

A-scan index		Receiver index							
		1	2	3	4	5	6	7	8
Transmitter index	1	x	1	2	3	4	5	6	7
	2	x	x	8	9	10	11	12	13
	3	x	x	x	14	15	16	17	18
	4	x	x	x	x	19	20	21	22
	5	x	x	x	x	x	23	24	25
	6	x	x	x	x	x	x	26	27
	7	x	x	x	x	x	x	x	28
	8	x	x	x	x	x	x	x	x

Figure 6: Description of total A-scan recorded per cycle.

This acquisition scheme is a variation of the so-called "Half Matrix Capture" (ultrasonic testing terminology), except that the pulse-echo signals (same channel used in transmission and reception) are not acquired.

In short, a complete cycle consists of 28 individual A-scans. These are used to create a B-scan which is displayed in real time on the measurement screen. This is extremely useful for carrying out quick spot checks at any point of the structure without the need to save any data.

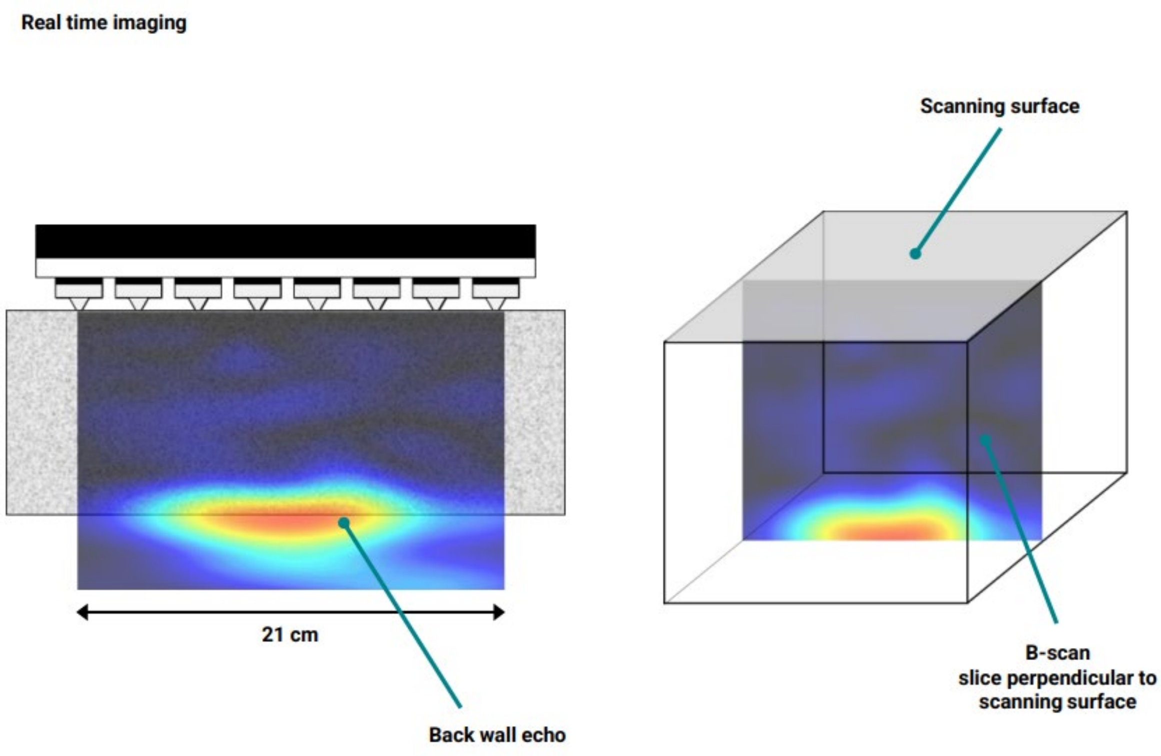


Figure 7: B-scan.

In the dual-device configuration (16 channels), a similar acquisition scheme is used:

- 1st transmission: channel 1 transmits, channels 2 to 16 receive (16 A-scans recorded),
- ...
- 15th transmission: channel 15 transmits, channel 16 receives.

Total: 120 A-scans are recorded.

Remark: doubling the number of channels (8 to 16) multiplies by more than 4 the number of A-scans recorded. This leads to much superior imaging in dual-device configuration.

A-scan index		Receiver index															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Transmitter index	1		1	1	1	1	1	1	1	12	12	12	12	12	12	12	12
	2			1		1st device			1	12				1st device and 2nd device			12
	3				1	1	1	1	1	12	12	12	12	12	12	12	12
	4					1	1	1	1	12	12	12	12	12	12	12	12
	5						1	1	1	12	12	12	12	12	12	12	12
	6							1	1	12	12	12	12	12	12	12	12
	7								1	12	12	12	12	12	12	12	12
	8									12	12	12	12	12	12	12	12
	9										2	2	2	2	2	2	2
	10											2	2	2nd device			2
	11												2	2	2	2	2
	12													2	2	2	2
	13														2	2	2
	14															2	2
	15																2
	16																

Figure 8: Description of total A-scan recorded per cycle – dual configuration.

Why do we record only 28 A-scans instead of 8x8=64 A-scans?

The A-scan obtained by channel i in transmission and channel j in reception is under some broad assumption equal to the A-scan obtained by channel j in transmission and channel i in reception. In other words, swapping the transmitter and the receiver leads to the same result. To reduce the amount of data processed and transmitted between the Pundit and the iPad, the redundant data is ignored.

Also, the pulse echo signals are not acquired because they have a poor signal-to-noise ratio: immediately after transmission, the transducer rings (dead zone), making it unable to record correctly.

For these reasons, only 28 A-scans are kept.

What's the advantage of using two Pundits together (16 channels)?

When using two Pundits connected together, the 16 channels lead to 15*16/2=120 signals, as shown in the table above, 28 signals come solely from the first device (purple), 28 from the second device (blue), the remaining 64 signals come from both the first and second devices.

A single acquisition with a 16-channel Pundit leads therefore to more than 4 times the amount of data compared to a single acquisition with an 8-channel Pundit. This does not mean that the image is 4 times "better", but the improvement remains significant.

4 Device Overview

4.1 Operation and handling

A Quick Start Guide is provided in the packaging (case) to help you to start the device and to set your Eagle ID which is necessary for using the Pundit Array app software.

A Quick Reference Guide is available on the Screening Eagle PD8050 website.

For further information to learn how to use the Pundit Array app, please have a look at all tutorial videos that are available under the “Tutorial” section.

- Carefully read and watch all documents mentioned above.
- Be careful when using the sensor and placing the transducer tips on the concrete surface. Avoid dragging the tips across the surface to reduce the risk of breakage.
- Make sure that your fingers are not trapped between the transducers and the concrete surface.
- When not in use replace the plastic cover which protects the transducer elements.
- The equipment should not be handed over to persons not aware of inherent risks of the device use or not knowing the content of this manual.
- Be sure to stand securely when measuring with the device.
- Keep a good posture during the handling of the device and avoid movements that will overloading any part of your body.
- Pay attention to your environment and potential hazards during the measurement.
- Always mechanically secure the device from falling when used in elevated areas.

4.2 Switching on and getting started

Please refer to the Quick Start Guide (included in standard delivery) for the first steps with your PD8050. The Quick Start Guide is also available in the download section of the product webpage: [Quick Start Guide PD8050 - screeningeagle.com]

The main instructions for getting started are presented in Figures 9 & 10.

Figure 9: Inserting batteries.

Figure 10: Charging the batteries.

4.3 Instrument overview & keys

The six keys of the sensor allow the user to control the instrument and navigate the sensor menu. Figure 11 shows the function assigned to the keys.

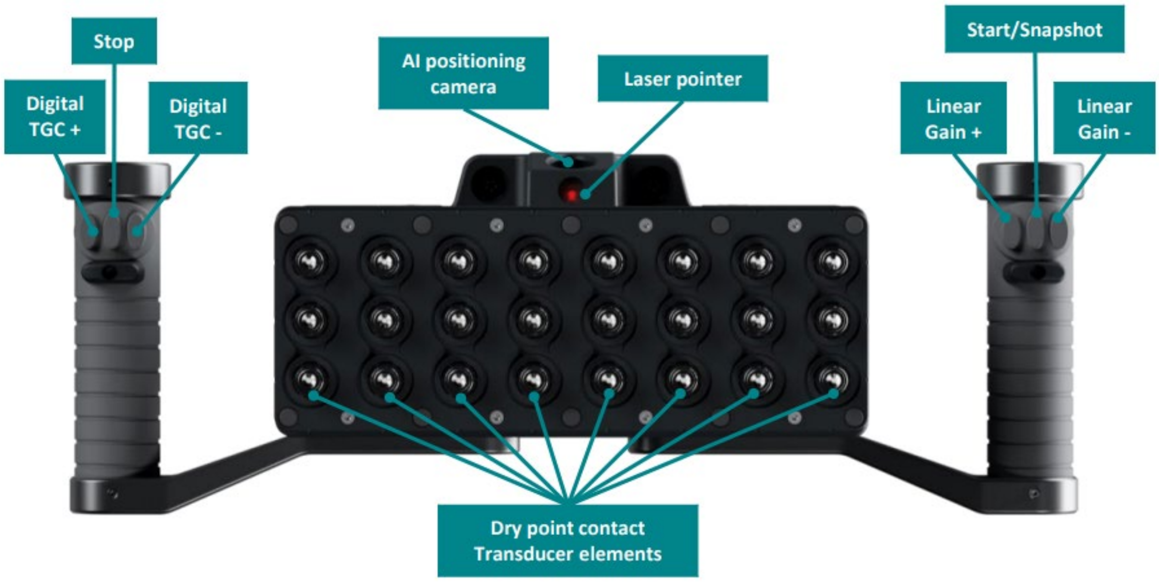


Figure 11: Bottom view.

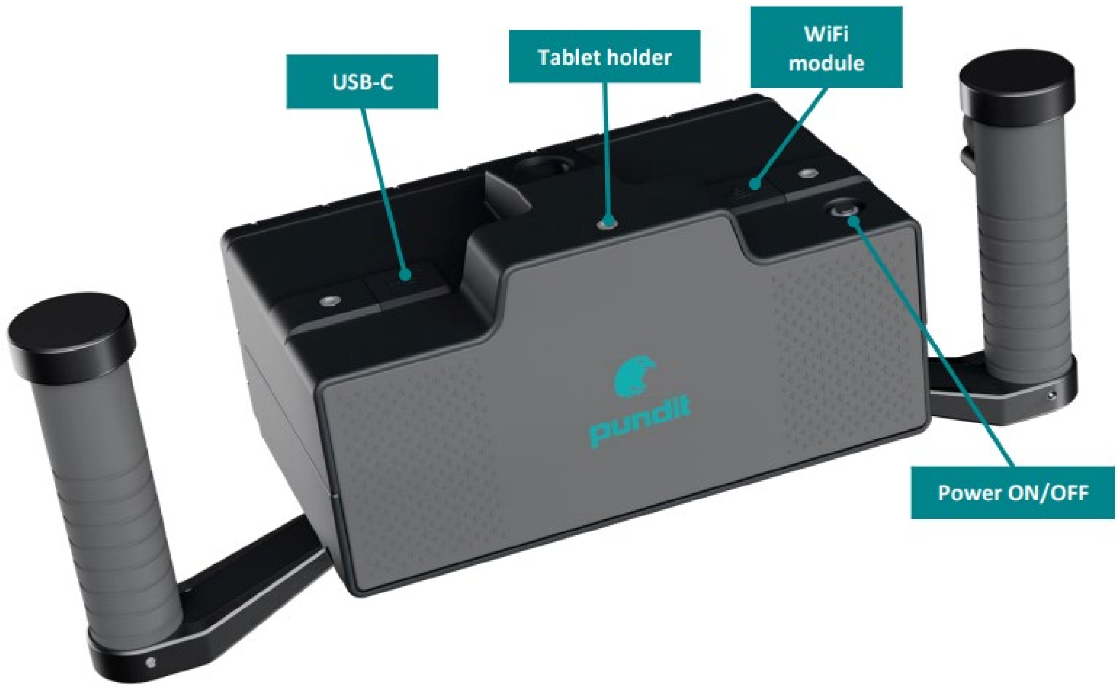


Figure 12: Front view.

4.4 Modularity

The PD8050 can be very easily configured for dual or single-handle operation. It can also be combined with a second unit for 16 channels operation.

Figure 13: Modularity: hand holders and channels.

PD8050 with the dual handle is supplied as standard (part No: 32540500).

PD8050 with the single handle requires a single-handle kit accessory (part No: 32540455).

PD8050 – 16 channels require the following accessories:

- PD8050 transducer (Part No: 32540500).
- PD8050 additional transducer (Part No: 32540500).
- PD8050 connection kit to 16 channels (Part No: 32540434).
- Dual handle kit (Part No: 32550001).*

*NOTE: The dual handle kit is normally not required to purchase additionally now. Previously our standard product came with the single handle. But now the standard product comes with the dual handle.

Changing from one model to another can be carried out simply on-site. Connect the two sensors as shown in the quick start guide. Turn on both sensors, then connect to the app as usual.

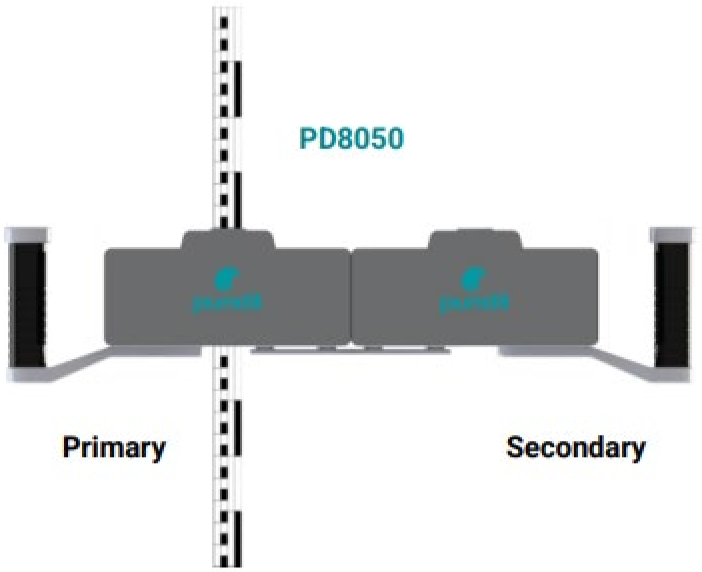


Figure 14: Primary and secondary sensors for 16-channel data acquisition.

4.5 LED behavior

LED Description:

LED NAME	Functions / Meaning
ON	Not lit when device is turned off. Flashing green during hardware initialization. Constant green when device is ready for operation.

5 General Use

5.1 A-scan

An A-scan is the display of the ultrasound amplitude of a single measurement over time.

You can determine how the A-scan is displayed. Choose between: Signal, Envelope, or Signal and Envelope under the “Image Processing” tab. The A-scan is hidden by default but can be seen on the left-hand side of the measurement screen. To do so, swipe your fingers from left to right on the left side of the iPad screen. The signal is shown in green and the envelope (if selected) is shown in red.

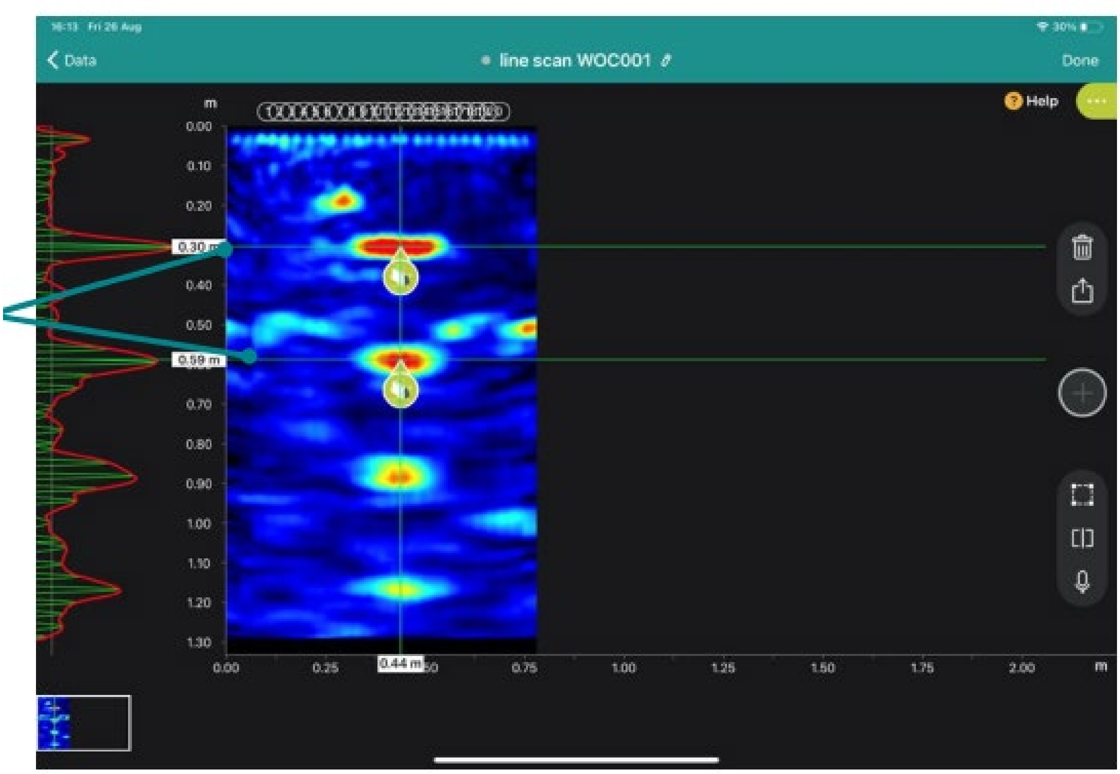


Figure 15: Second backwall is visible.

Understanding the echoes:

Small echoes are in the blue scale, while strong echoes are in the areas from yellow to orange to red (typical from concrete to air boundaries).

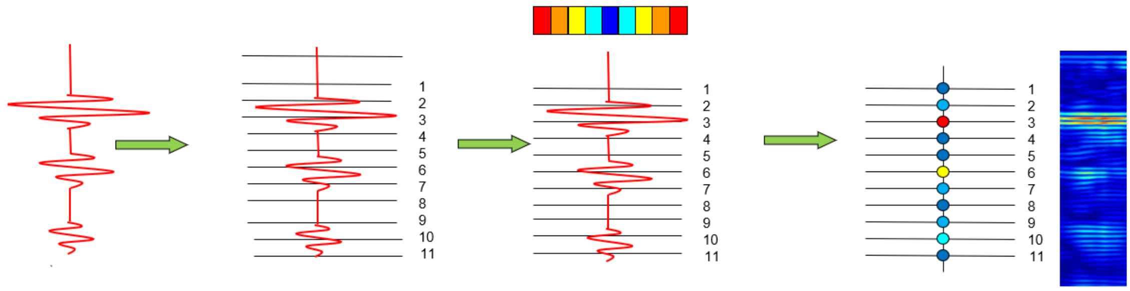


Figure 16: A-scan interpretation.

Ultrasound waves are reflected by materials with a different acoustic impedance than concrete. The air (cracks, voids) completely reflects the signal, while the steel (rebars, PT ducts) reflects part of it. This is why ultrasounds are perfectly fit for finding air defects and can be used in some cases for finding rebars.

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

Z_1 = acoustic impedance concrete

Z_2 = acoustic impedance 2nd material

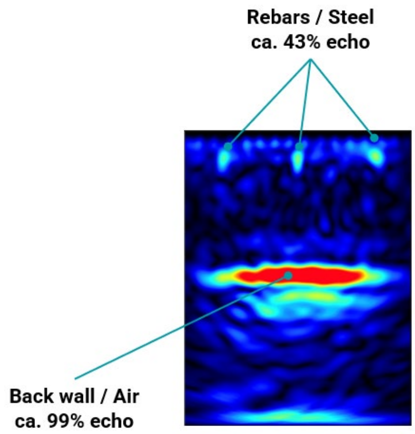


Figure 17: Acoustic impedance.

5.2 B-scan

B-scans are a pictorial representation of the A-scans of several measurements taken along a measuring line, as a section through the component perpendicular to the surface. The amplitudes of the A-scans are coded in color scales.

B-scans provide a cross-sectional image of the test object perpendicular to the scanning surface in the plane through which the individual A-scans have been collected. The width of the B-scan corresponds to the width of the aperture, i.e., width = (number of channels-1) x 3 cm.

The PD8050 is an 8-channel transducer. One channel transmits and the echoes are received by the other seven channels. Each channel transmits in turn.

A complete cycle consists of 28 individual A-scans. These are used to create a B-scan which is displayed in real time on the measurement screen. This is extremely useful for carrying out quick spot checks at any point of the structure without the need to save any data. Once areas of interest have been located, more extensive scans can be made.

The cursor can be dragged to any point on the B-scan and the corresponding A-scan will be displayed in the left-hand window. As the cursor is moved around the B-scan, the left-hand scale shows the depth at which the cursor is located. The bottom scale shows the cursor position relative to the left-hand side of the transducer and the left-hand scale shows the transmission time in the A-scan view.

Correct depth indication depends on the accuracy of the pulse velocity setting. The pulse velocity can be entered manually if known, or it can be estimated automatically as described in the following chapters. Correct identification of the backwall echo is assisted by analysis of the A-scan and is described in the following chapters. The B-scan can be optimized in real-time also by adjusting the gain and the time gain compensation using the controls on the transducer as described in the following chapters.

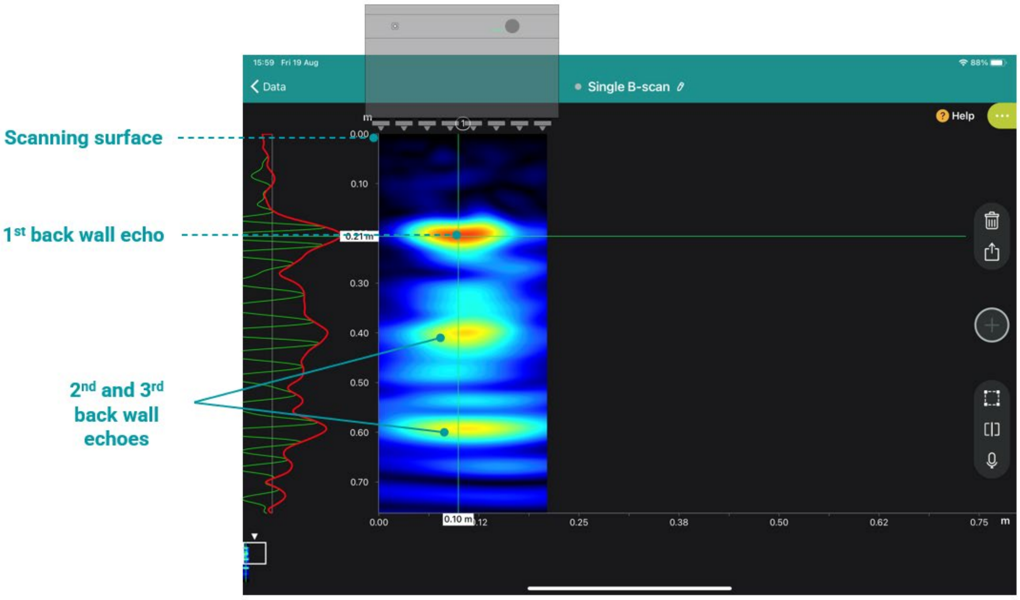


Figure 18: Understanding echoes with B-scan.

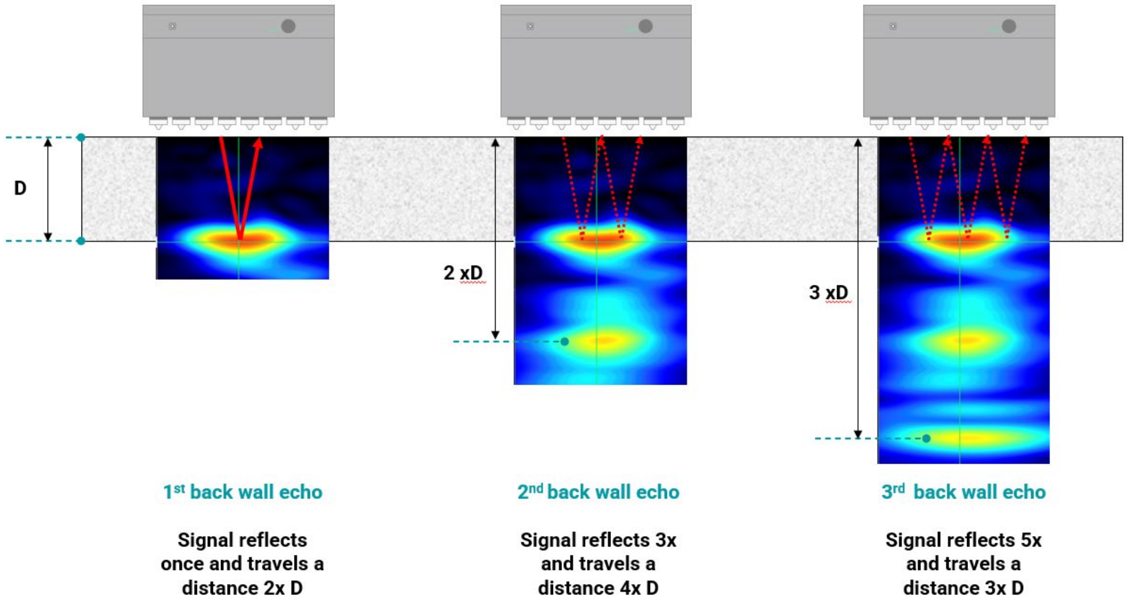


Figure 19: Understanding echoes with B-scan.

5.3 Recommended Workflow

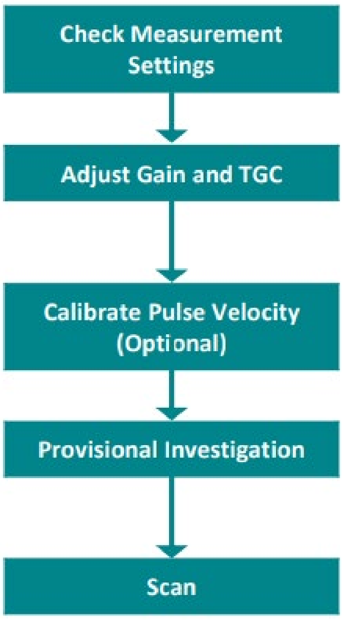


Figure 20: Recommended workflow.

