Human Centric Innovation

Co-creation for Success

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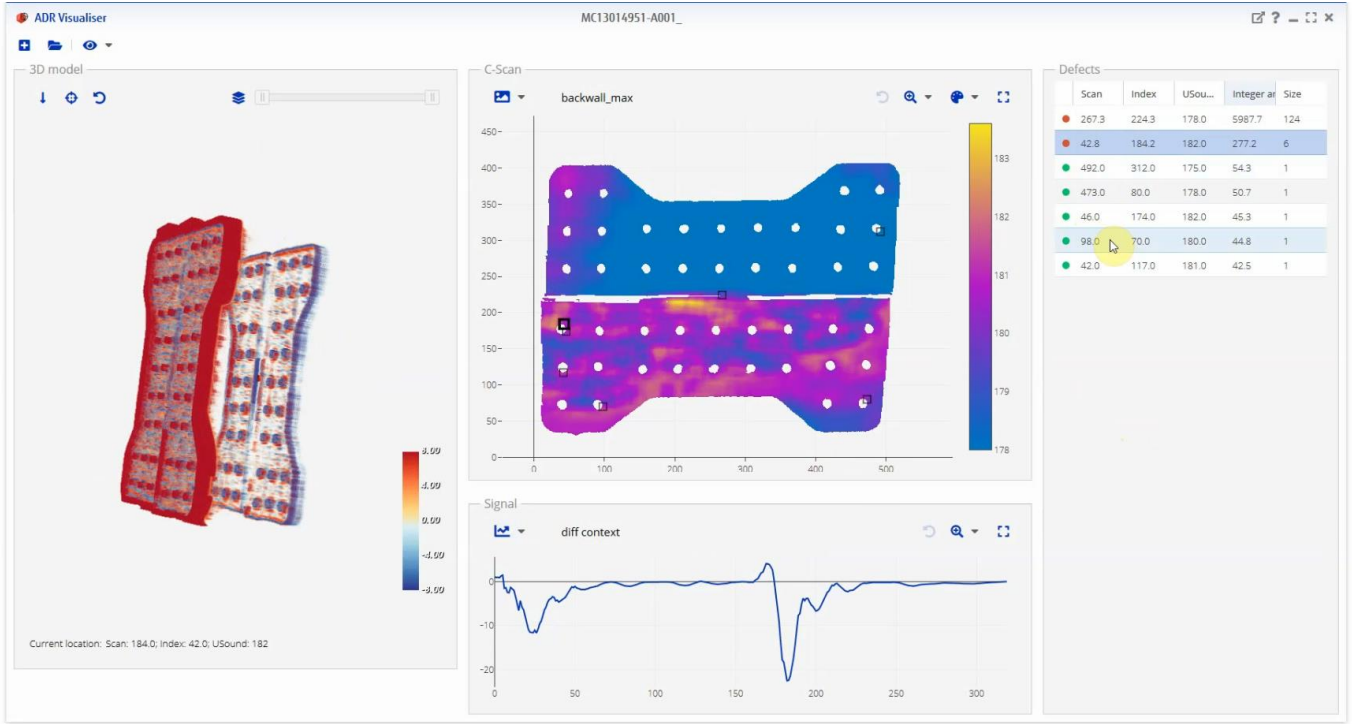
Preliminary ADR study for Ultrasonic PE inspection

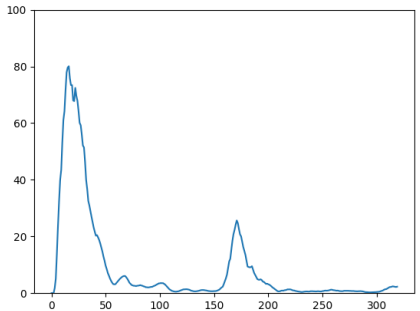
Fujitsu Systems Europe

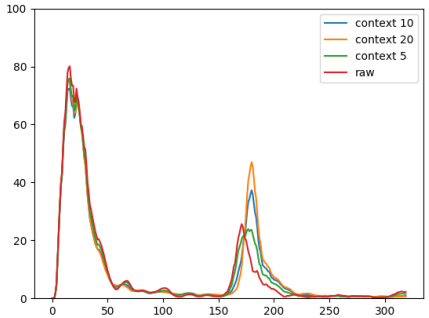
1D/3D Assisted Defect Recognition

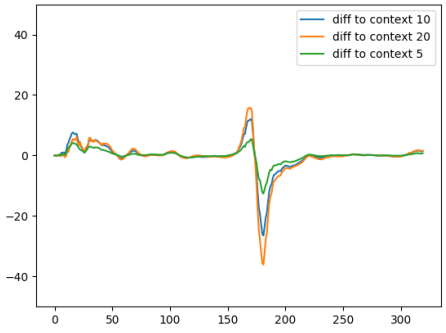


M2: Difference to context

- Difference to the context seems characteristic if a defect
  - Isolate the defect from the backwall
  - Visible even close to the border
  - 3D data -> make the defects visible in 3D rendering



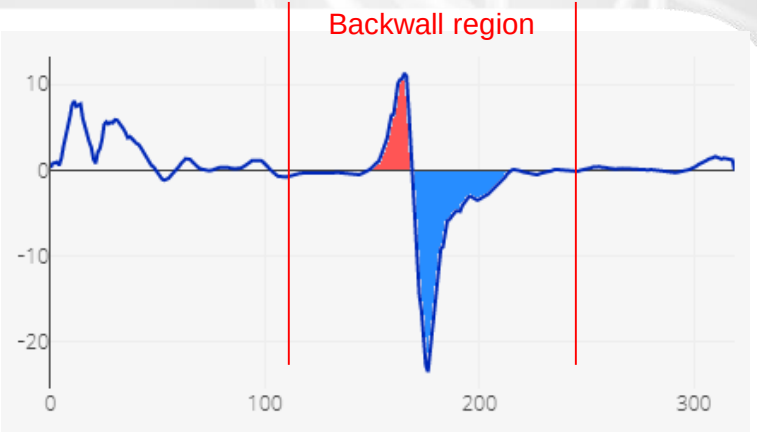




M2: Scoring the defects

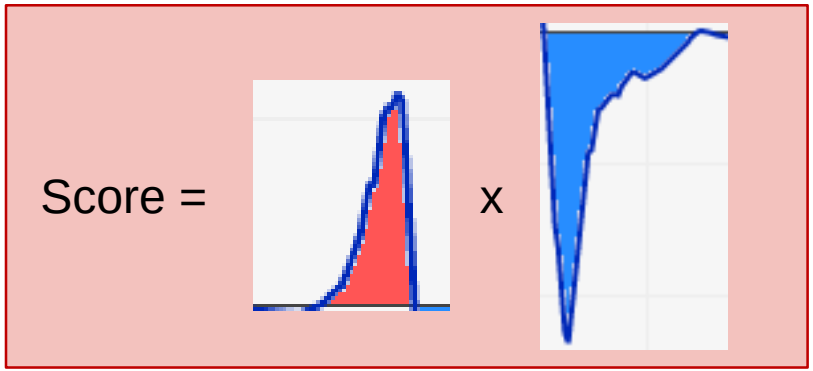
The pattern of a defect is very specific around the backwall:

- An hyper-signal on the defect (red)
- An hypo-signal on the backwall position



To compute the score on each signal, we compute the positive and the negative part of the signal.

Then we apply a formula that scores strongly the signal with both a large positive and negative divergence.



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Preliminary ADR study for Ultrasonic PE inspection Technical insight

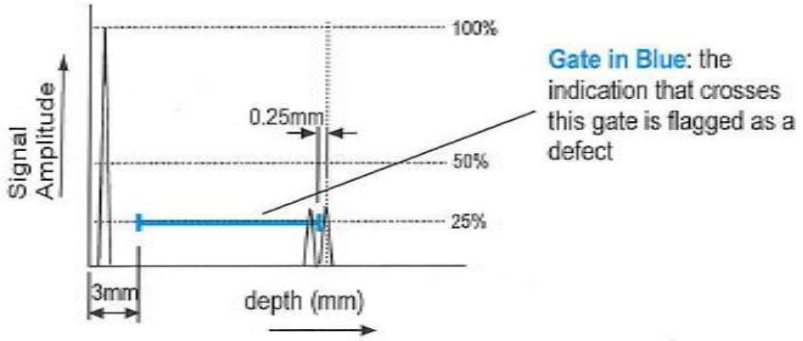
Fujitsu Systems Europe

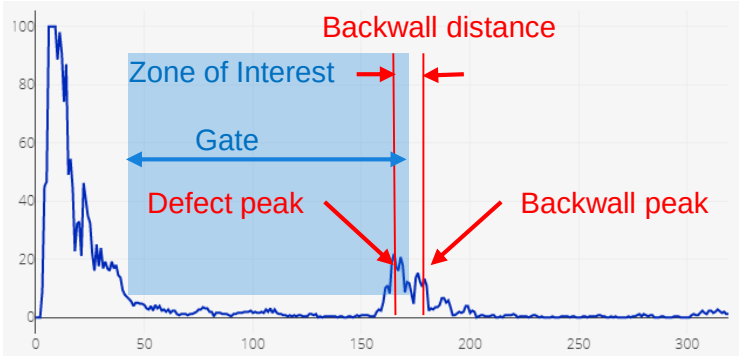
1st Detection Method : Backwall distance

The "Backwall distance" method is the one described in GKN Report 19CTC0025SOW.

We try to find all the first signal peak in the zone of interest between the frontwall and the backwall and above a defect threshold.

