Sharck™ G2 User Guide

Version: 1.1 (Magnifi® 4.4, Go 1.5)

Date: 2018-06-28

Contents

1. Probe Description

1a. Butt Weld

1. Keypad (see section 1c)
2. Active area markers
3. Scan direction
4. Strap attachment
5. Removable embedded encoder (see section 9 for cleaning)
6. Wheels (see section 9 for cleaning)
7. Removable frame to clean fingers (see section 9)
8. Fingers with TECA™ elements (22)

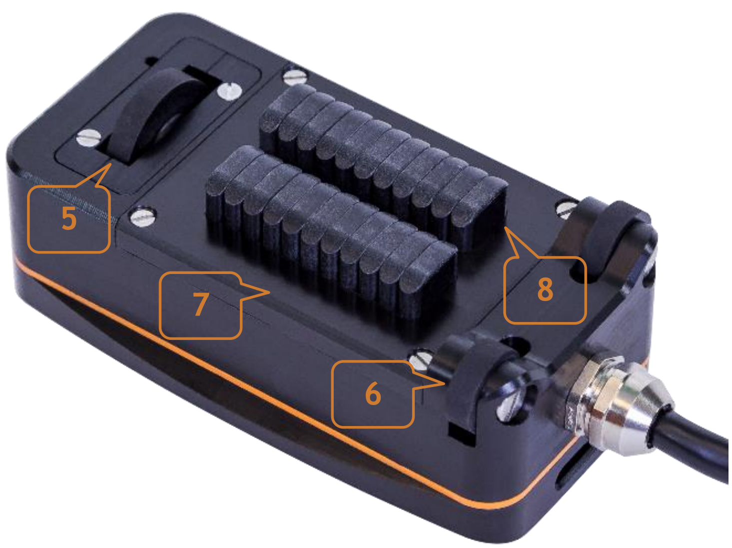


Figure 1. Sharck-Butt Weld features

1b. Fillet Weld

1. Keypad (see section 1c.)
2. Active area markers
3. Scan direction
4. Spring loaded side wheels
5. Side wheels adjustment buttons (see section 7b IV)
6. Adjustable module screw
7. Spring loaded embedded encoder
8. Wheels (see section 9 for cleaning)
9. Removable frame to clean fingers (see section 9)
10. Adjustable module fingers (6)
11. Fixed module fingers (6)

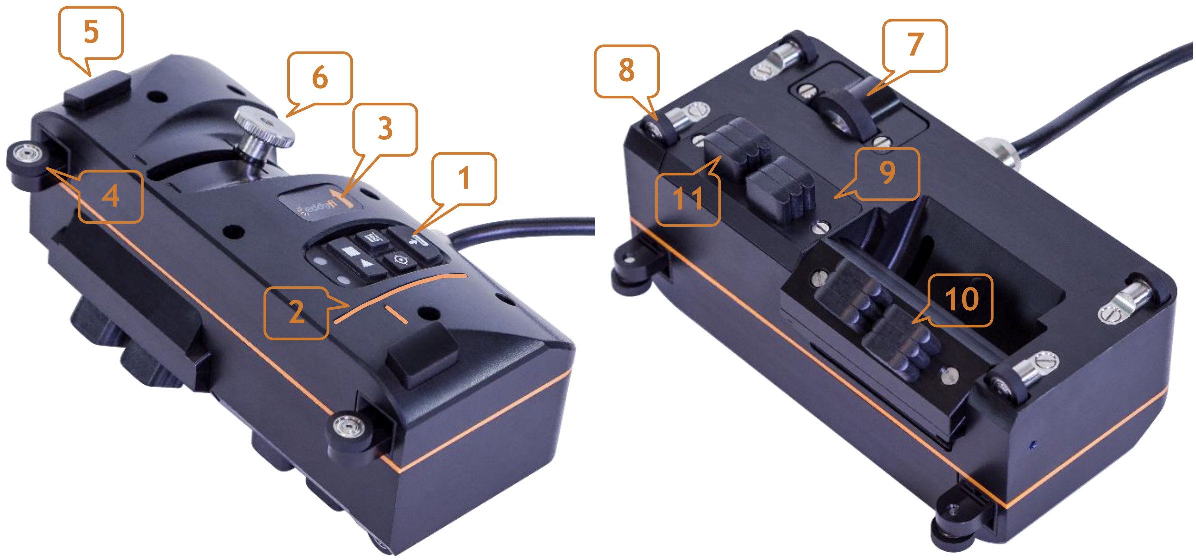


Figure 2. Sharck-Fillet Weld features

1c. Keypad

1. LED: Green LED turned on during an acquisition (not functional on 1st generation of Ectane®)
2. Start/Stop an acquisition
3. Null the probe
4. Calibration wizard
5. Save data (currently not functional on Reddy®, but will be implemented in a future version of Magnifi)