Tips on obtaining a good backwall image.

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

If no backwall 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 backwall echo is immediately visible. (Note: to do this, the auto gain function must be switched off).
- If this fails, try increasing the analog gain and TGC. These features are in Advanced Presets.
- 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 it with the custom setting.

Reasons why a backwall 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, and yellow echoes.
- There are delaminations not visible due to destructive interference which block the path to the backwall. 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.

5.4 Recommended measurement settings.

These are the initial settings that are recommended to obtain 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	

Image Processing		Variation
Auto Gain	ON	If auto gain is off, then set Linear Gain and Digital TGC to default values (0, 0)
Global Pulse Velocity	2600	
Ascan	Signal and Envelope	

Advanced Image Processing		Variation
Surface Wave Cancellation	OFF	Removes noise caused by surface waves
Raw Data Offset (µs)	-30	Only change this if it can be calibrated with 1st and 2nd back wall echoes

Figure 21: Recommended settings.

If desired, the settings to set the depth of field can also 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

Figure 22: Recommended settings: depth of field.

5.5 Analog Gain and Analog Time Gain Compensation (TGC)

Analog gain and time gain compensation are measurement presets. They are used to set the optimum signal strength before starting to scan.

Analog gain regulates (increases or decreases) the analog signal amplitude before being transformed into a digital signal by analog-digital converter. Analog gain units are in decibels (dB). It is essential to adjust the analog gain every time before you start working with a new object.

Too high analog gain leads to ADC overflow error and may cause sever distortions in the image synthesis procedure. The low analog gain suppresses the useful amplitudes and increases quantization and thermal noise.

Time gain compensation increases signal analog gain with time. The TGC units are decibels per microseconds (dB/µs). The correct usage of TGC may lead to reducing of quantization and thermal noise. Another benefit of TGC is compensation of ultrasound attenuation caused by the material structure.

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 digital TGC under Image Processing settings to obtain a good image.

However, for very thick structures, or very thin structures, it may be advantageous to either increase or decrease the analog settings respectively.

It is often the case that if these analog settings are adjusted, users forget to reset them, which can lead to poor image quality with future measurements.

To reset the settings as default (Analog Gain = 36dB and Analog TGC = 0 dB), double-tap on the slider.

Figure 23: Analog Gain and TGC sliders.

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

Please note that if analog gain and TGC are adjusted, remember to reset to the default values on completion of the test.

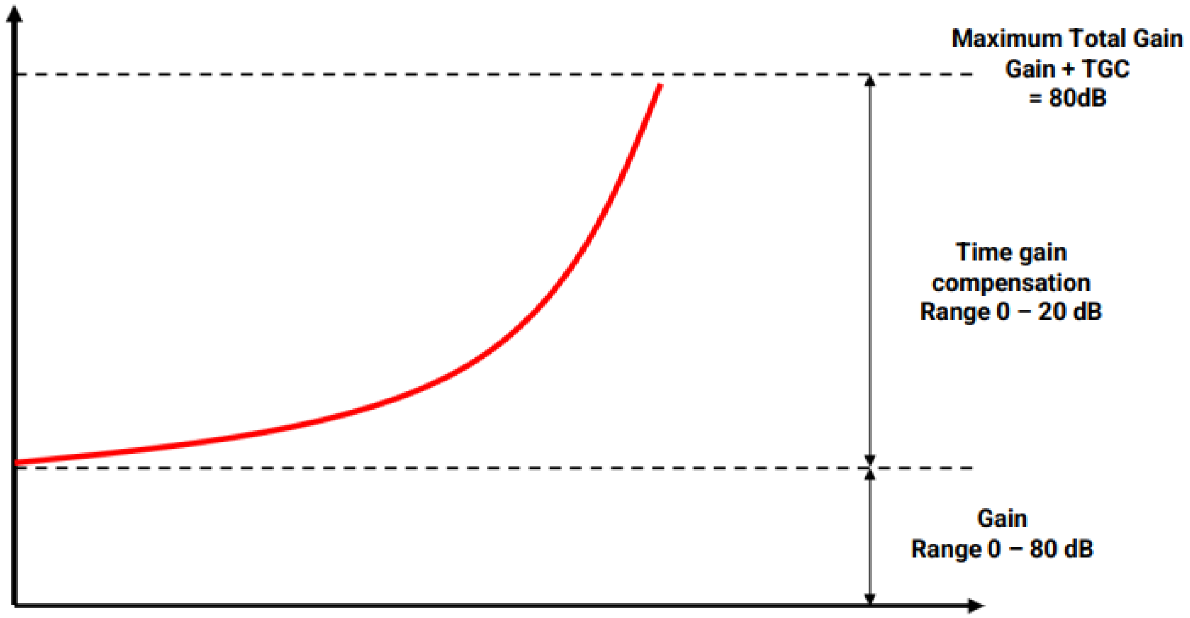


Figure 24: Analog Gain and TGC.

For adjusting the Analog Gain and the Analog TGC, you must do it before starting the measurement – this is a preset.

You can use the app sliders under “Measuring presets”. Have a look at the unique real-time B-scan to adjust these values before saving any images.

Analog gain adjusts the entire signal equally. Reduce the Gain whenever the surface elements are red.

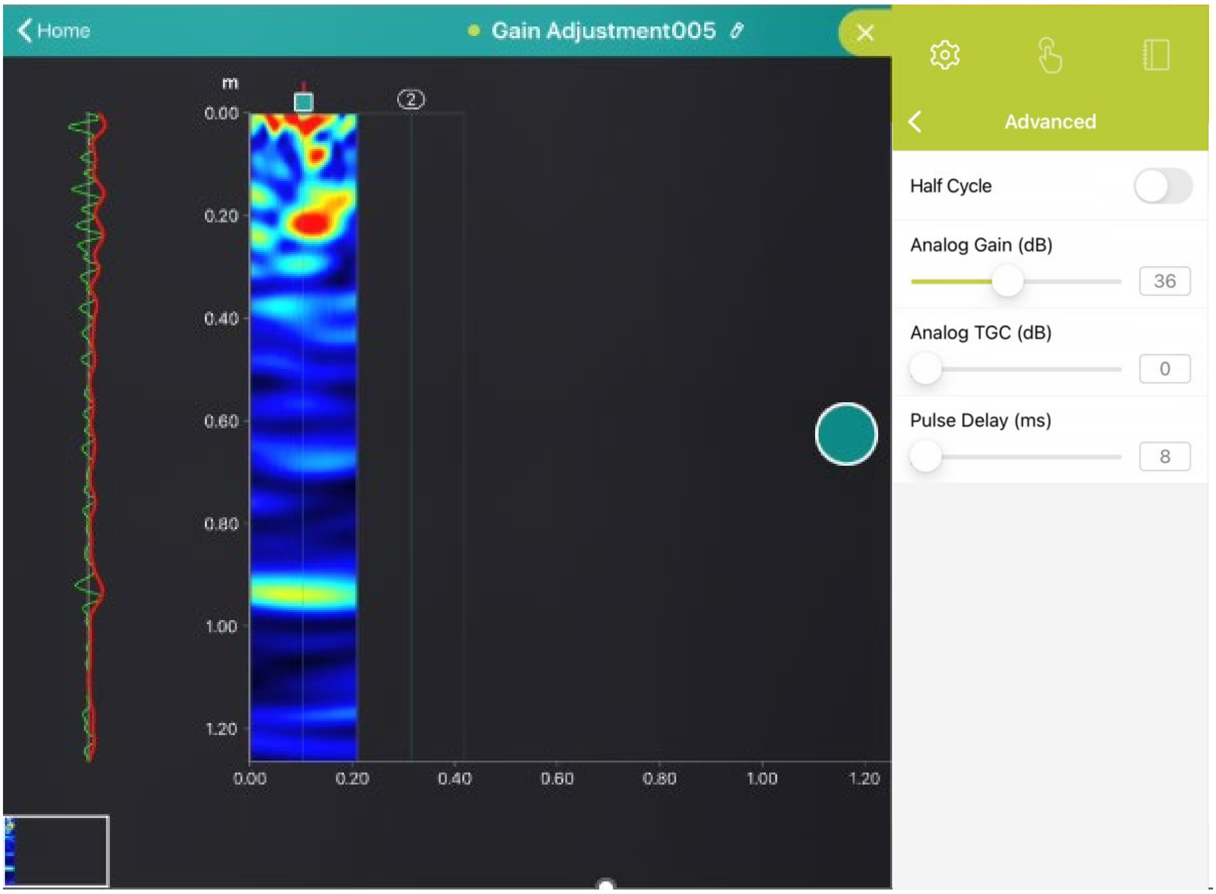


Figure 25: Analog gain is too high on the surface.

Time Gain Compensation: This feature amplifies echoes that are further away from the transducer to provide a more balanced B-scan (See figure above.)

Objects close to the surface are not amplified, while those deeper in the element are amplified. It is often used to make the backwall echo more visible without amplifying near-surface objects that would distort the image.

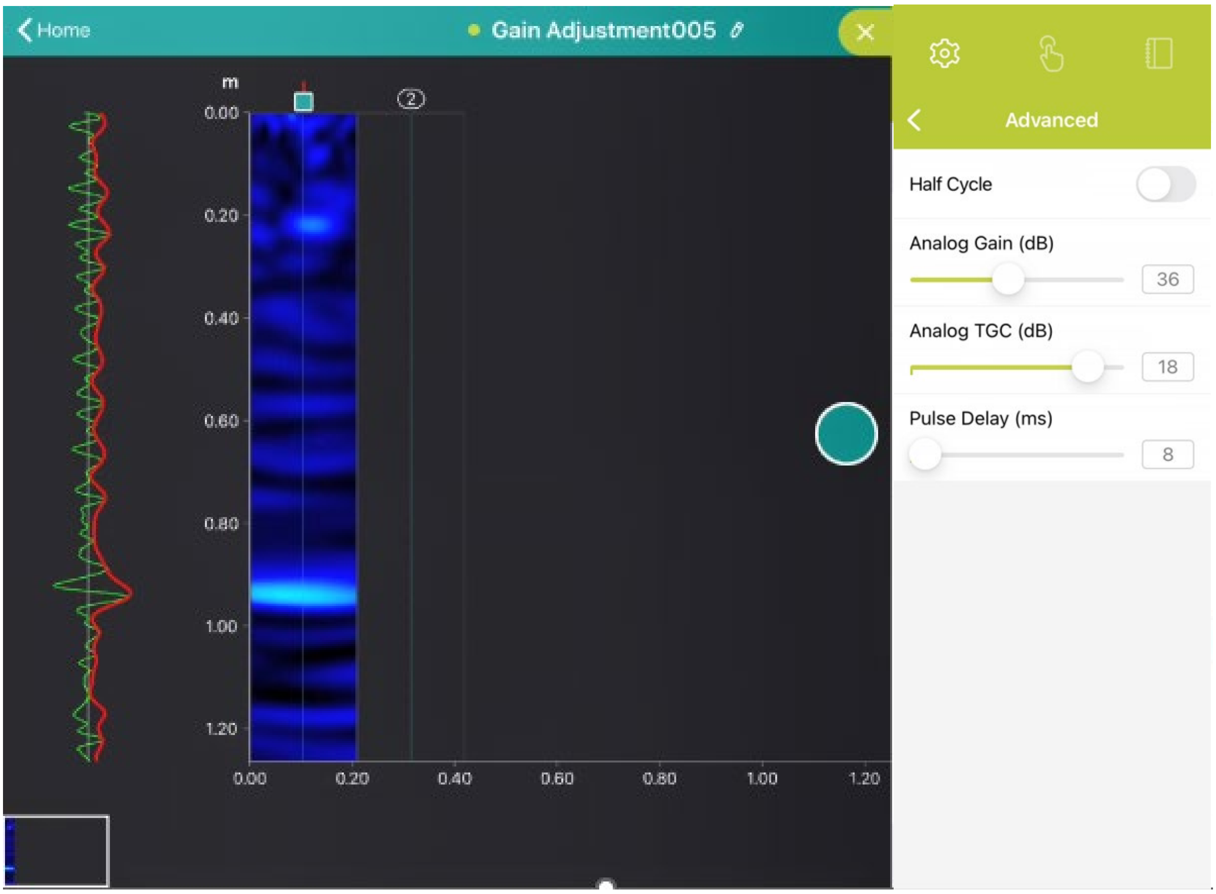


Figure 26: Increase TGC to see better the deep objects.

5.6 Digital gain and Digital Time Gain Compensation (TGC)

Digital gain and Time Gain Compensation are used to optimize the images similarly to the preset functions (analog filters), but this operation can be carried out at any time during a scan.

The digital gain adjusts the entire signal equally. The TGC is used to amplify deep objects.

These filters can be modified using the sliders on the Pundit Array app or using the buttons on the sensor handles.

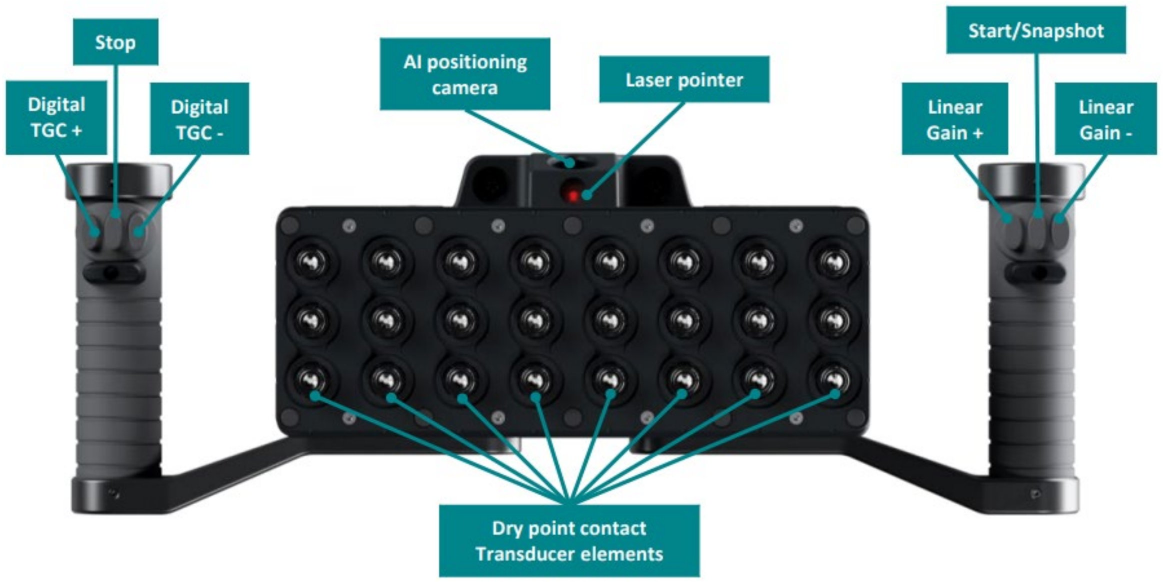


Figure 27: Sensor buttons for increasing or decreasing the digital gain and TGC.

You can also adjust the digital gain and the digital time gain compensation using the sliders under the “image processing” menu:

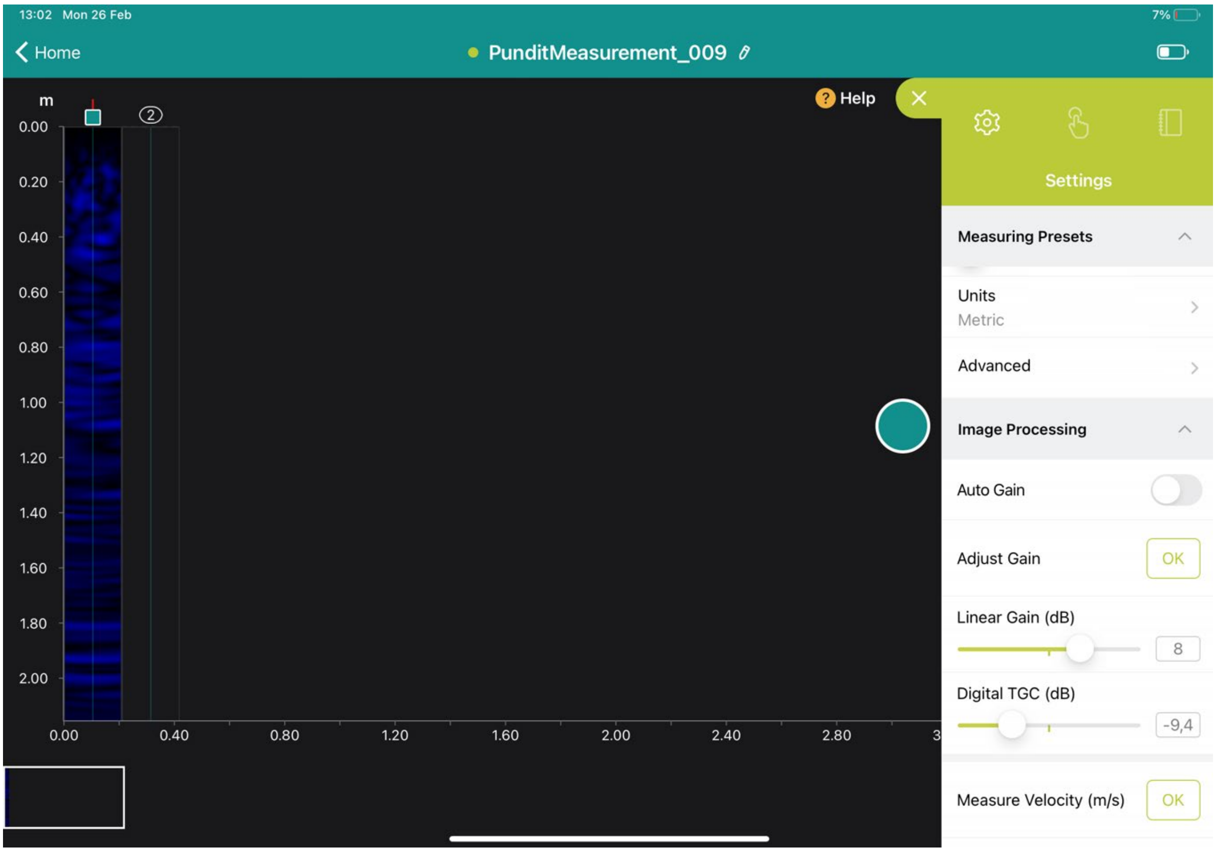


Figure 28: Digital gain and digital TGC settings.

5.7 Depth of field

The depth of field setting sets optimized transmission parameters depending on the depth of the object of interest.

The default setting is “Intermediate Field”:

- Tx frequency: 40 kHz
- Tx voltage: 100 V
- Max Tx time: 1000 µs

This is a useful preset for a typical depth of 1.2 to 1.3m.

The operating frequency parameter defines the frequency of the pulse applied to the DPC-transducer.

There are three other options:

“Near Field” for superficial objects – with a typical depth of 0.5 to 0.6m

- Tx frequency: 60 kHz
- Tx voltage: 50 V
- Max Tx time: 500 µs

“Far Field” for deep objects – with a typical depth of 2.2 to 2.4m

- Tx frequency: 30 kHz
- Tx voltage: 150 V
- Max Tx time: 200 µs

“Custom” – freely configurable by the user

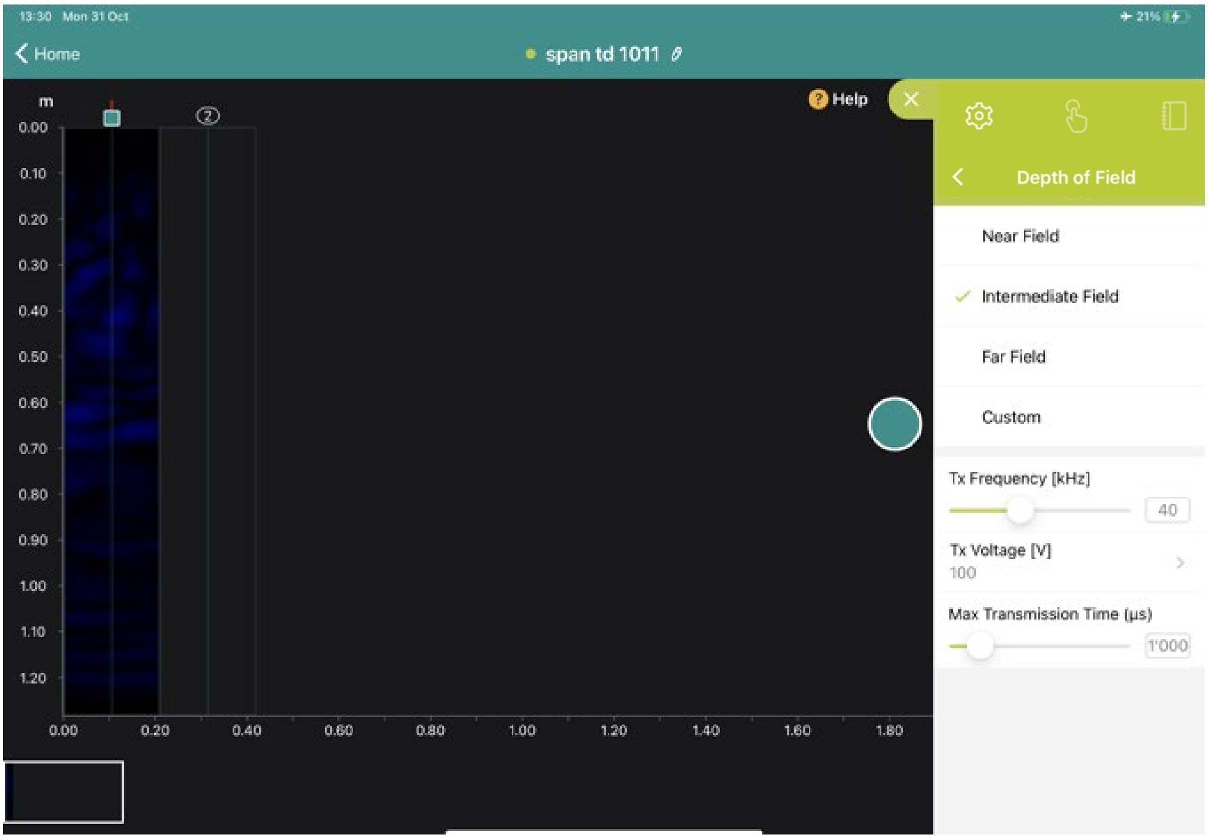


Figure 29: Depth of field.

With the “Custom” feature, the user can control the maximum transmission time to extend or reduce the range of the instrument.

The default value is 1000 microseconds. This value corresponds to 1 to 1.2m depending on the pulse velocity.

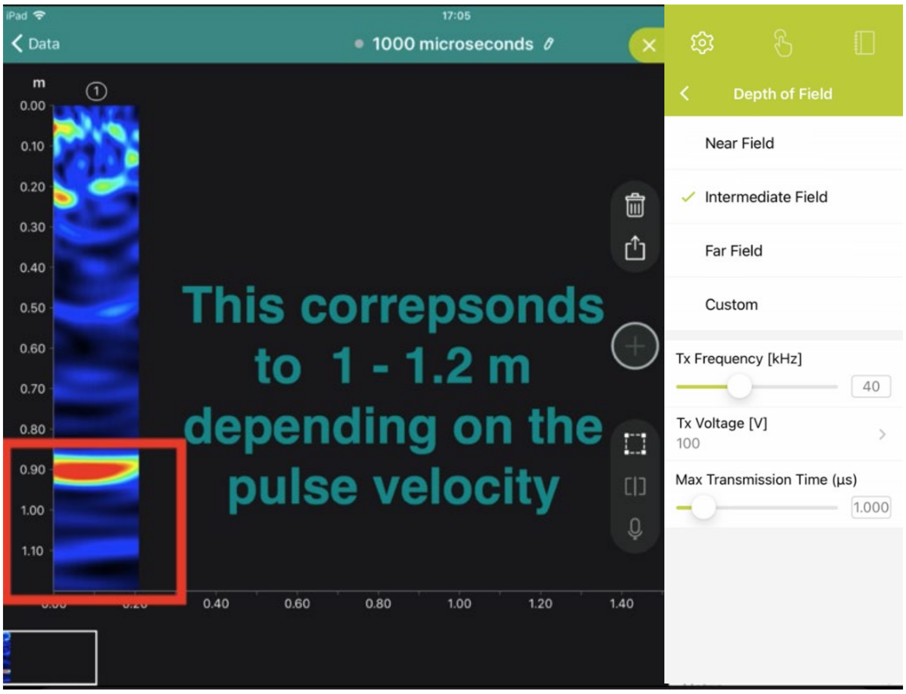


Figure 30: Default transmission time.

This value can be increased for testing deeper structures.

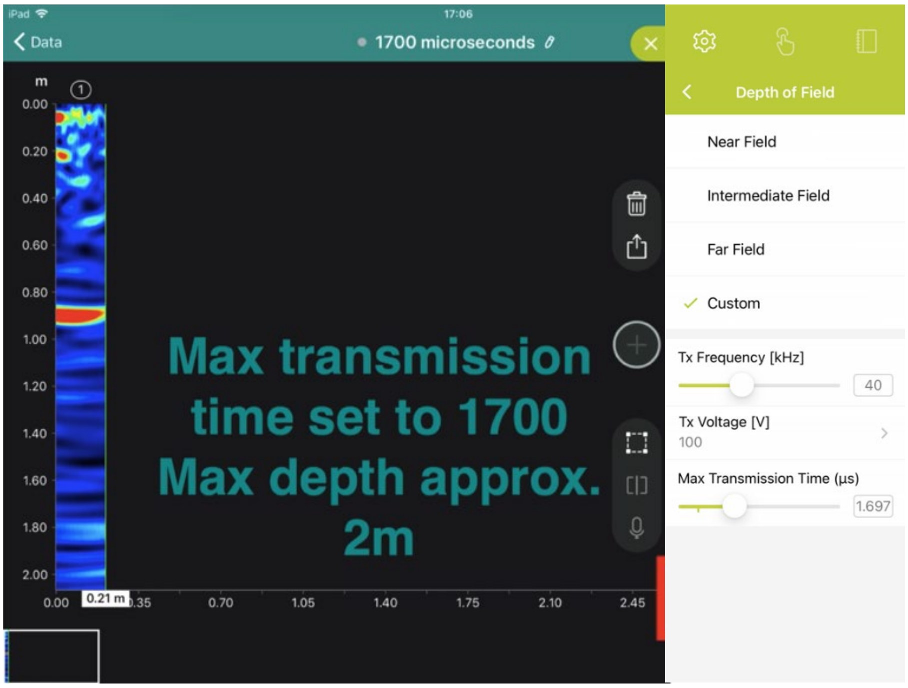


Figure 31: Modified transmission time.