1. Find the backwall position
2. Find the first peak after the frontwall greater than the defect threshold
3. Create a map of peak-to-backwall distance
4. Identify and size the defect regions in the map

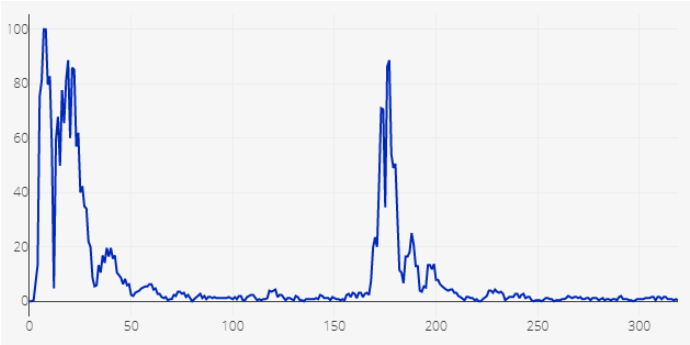


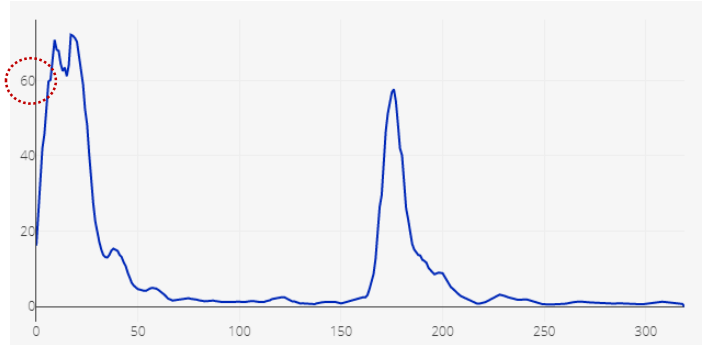


M1: 1D Smoothing

We use a simple smoothing to simplify the interpretation of the signal

- Moving window mean on the whole volume
- 1D mean along the beam direction
- Centered on the raw signal
- !!! The smoothing reduce the peak amplitude (ex: 90 -> 60)
  -> for scoring the defects, we use the raw amplitude

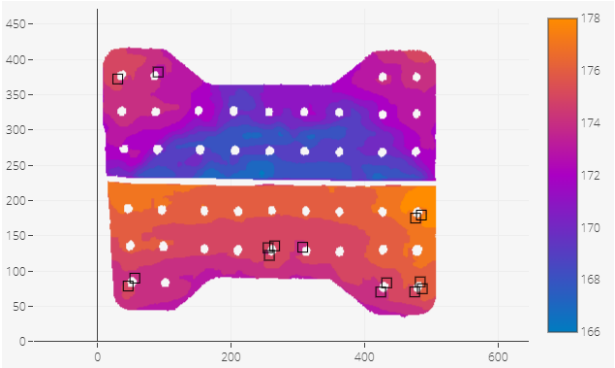




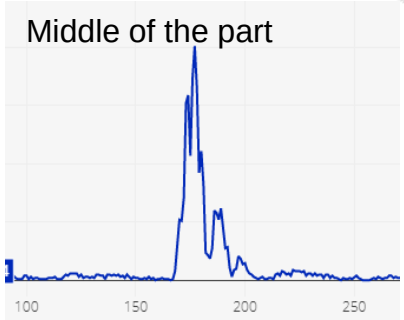
M1: Finding the « ideal » backwall

PB: It is very difficult to find the actual position of the backwall on a single signal, in particular close the a hole or the hedge.

- Use the peak signal as raw backwall
- 2D moving window mean to “smooth” the backwall position
- Masking the holes to keep only the significant signals



We mimic a user that looks to a “close” defect-free signal to estimate the backwall position on the defect

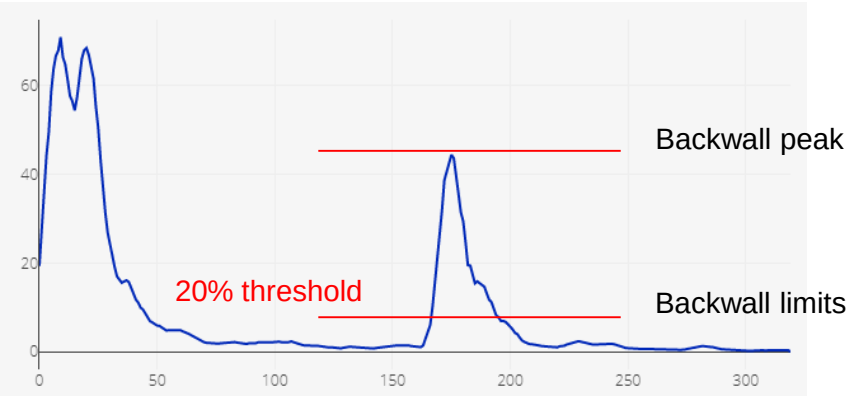


M1: Finding the backwall min

PB: The defects detection is influenced by the width of the backwall.

- We compute a map of the minimum position of the backwall
- The computation is based on the “ideal” backwall
- Using relative threshold (10% or 20%) to determine the beginning of the backwall

Using the “min” backwall instead of the center of the backwall made the error detection more robust.
We don’t need to tune the distance threshold for each scan being analyzed.

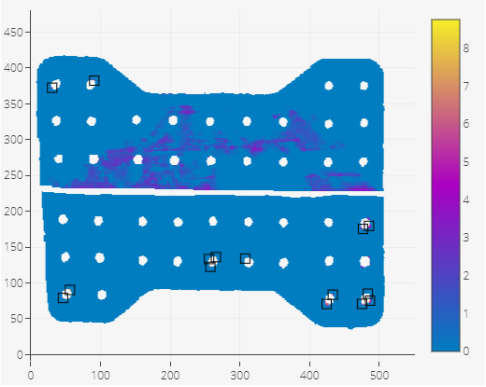


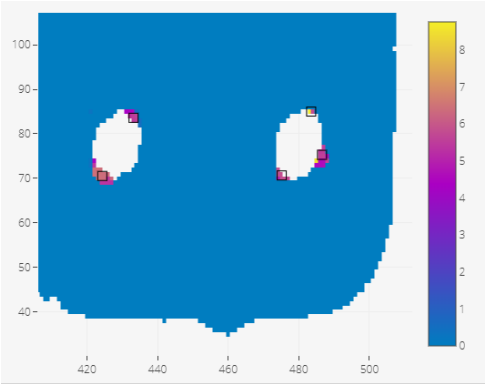
M1: Scoring the defects

Using the map of the distance to backwall, we :

1. Apply the distance threshold, to keep only the zone above the limit
2. Use a standard coloring algorithm to identify the defect regions
3. Score each defect region with:
   - **Defect Size** : number of signals in the defect region
   - **Defect Amplitude** : raw amplitude at the defect peak of a signal

Score = defect size * mean amplitude





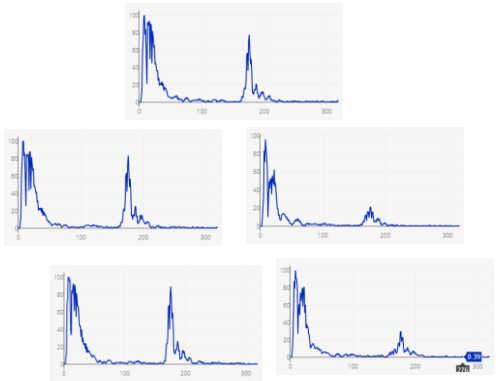
2nd Detection Method : Amplitude

The "Amplitude" method has been developed by Fujitsu.

It is a more brute force approach based on the analysis of the signals regarding their neighbors.

1. Compute the "context" of the signals on the whole data volume
2. Compute the difference between the signals and their context on the whole volume
3. Compute a score map based on the defect pattern
4. Identify and size the defect regions in the map

VS

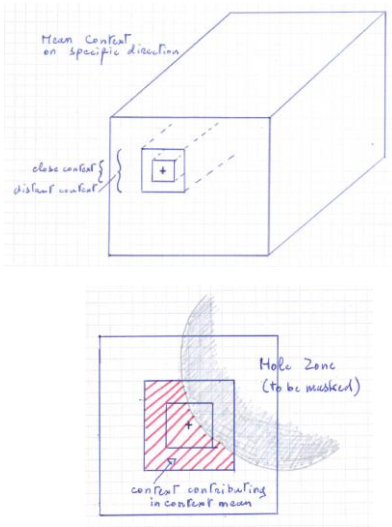


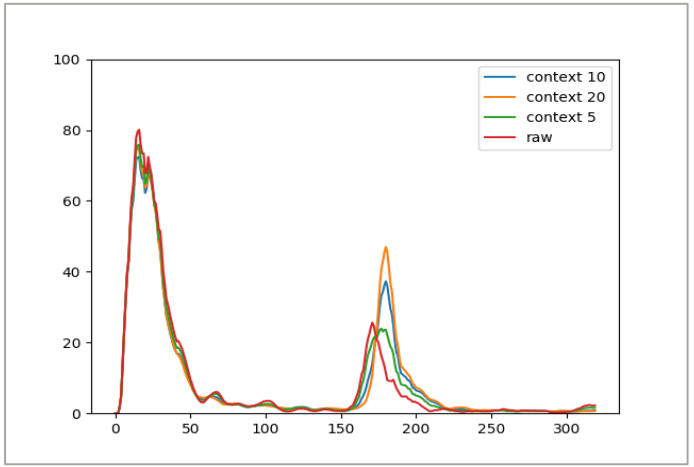
Signal neighbors

M2: A-scan Context

We compute for each signal the mean value of its surrounding

- Moving window mean on the whole volume
- 2D mean orthogonal to the beam direction
- Masking the holes to keep only the significant context





Context of the defective signal

M2: Difference to context

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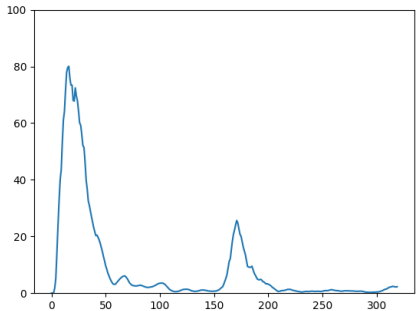
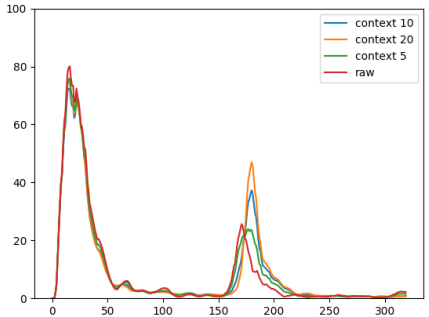
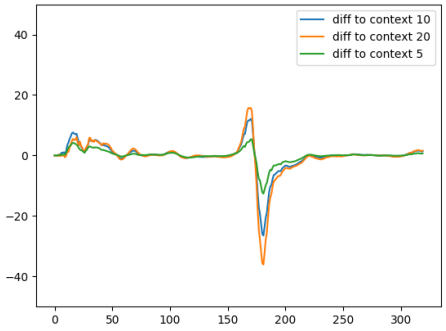
  - Isolate the defect from the backwall
  - Visible even close to the border
  - 3D data -> make the defects visible in 3D rendering