Figure 3. Keypad features

1d. Key characteristics

Type of defect	Fatigue cracking (axial and transverse to weld)
Conformability	Conforms to weld
Coverage	53 mm (2.1 in)
Channels requirements	64
Minimum pipe OD	25.4 mm (10 in) for circumferential scans 40.6 mm (16 in) for axial scans
Detection capabilities	Axial and transverse From 3 x 0.5 mm (0.12 x 0.02 in)
Sizing capabilities	Axial only From 12.5 x 1 mm (0.5 x 0.04 in) Up to 7 mm (0.28 in) deep Up to 3 mm (0.12 in) Lift-off
Temperature	100 deg C (212 F)
Maximum probe speed	Up to 200 mm/s (7.9 in/s)

2. Material compatibility

The User Mat calibration that will be discussed later in this User guide is mainly useful to compensate for permeability changes which may occur during scans, either along a same part being inspected or simply, between alloys having different properties. Permeability changes affect signal amplitude for a given flaw, this is then the reason why there is a need to compensate for it, assuring accurate depth sizing on each individual crack. The Sharck probes were primarily designed for the assessment of surface breaking cracks in carbon steel material and welds. Those can also be used to derivates to a certain extend.

Carbon steels (most of construction steels)

- Reliable detection.
- Reliable length and depth sizing.

Alloy steels

- Reliable detection
- Reliable length sizing but possible underestimation of depth sizing (specifically Nickel based one).

Note: A dedicated sizing matrix, hence setup file can be produced for specific alloys providing a sample with EDM notches is made available to Eddyfi.

High strength low alloy (HSLA) steel

- Reliable detection.
- Reliable length and depth sizing.

Note: Forged steels can be carbon steels, alloy steels or HSLA steels. Same capabilities as mentioned above.

3. Magnifi setup

I) Make sure to use Magnifi 4.4 or Magnifi GO 1.5 (or a more recent version).

II) Click Open setup and select the setup corresponding to the probe in the Default Master List.

III) Connect the 160-pin ECA probe connector to an Ectane or Reddy unit.

IV) Connect the 18-pin encoder connector to the Ectane I/O connector or the 12-pin encoder connector to the Reddy I/O connector.

V) For Ectane only: connect the instrument to Magnifi.

4. Data management

This section suggests a convenient way to manage and save automatically large amounts of data files during an inspection. The following steps can be done in advance in Magnifi (or Magnifi GO), before getting to the inspection site.

I) In the backstage of Magnifi, in the Inspection menu, select a project folder and an inspection folder .

II) In the Acquisition menu, select the Prefix filename option.

III) Click Create New List .

IV) Select the prefix for the data file list, the number of files in the list, the index for the first data file and the index increment between each file. The example below shows a data file list based on the following parameters:

Selected parameters:

Prefix:	TECA
Number of elements:	4
Element start number:	10
Element increment:	2

Resulting datafile list:

Prefix	Index
TECA	010
TECA	012
TECA	014
TECA	016

V) Click Create.

VI) In the frontstage, in the Layout tab, make sure the Data button is checked. The data file list will be displayed on the left side of the screen.

VII) At the bottom of the data file list, click Acquisition preferences , and check the following two options:

i) Automatic file recording.

ii) Automatic Next on Stop Acquisition.

When an acquisition is stopped, these two options allow to automatically save the data file and select the next one in the list. The user can then start the next acquisition, without any other action required.

VIII) Once the setup parameters and preferences are settled and the probe has been calibrated (see section 4), uncheck Setup Mode Setup Mode in the Home tab.

IX) In the data file list, select the first file to be acquired. The inspection can then begin.

A few more information about data management in Magnifi and Magnifi GO:

- The small icon beside each data file indicates its current state:

Icon	Definition
	The datafile was acquired and saved, but has not been analyzed yet
	The datafile was acquired, saved and analyzed, and it was reported as being defect-free
	The datafile was acquired, saved and analyzed, and defects have been reported
	The datafile has not been acquired yet (empty file)
	The datafile is tagged for further review

For more information on data analysis, refer to section 7 of this user guide.

- At any time during the inspection, the user can click *Add data* or *Delete data* at the bottom of the datafile list. Datafiles added with this button will keep the same prefix, and their index will be incremented by the number selected in the index menu. To create datafiles with a new prefix, go back to the backstage and click *Create New List*.

- To re-scan a datafile that has already been acquired and saved, right-click on the datafile (or hold the Reddy's touchscreen) and click *Re-scan*. To choose whether the original datafile should be kept or erased, select the corresponding option in *Acquisition preferences*.

5. Layout

1. Dp-Proc C-scan: Visualisation of axial cracks with material permeability and lift-off compensations. Each horizontal line corresponds to a channel of the probe.

   ➔ Used to localize axial cracks indications, in combination with Lg C-scan.