For very deep objects, the 16-channel model is recommended.

The maximum transmission time is 2’500 microseconds. The maximum depth will be around 3m.

On the other side, this value can also be reduced for shallower objects. It reduces irrelevant data. This is particularly useful for 3D full matrix scans of shallow objects.

5.8 Image Stabilizer

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

The image displayed on the 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.

5.9 Advanced Settings – Half Cycle

This setting can help to distinguish near-surface objects that are close to each other.

In transmission, the transducers are driven by a high-voltage square wave.

Switching on the Half Cycle button uses a half pulse with a single polarity. As a result, the generated ultrasonic pulse has also a shorter duration, which improves the resolution along the depth (z) axis. The drawback is a shorter amount of transmitted energy, so the signal-to-incoherent noise ratio is lower.

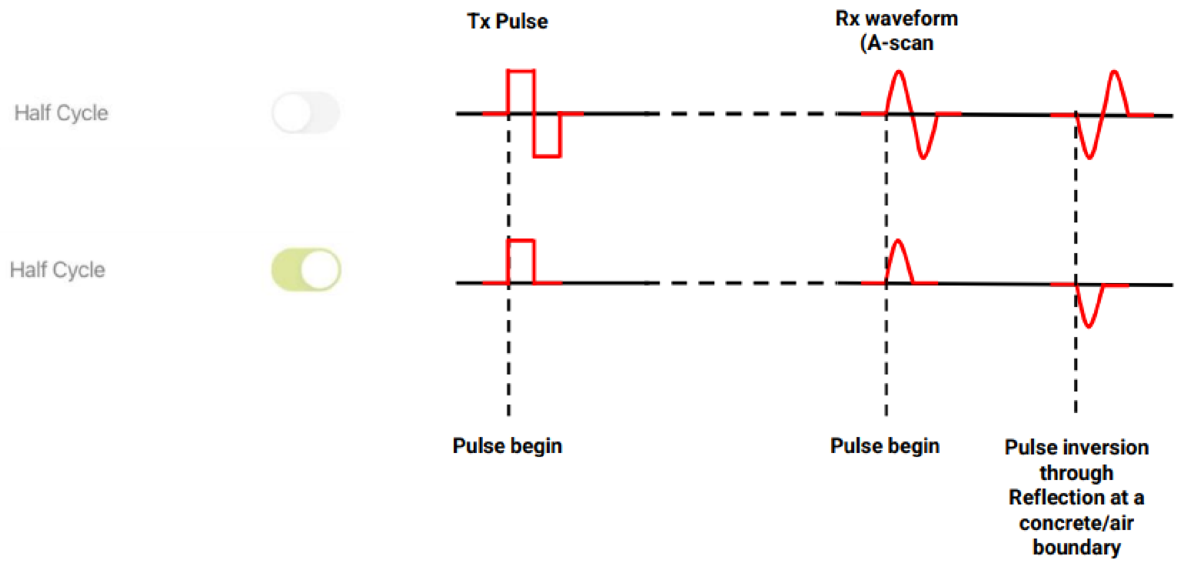


Figure 32: Half Cycle Analysis.

5.10 Advanced Settings – Pulse Delay

This setting introduces a delay between transmission pulses. It is mainly used for research projects.

The default value is 8ms. This will give the fastest screen refresh when carrying out a real-time B-scan. For narrow objects and objects with very little attenuation, the delay between pulse cycles can be increased. This reduces the noise effect of reflections from side walls etc.

As said before, the pulse delay is the time between two successive transmissions.

Assuming a Pulse Delay of 8 ms (default):

- Transmission 1 occurs at t=0 ms
- Transmission 2 occurs at t=8 ms
- Transmission 3 occurs at t=16 ms
- etc

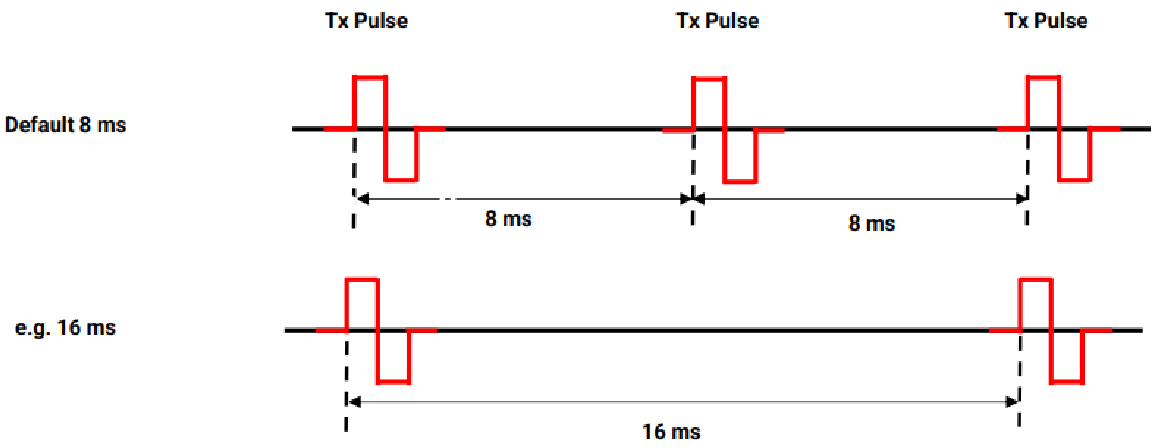


Figure 33: Pulse Delay.

Remark: the PD8050 records the first 1 to 4 µs after the transmission (1 ms = 1000 µs). So the pulse delay is typically 2'000-8'000 times longer than the actual record; the PD8050 spends most of its time idle. This delay is needed to ensure that the waves generated in the previous transmission will have time to fully attenuate. If the Pulse Delay is too short, the previous transmission will perturb the following one, leading to poor signal and image artifacts.

Recommendations:

- The default value (8 ms) should work for most cases.
- To ensure the Pulse Delay is adequate: increase its value (for example, multiply by 2) and compare the B-scan before/after. The images should be identical.

5.11 Advanced Settings – Raw Data Offset

This setting is used for more accurate depth estimations.

This feature allows the user to work with the envelope peak for depth measurements. This is much easier than trying to locate the beginning of a pulse. The default value is -30 µs. Using the calibration function using two echoes described later in this document, this value is set automatically. If two echoes are not available, it is recommended to work with the default value.

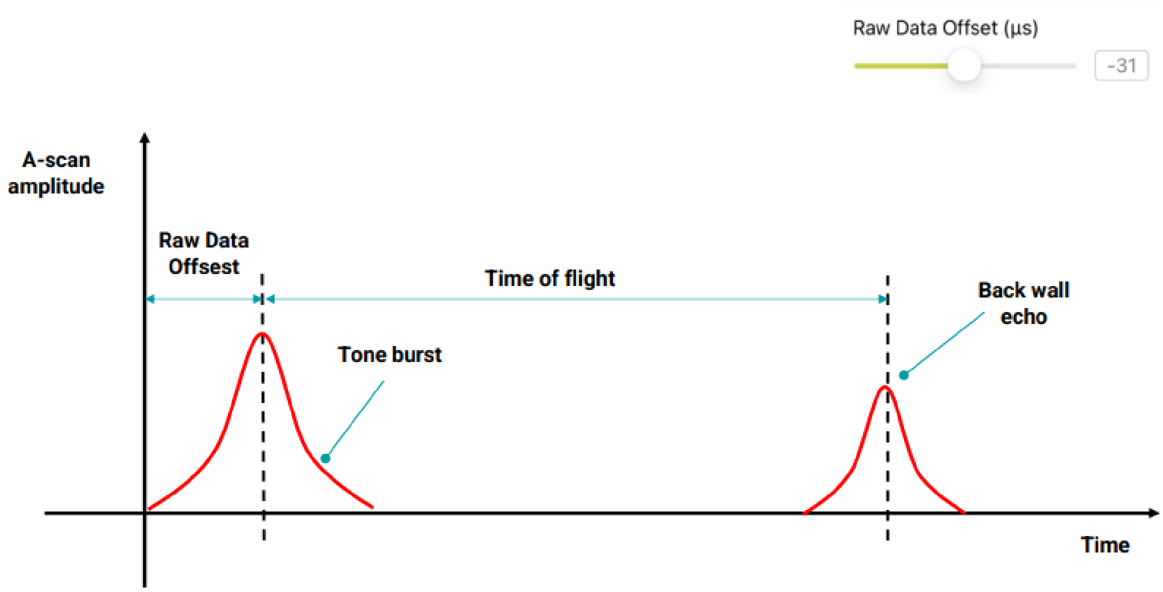


Figure 34: Raw Data Offset.

5.12 Advanced Settings – Surface Wave Cancelation

Surface Wave Cancellation Removes the surface wave component from the displayed B-scan.

5.13 Auto Gain and Adjust Gain

The auto gain function adjusts the digital gain and TGC to optimum settings based on signal levels acquired in the entire scan. If this is activated it is not possible to adjust those settings manually. It generally gives a good starting point and can be disabled on completion of the scan to further adjust using the manual settings.

5.14 Pulse Velocity Calibration

PD8050 measures shear waves, which are also called S-waves. The velocity of the ultrasound waves depends on the quality, homogeneity, and density of the material. This is why it is very important to calibrate first the wave velocity in each specific concrete element.

S-wave Velocity	Corresponding P-wave Velocity	Concrete Quality Classification
> 2'800 m/s	> 4'500 m/s	Excellent
2'100 – 2'800 m/s	3'500 – 4'500 m/s	Good
1'700 – 2'100 m/s	3'000 – 3'500 m/s	Medium
< 1'700 m/s	< 3'000 m/s	Doubtful

Figure 35: P and S waves velocity.

Calibration of the speed of sound based on the thickness of the test object:

The speed of sound is determined at a point on the test object whose thickness is known through a comparison measurement. If access is one-sided, penetrations or exploratory drillings can be used for calibration.

Case A: 1st and 2nd backwall echoes are visible – Select "Calibrate".

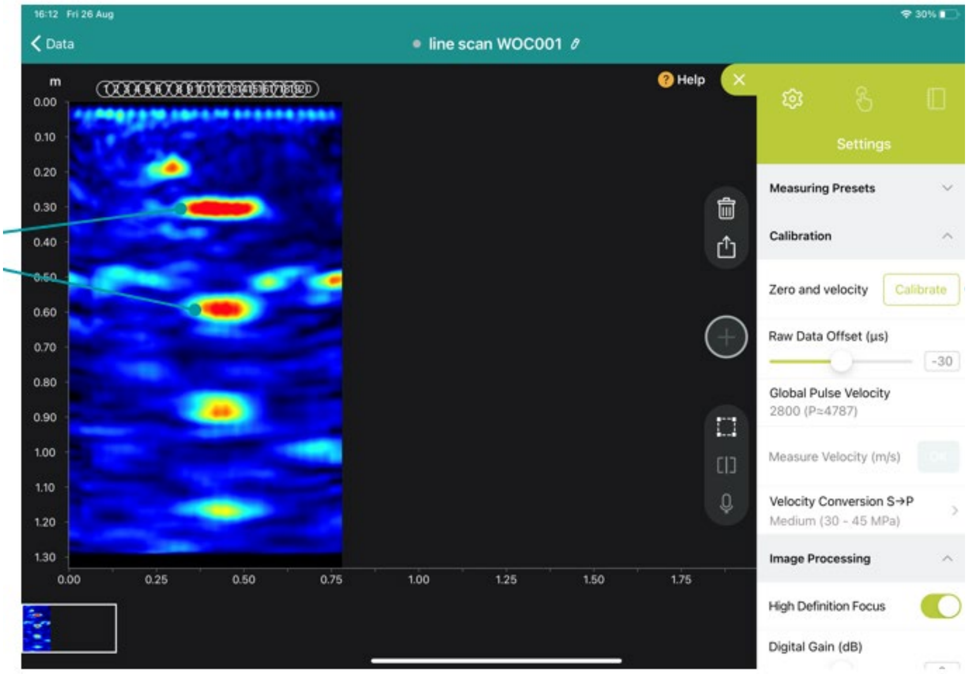


Figure 36: Case A – 1st and 2nd backwalls are visible.

- Use A-scan to align tags to the peaks of the 1st and 2nd backwall echoes.

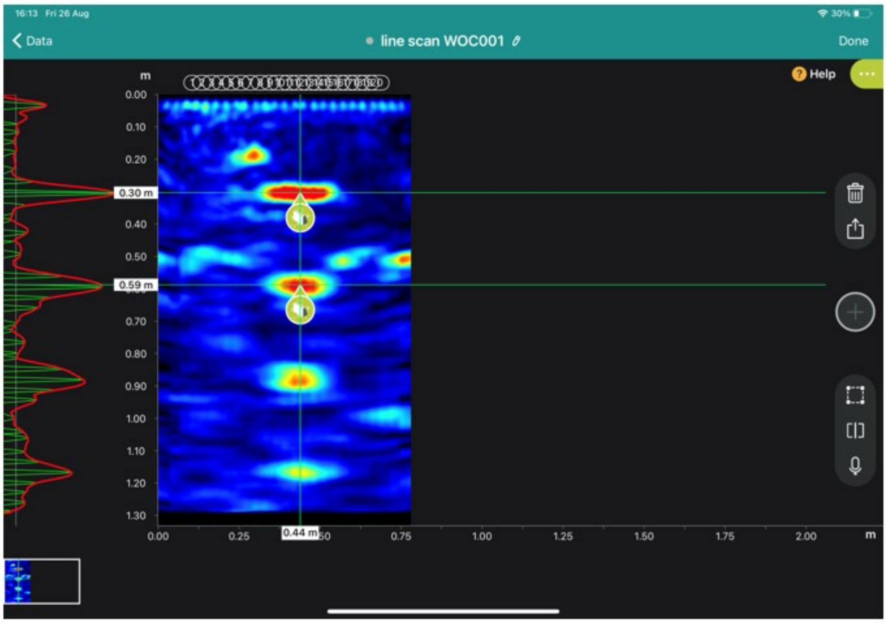


Figure 37: Case A – 1st and 2nd backwalls are visible.

- Tap on 1st tag and 2nd tag to enter the known depth of the test object, then click "Done":

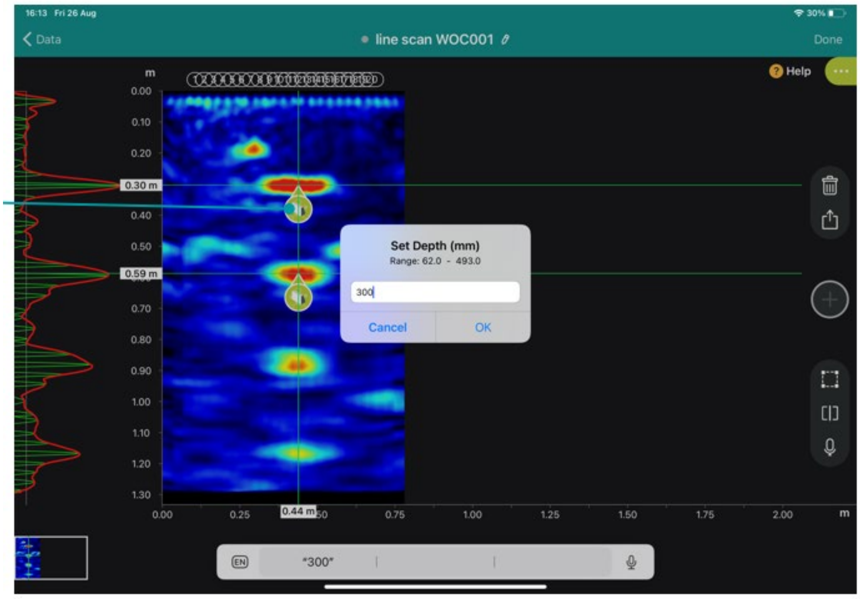


Figure 38: Case A – 1st and 2nd backwalls are visible.

- Orange tags indicate tags are used for pulse velocity calibration.

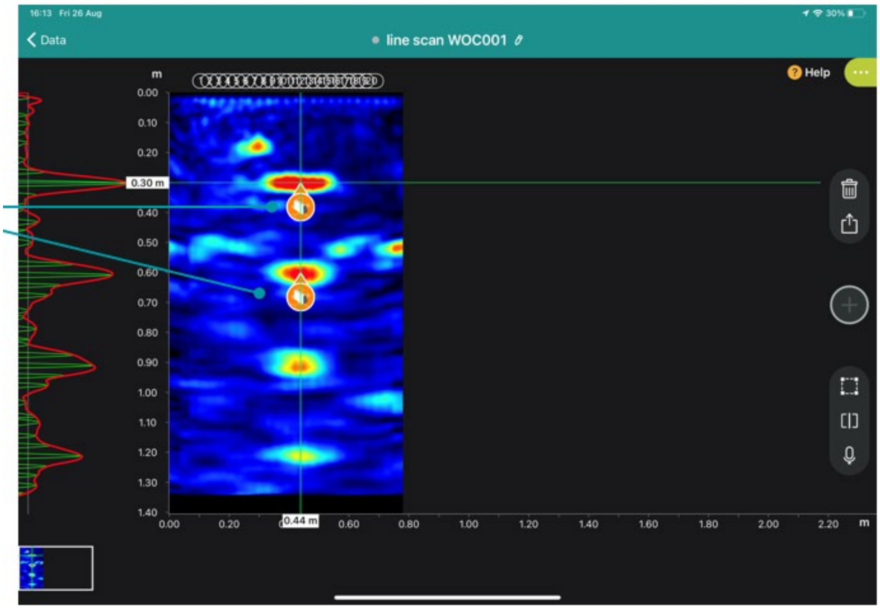


Figure 39: Case A – 1st and 2nd backwalls are visible.

- Raw Data Offset and Global Pulse Velocity are now calibrated to the concrete under test. The transit time is calculated from peak to peak as seen in the screenshot below. The raw data offset is shown in the right menu of the measurement screen.

Case B: Only 1st backwall echo is visible:

- Set raw data offset to default value = -30µs.

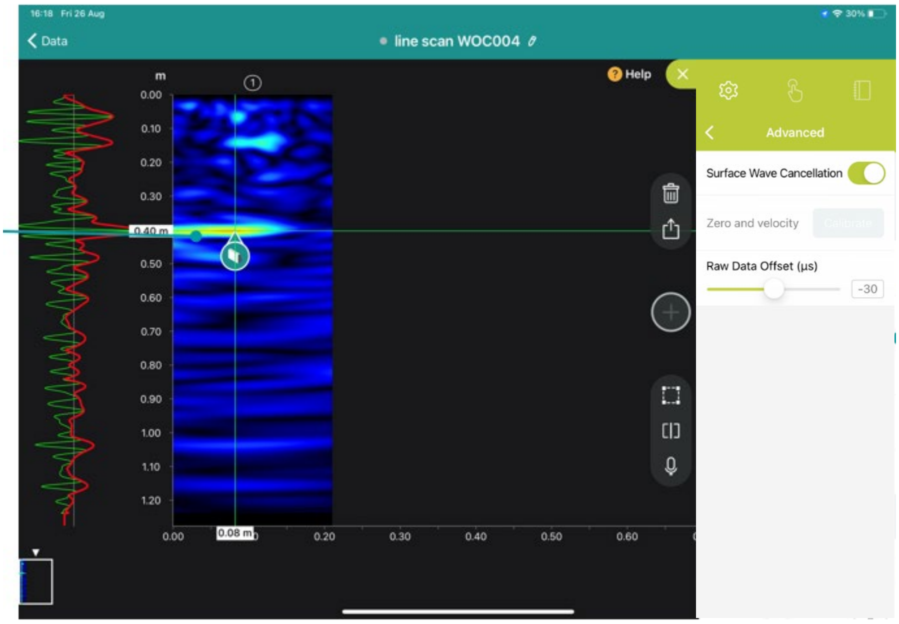


Figure 40: Case B – 2nd backwalls are not visible.

- Use A-scan to align the tag to the peak of the backwall echo. Long press to add a backwall tag manually and align with the peak of the A-scan. Then tap in “set depth” to include the known depth of the object.

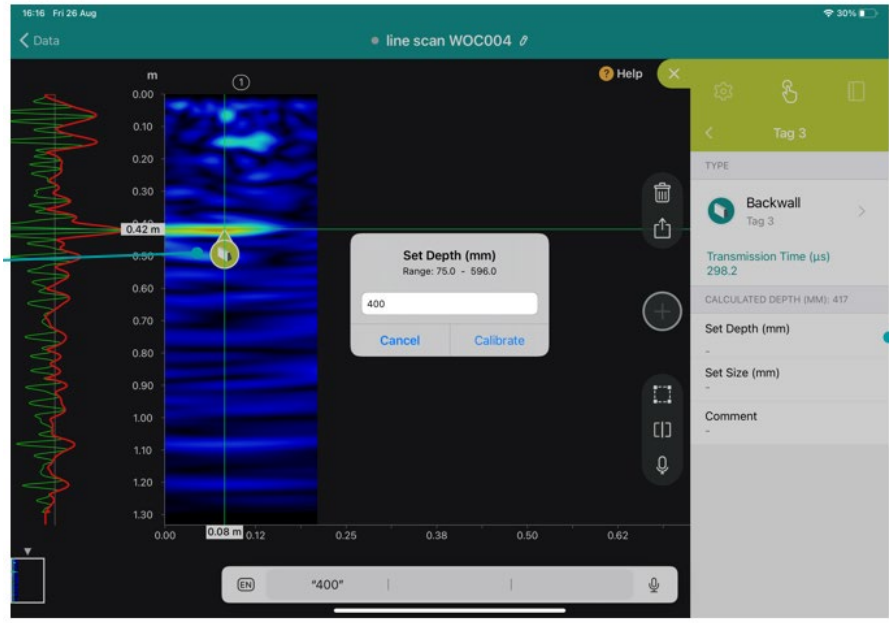


Figure 41: Case B – 2nd backwalls are not visible.

- The orange tag indicates that this tag has been used for the calibration of pulse velocity.

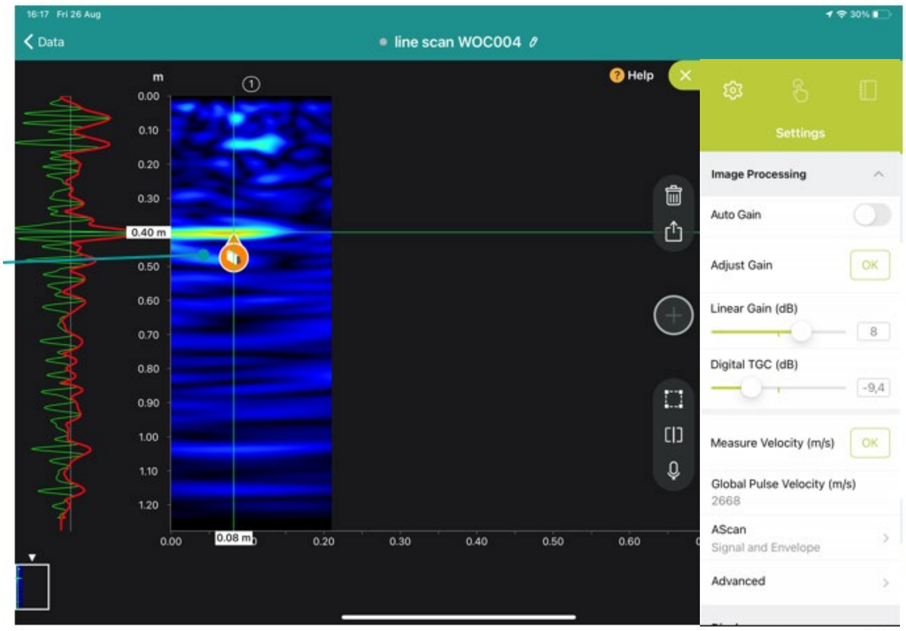


Figure 42: Case B – 2nd backwalls are not visible.

Calibration of the speed of sound on the surface of the test object

This option can be used when the thickness of the test object is not known. However, the properties of concrete in the near-surface area can differ from those in the volume. This means that the speed of sound can also differ.

The pulse velocity of signals traveling near the surface of the concrete is determined. Press the transducer against the surface to make a measurement. Several measurements can be made using the snapshot key at different locations and an average value is calculated.

To do so, tap “Measure Velocity”. Then a window will pop up. Perform 5 to 10 measurements in the test area moving the sensor around. The average value will be stored.

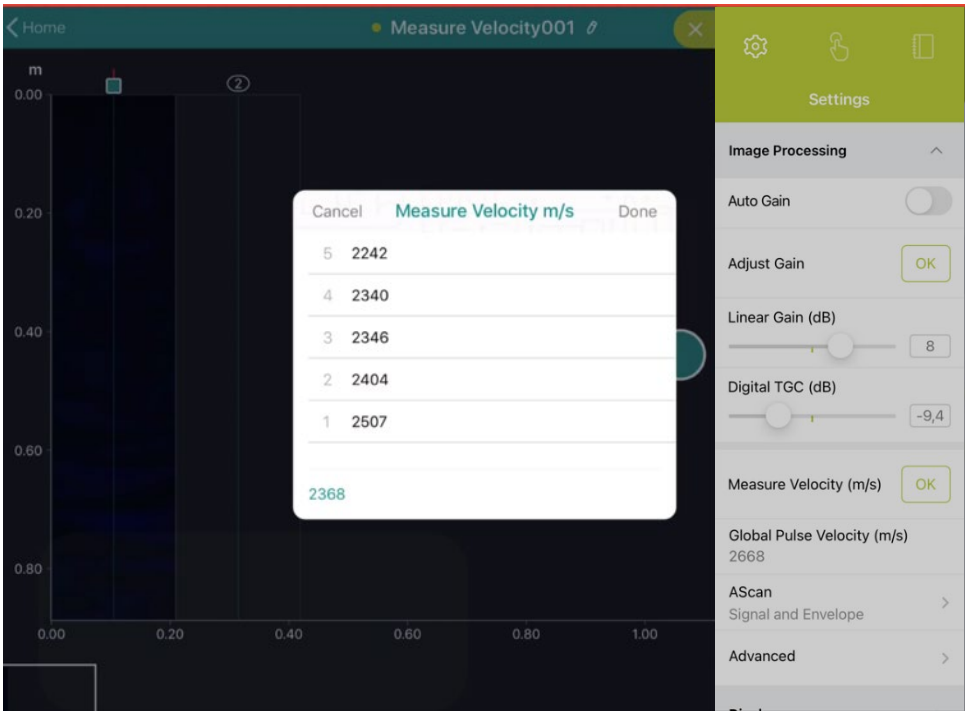


Figure 43: Calibration of the speed of sound in the test object.