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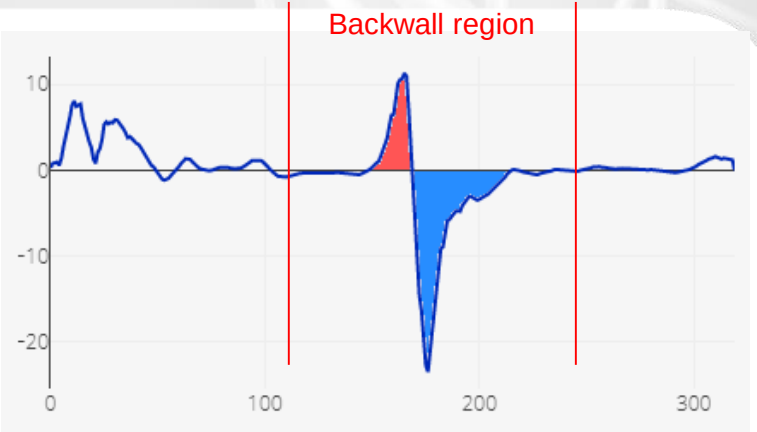

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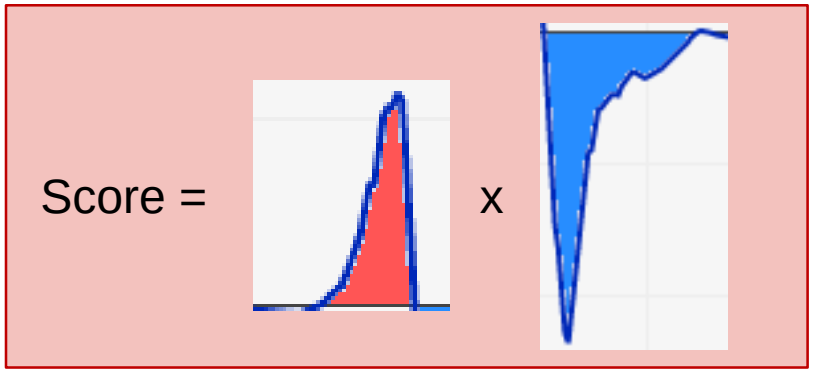

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User Guide for Automatic Defect Recognition Visualiser

Fujitsu Systems Europe

Homepage

This is the starting view of the Automatic Defect Recognition Visualiser.

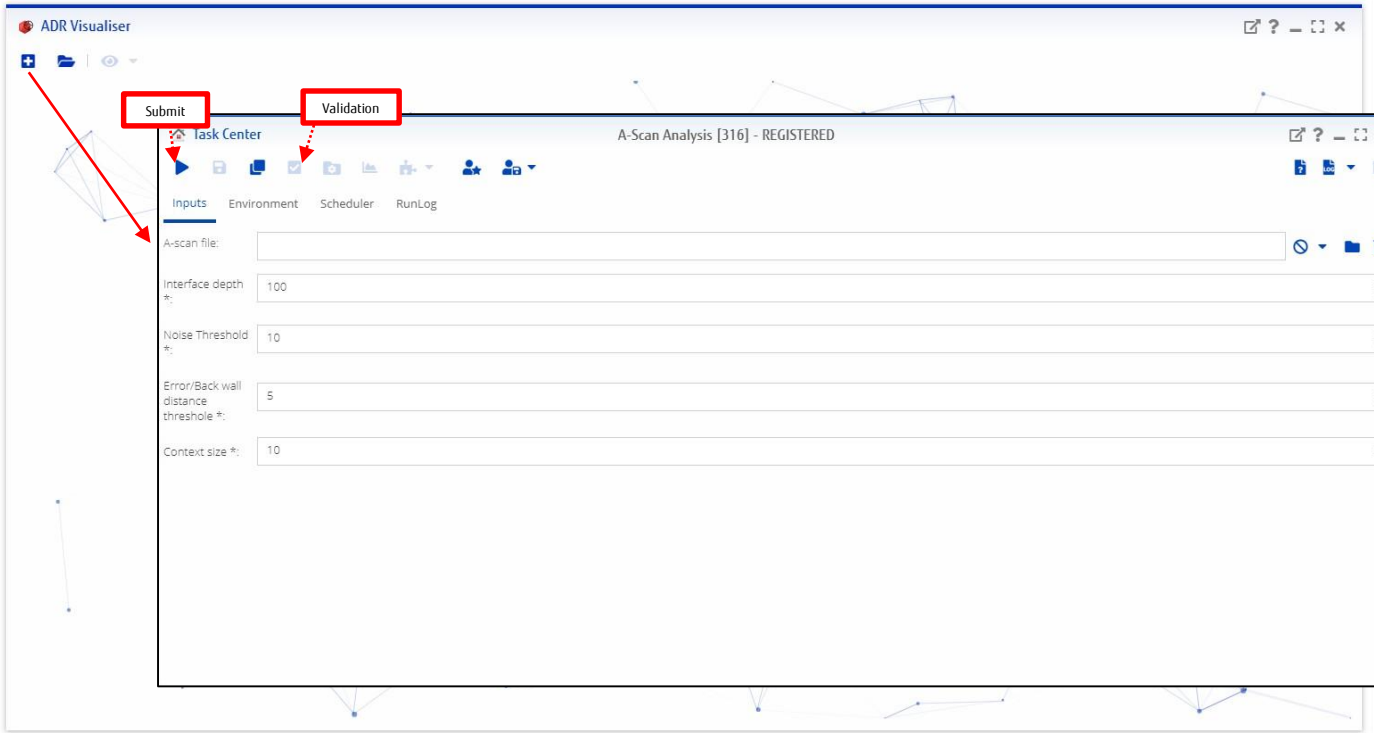
Toolbar – Add analysis

The first button of the ADR Visualiser's toolbar is the « Add analysis » button. It will help you create an A-Scan analysis (you must have one to use this tool).

When clicking on it, you will have to fill a form asking for an A-Scan file and some parameters.

After doing so, you click on the « Validation » button.
Then the « Submit » button to launch the task.

When the state of the task is « FINISHED » the analysis is done and added to the database.

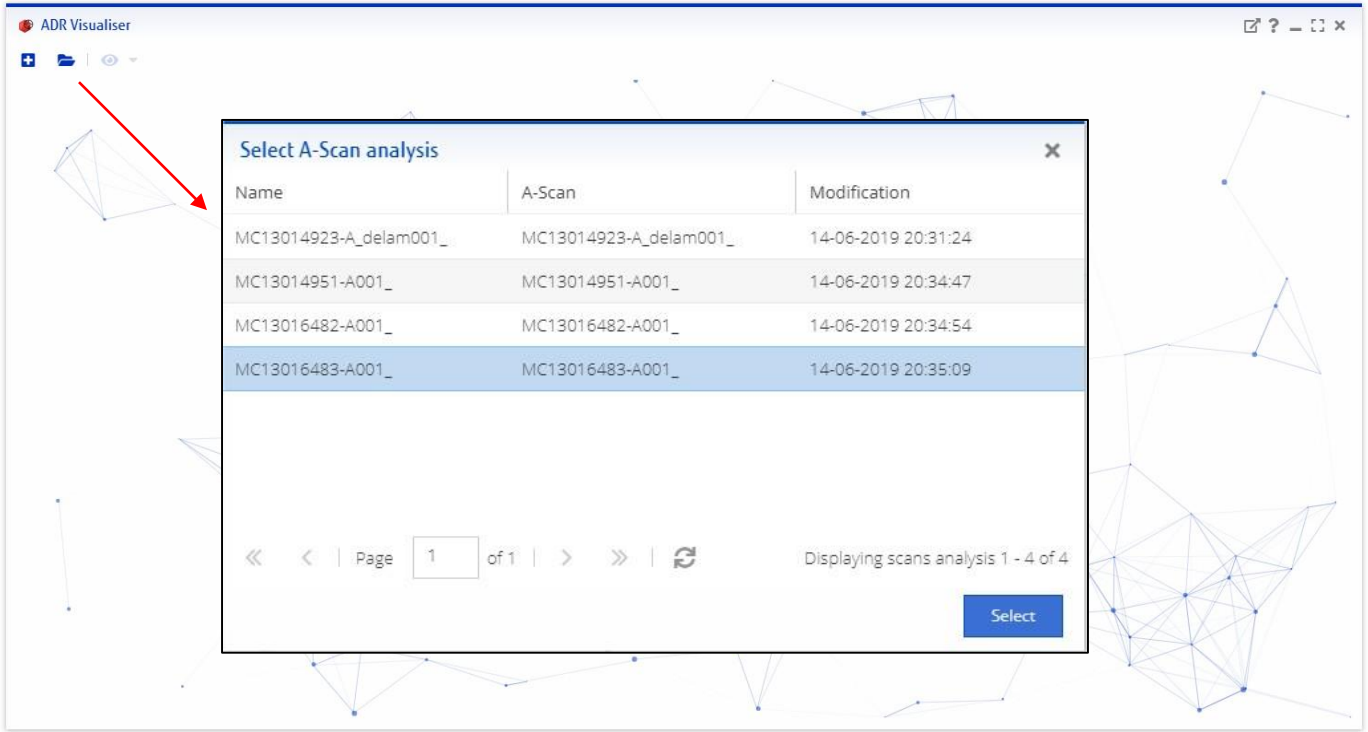


Toolbar – Select analysis

The second button in the toolbar, let the user select an analysis to visualise.