2. Dp-Raw Lissajous: Raw impedance signal of the channels underneath the cursor in the Dp-Proc.

   ➔ Used for depth measurement of axial cracks.

3. Lg C-scan: Visualisation of axial cracks ends.

   ➔ Used to localize axial crack indications quickly, in combination with Dp-Proc C-scan, and size the cracks length.

4. Lg Lissajous: Signal of the channels underneath the cursor in the Lg C-scan.

5. Tr Strip chart: Superimposed strip charts of the transverse channels.

   ➔ Used to detect transverse crack.

6. Compensated Depth: Depth measurement of the axial crack, up to 7 mm (0.28 in), with compensation for lift-off and permeability.

7. Length: Length measurement of the axial crack.

8. Lift-off: Local lift-off measurement, up to 3 mm (0.12 in).

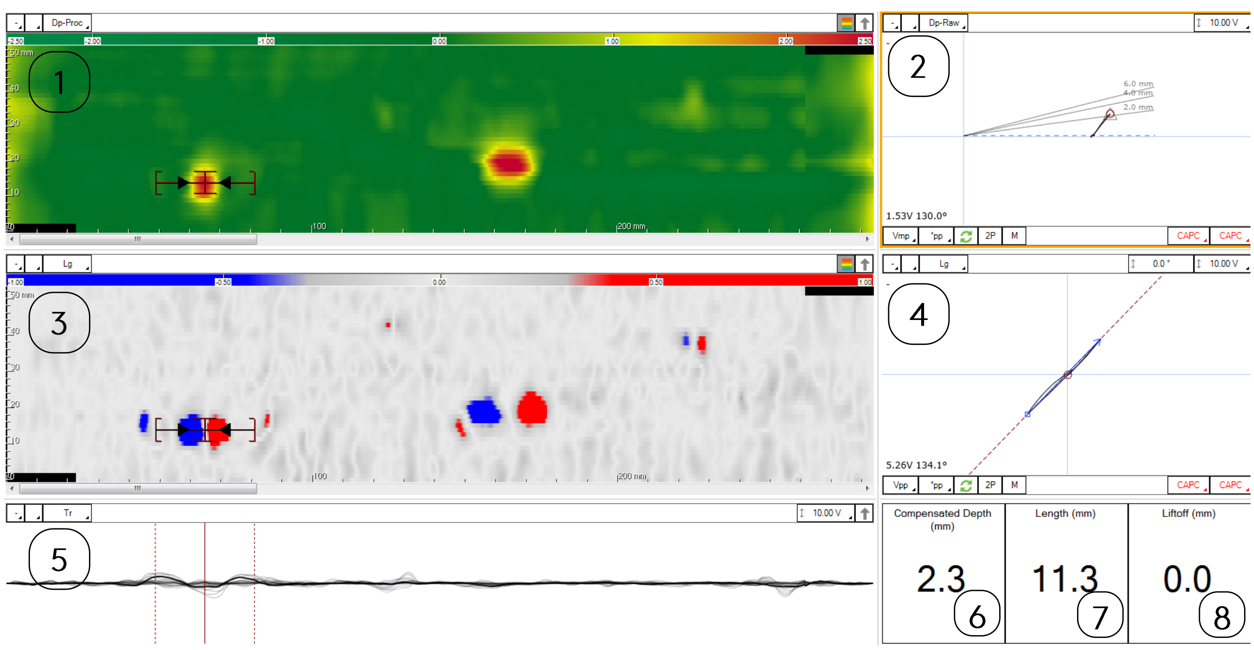


Figure 4. Sharck BW / FW acquisition and analysis layout

Note: To change the settings of any of these windows or to access the Transverse C-Scan, select it and go to the Current View tab.

6. Probe calibration

6a. Calibration from the Sharck menu

The following calibration should be performed before beginning a new inspection:

I) Place the probe in the air, away from any metallic surface, then click Null.

II) In the *Sharck* menu, click *Calibration*.

III) Keep the probe in the air and click Air reference block.

IV) Put the probe in the middle of the aluminum plate supplied for calibration purposes and apply pressure to ensure that all wheels are in close contact with the surface, then click Aluminum.

Note1: For the Fillet Weld probe, make sure that the adjustable module is set flat.

Note2: Ensure the Aluminium plate is placed away from any conductive material prior to performing the calibration.

Figure 5. Sharck probes on aluminium plate

V) Place the probe on the weld to be inspected.

Note: For the Fillet Weld probe, ensure the adjustable module is set correctly to the weld cap under assessment.

VI) Click Carbon Steel and move the probe along the weld.

VII) Click Calibrate.

VIII) Close the Sharck calibration window.

Figure 6. Sharck probes on carbon steel weld

6b. Calibration from the probe keypad

It is also possible to calibrate the probe using the calibration button on the probe's keypad. The overall process does not change; only the clicking operations change:

I) Place the probe in the air, away from any metallic surface, then press the Null button on the probe.