Estimation of the speed of sound based on empirical values.

This method should only be used in exceptional cases and requires a good knowledge of the materials. Increased measurement uncertainties are to be expected.

5.15 Ultrasound Pulse Velocity Determination with Ultrasound Pulse Echo

PD8050 measures shear waves, which are also called S-waves. The velocity of the ultrasound waves depends on the quality, homogeneity, and density of the material.

Even if it is important to calibrate first the wave velocity in each specific concrete element, you will always get good images with a typical pulse velocity. Afterward, if you want more precise depth information, you can calibrate the pulse velocity.

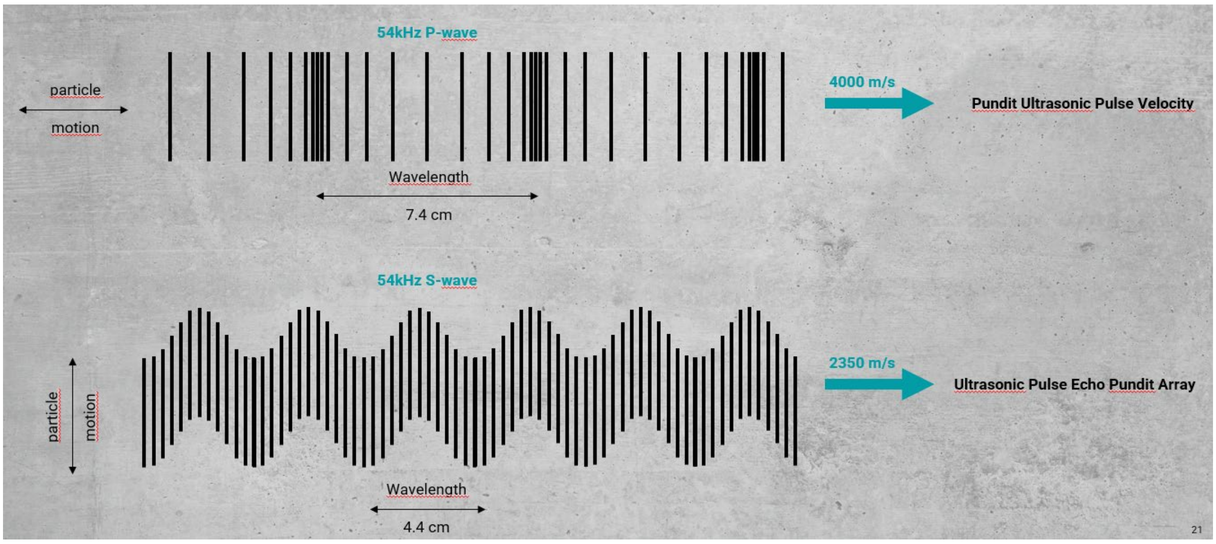


Figure 44: P-waves vs S-waves.

For pulse echo instruments to create images using Synthetic Aperture Focusing Technique (SAFT), it is needed to use a global pulse velocity, which is set using one of the methods described in the previous chapter.

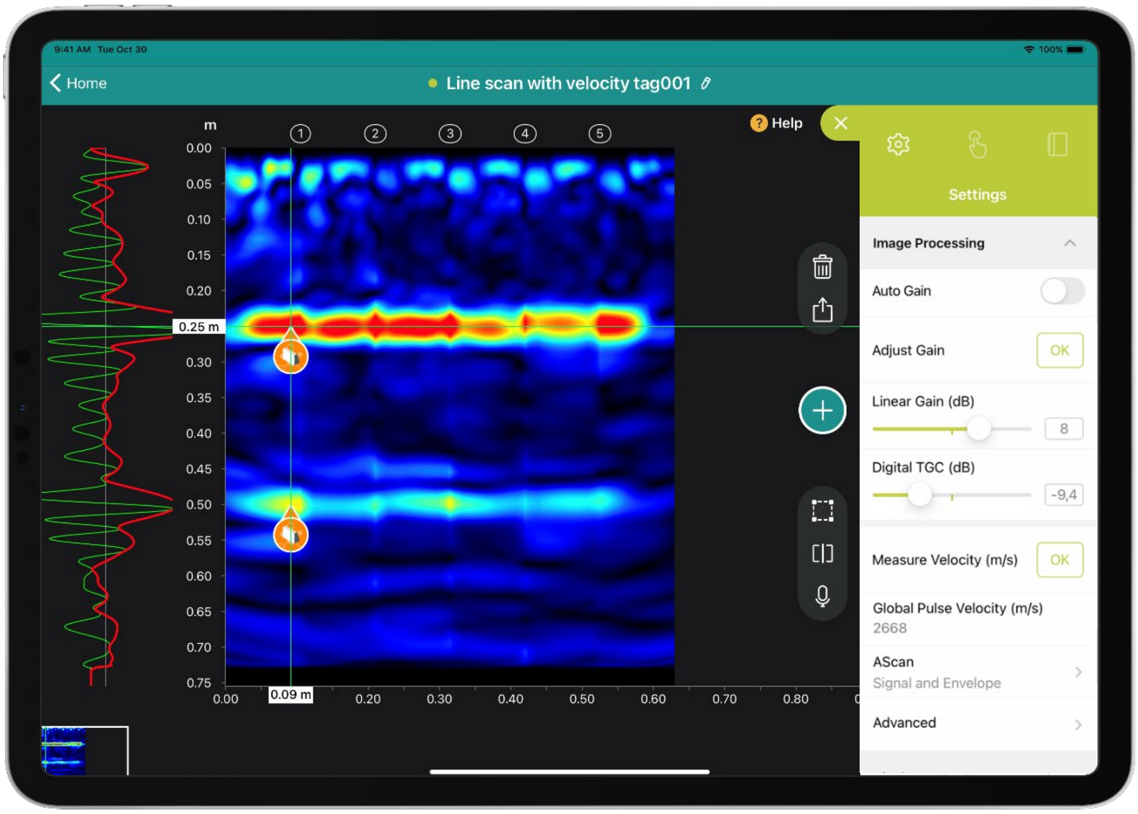


Figure 45: Global Pulse Velocity.

- The pulse velocity tag allows a Local Pulse Velocity to be recorded at any point in the scan.
- It is added in the same way as any other kind of tag by tapping on the screen and holding until the tag menu appears.

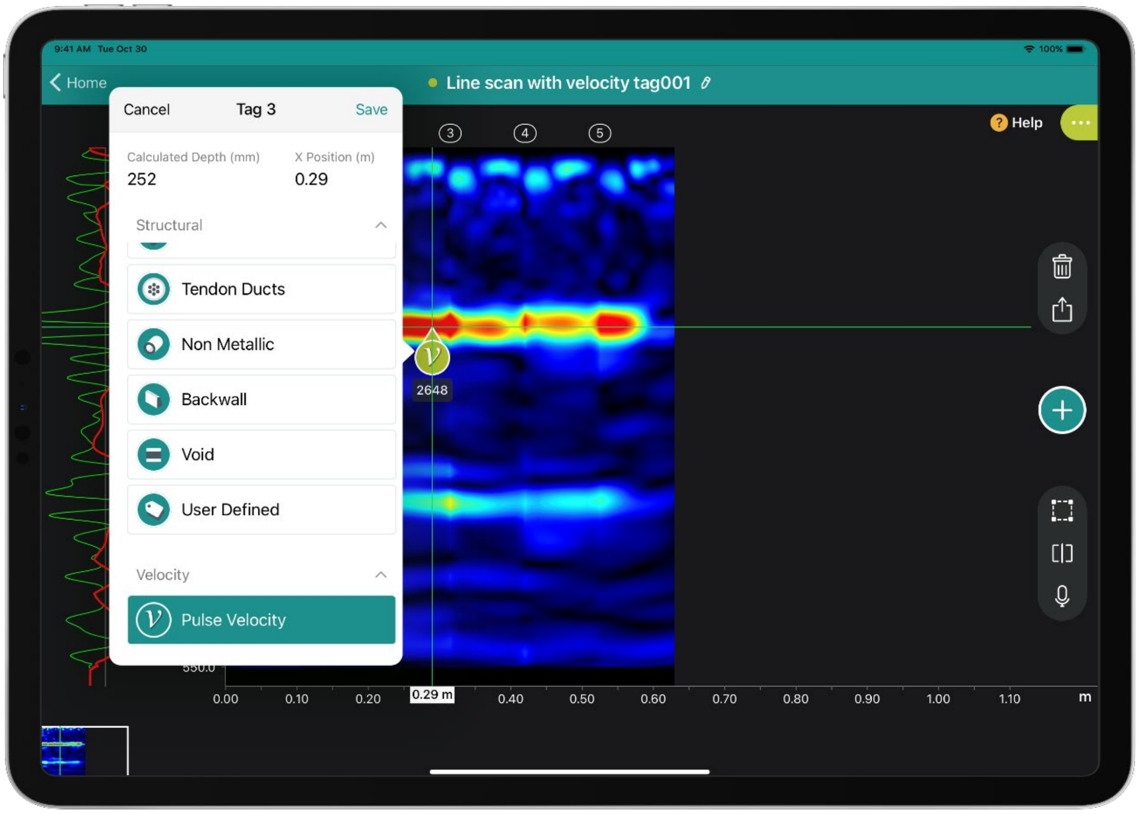


Figure 46: The velocity tag.

- The tag information shows the measured transmission time, the local S-wave velocity, an estimated P-wave velocity, and the local depth.
- On creation of the tag, the local depth is simply calculated from the global pulse velocity.
- Tap on it and set the known depth (in this example 250 mm) to determine the local S-wave velocity.

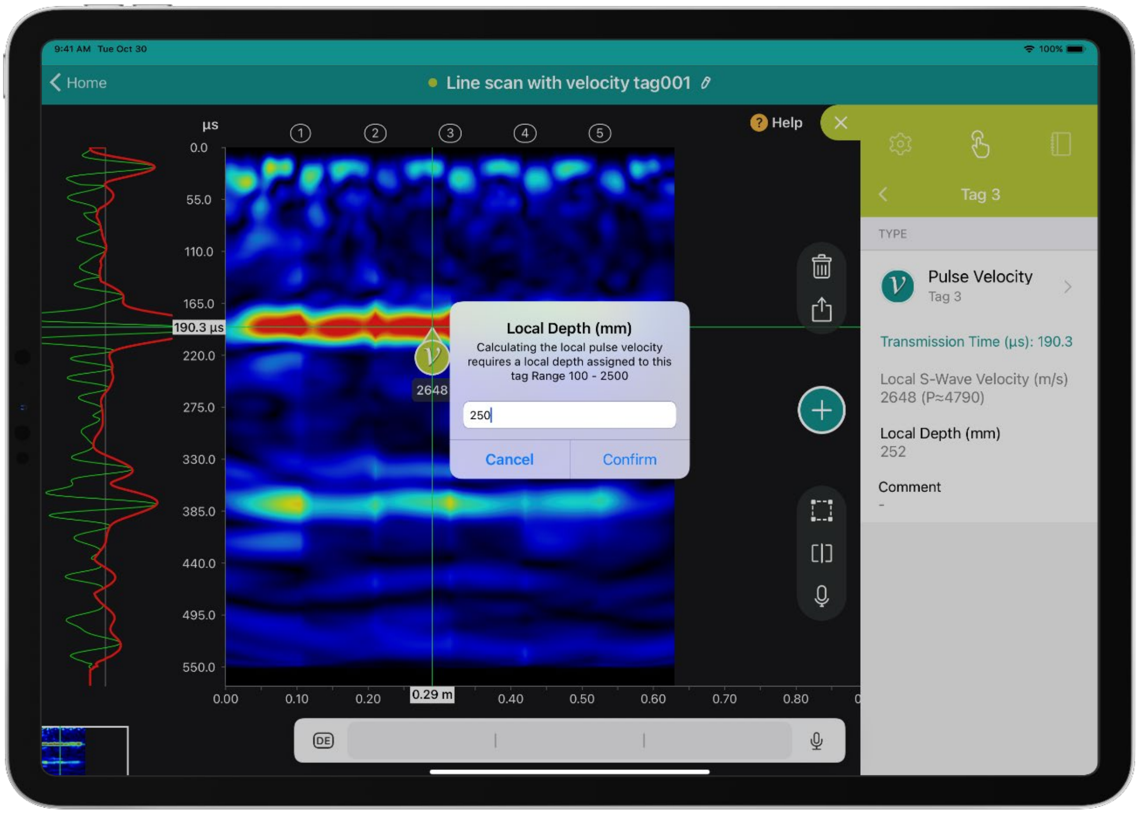


Figure 47: The velocity tag.

- The local pulse velocity value is displayed below the tag.
- Velocity tags can be added at any point on the scan.

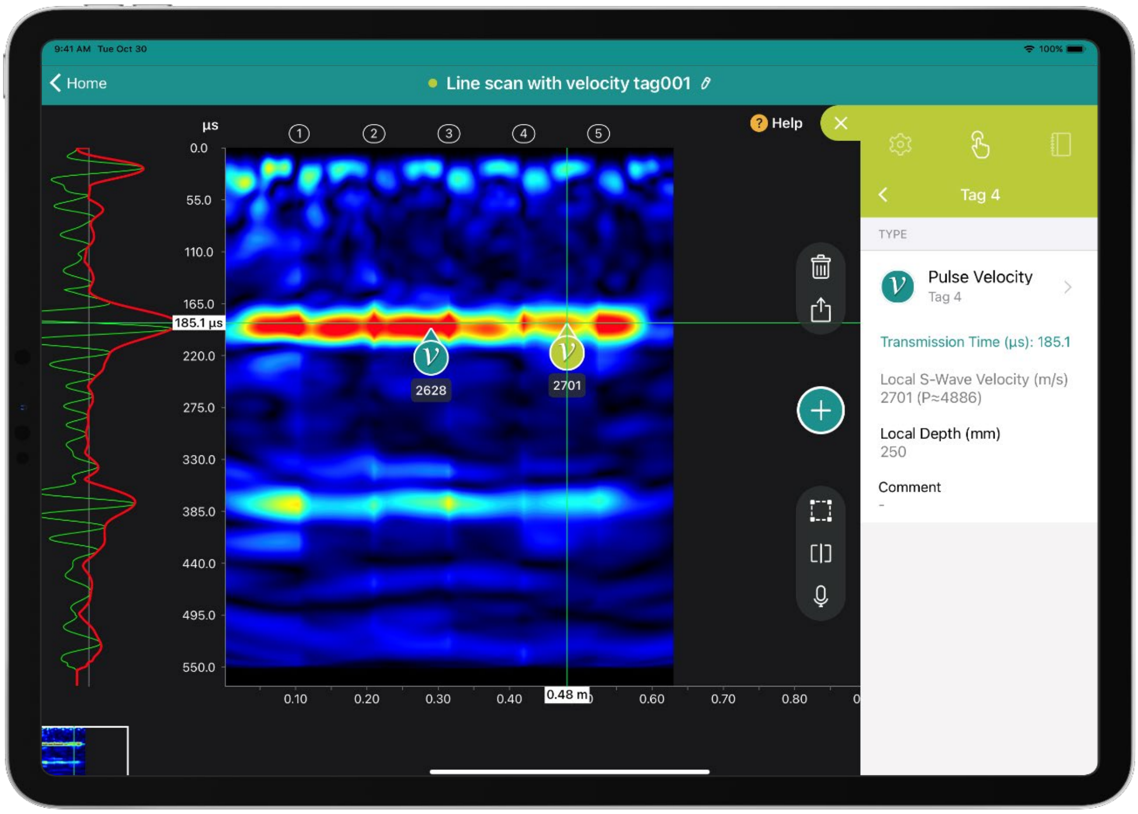


Figure 48: The velocity tag.

5.16 P-wave estimation from measured S-wave value

- Many users will be more familiar with P-wave values as an indicator of concrete quality.
- The P-wave velocity can be calculated directly from the S-wave velocity if the Poisson’s ratio of the concrete is known.

$$V_P = \sqrt{\frac{2{V_S}^2(\nu - 1)}{2\nu - 1}}$$

Where :

V_P = P-wave velocity

V_S = S-wave velocity

v = Poisson’s ratio

- If the Poisson’s ratio is known this can be entered manually.
- To simplify things, typical values for the Poisson’s ratio can be used based on the compressive strength.

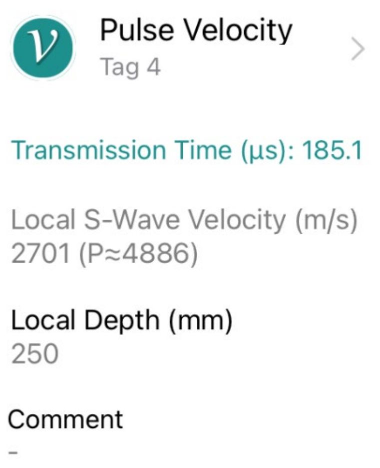


Figure 49: S-wave to P-wave velocity.

5.17 Line Scan

A Line Scan can be created by stitching individual B-scans together to make a larger image. A scan is always carried out from left to right.

Scan parallel to the long axis of the sensor. This mode will combine each individual B-scan with or without an overlap to create a line scan.

Please note that the analog gain and TGC can only be adjusted before saving the first B-scan. After that, these controls will be blocked.

However, digital gain and TGC can be adjusted at any time and after the scan has been finished.

Zero Overlap means that the transducer is moved by a complete transducer length to create the next B-scan.

Due to the edge effects caused by the SAFT algorithm, an image created with zero overlap can be disjointed at the borders. For this reason, it is often better to use an overlap.

For best results and ease of alignment when carrying out the scan it is best to set the overlap as a whole number of channels (each channel overlap is equal to 3cm).

When carrying out a typical application like trying to determine the extent of delamination on a large structure, it may be preferable to leave a gap between B-scans to reduce the effort.

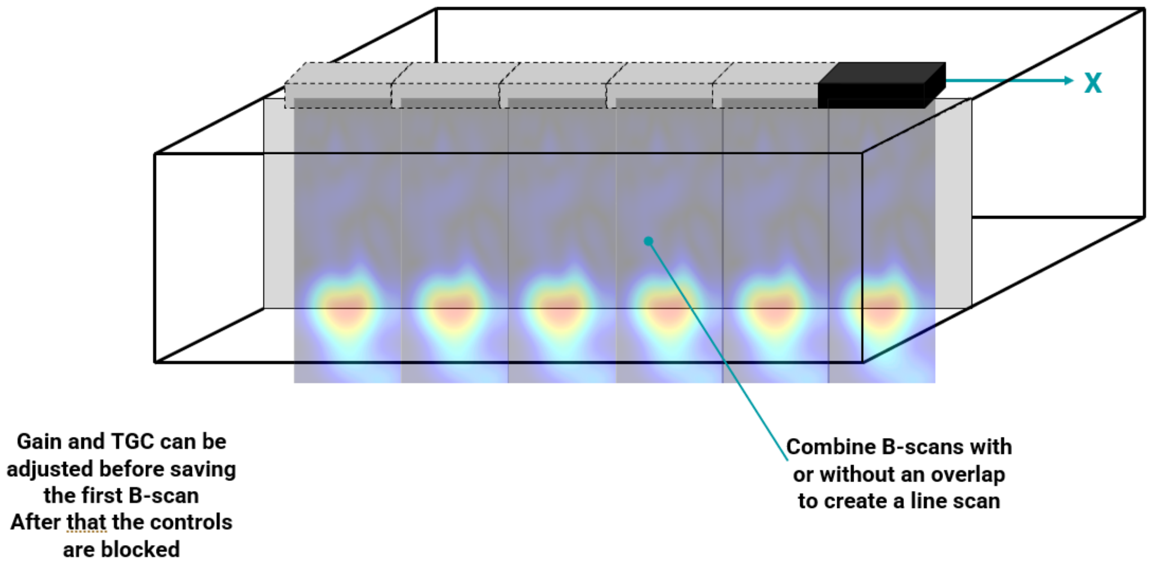


Figure 50: Line Scan Sketch.

Unless AI positioning is used (by using the measuring tape), it will be necessary to set the X spacing. This is equivalent to how far you want to move the sensor between snapshots.

The default spacing is x = 21cm, which is equal to the distance between the outer transducers.

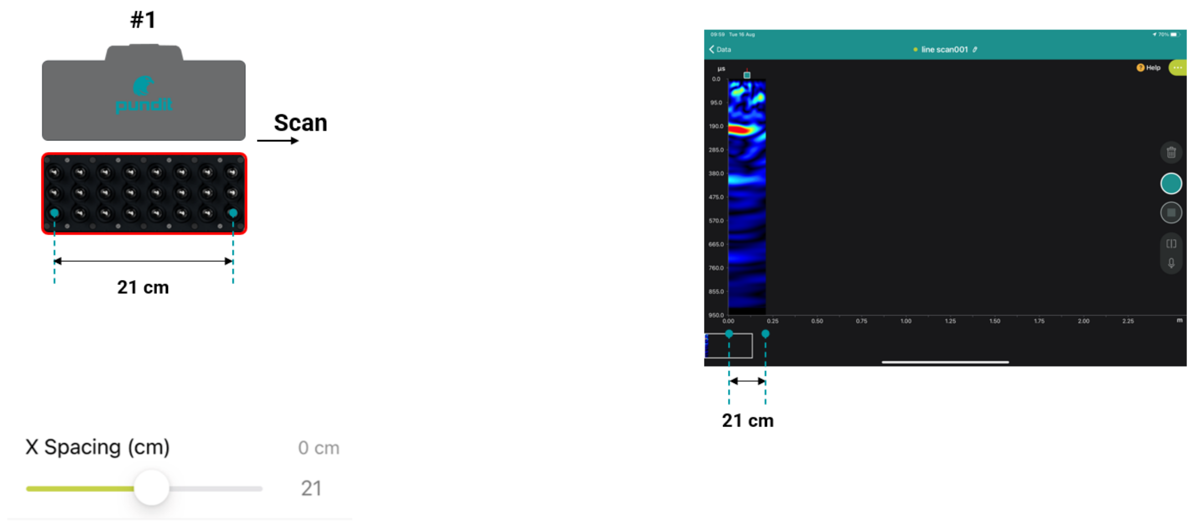


Figure 51: Default spacing.

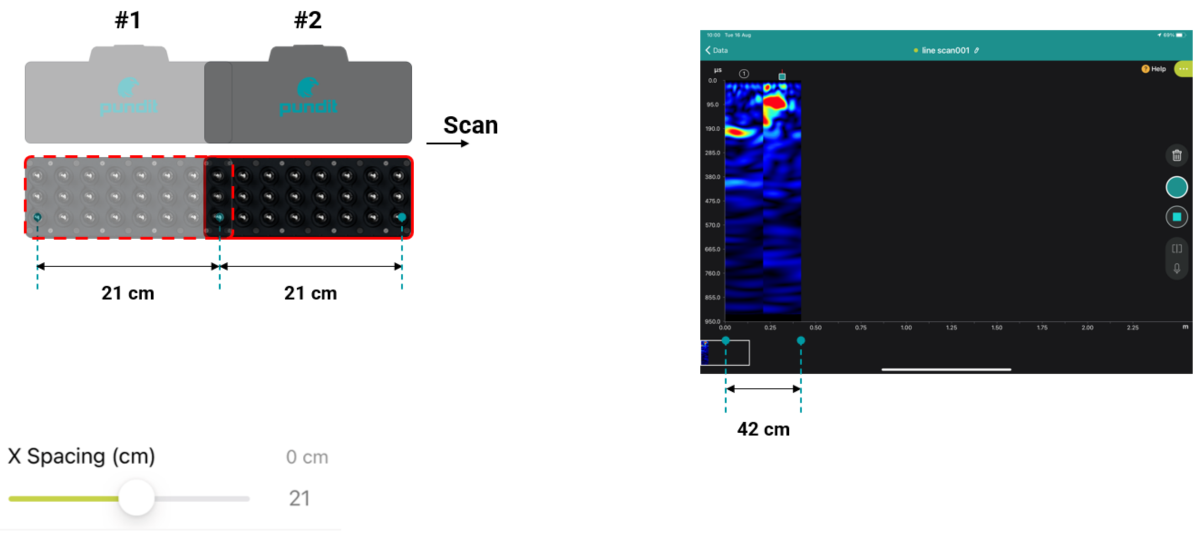


Figure 52: Default spacing.

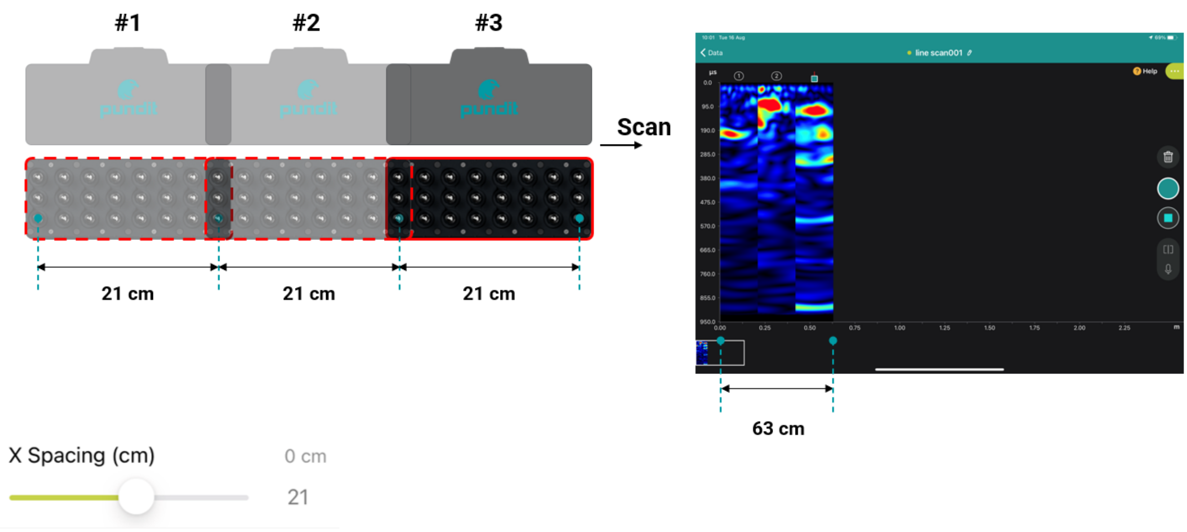


Figure 53: Default spacing.