After clicking on it a window will appear allowing the selection of an analysis from an analysis table. This table can be sorted and offers a pagination that is useful when the number of analyses is large.

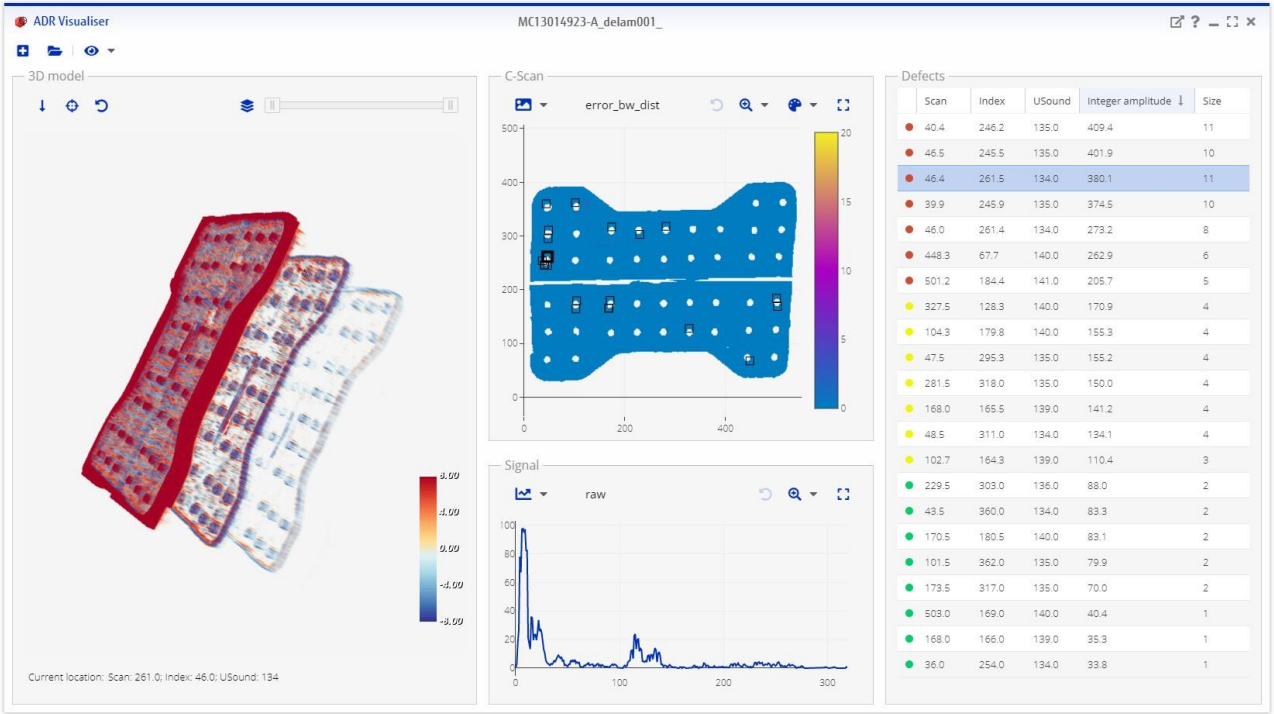
Select the analysis by clicking on it then on the button « Select » or just double click on it. Then it will load the analysis in the ADR Visualiser tool.



Overview

After selecting an analysis, 4 views are presented:

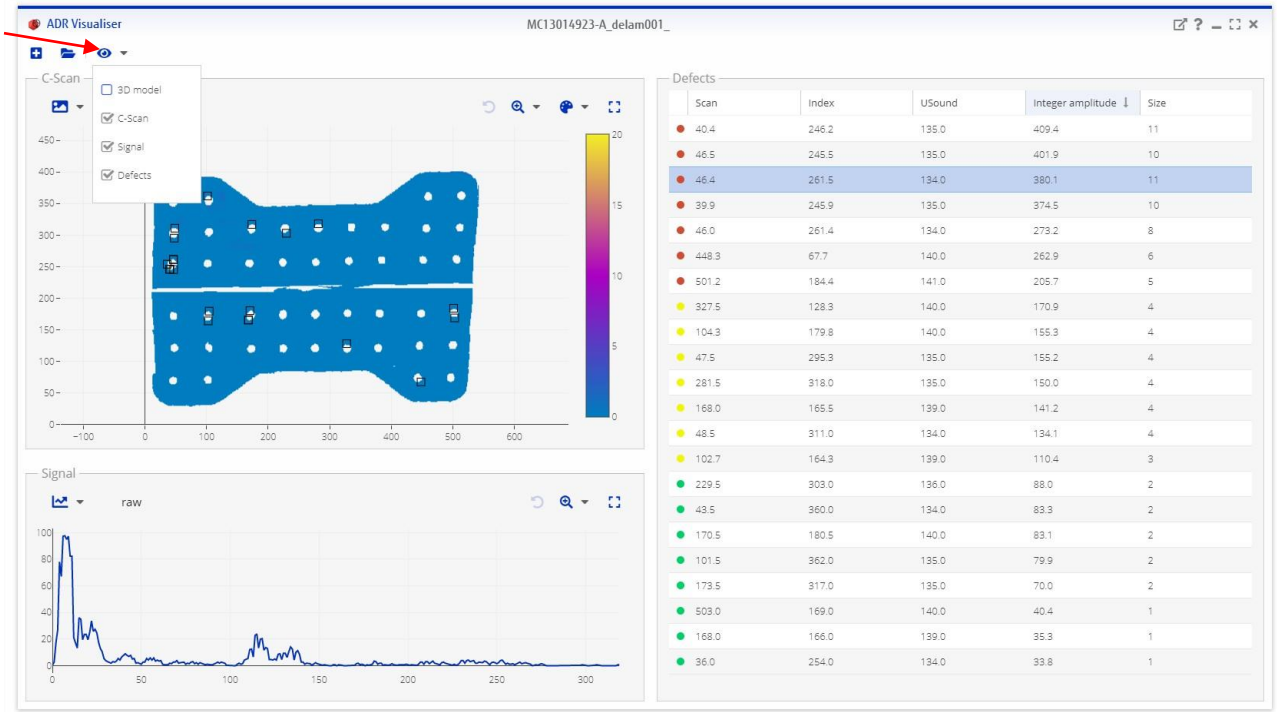
- The 3D view with defects represented by cubes of color and size depending on their importance (this view can take a few seconds to be displayed).
- The 2D view (C-Scan) with defects represented by boxes.
- The signal for a given position (no position at the beginning so no signal).
- A table of defects.



Overview – Layout change

The third button in the toolbar allow the user to change the layout.

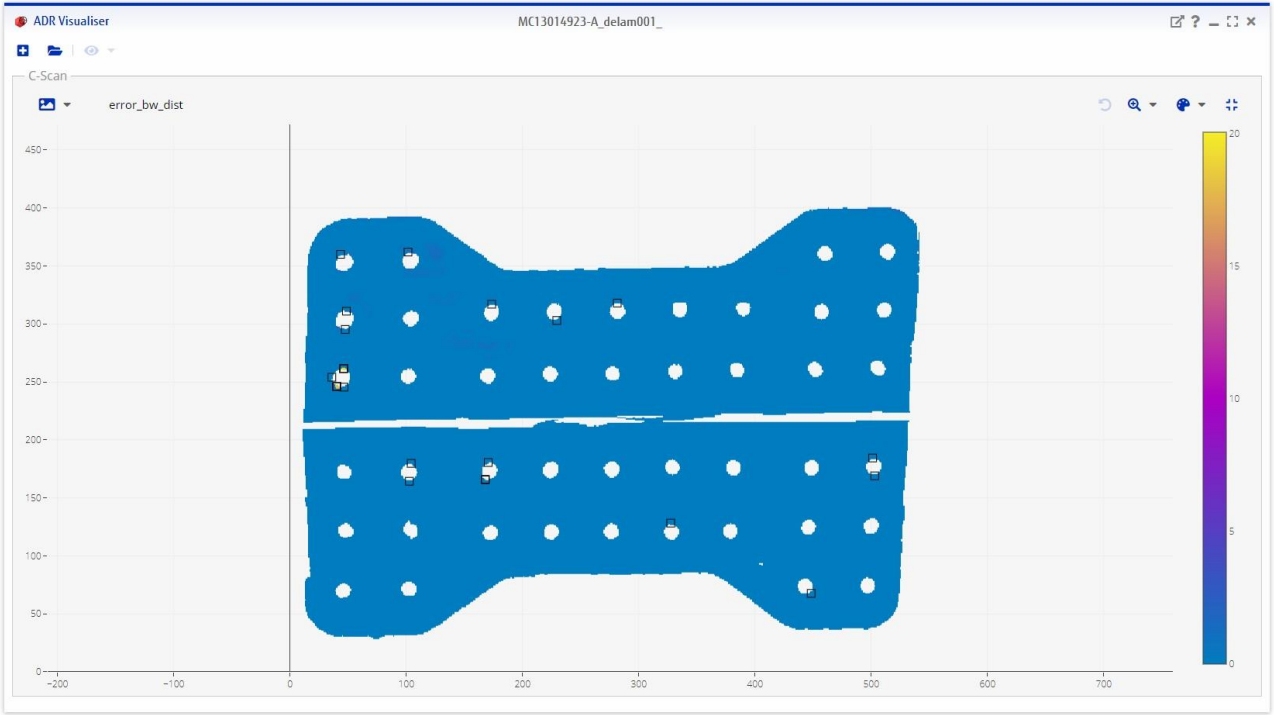
In this case the 3D view is hidden so the C-Scan, signal and defect table view are adjusted.