II) Press the calibration button on the probe.

III) Put the probe in the middle of the aluminum plate (supplied for calibration purposes) and apply pressure to ensure that all wheels are in close contact with the surface, then press the calibration button on the probe.

IV) Place the probe on the weld to be inspected.

V) Press the calibration button on the probe and move the probe along the weld.

VI) Press the calibration button on the probe to calibrate the probe.

VII) Press any button on the probe to close the calibration window.

7. Acquisition

7a. Butt Weld

I) Null the probe in the air.

II) Place the probe on the weld. Use the marker lines on top of the probe to center it on the weld, and the marker line on the cable side of the probe to align the x=0 position with the beginning of the area to scan.

Figure 7. Scan position x=0 aligned with the marker line on the probe side

III) Start the acquisition.

IV) Acquire data by moving the probe along the weld following the direction indicated by the arrow on the top of the probe.

V) Stop the acquisition.

Note1: The total scan length can be changed in Setup → Scan.

Note2: Always Null the probe before performing an acquisition.

7b. Fillet Weld

I) Null the probe in the air.

II) Set the angle of the adjustable module (This can be done before step I).

III) Place the guiding wheels on the edge of the weld, near the bottom toe.

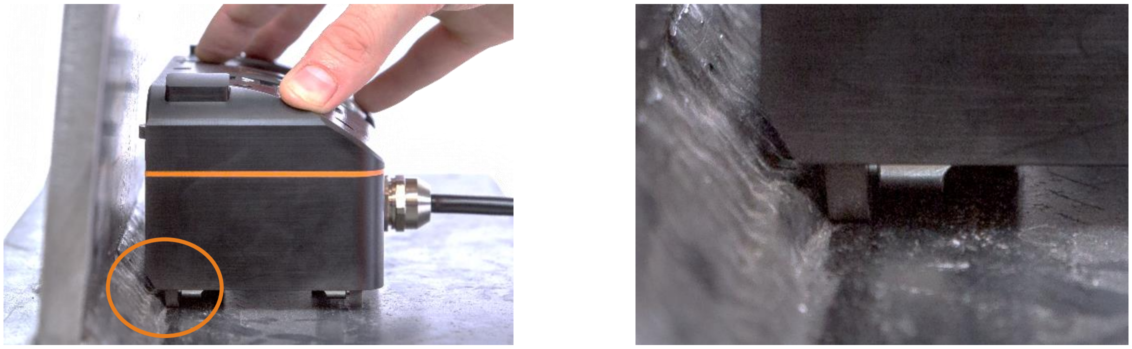


Figure 8. Probe guiding wheels leaning against weld toe

IV) Press the side wheel adjustment buttons.

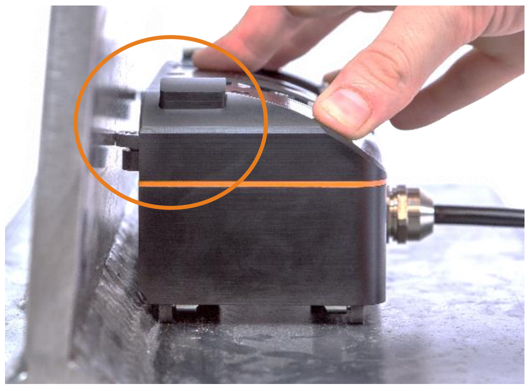


Figure 9. Pressing the side wheel adjustment buttons will trigger the mechanism

V) Align the marker line on the probe with the beginning of the area to scan.

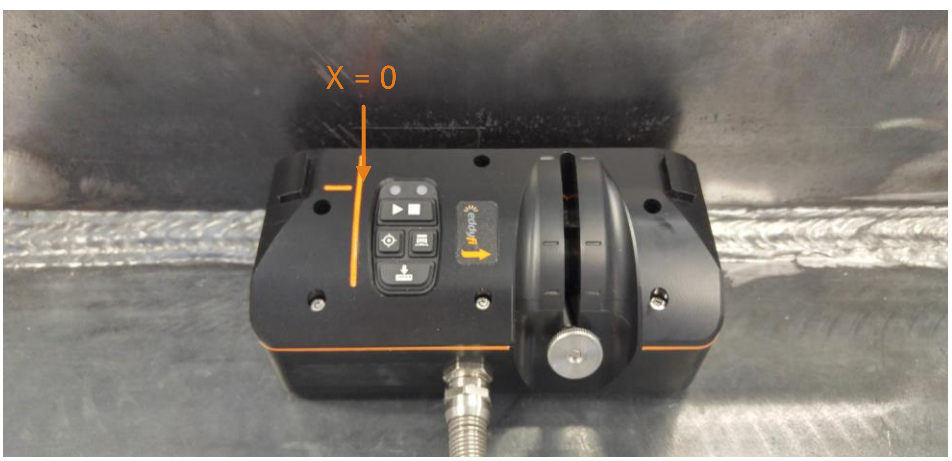


Figure 10. Scan position X=0 aligned with the marker line on the fillet weld probe

VI) Start the acquisition.