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.

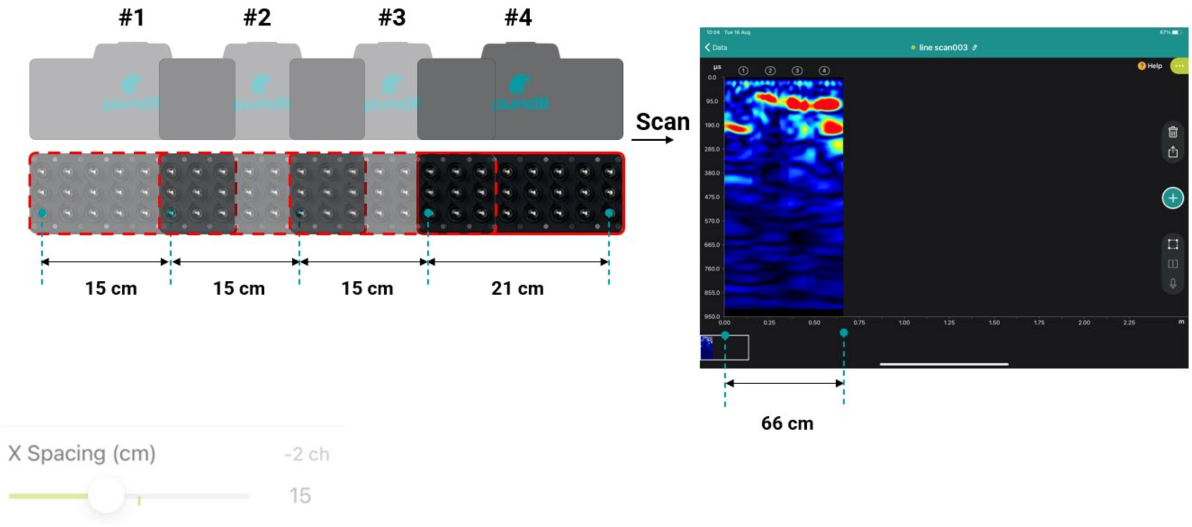


Figure 54: Default spacing.

The maximum overlap is the distance between two consecutive channels (x = 3cm).

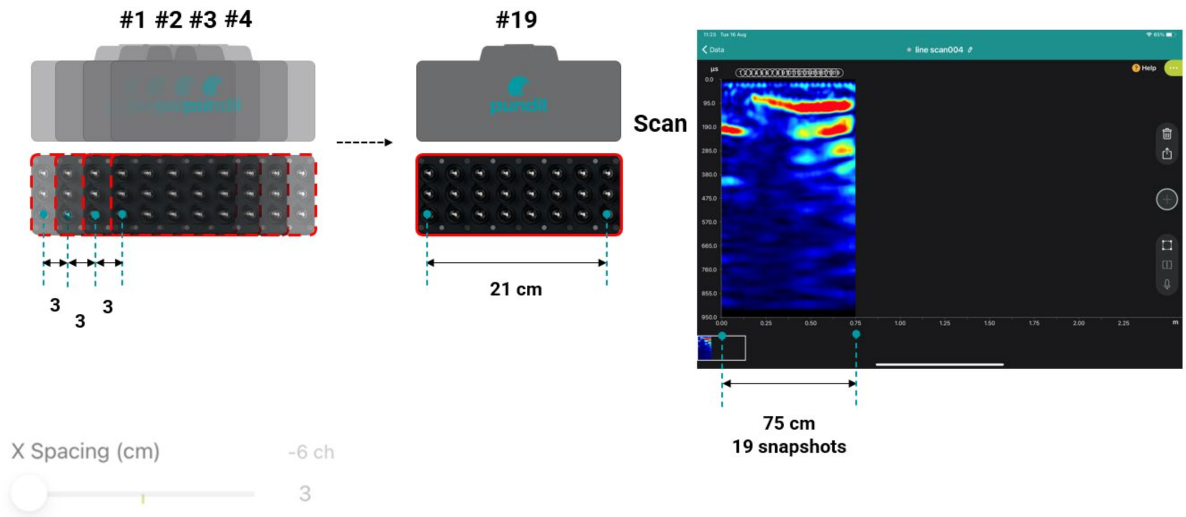


Figure 55: Maximum overlap.

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.

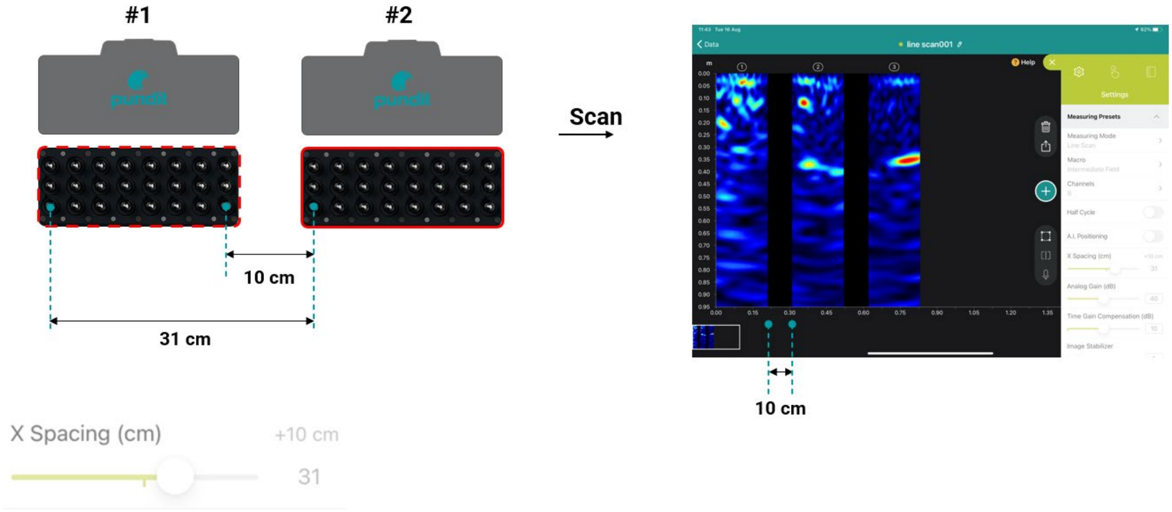


Figure 56: Spacing bigger than 21cm.

5.18 Full 3D Matrix

PD8050 can create 3D scans that are very useful for some common applications such as PT duct inspection.

To do so, scan parallel to the short axis of the sensor.

Keep in mind that the maximum length of a 3D matrix scan is 1.5m. Also, the analog gain and TGC must be adjusted before saving the first B-scan. Switch to the B-scan view to adjust the transmission parameters as required before commencing with the scan. After that, these controls will be blocked.

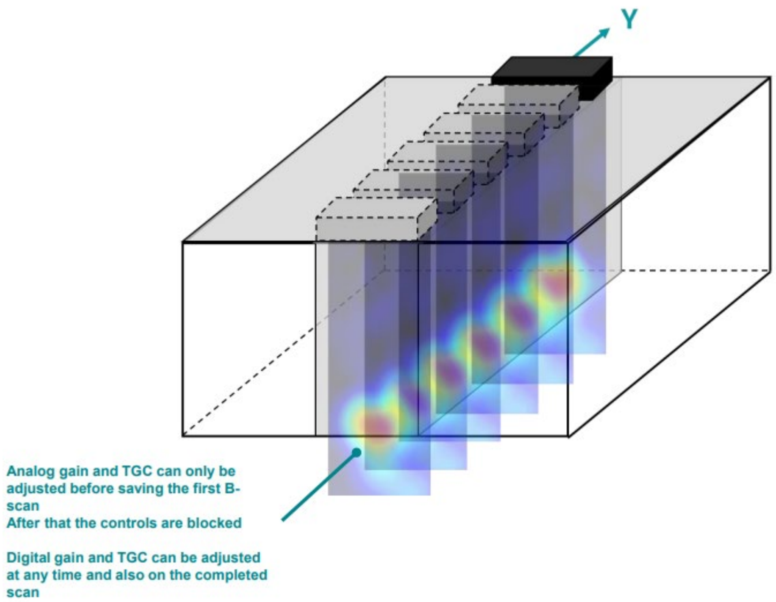


Figure 57: Full 3D matrix scan.

By interpolating consecutive B-scans, a 3D image is then created.

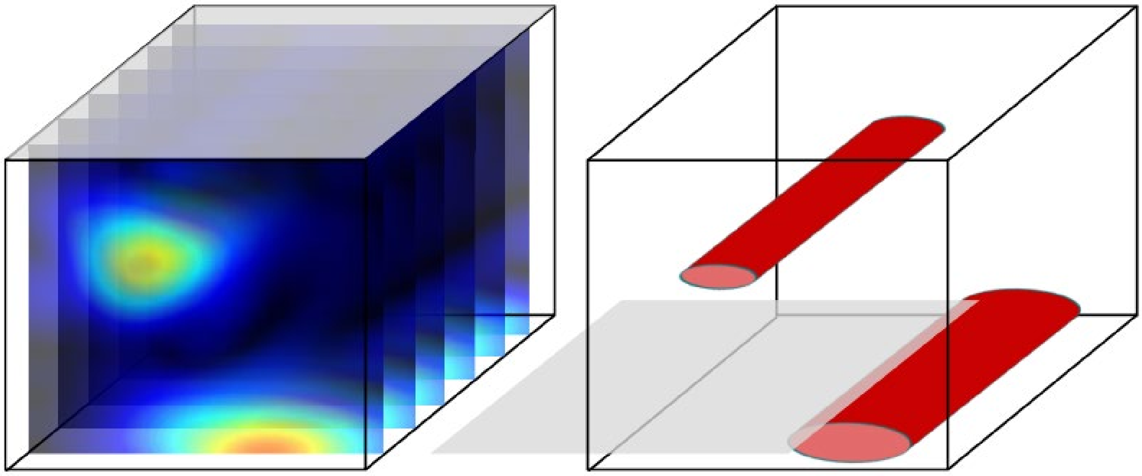


Figure 58: Full 3D matrix scan.

This 3D view can be sliced to see what is called the “Time Slice” or C-scan. It shows the amplitude of the signal at a chosen depth. We can adjust the thickness of the slice and move it to any depth.

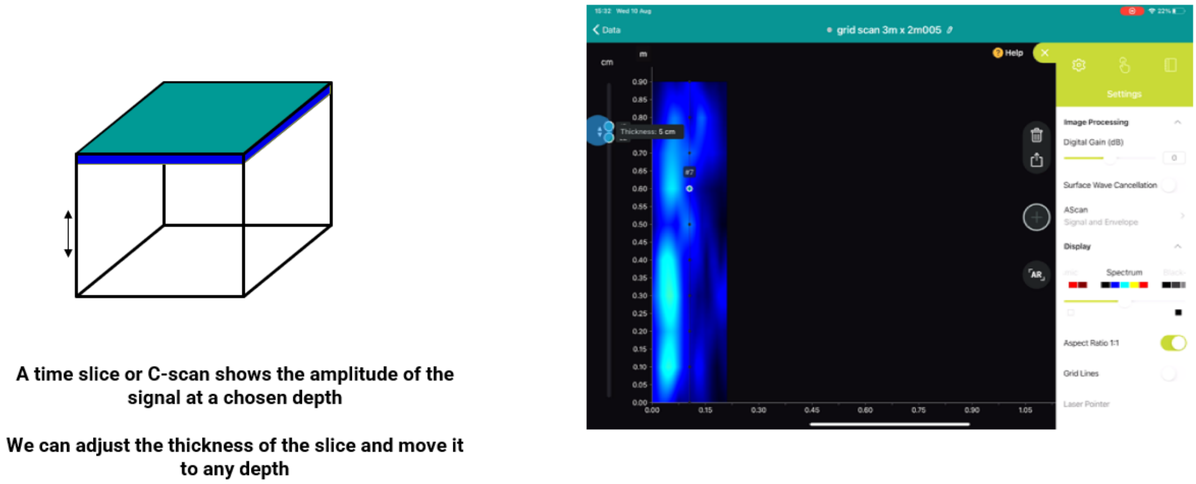


Figure 59: C-scan view.

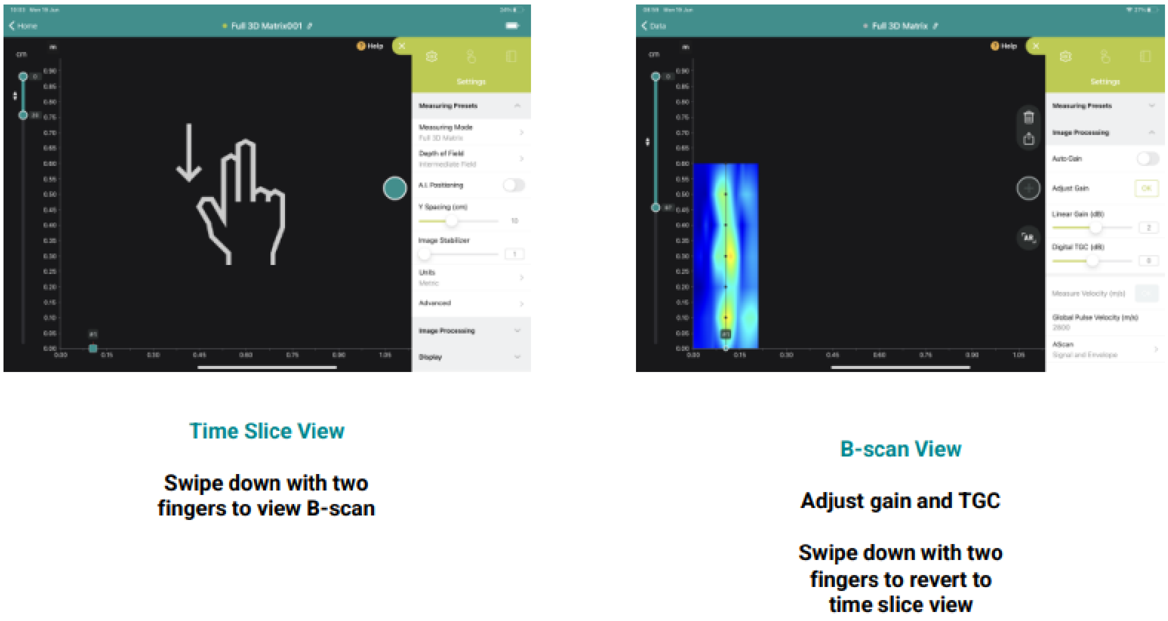


Figure 60: Time slice and B scan view.

Unless AI positioning is being used, it is necessary to set the transversal spacing (Y). This is equal to how far you wish to move the sensor between snapshots.

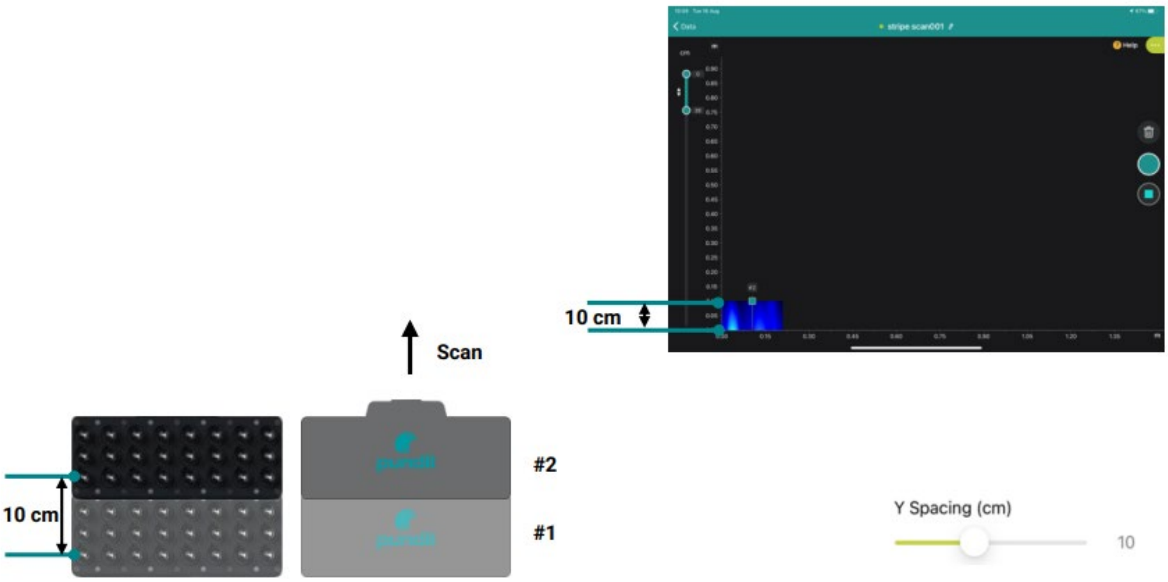


Figure 61: Transversal spacing and C-scan.

The image that is shown between two consecutive positions where the sensor was located is calculated via interpolation.

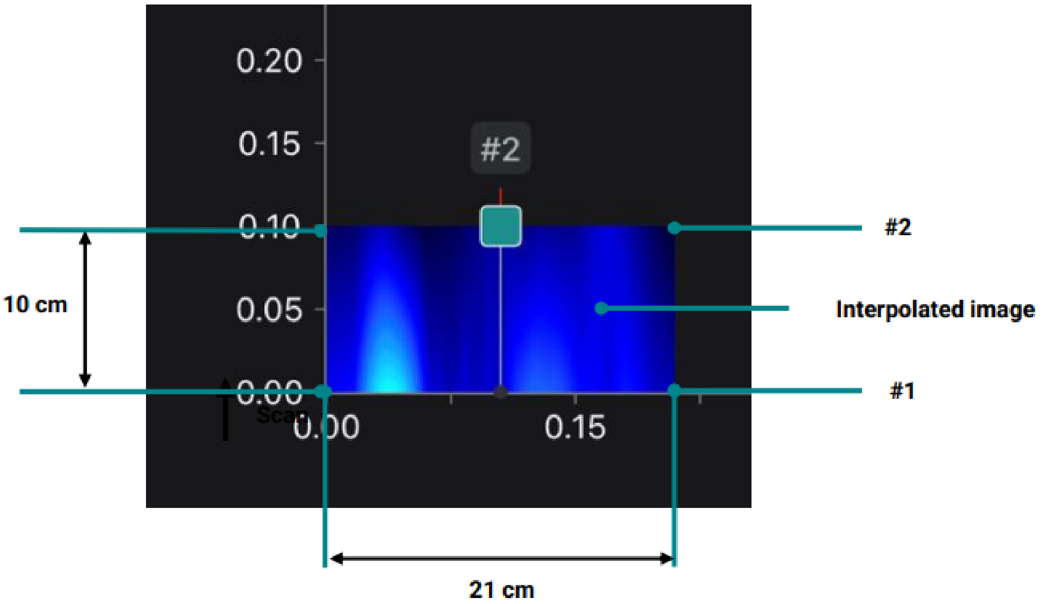


Figure 62: Interpolation of images.

The maximum length of a full 3D matrix scan is equal to 1.5m.

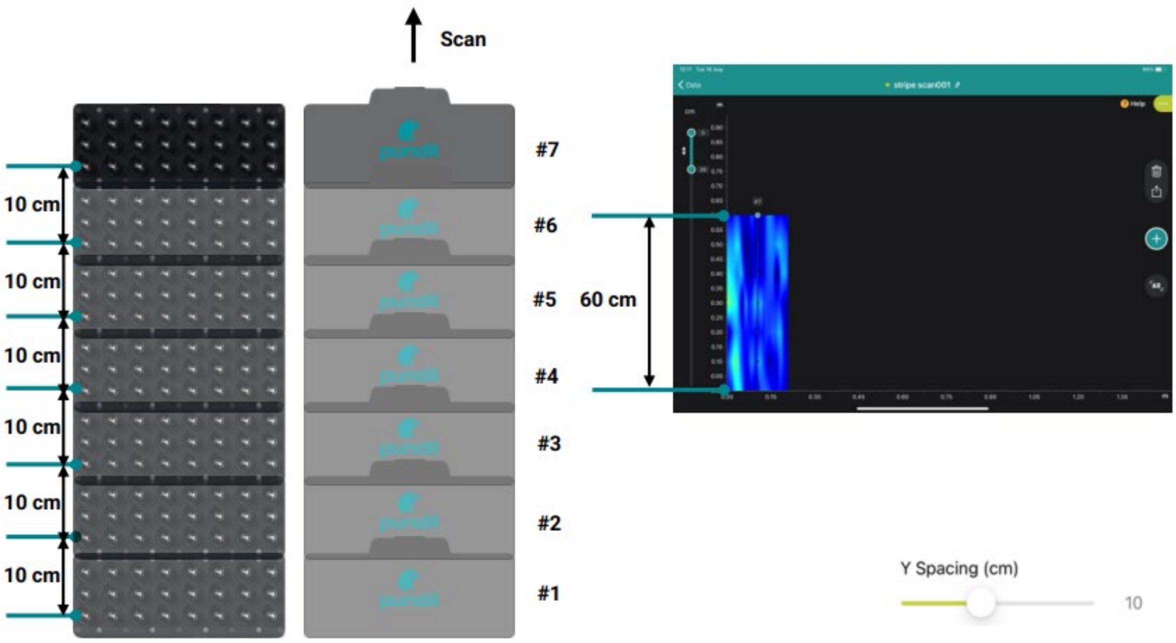


Figure 63: Transversal spacing and C-scan.

Once the measurement has been finished, you will be working under the review mode. In this mode, three different views can be seen by sliding up your fingers: B-scan, C-scan, and full 3D matrix view.

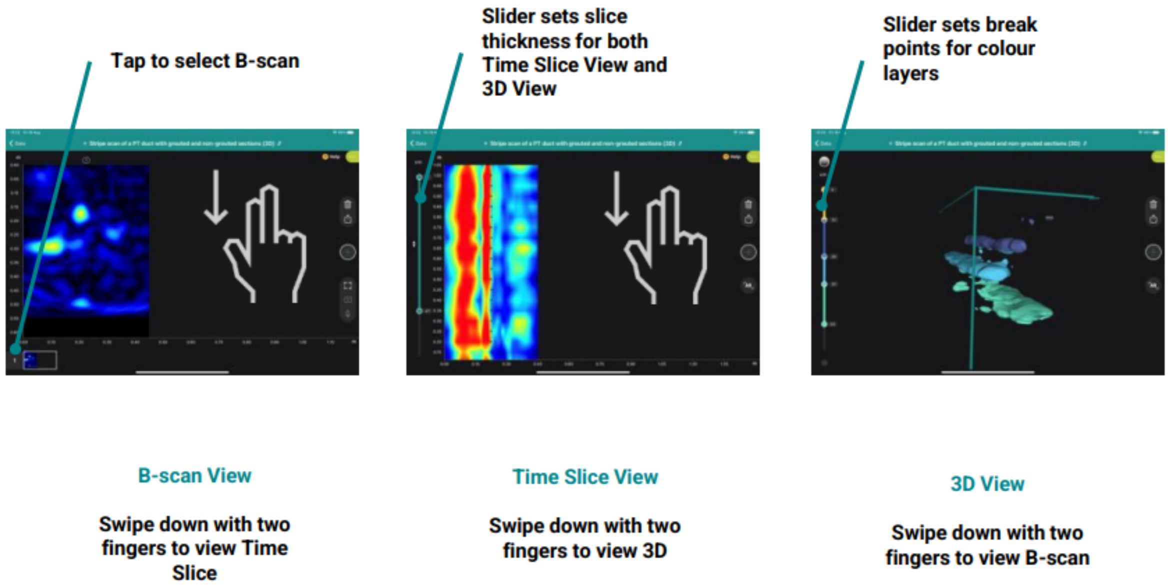


Figure 64: Three different views in Review Mode.

If you are using two PD8050 in parallel – 16 channels – you will be able to collect data two times faster than in the standard mode.

Also, multiple 3D matrix scans can be combined to create larger volume scans using the optional Pundit Vision Software.

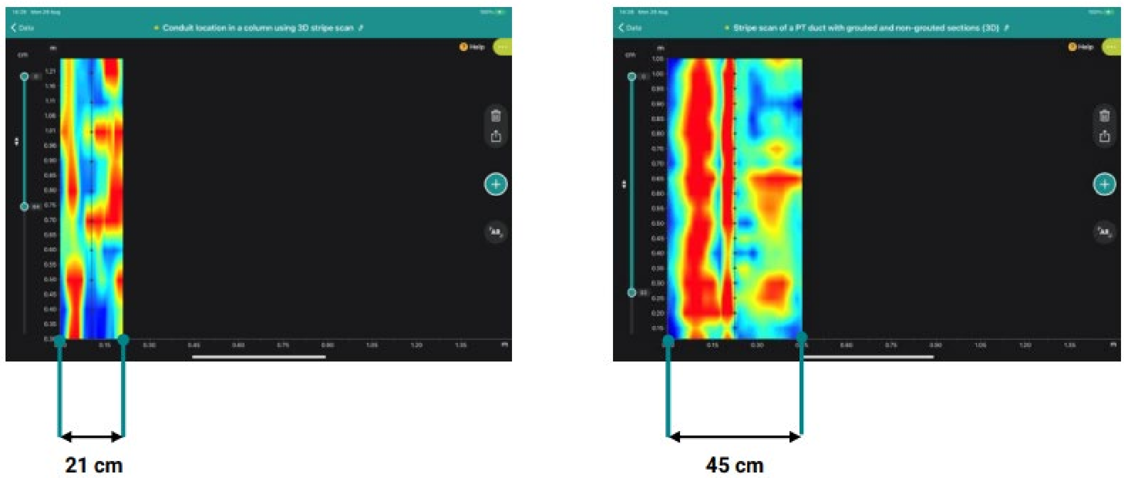


Figure 65: 8 vs 16 channels.

5.19 Grid Scan

PD8050 measures shear waves, which are also called S-waves. The velocity of the ultrasound waves depends on the quality, homogeneity, and density of the material.