C-Scan view - Overview

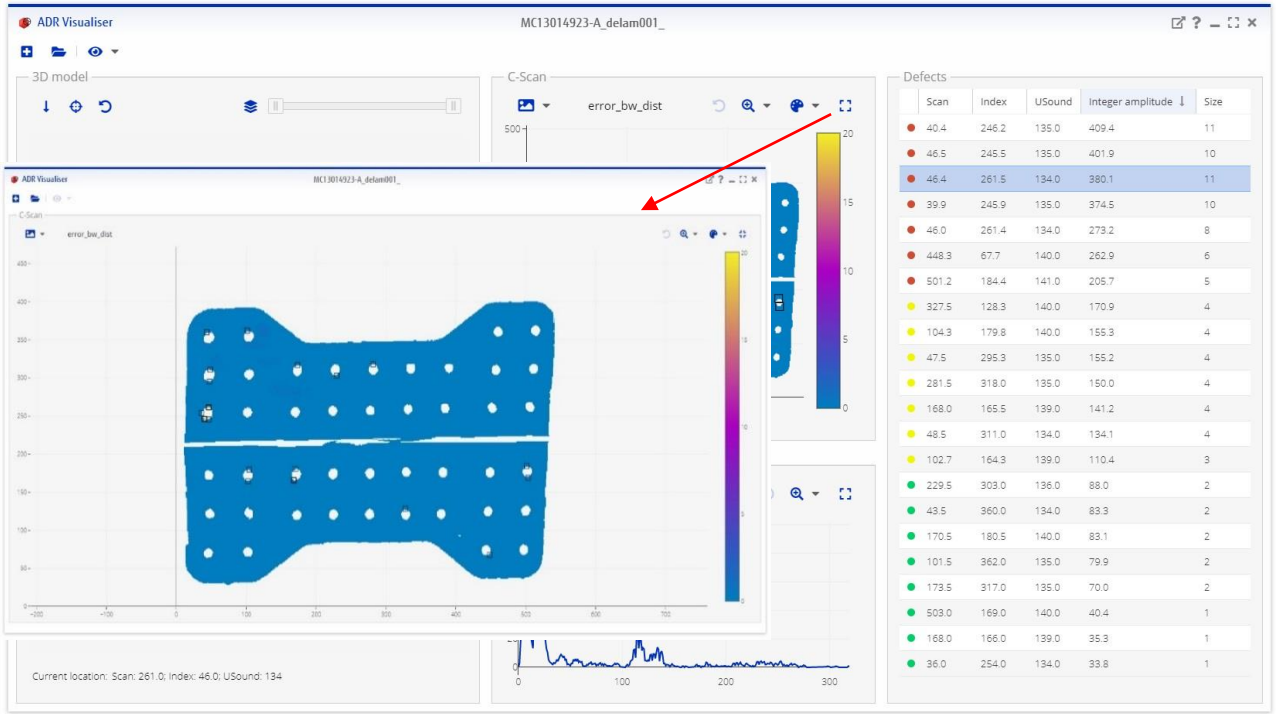
The C-Scan view is the 2D representation of the A-Scan.

It allows the user to see the defects which are shown as black boxes.



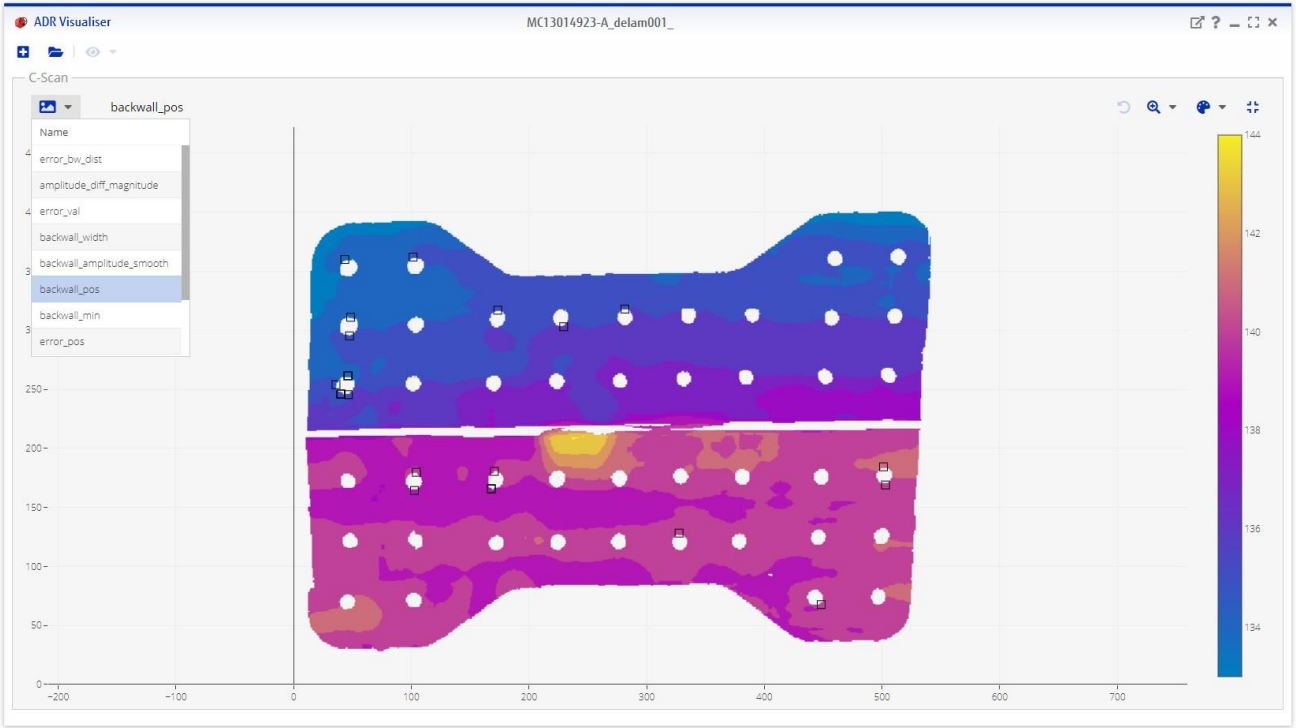
C-Scan View – Full-screen mode

The C-Scan view can be changed to full-screen by clicking on the full-screen button.



C-Scan View – Change heatmap

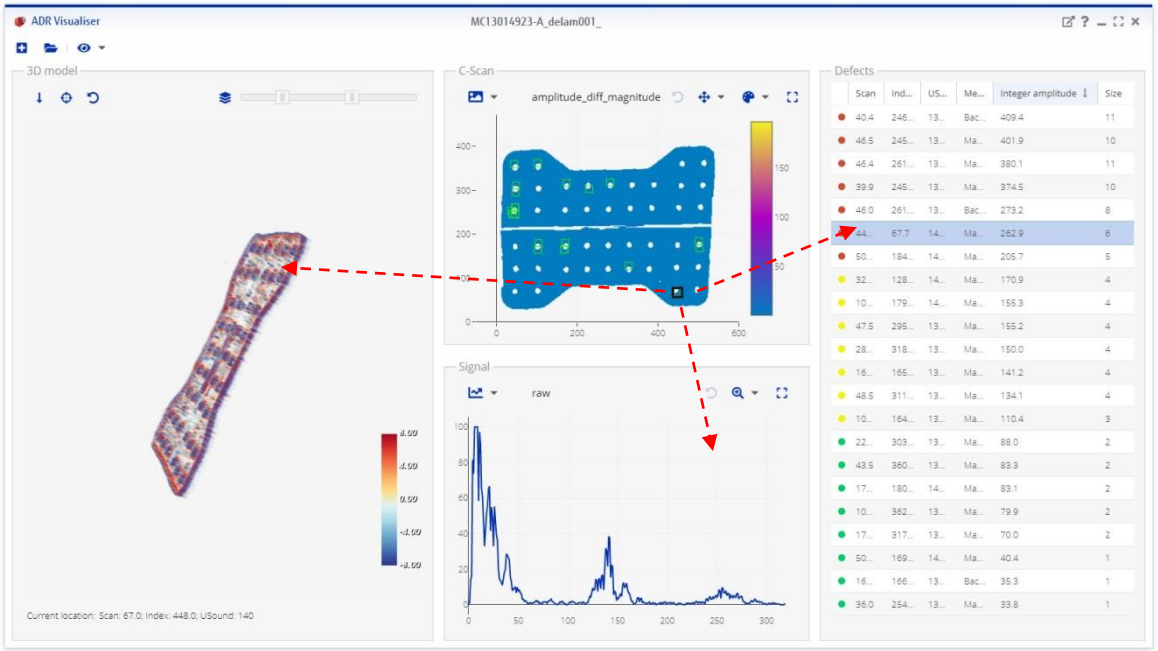
Change the C-Scan heatmap with the button « Select image to display ».



C-Scan view – Click on defect

Clicking on a defect in the C-Scan view causes not only its selection but also its selection in the defect table.

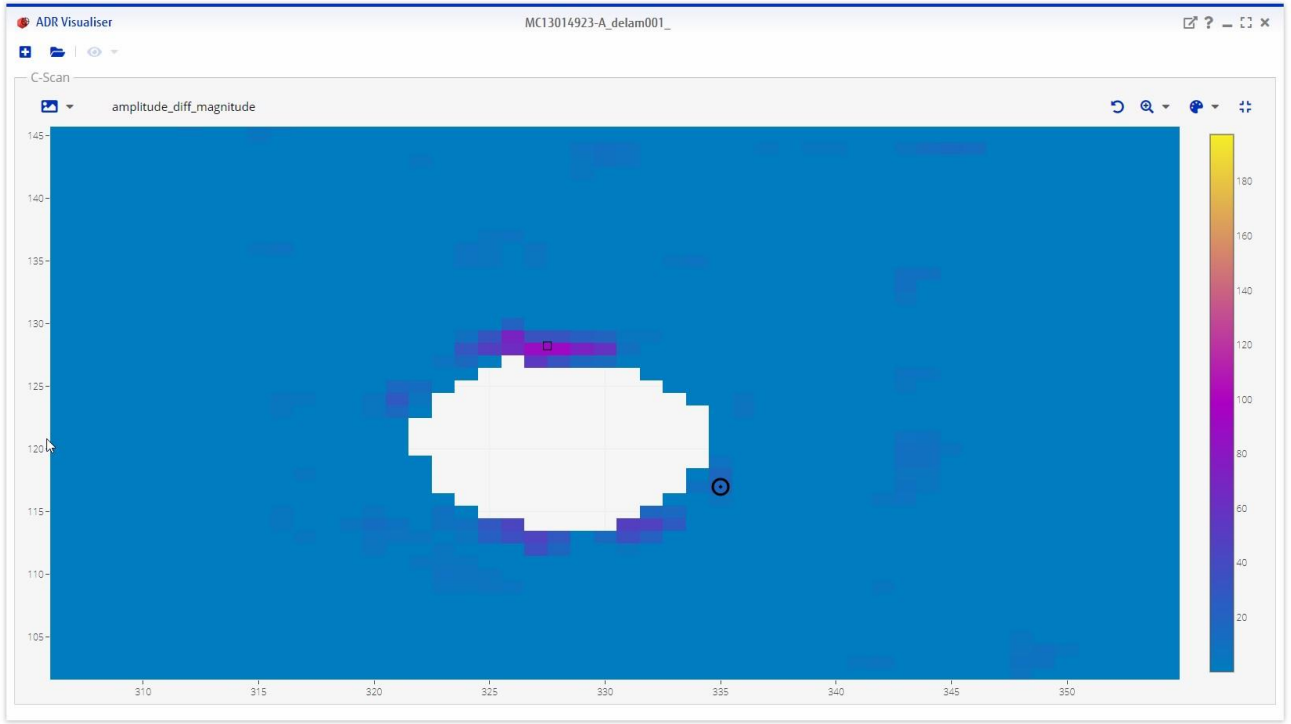
This also causes a change in the signal and selects the defect in the 3D view.