VII) Acquire data by moving the probe along the weld.

VIII) Stop the acquisition.

Note: To perform a full inspection, a second pass is carried out on the wall by turning the probe and carrying out steps I to VII again.

8. Analysis

The analysis is performed in three simple steps: user material calibration, detection and sizing.

> *Note: The Sharck BW and FW probes are designed to detect both axial and transverse cracks but only axial ones can be sized. Transverse cracking would need to the scanned axially to be fully assessed.*

8a. User material calibration

To compensate for the magnetic permeability of the inspected material, a "user material calibration" should always be performed before analyzing data. This will help with the detection of defects and will ensure the accuracy of the depth sizing.

I) Open the C-scan cursor as large as possible in the middle of the C-scan. To compensate properly, it is very important that every channel contains more data from clean material than from apparent defects within the width of the horizontal cursor (see Figure 12).

II) On the Dp-Raw Lissajous, verify that you are on a real channel and not an interpolated channel. If you are on an interpolated channel, move the cursor up and down until the channel name appear on the screen.

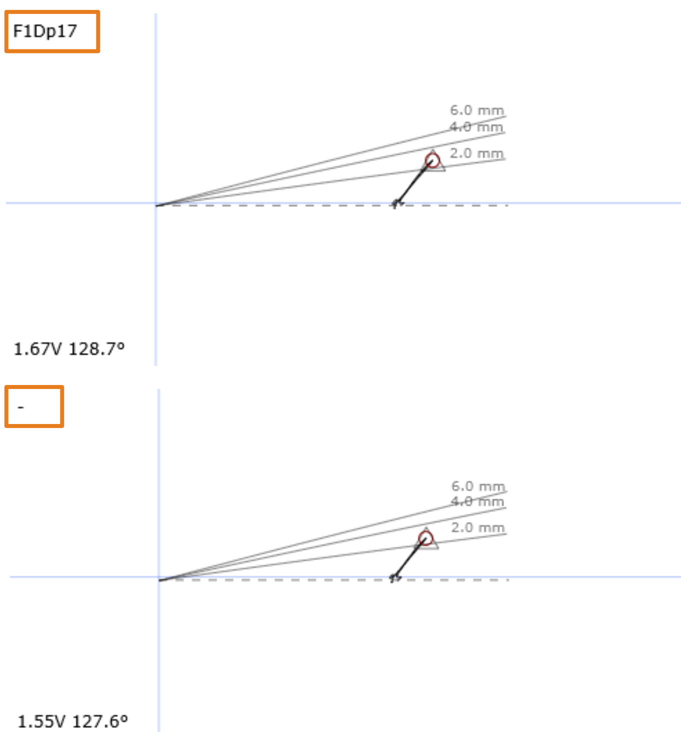


Figure 11. Identification of a real channel. On top, the channel F1Dp07. Below, an interpolated channel, identified as "-"

III) In the Sharck menu, click the UserMaterial button.