S-wave Velocity	Corresponding P-wave Velocity	Concrete Quality Classification
> 2'800 m/s	> 4'500 m/s	Excellent
2'100 – 2'800 m/s	3'500 – 4'500 m/s	Good
1'700 – 2'100 m/s	3'000 – 3'500 m/s	Medium
< 1'700 m/s	< 3'000 m/s	Doubtful

Figure 66: P and S waves velocity.

Grid scans are used for uniformity testing of either thickness or pulse velocity. This is very helpful for rapid identification of problematic areas in large elements.

This grid scan mode makes this test very fast.

Workflow:

Select grid mode under the "Measuring Mode" tab. Then save one measurement in each cell to create a heat map of the backwall depth or pulse velocity.

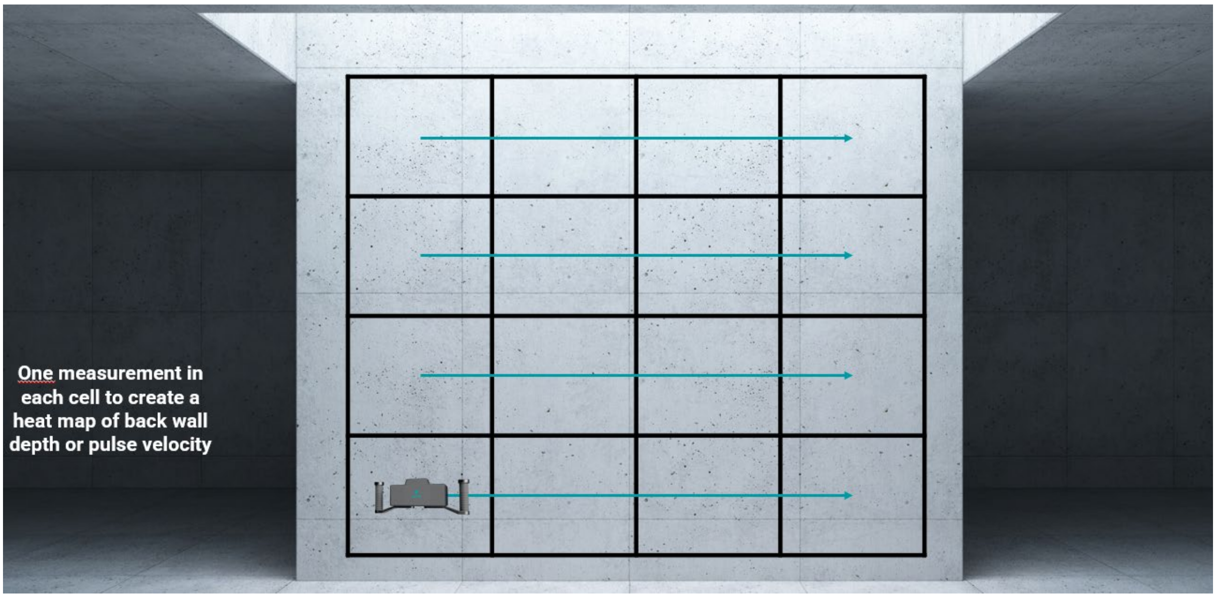


Figure 67: Grid pattern.

The heatmap is color-coded to show variations in backwall depth or in pulse velocity.

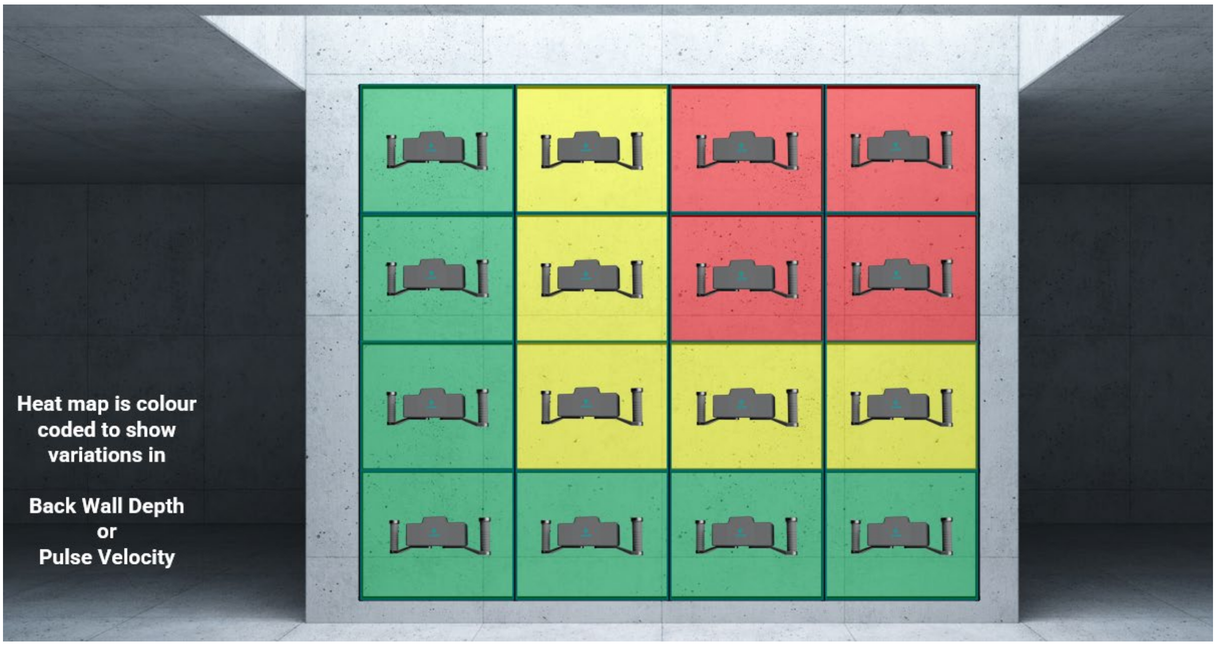


Figure 68: Grid scan heatmap.

To define the grid properties, please follow the following steps:

- Drag or long-press the corner arrow to type in the grid size.
- Tap the plus icon to set the cell size.
- Tap the pencil icon to set the starting point for the origin of coordinates.
- Select backwall depth or pulse velocity according to the data of interest.

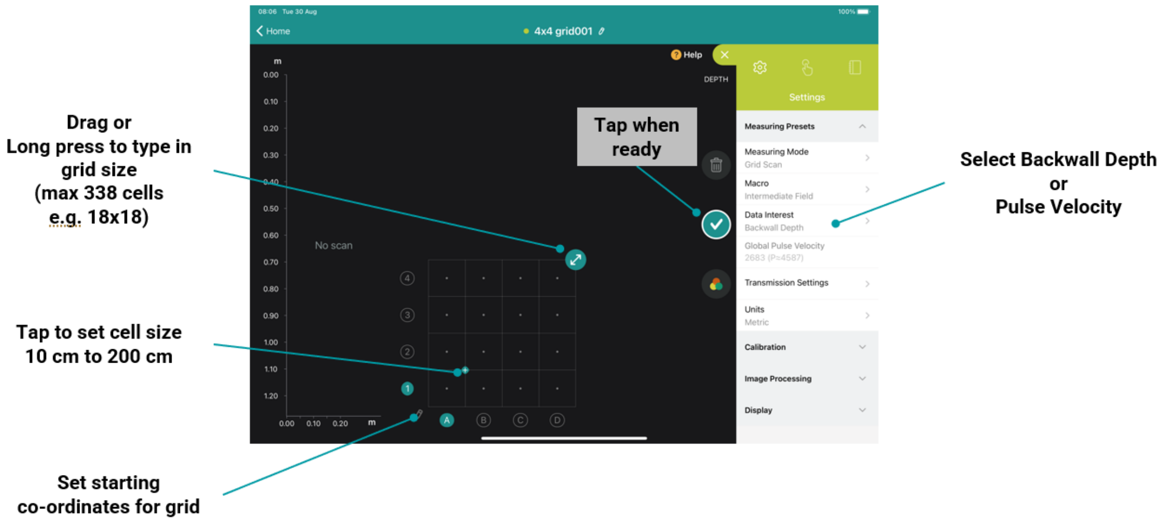


Figure 69: Setting up the grid.

- Additionally, set the backwall depth if it is known.

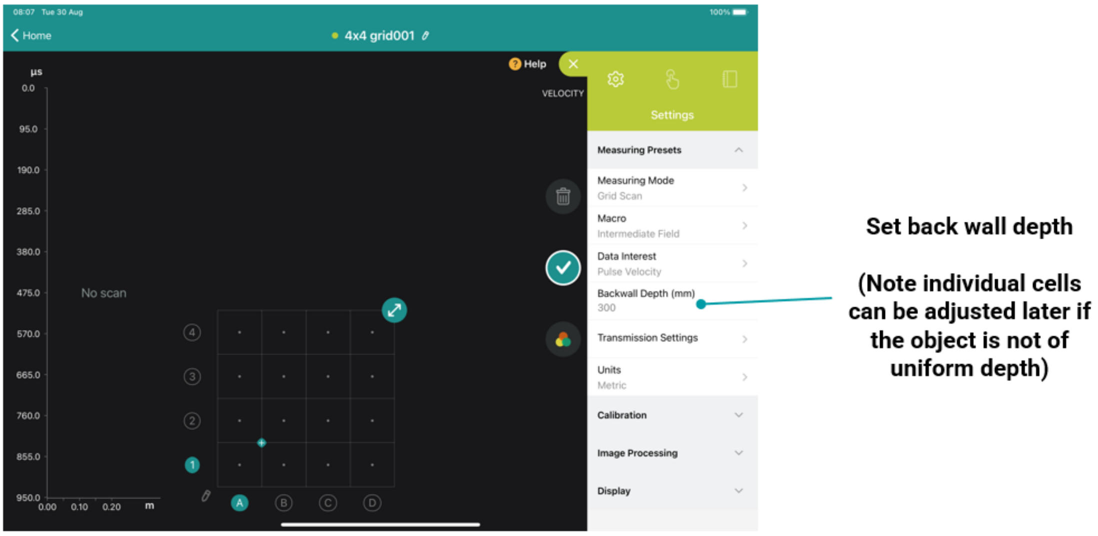


Figure 70: Setting up the backwall depth.

Once you start doing the measurement, you will be able to see a 2D plan view with the information (either the backwall depth or the pulse velocity) of each measured cell. On the left area, you will be able to see the B-scan of the selected cell.

To save the measurement, you can either use the “play” button on the iPad or the left central button of the handle.

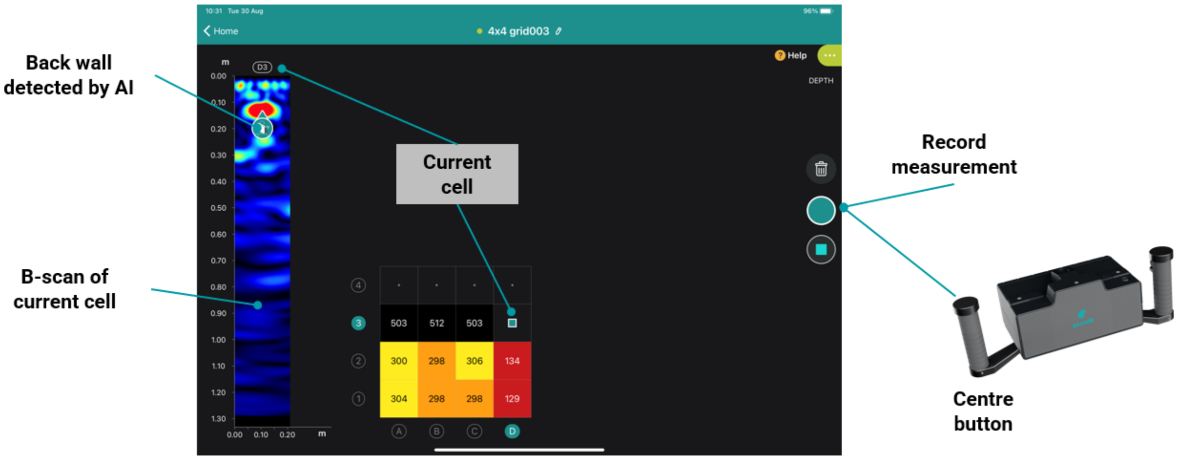


Figure 71: Grid scan.

You can also delete any particular cell, or the whole scan.

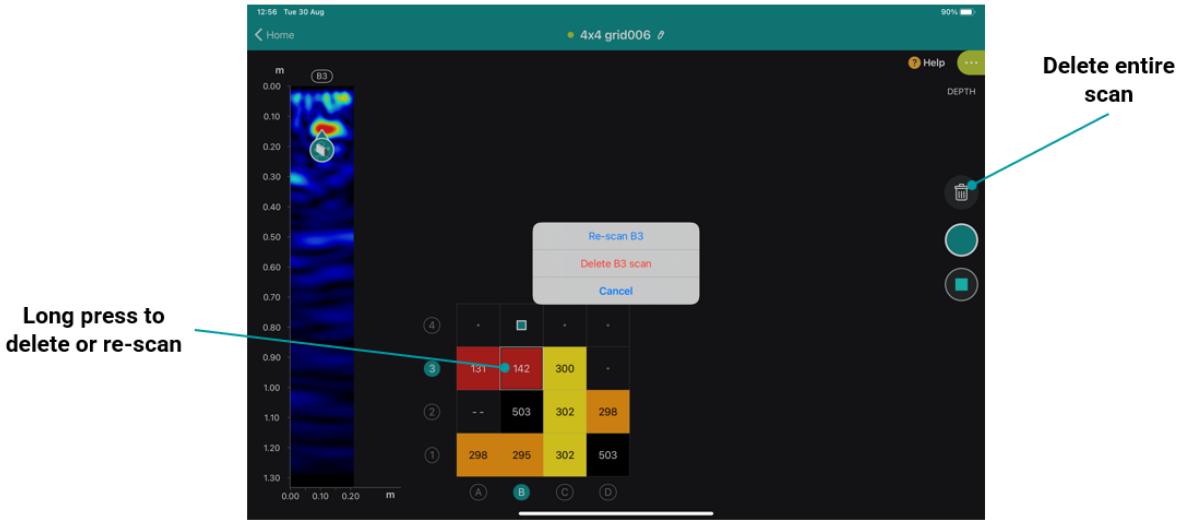


Figure 72: Deleting information.

It is always possible to resume a measurement. Even if the file has been closed. To do so, you will need to press the “play” button.

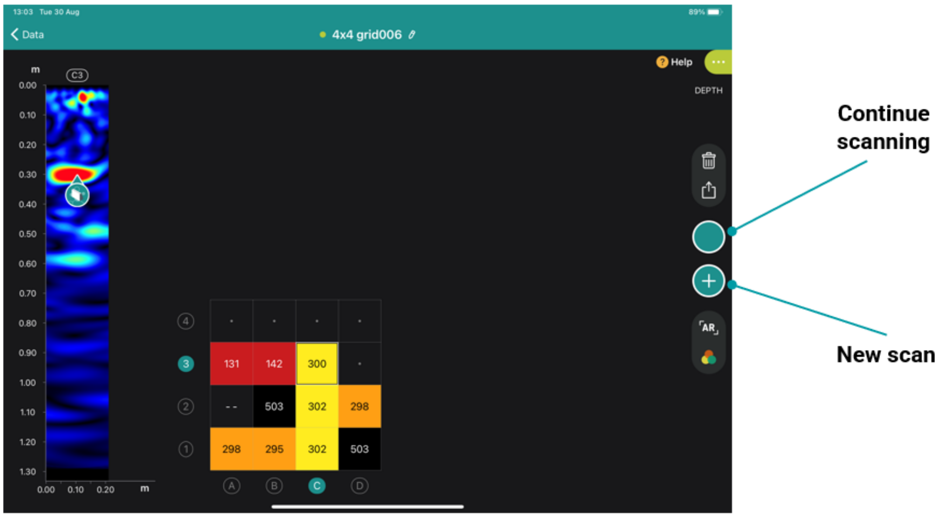


Figure 73: Resuming files.

Once the measurement is finished, you will be able to see the whole grid scan heatmap. It is also possible to see each individual B-scan by swiping two fingers down on the main screen.

In this way, you can manually adjust the automatic backwall detection in case the AI has made a mistake.

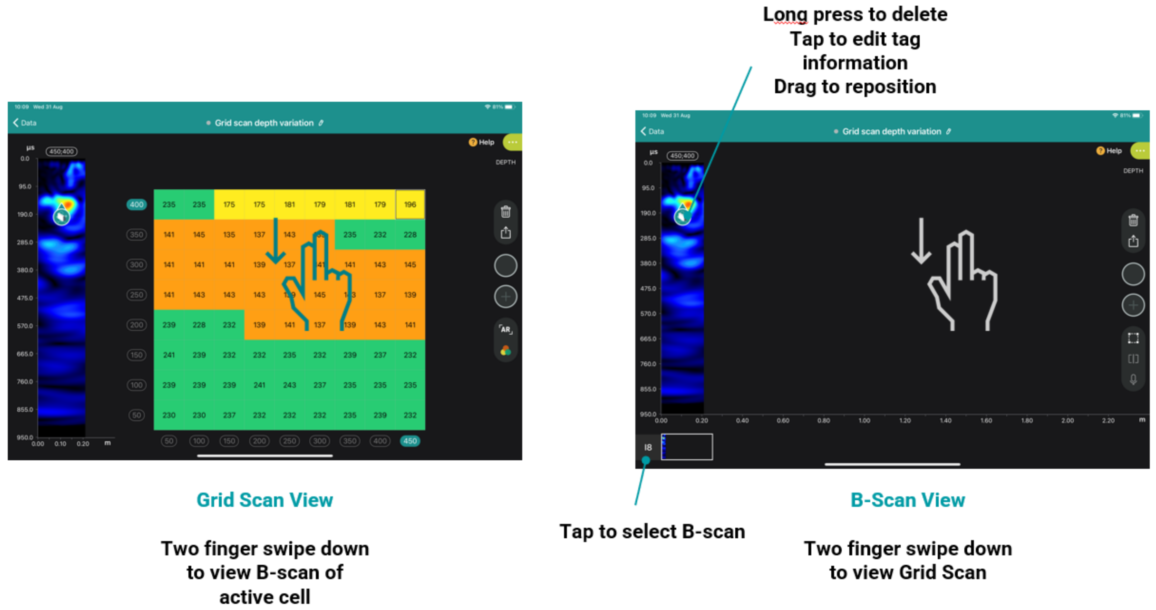


Figure 74: Review mode.

In this view, you can also edit tags, activate the augmented reality feature, adjust the color sliders, and export data:

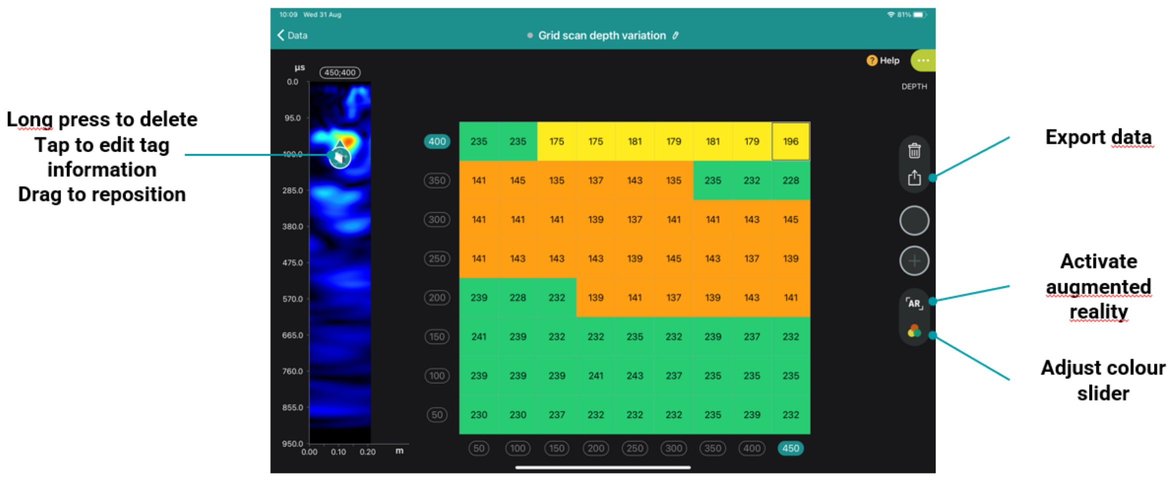


Figure 75: Review mode.

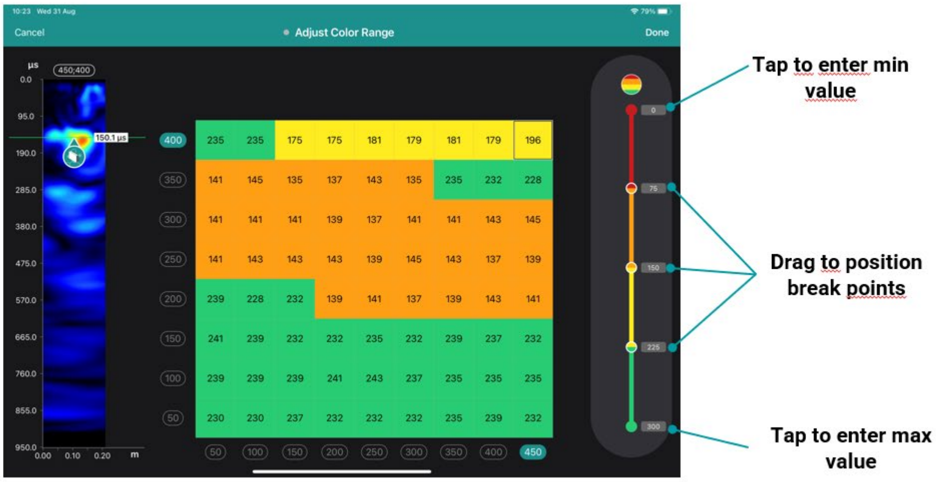
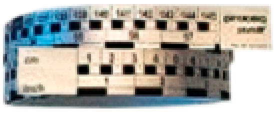


Figure 76: Review mode.

5.20 AI positioning

PD8050 comes with a built-in camera and an AI feature that enables it to read a measuring tape and automatically place the scans in the right location. To do so, you just need to enable the AI feature.

- Detects and positions the B-scan automatically.
- Applicable to both Line Scan and 3D matrix scan.
- Metric or imperial units.
- Line scans – up to 10 tapes can be used in series for longer scans up to 15 m.



32730418S
(Set of 10x 1.5 m tapes)

Figure 77: AI positioning and measuring tape.

- Faster scans as there is no need to carefully align the channels for correct overlap.
- More accurate scans as positioning is precise.
- Each image is correctly positioned.

For more detailed information about the use of this feature, please visit the relevant tutorial video which is available in the Pundit Array app.

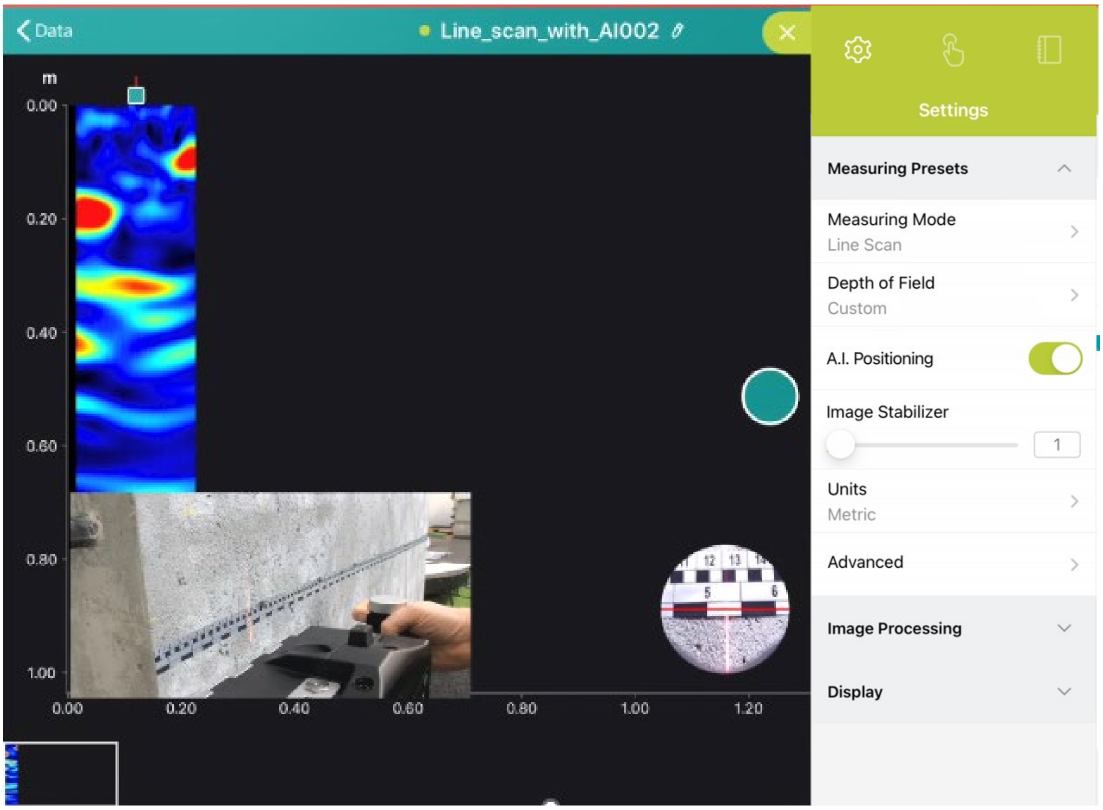


Figure 78: AI positioning and measuring tape.