C-Scan View – Cursor

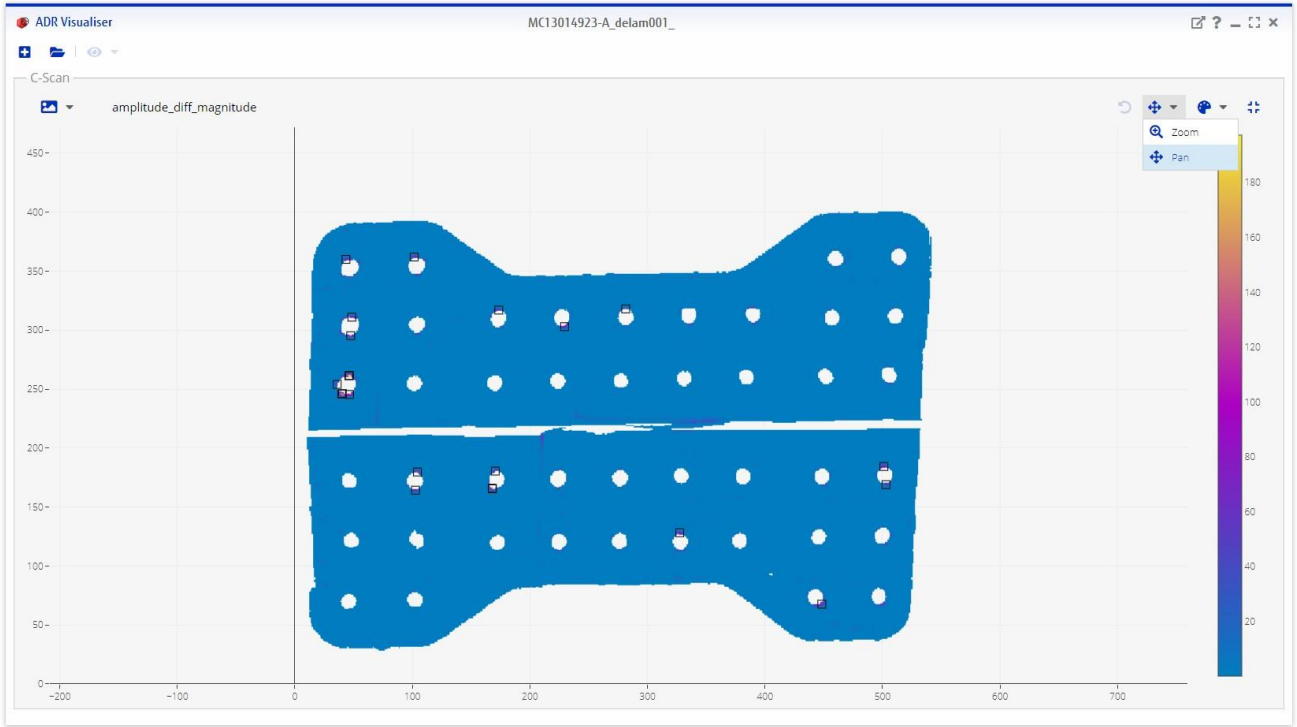
A cursor appears after clicking on the heatmap.

Note : this action changes the signal.



C-Scan View – Move or zoom

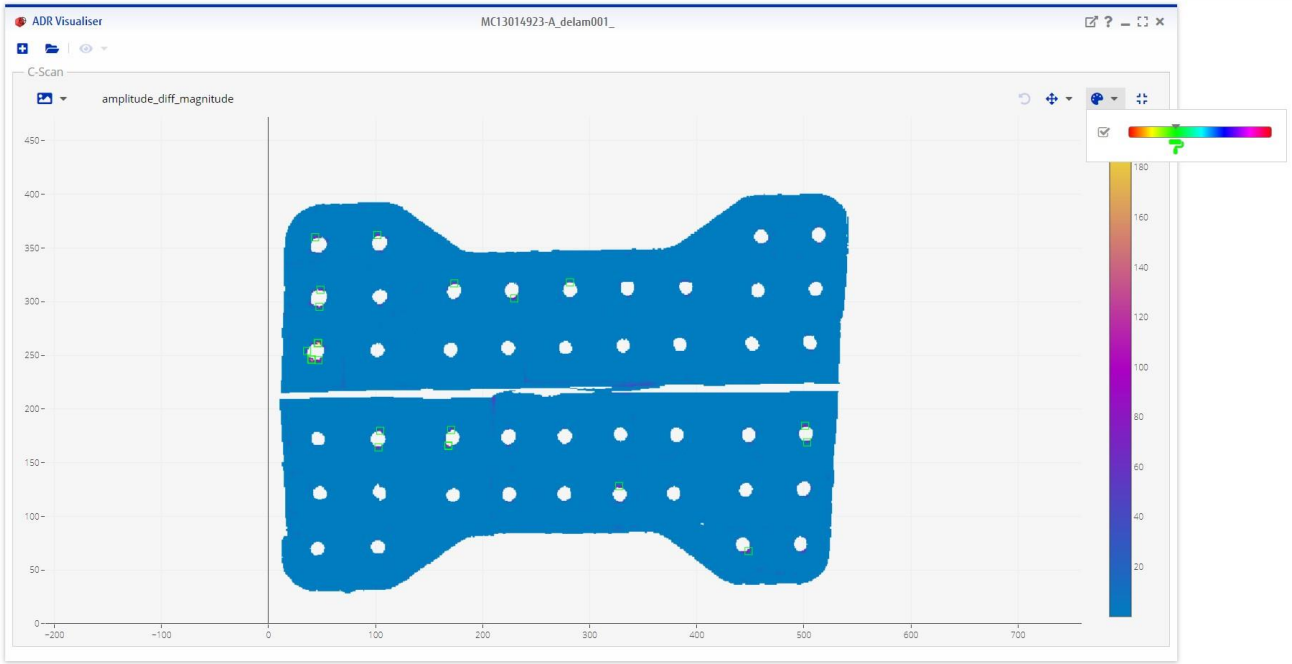
In the C-Scan view you can zoom or move the heatmap by selecting one of these options.



C-Scan View – Change defects color

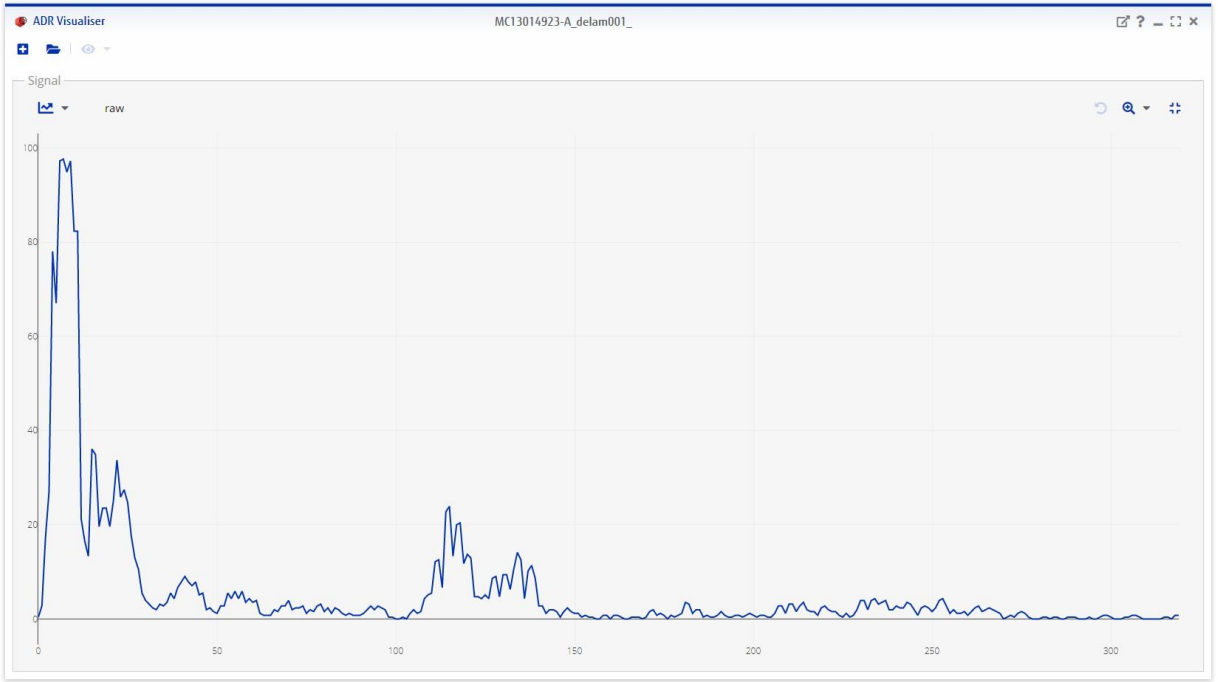
Change the defects color by clicking on the color panel button. Then allow the color change by clicking on the check case.