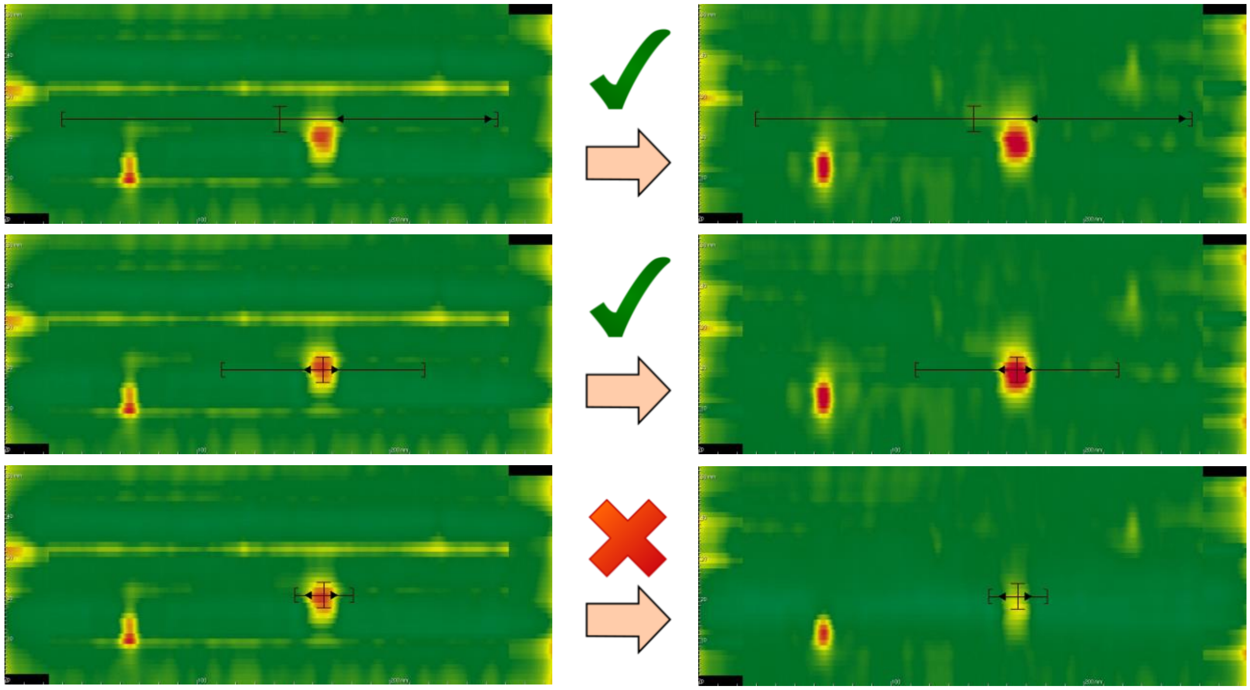


Figure 12. Top: Good user material calibration, with the C-scan cursor widely opened; Middle: Good user material calibration, cursor contains only one specific crack, but opened wide enough (at least three times the length of the crack) providing a local averaging; Bottom: Bad user material calibration, cursor too closed around the crack signal. The user material is not well measured because there is not enough safe material information in it, averaging mostly calculated on the crack signal.

8b. Detection of axial cracks

The detection of axial cracks must be done with both Dp-Proc and Lg C-scans. The Dp-Proc C-scan detect a crack along its entire length, while the Lg C-scan shows its ends.

An indication is considered as an axial crack when it presents these criteria:

- Positive vertical signal (yellow/orange/red) in the Dp-Proc C-scan.
- Blue and red dots in the Lg C-scan. Note that the blue dot is always to the left (first end) of the red dot (last end). If the red dot is to the left of the blue dot, it is not an axial crack (can be linked to a transverse crack or a geometrical indication).
- Correlation between the two C-scans: The blue and red dots must be at the beginning and end of the yellow/orange/red signal.

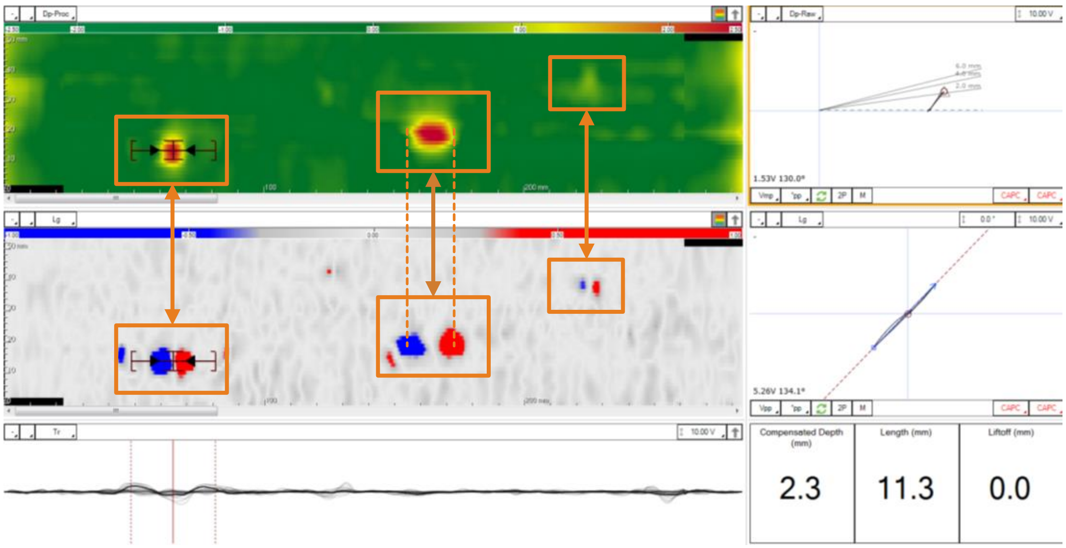


Figure 13. Detection of axial cracks. 3 cracks detected in this example (2 deep and 1 shallow)

On the DP-Proc C-scan, the green color represents the base material (amplitude close to 0.00 V). Crack-like defects are associated to a positive signal that is proportional to their depth (increasing order of crack depth: yellow, orange, bright red, dark red).

The color palette is a visual threshold directly related to the depth of the cracks. To enhance the contrast of the cracks, the color scale can be lowered manually. However, this will also enhance the noise caused by permeability variations, weld geometry, or other surface conditions.