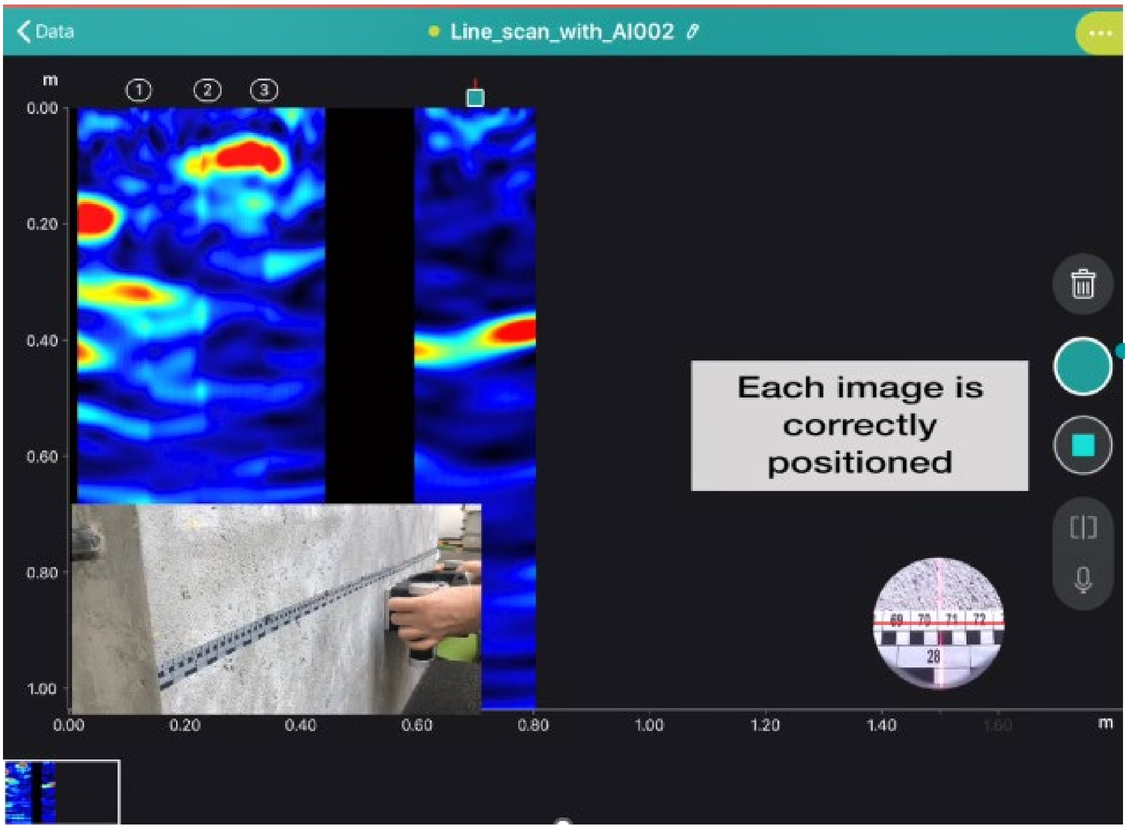


Figure 79: AI positioning and measuring tape.

You can return to any spot to add denser scans in areas of interest; also, you do not need to go in any particular order.

For 3D Matrix scans with 16 channel instruments using AI detection, you have to position the instrument accordingly for PD8050 and PD8000:

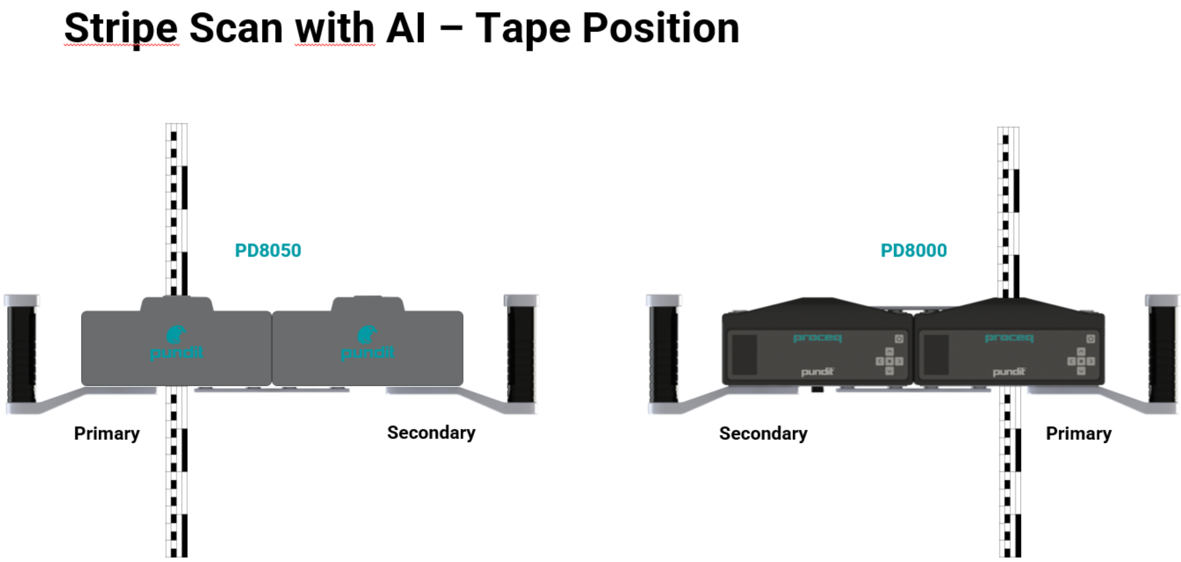


Figure 80: AI in the dual operation system.

5.21 Augmented Reality (AR)

It is possible to project Line Scans and Grid scans onto the tested surface using the Augmented Reality feature. To do that, you just need to activate “AR”.

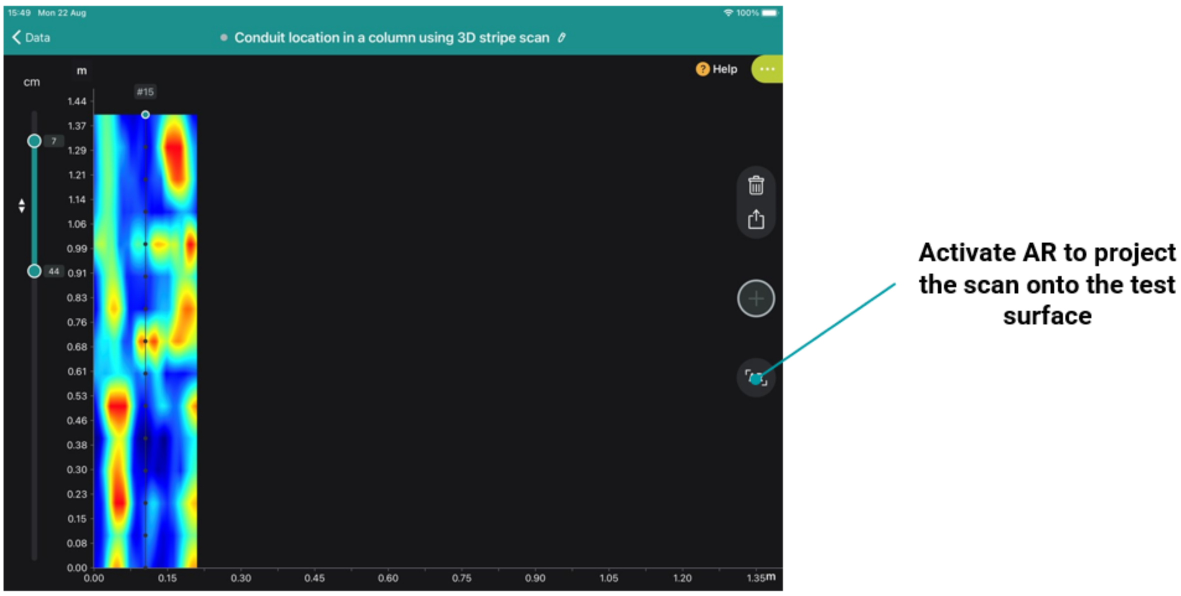


Figure 81: How to activate AR functionality.

Then, you need to place the printed AR marker onto the surface at the right location. Please be careful to position this marker as indicated in the images below.

The marker is available in the PD8050 kit, but it can also be downloaded from the PD8050 website or directly from the app.

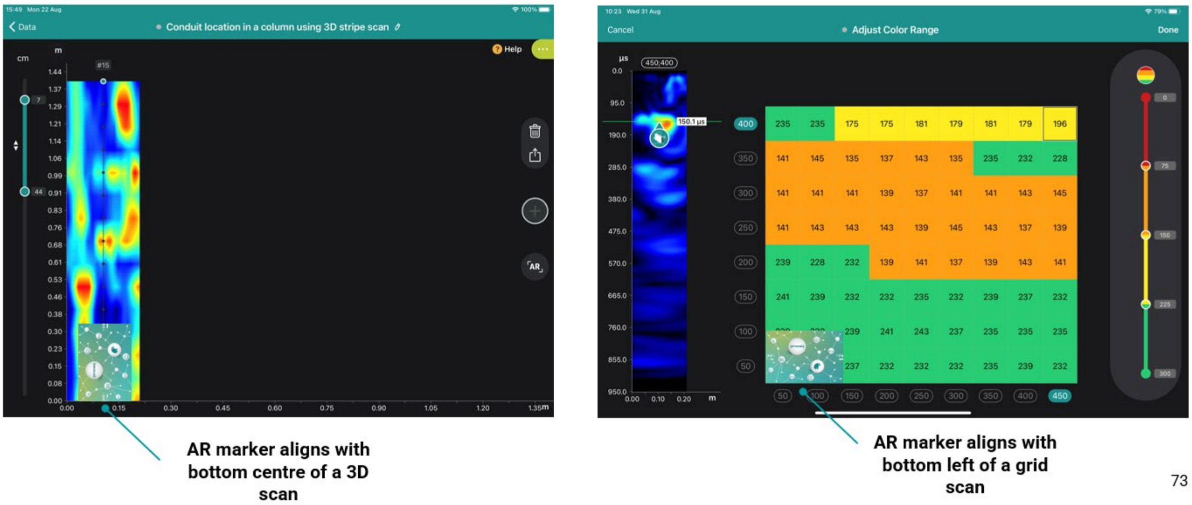


Figure 82: AR marker.

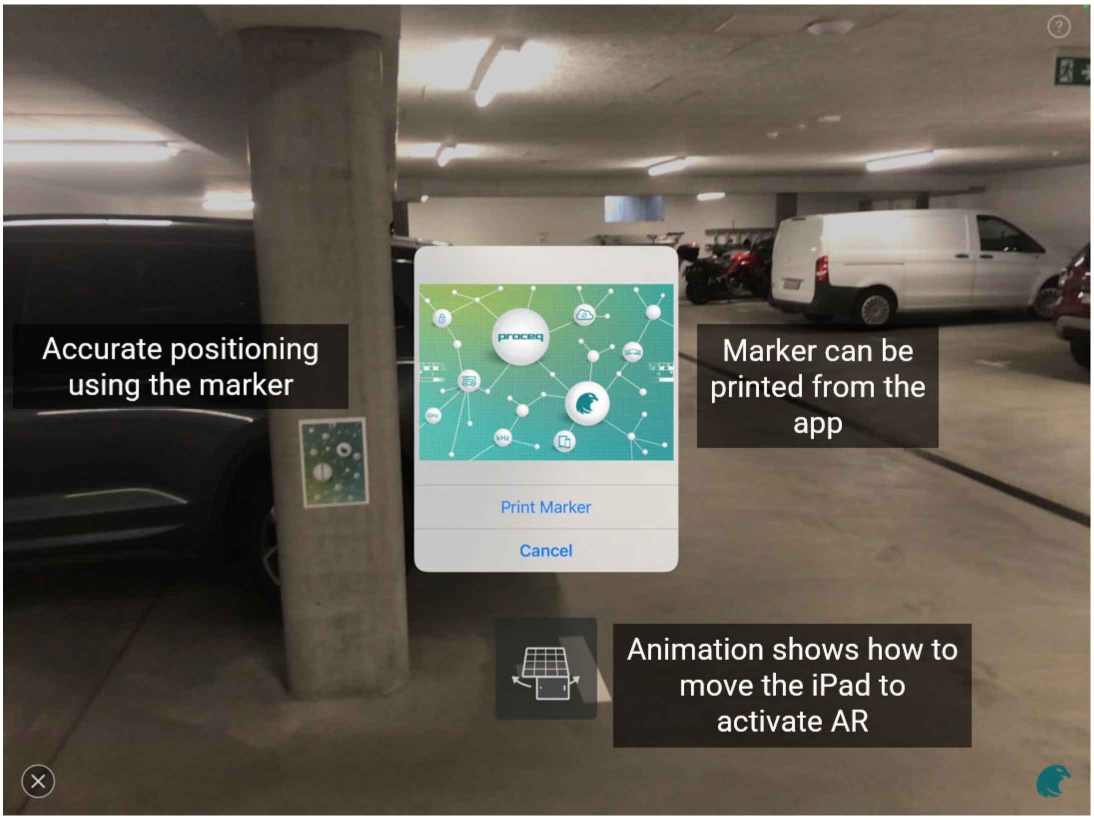


Figure 83: AR marker.

The time slice view will be projected onto the concrete surface in the correct position.

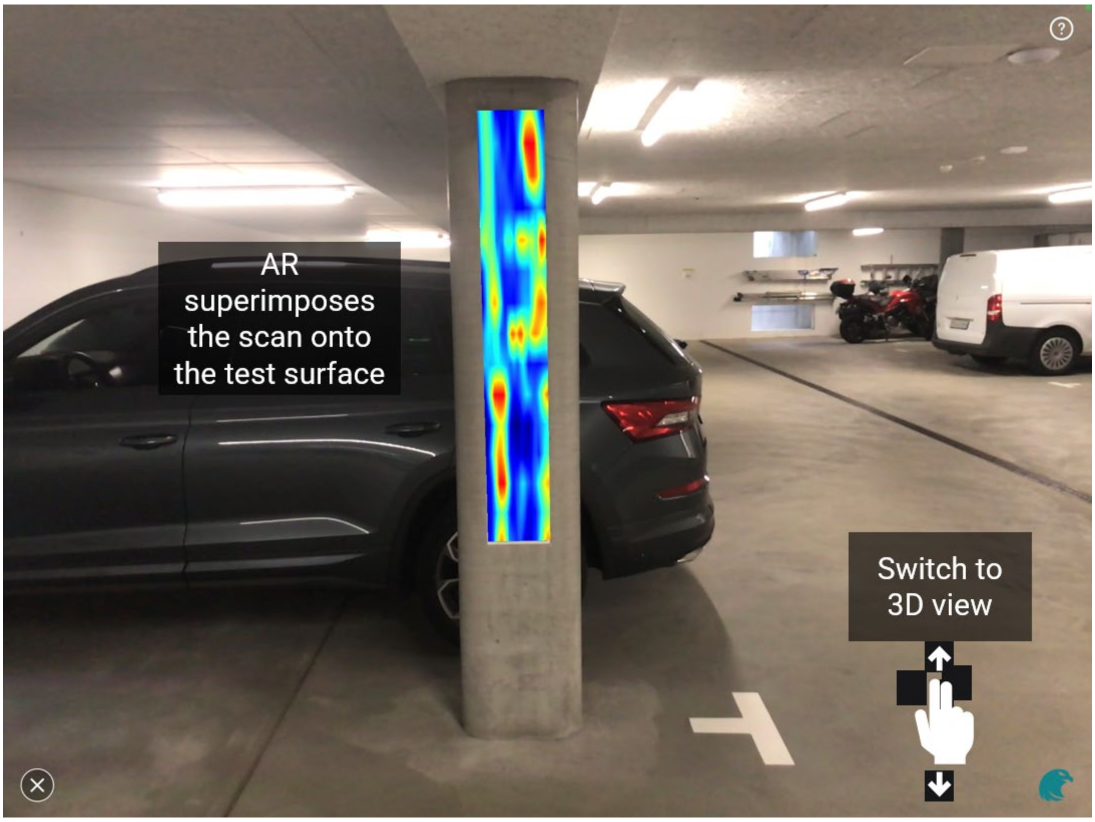


Figure 84: AR time slice view.

If a 3D full matrix scan has been done, a 3D view of the inner elements can be seen. To do so, swipe two fingers up, so the view shown on the iPad is changed:

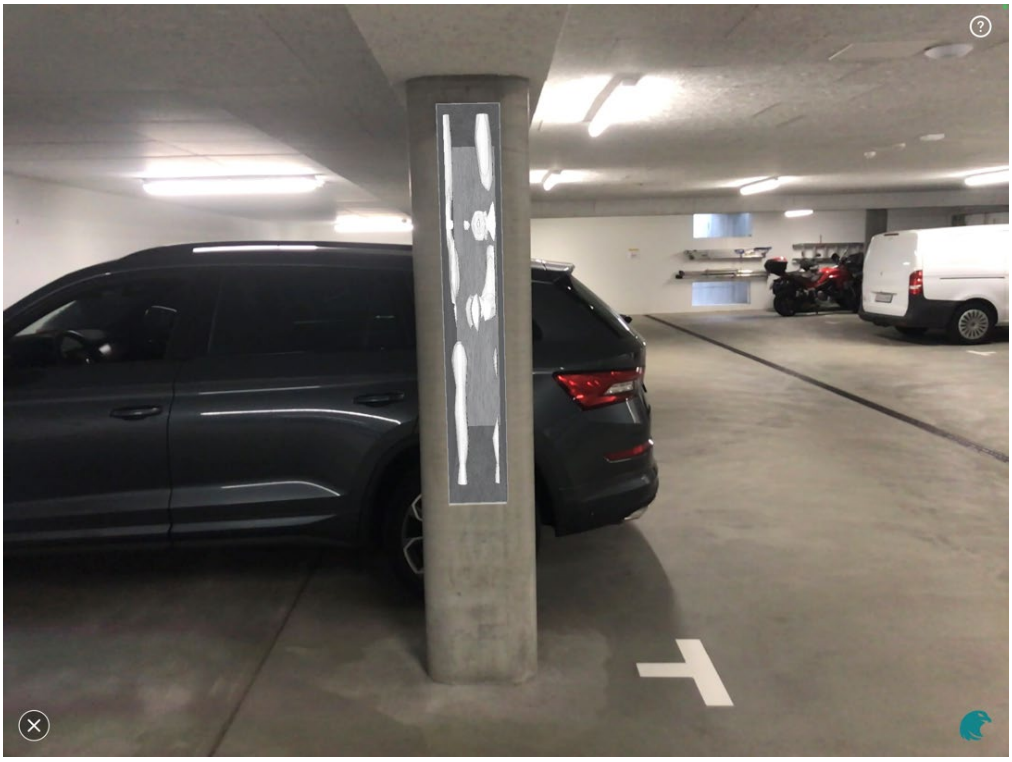


Figure 85: AR 3D full matrix view.

This view can be extracted from the structure using your fingers. You can also move around in the real world to view it from different angles.

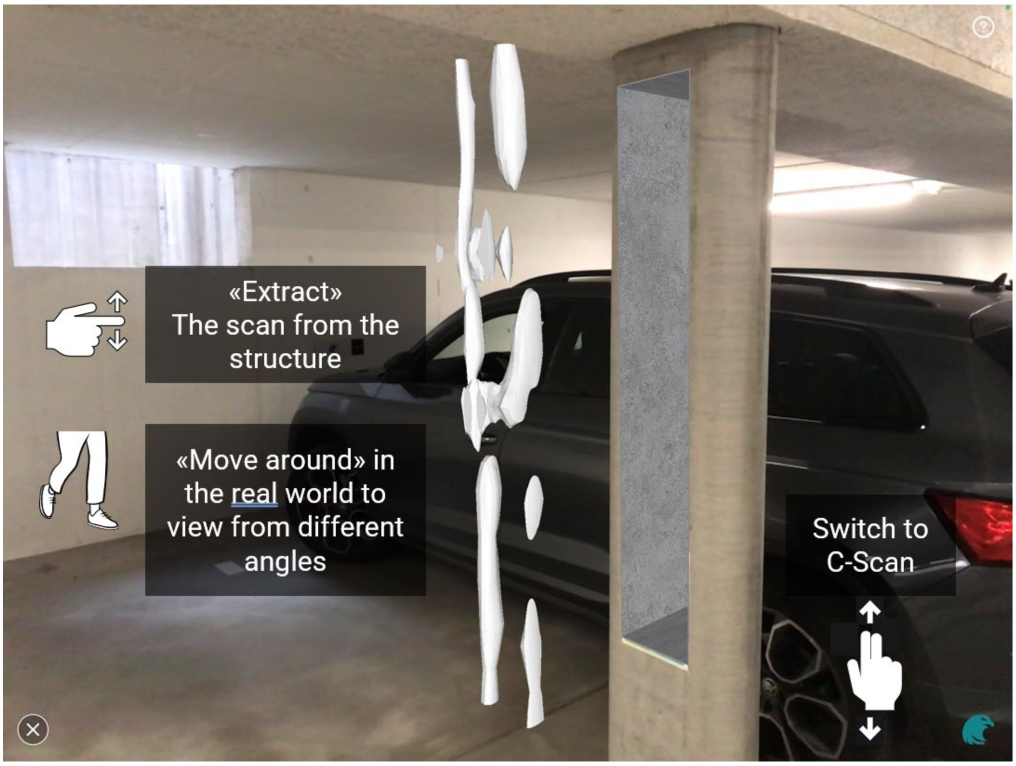


Figure 86: AR 3D full matrix view.

The grid scan heatmap view can also be seen as augmented reality:

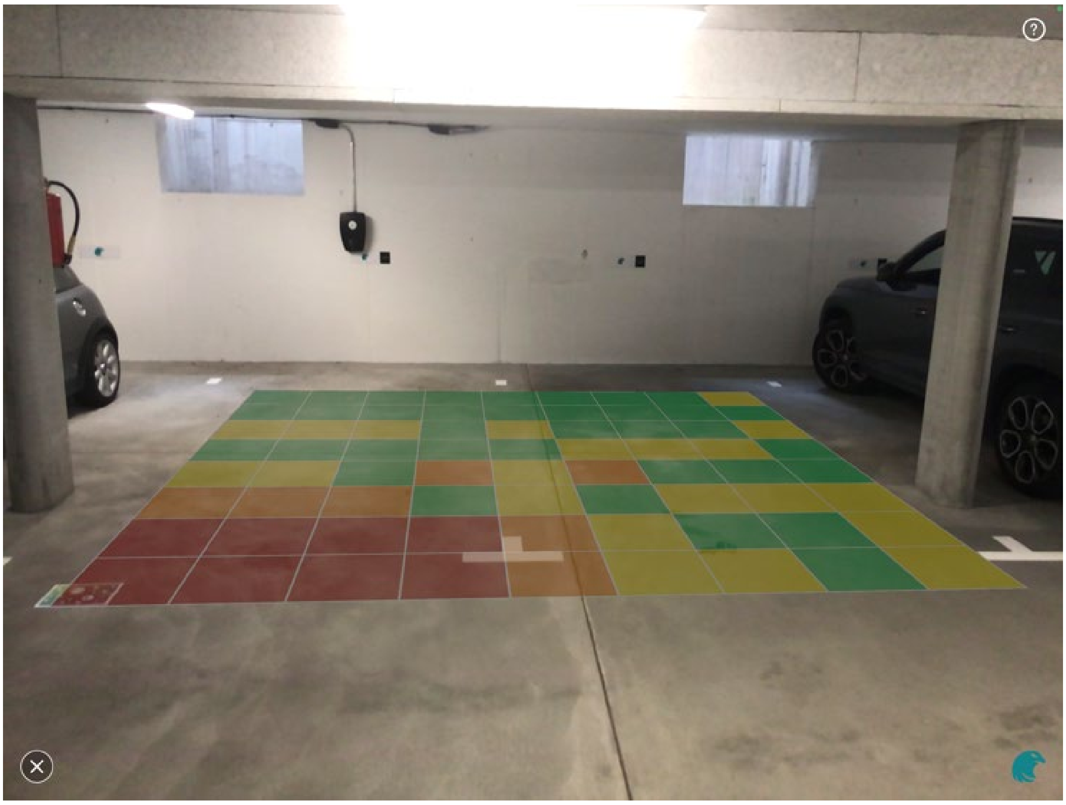


Figure 87: AR Grid scan.

5.22 Pundit Vision Software

Pundit Vision is an Advanced visualization and analysis of ultrasonic pulse-echo data.

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.

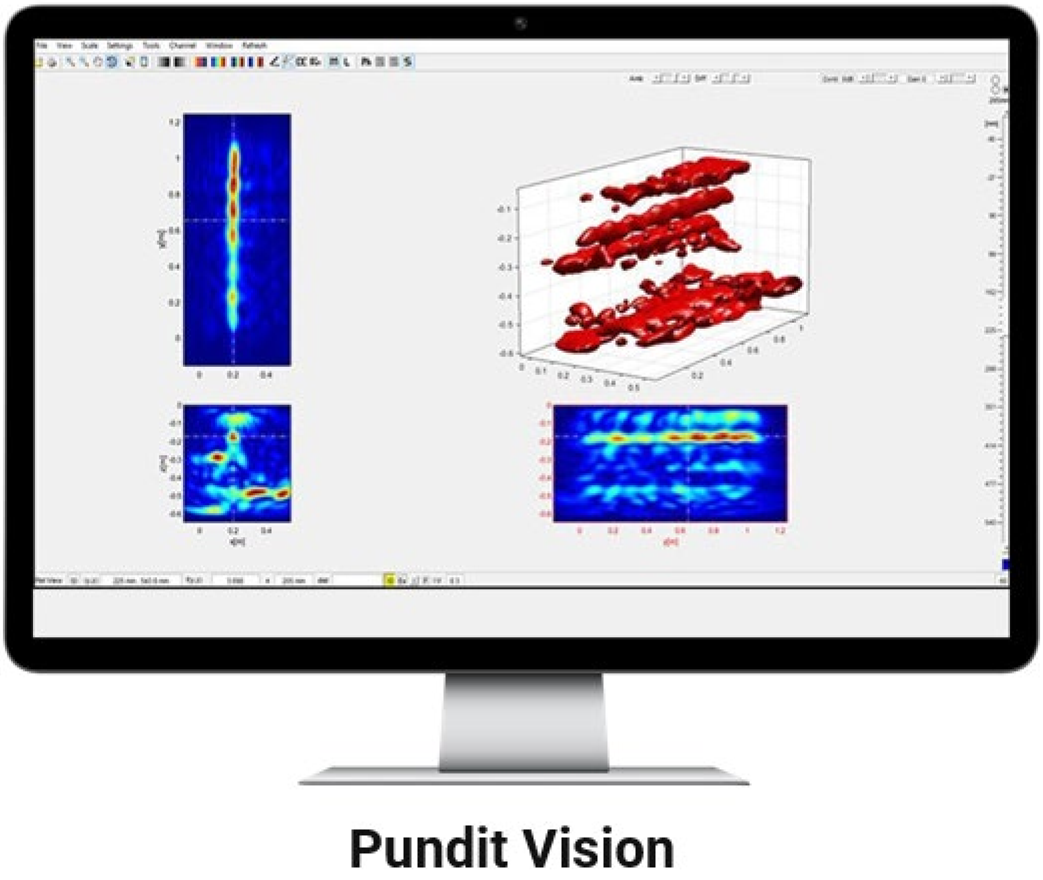


Figure 88: Pundit Vision.