Now select the color you want to see display on the defects.



Signal view – Overview

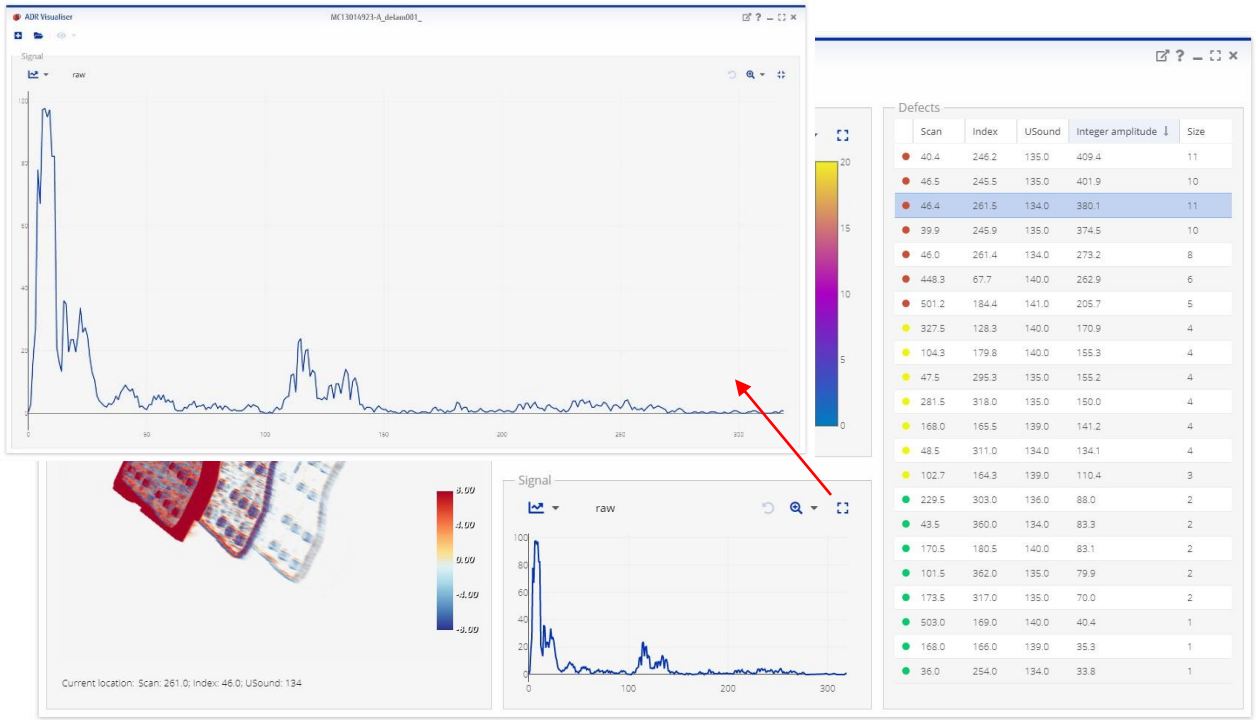
The signal view will allow the user to see what signal is shown for a given position.



Signal view – Full-screen

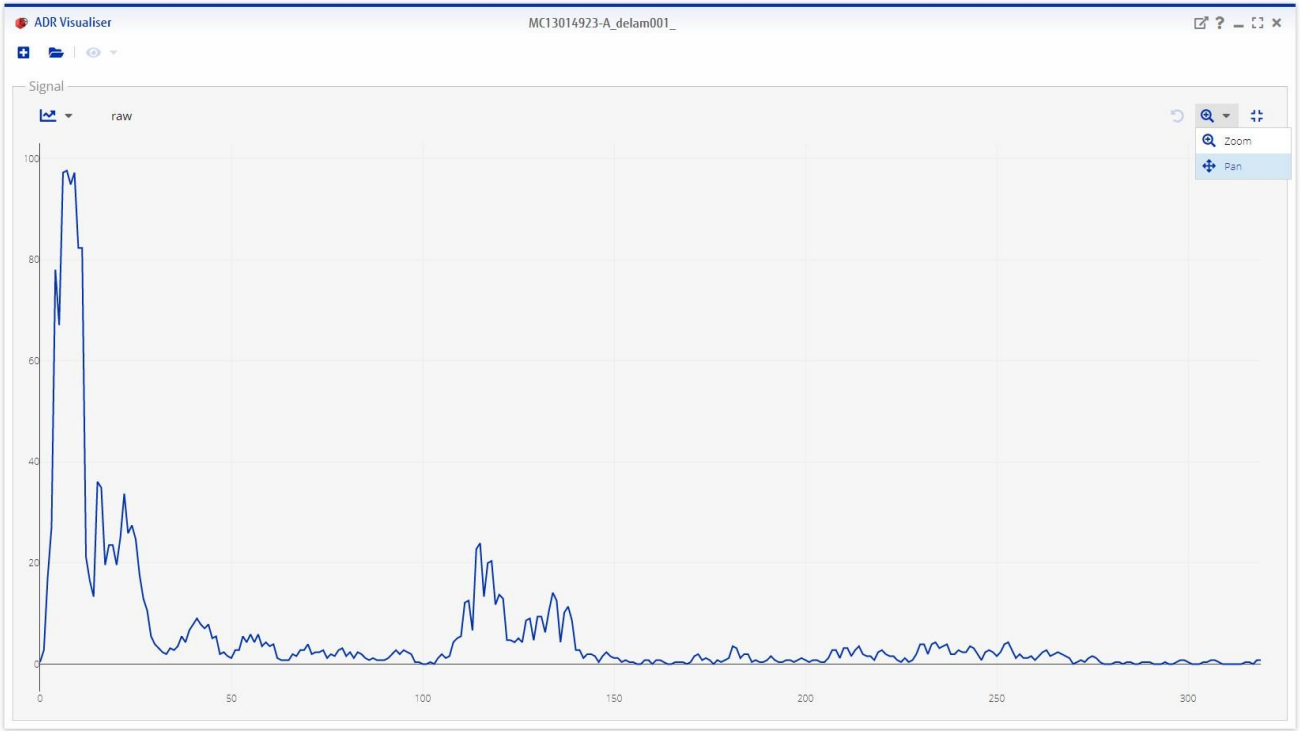
Click on the full-screen button in the signal panel to switch to full-screen mode.

To undo this action just click again on the same button.



Signal view – Move or zoom

In the signal view you can zoom or move the time-serie by selecting one of these options.

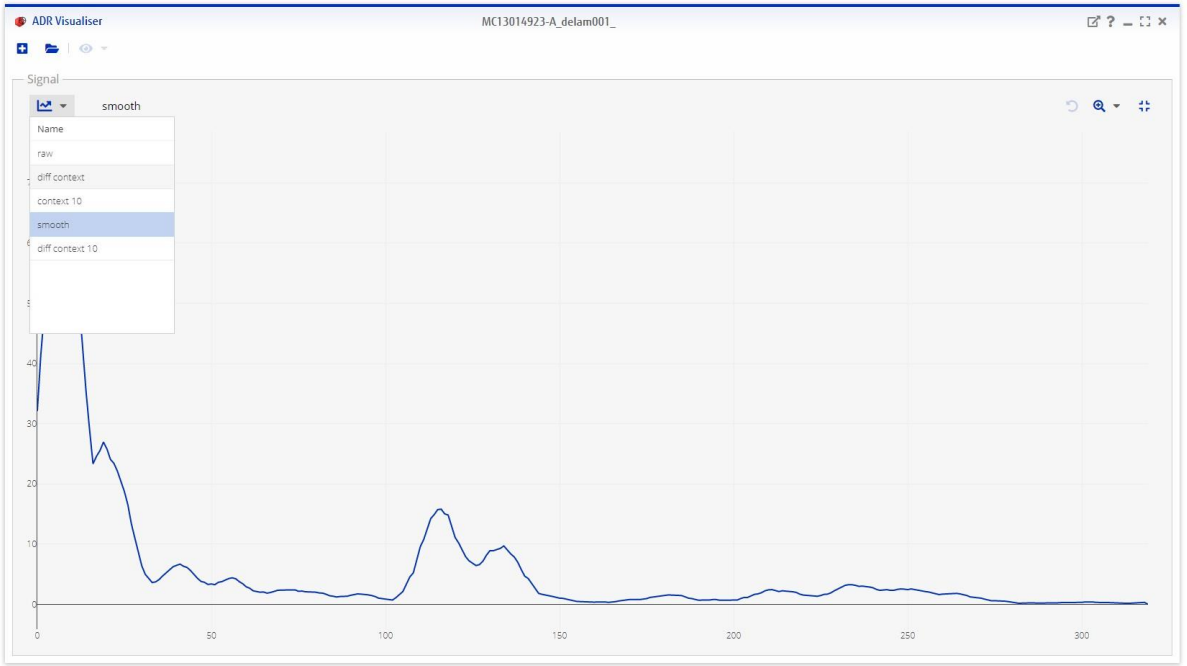


Signal view – Change signal

Change the type of signal to display by clicking on the signal button.