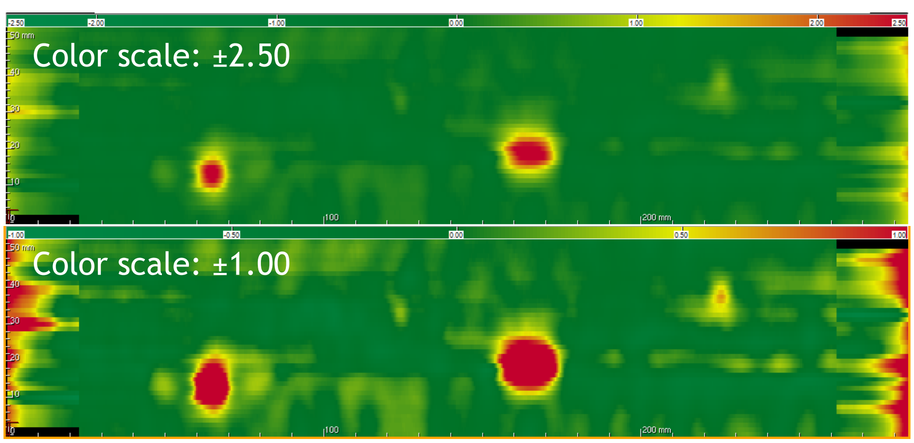


Figure 14. Same cracks displayed with 2 different color scales in Dp-Proc C-scan

In previous version of Magnifi the Lg C-scan is not compensated for lift-off. When lift-off is detected, it is recommended to reduce the scale of Lg C-scan color palette to help with the detection.

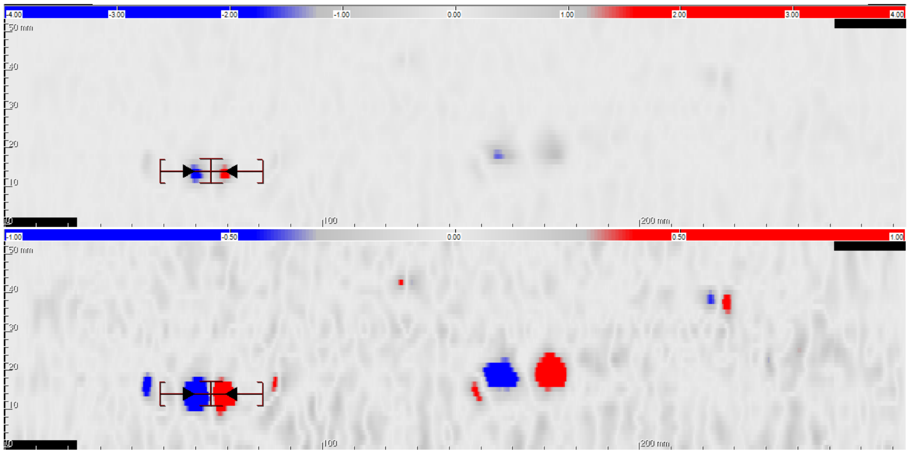


Figure 15. Same cracks displayed with 2 different color scales in Lg C-scan

8c. Depth sizing and reporting of axial cracks

Sizing information

During the analysis of a data file, the sizing of axials cracks is shown in the lower right corner of the screen. This information is updated in real time as the cursor is moved in the C-scan views.

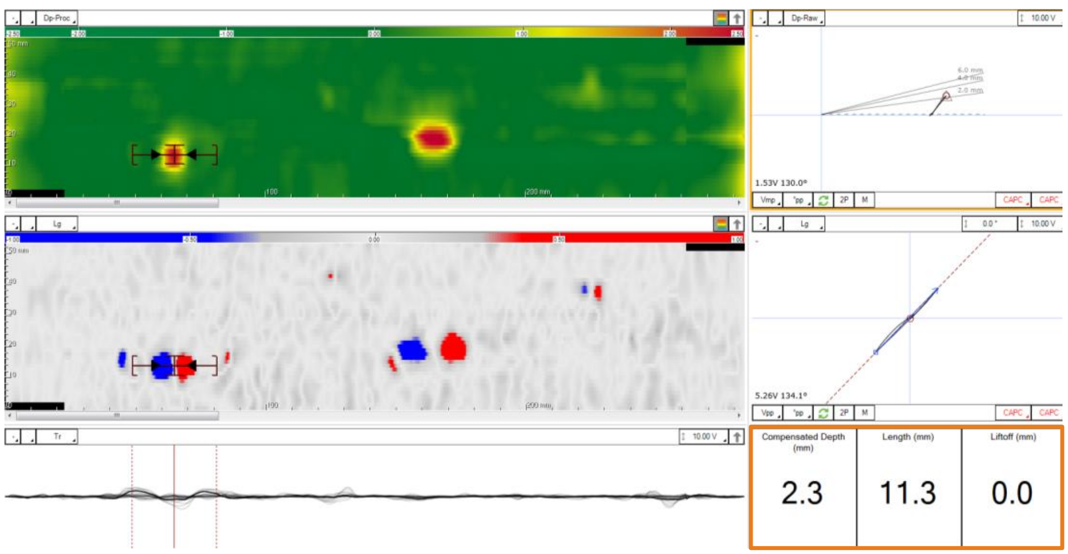


Figure 16. Magnifi automatically maximise the cursor position and measure the depth of crack.