6 Measuring Range

Typical measuring ranges were given in the section describing the depth of field. However, the maximum range is very much dependent on the concrete quality and the amount of steel, aggregate size, etc. In practice, in some cases is not possible to see beyond 1m.

7 Testing the transducers

Each individual dry contact transducer can be tested for correct functionality. After having started the test procedure the graphic on the Pundit Touchscreen Unit indicates which transducer row is to be tested (blue highlight).

Figure 89: Channels being pressed with a testing plate.

Press the PD8050 Tester onto the transducer row as shown. A successful test is indicated by the transducer row being highlighted green. The next row to be tested is then highlighted in blue. Continue until each transducer row has been tested. If one row fails the test, it may be repeated before continuing. If it continues to fail the test, contact a Proceq service center.

8 Data storage, reading, sharing & reporting

The Pundit Array app enables the visualization of A-scans, B-scans, C-scans, 3D full matrix scans and grid scan views, statistics, and heat maps. In addition, there is a logbook providing traceability of each measurement: time, operator, position and instrument information, pictures (with iPad camera), and written or oral notes.

Given mobile data connectivity (Wi-Fi or mobile network), the Pundit Array app automatically and safely stores all measurements on the Screening Eagle Workspace by synchronizing with the cloud. Reporting is done from the Screening Eagle Workspace.

Reading, sharing & reporting (pdf printing of tab) is possible.

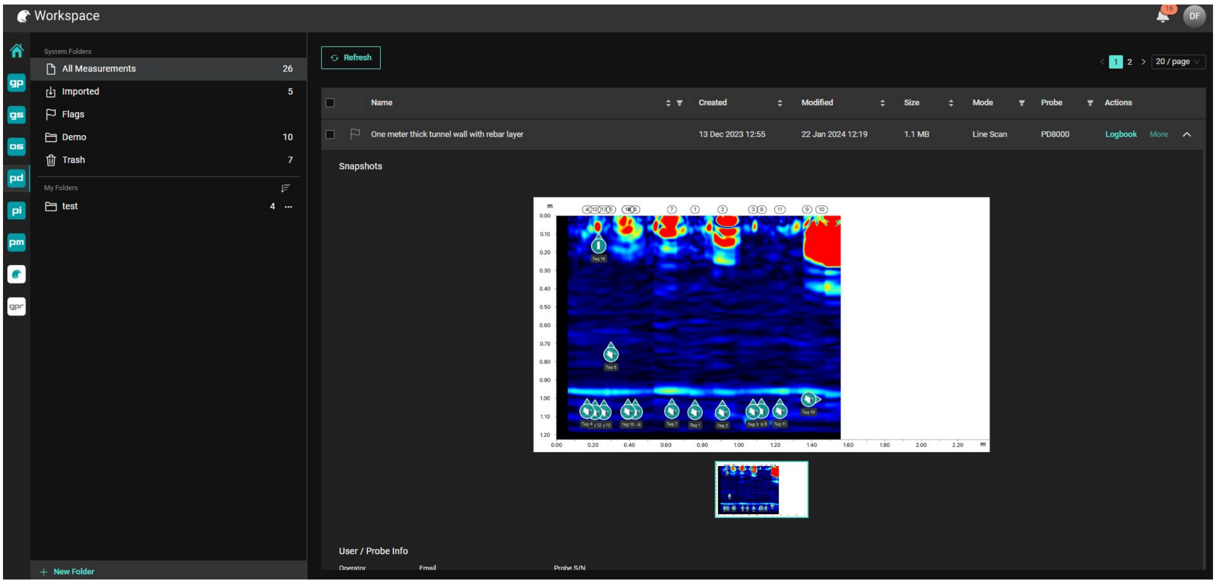


Figure 90: Screening Eagle Workspace.

9 Application hints

9.1 Use cases.

9.1.1 Delaminations

Cracks or debonding failures approximately parallel to the concrete surface can be detected using PD8050:

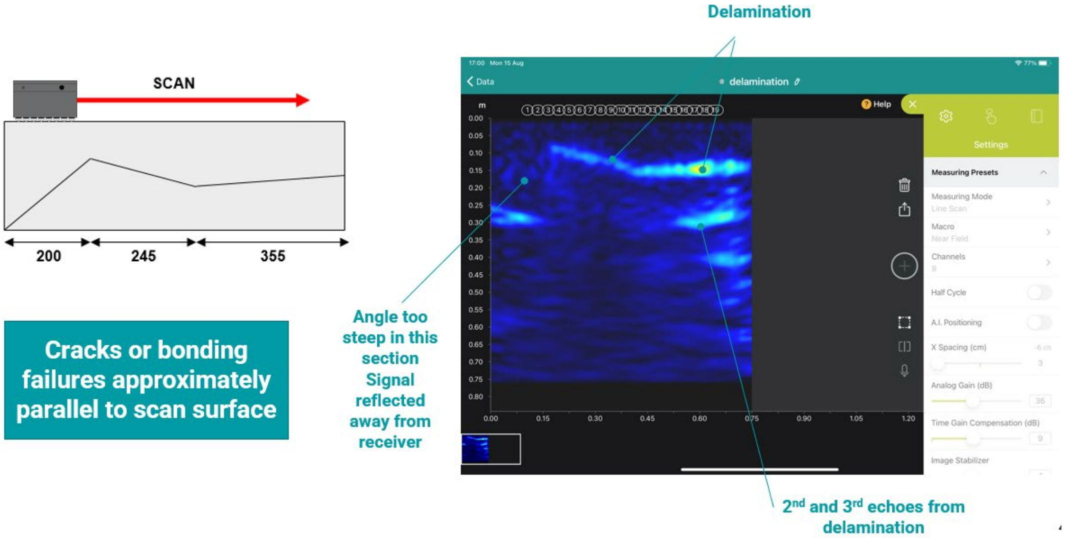


Figure 91: Use case - delamination.

9.1.2 Defect and thickness detection

Internal defects, such as voids, cracks, honeycombs, etc, can be detected using PD8050:

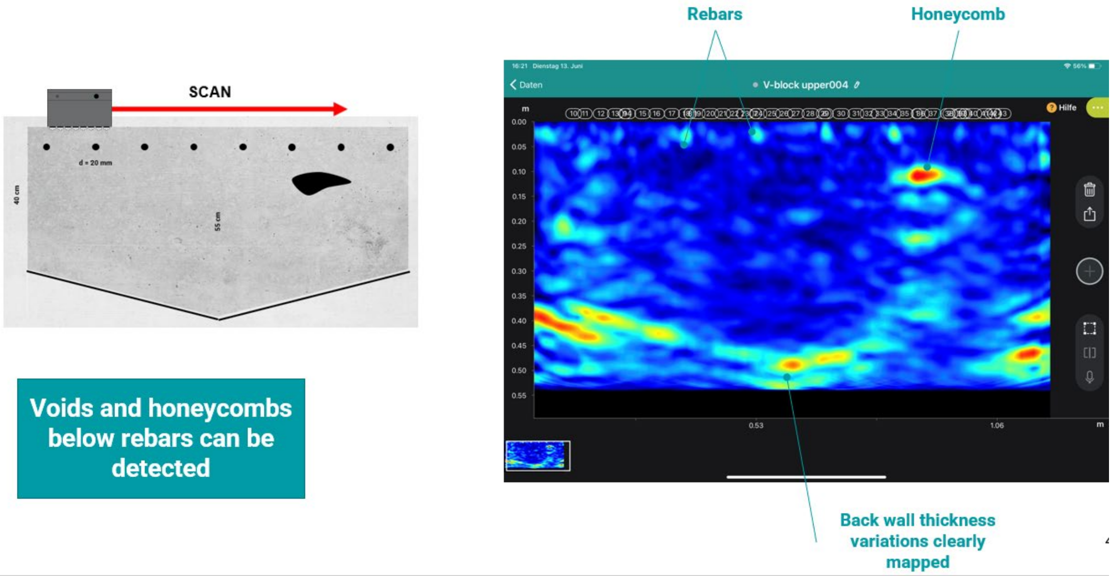


Figure 92: Use case – thickness and defects.

9.1.3 Thick objects

Thick objects can be tested using PD8050 up to 1 meter thick.

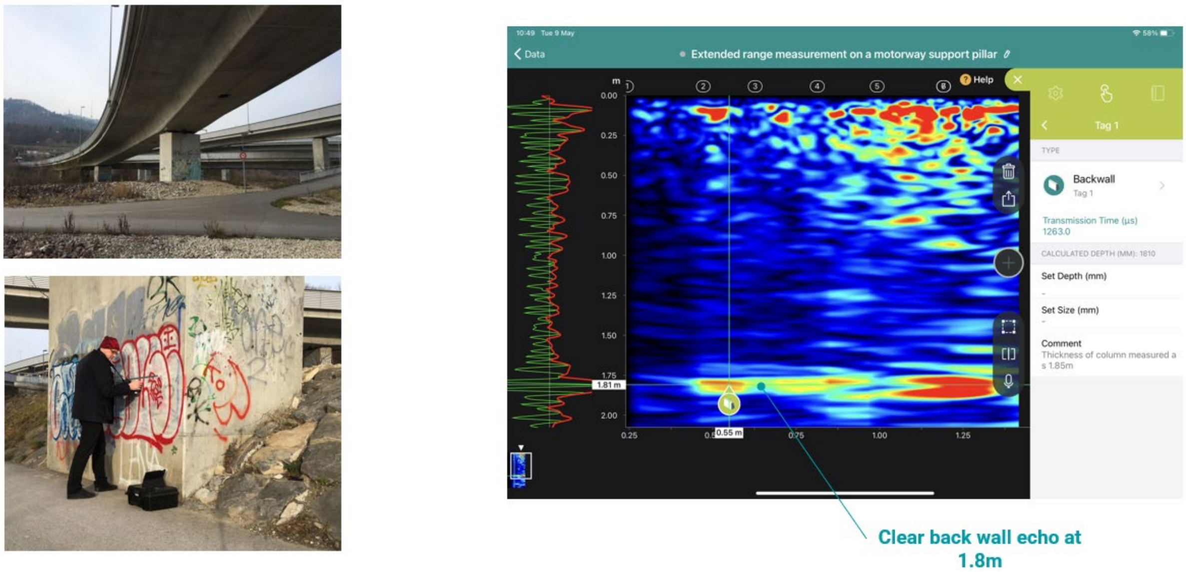
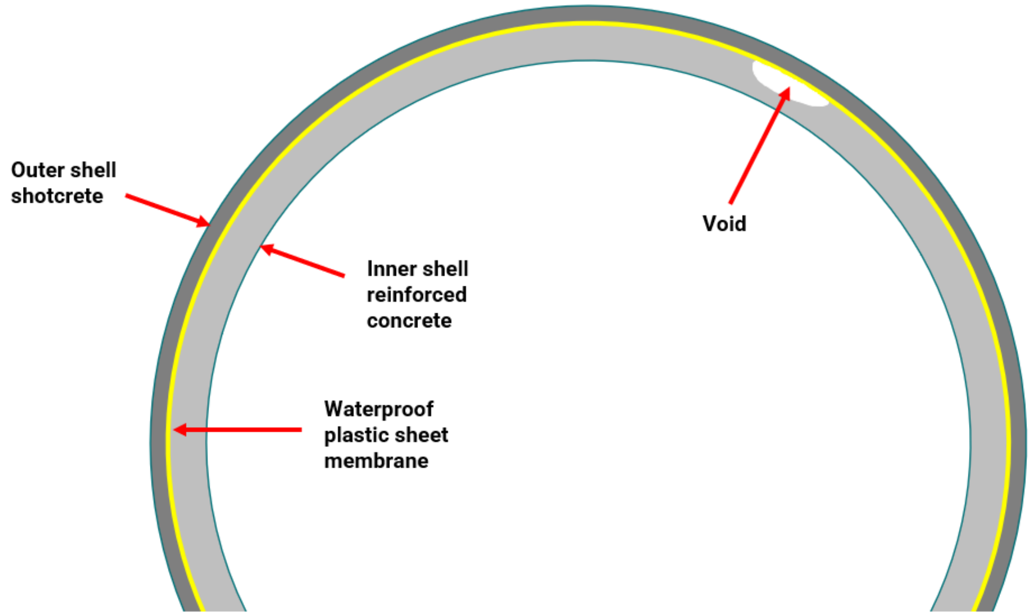


Figure 93: Use case – thick objects.

9.1.4 Tunnel lining

Detecting the thickness of a tunnel lining is also a common application for PD8050:



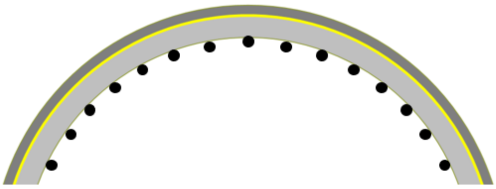


Figure 94: Use case – tunnel lining thickness.

9.1.5 Prestress duct

Prestress duct inspections are also a very common application, with some international guidance recommending how to do it. It is possible to detect the areas that are fully grouted, and the areas where the grout has not been fully injected:

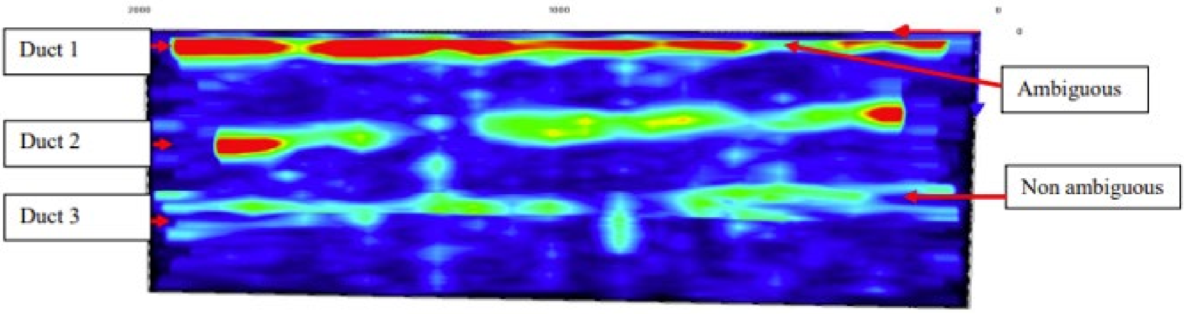


Figure 95: Use case – PT duct inspection.

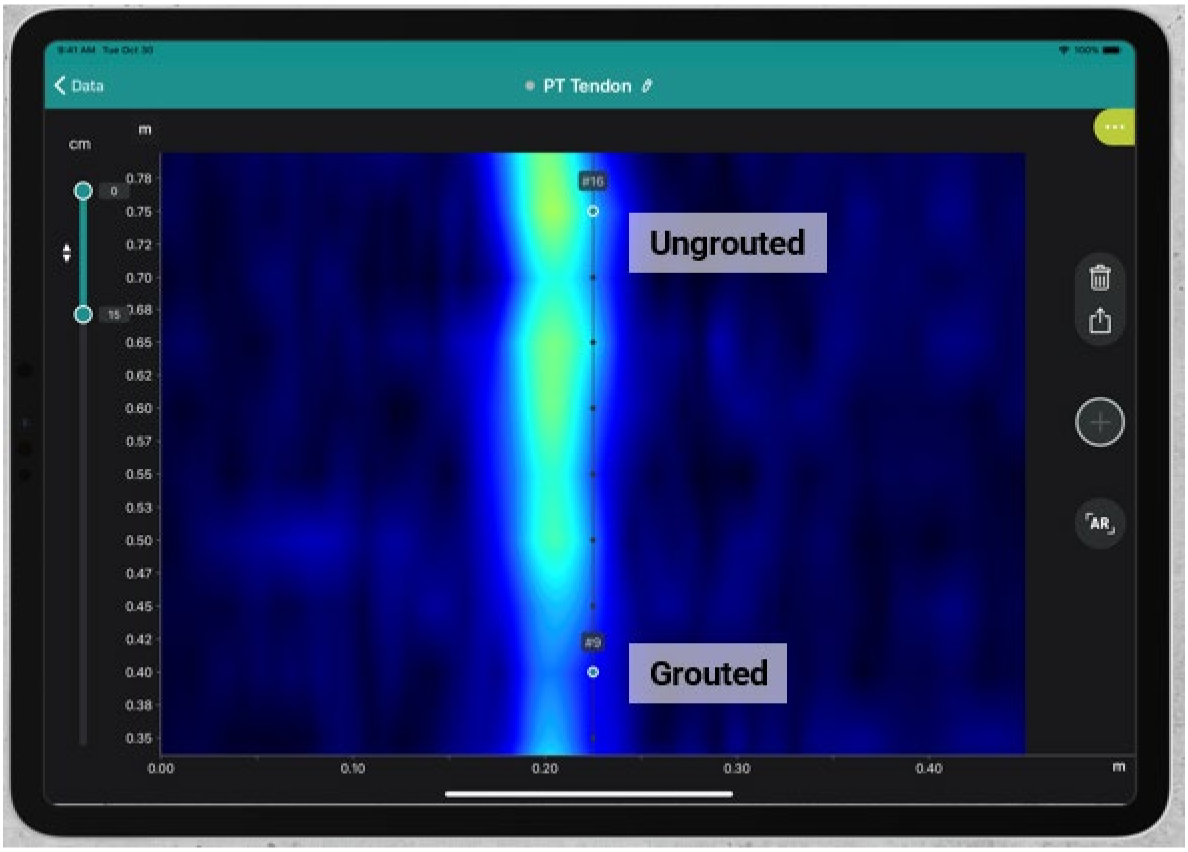


Figure 96: Use case – PT duct inspection.

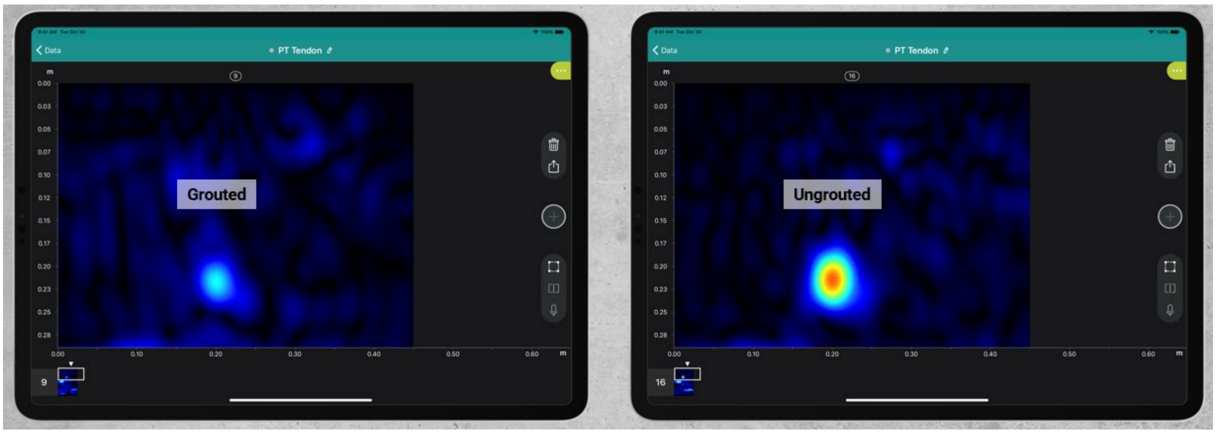


Figure 97: Use case – PT duct inspection.

9.1.6 Steel fiber concrete

Steel fiber concrete can also be tested. The areas with a big concentration of steel fibers will reflect completely the signal in all directions. Voids in between the fibers can easily be detected.

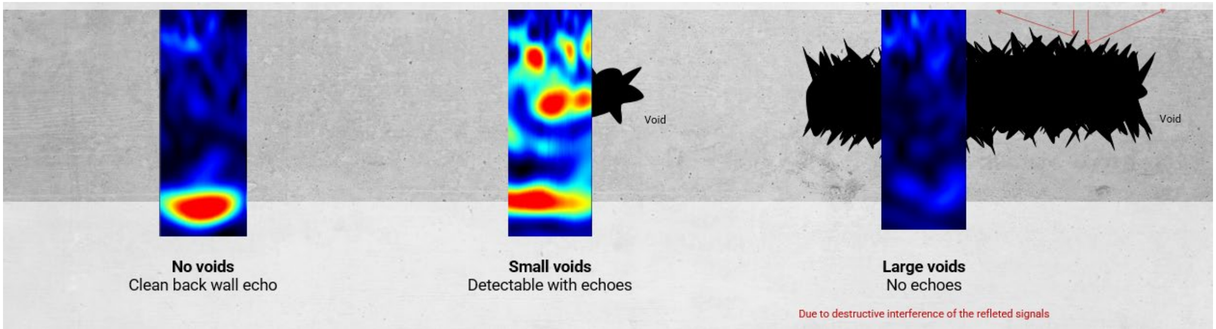


Figure 98: Use case – Steel fiber concrete structures.

10 Frequently asked questions

Is it possible to detect grouting defects in tendon ducts with ultrasonic pulse echo?

Ultrasonic pulse echo is one of the only technologies that can detect grouting defects in tendon ducts. The technique is based on variations in the amplitude detectable in grouted and non-grouted sections. Fully grouted ducts give a partial reflection. Non-grouted sections give a total reflection.

Is it possible to measure steel fiber-reinforced concrete with ultrasonic pulse-echo?

Yes. Unlike electromagnetic methods such as those employed by GPR and cover meters, which do not work on steel fiber-reinforced concrete, ultrasonic pulse echo is well suited for measuring this material. It has been successfully used for detecting voids, detecting cover depth to rebars and pipes, and also for determining the thickness of shotcrete layers.

Is it possible to combine multiple 3D matrix scans in the Pundit Live Array app?

With the Pundit Live Array App, you can create a single *3D matrix* scan limited to 1.5m in length. If you wish to combine multiple *3D matrix* scans to create a wide-area 3D image, this can be done using the Pundit Vision software. The Pundit Vision software also allows the combination of orthogonally collected *3D matrix* scans to create the most detailed images possible using ultrasonic pulse-echo technology.

Is it possible to detect water-filled voids with ultrasonic pulse echo?

Yes, it is possible to detect water-filled voids. One of the reasons that shear waves are used in the Pundit PD8000 instruments is that in comparison with P-waves (compression waves), they are better suited to detecting water-filled cracks and voids.

Is it possible to detect voids below rebars using ultrasonic pulse echo?

Yes, ultrasonic pulse echo is the correct technology for detecting voids, honeycombs, and delaminations below the rebar grid. Whereas a dense rebar structure will block a GPR signal from penetrating deeper into the structure, an ultrasonic pulse echo signal is only partially reflected. The signal that passes through is able to detect deeper-lying voids.

Are there any standards for pulse echo testing?

Pulse echo testing is included in the European standard EN 12504-4 for pulse velocity determination. This is then subsequently included in the standard EN13791 for in-situ compressive strength estimation. The application is also covered in several guidelines. The most comprehensive of these is the German Society for Non-Destructive Testing Guideline B4. It is also covered in a German highway authority guideline for measuring tunnel lining thickness (ZTV-ING Teil 5 Tunnelbau) and ACI 228.2R.

How close to the surface is it possible to measure with ultrasonic pulse-echo technology?

While this is being improved all the time it is possible to give a reference for this. A major study was carried out in Germany that deals with this topic. Here it was shown that 16 mm rebars could be detected with a minimum cover of 20mm. The reference to the paper is shown below.

Detection of near-surface reinforcement in concrete components with ultrasound Sarah Vonk1,*, and Alexander Taffe1.

1HTW Berlin – University of Applied Sciences Berlin, Nondestructive Testing in Civil Engineering Department, 12459 Berlin.

11 Technical Specification

Applications
Void and delamination detection
Bonding assessment
Thickness measurement
Honeycombing detection
Fiber concrete
Concrete hit prevention
Imaging of closely spaced rebars

Bandwidth

20 - 80 kHz

Technology

Multi-channel Ultrasonic Pulse Echo

Measuring Resolution

1 us

Pulse Voltage

±50 to ±150 V
(UPE)

Receiver Gain

1 to 10’000
(0 to 80 dB)

Report Generation

Cloud synchronization
Share via URL
Cloud-enabled logbook
Cloud-based raw data export
Cloud-based HTML export
Cloud-based report generation

Measurement Modes

Line scan
Full 3D Matrix Scan
Grid Scan

Measuring Range

Up to 2 m / 6.6 ft depending on concrete quality

Review modes

A-scan (incl. envelope)
B-scan (Line view)
C-scan (Time-Slice view)
Heat map (depth)
Heat map (pulse velocity)

Battery

Battery pack, 6x AA (NiMH), flight-safe

Display

Any compatible Apple® iPad (iOS 11.0 and higher)[1]

Memory

Apple® iPad specified

Connections

Encrypted Wi-Fi connection to Apple® iOS tablet
USB port for Wi-Fi module
USB-C for Wi-Fi-restricted areas

1. Recommendation: The newest models enhance performance, number of sensors, and optional capabilities.

The English version of the content remains the official version. All translated content should bear an appropriate notice to this effect.

For safety and liability information, please download at

www.screeningeagle.com/safety-and-liability

Proceq Europe

Ringstrasse 2
CH-8603 Schwerzenbach
Switzerland

+41 43 355 38 00

Europe

Screening Eagle UK Limited
Bedford i-lab,
Stannard Way Priory Business Park MK44 3RZ
Bedford London
United Kingdom

T +44 12 3483 4645

USA, Canada & Central America

Screening Eagle USA Inc.
117 Corporation Drive
Aliquippa, PA 15001
United States

T +1 724 512 0330

South America

Proceq SAO Equipamentos de Mediçao Ltda.
Rua Paes Leme 136
Pinheiros,
Sao Paulo SP 05424-010
Brasil

T +55 11 3083 3889

Proceq Middle East

Sharjah Airport
International Free Zone
P.O.Box: 8365
United Arab Emirates

T +971 6 5578505

ASIA-PACIFIC

Proceq Asia Pte Ltd. 1
Fusionopolis Way Connexis South Tower #20-02
Singapore 138632

T +65 6382 3966

CHINA

Proceq Trading Shanghai Co.,
Limited Room 701, 7th Floor,
Golden Block 407-1
Yishan Road,
Xuhui District
200032 Shanghai | China

T +86 21 6317 7479