Then select the type of signal you want to see:

- Raw
- Smooth
- Diff context 10
- Context 10



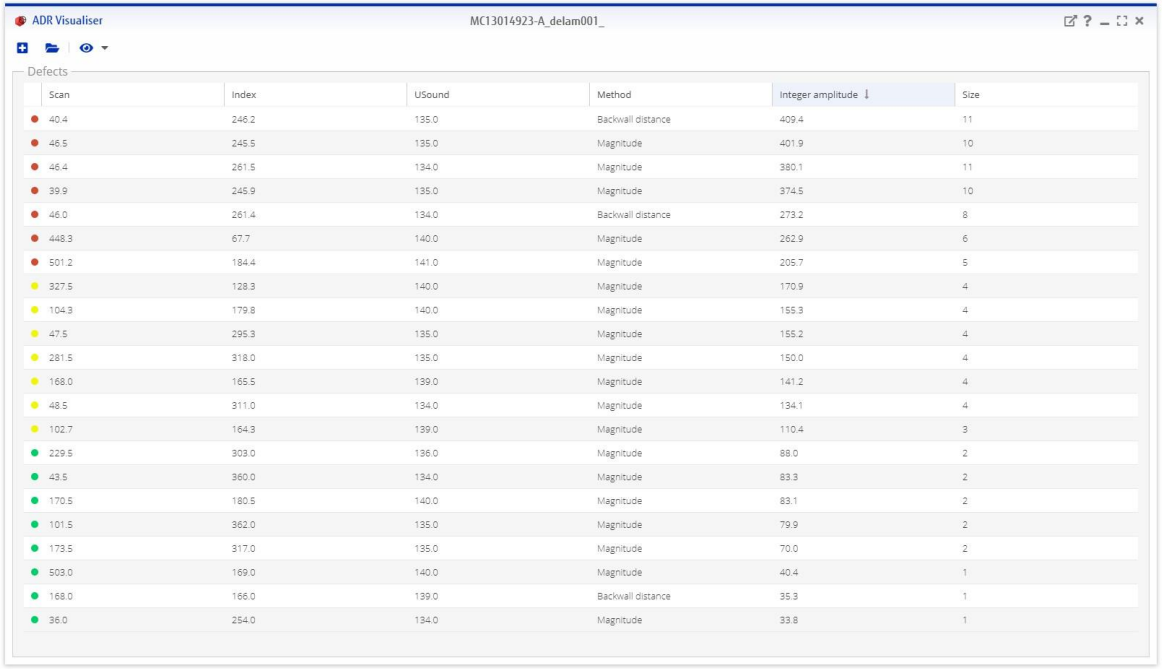
Defect table - Overview

The defect table shows as its name indicates the defects found on the A-Scan provided as a parameter.

On this table we find their x, y ,z coordinates (Scan, Index and USound) and by which detection methods they were found.

We can also find their score (Integer Amplitude) and size.

Colors categorize defects, the warmer the color is, the more important the defect is considered significant.

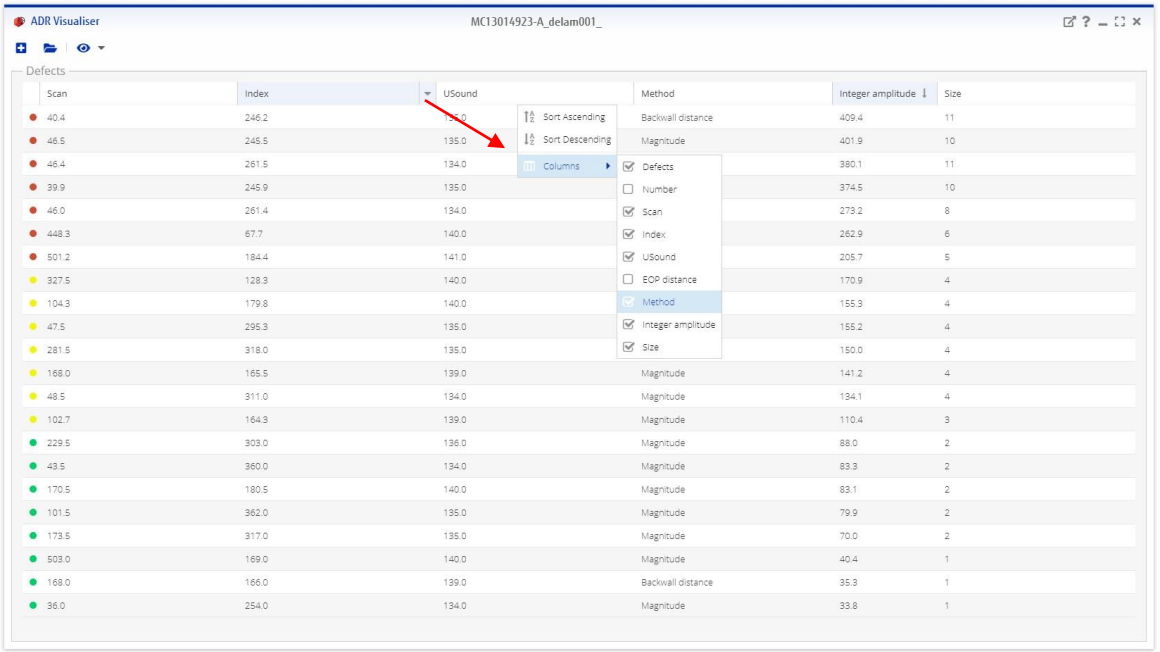


Scan	Index	USound	Method	Integer amplitude	Size
40.4	246.2	135.0	Backwall distance	409.4	11
46.5	245.5	135.0	Magnitude	401.9	10
46.4	261.5	134.0	Magnitude	380.1	11
39.9	245.9	135.0	Magnitude	374.5	10
46.0	261.4	134.0	Backwall distance	273.2	8
448.3	67.7	140.0	Magnitude	262.9	6
501.2	184.4	141.0	Magnitude	205.7	5
327.5	128.3	140.0	Magnitude	170.9	4
104.3	179.8	140.0	Magnitude	155.3	4
47.5	295.3	135.0	Magnitude	155.2	4
281.5	318.0	135.0	Magnitude	150.0	4
168.0	165.5	139.0	Magnitude	141.2	4
48.5	311.0	134.0	Magnitude	134.1	4
102.7	164.3	139.0	Magnitude	110.4	3
229.5	303.0	136.0	Magnitude	88.0	2
43.5	360.0	134.0	Magnitude	83.3	2
170.5	180.5	140.0	Magnitude	83.1	2
101.5	362.0	135.0	Magnitude	79.9	2
173.5	317.0	135.0	Magnitude	70.0	2
503.0	169.0	140.0	Magnitude	40.4	1
168.0	166.0	139.0	Backwall distance	35.3	1
36.0	254.0	134.0	Magnitude	33.8	1

Defect table – Sort and hide/show columns

Each column of the defect table can be shown or hidden according to the user's preference.
To do it, click on a column head's trigger then click on « Columns » and check the boxes to show the columns.

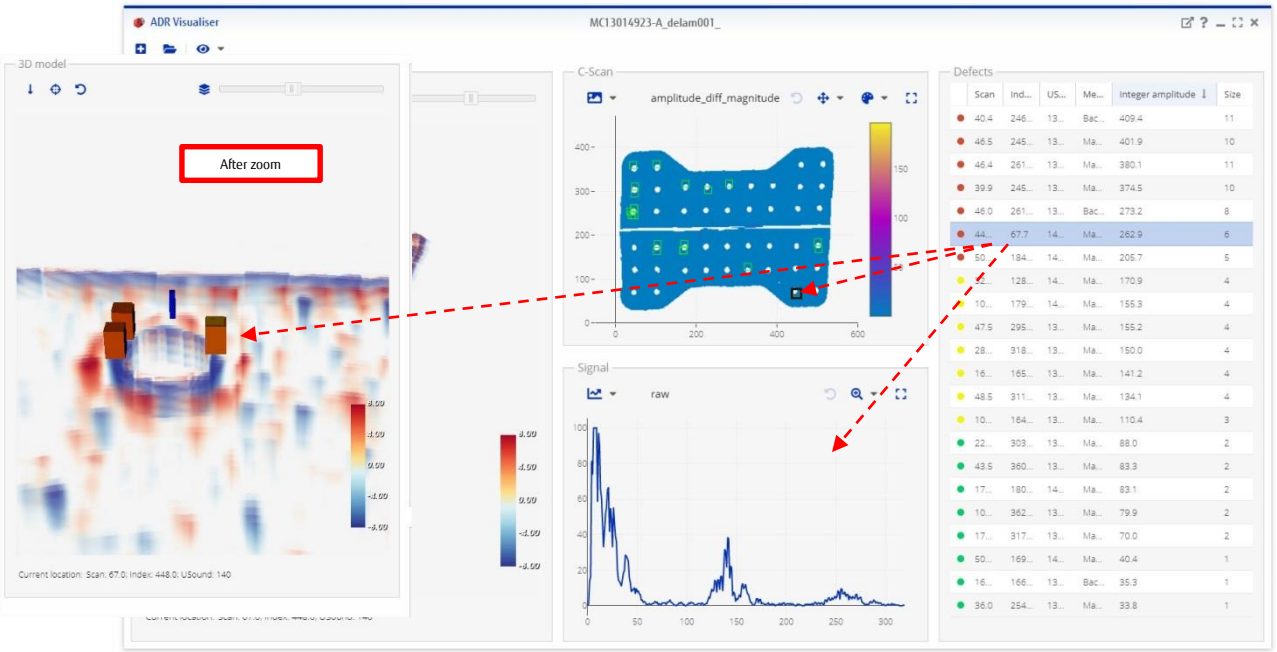
They can also be sorted (by default the score is the column used to make a descending sort). Just click on a column head to sort it.



Defect table – Click on line

Clicking on a line in the defect table causes not only its selection but also its selection in the C-Scan view.

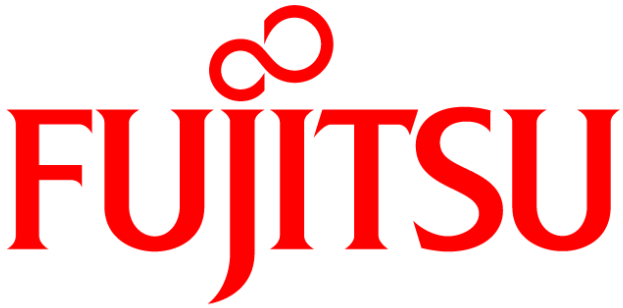
This also causes a change in the signal and selects the defect in the 3D view.



3D view – Overview

3D view of the A-Scan part.
Multiple actions are available here:

- Move the 3D model.
- Move the gate with the sliders(see screenshots).
- Move camera to selected defect position.
- Move the camera to the center.
- Reset camera.



shaping tomorrow with you