Sometimes, there could be several blue and red dots closed to each other. The black arrows on both Dp-Proc and Lg C-scans show which blue and red dots are used for the crack length sizing. This can be adjusted if necessary by the user.

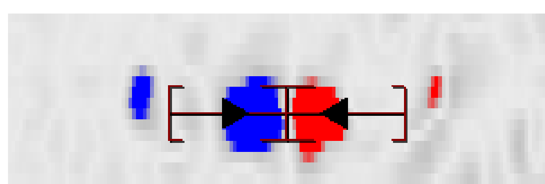


Figure 17. Length arrows on the Lg C-scan

<u>Local user material calibration:</u>

To improve the depth sizing of an axial crack, it is recommended to perform a local user material adjustement (close to the indication) before reporting it.

I) Click close to the crack in the Dp-Proc or Lg C-scan to center the cursors on the crack.

II) Open the cursors around three times the length of the defect.

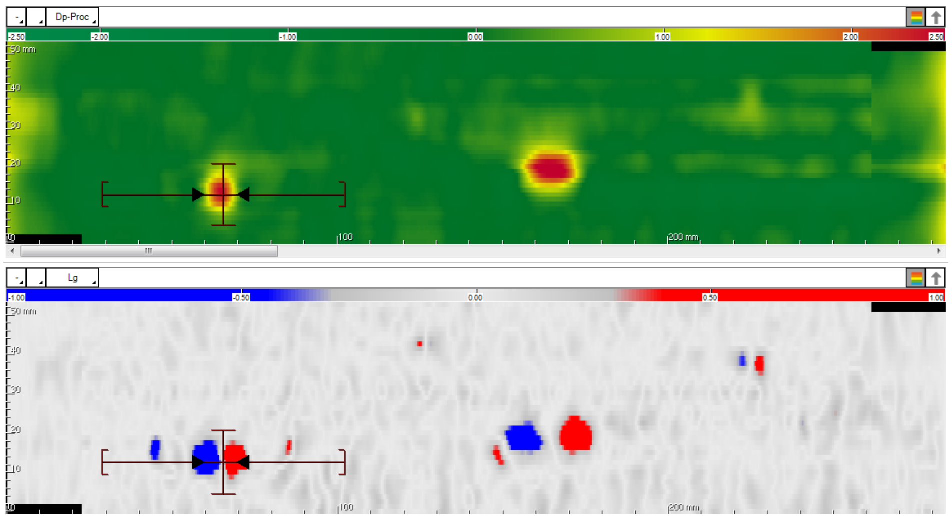


Figure 18. Step Position and size of the cursors on a potential axial crack

III) Verify that the user material calibration has been done properly around the defect (see Figure 19).

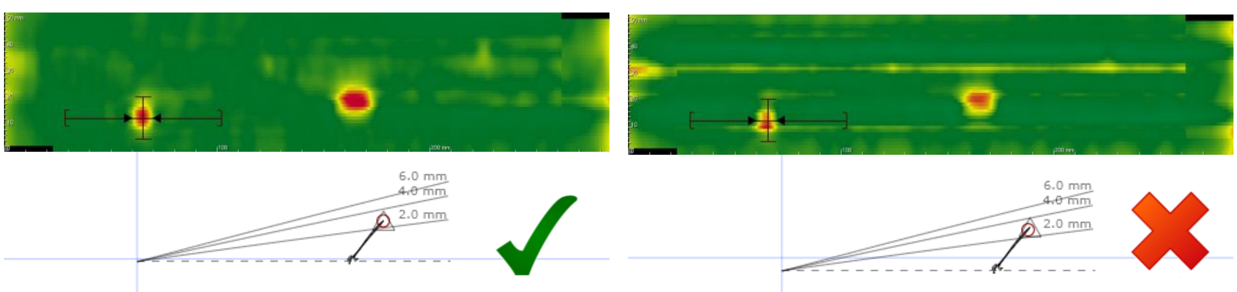


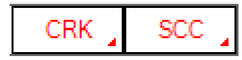
Figure 19. Correct and incorrect user material calibration

Note: When correctly applied the background of the Dp-proc C-scan is green around the defect, and the dashed line in the Lissajous is close to the horizontal centreline. When not applied correctly, two yellows stripes are seen around the crack signal, and the dashed line in the Lissajous is far from the horizontal centreline.

IV) If the user material calibration is not correct, perform a local material calibration by clicking the UserMaterial button without moving the cursors.

Precision sizing and entry report

I) Use the indication code buttons in the lower right corner of the Lissajous window (for example “CRK” or “SCC”) to add the automatic analysis tool inside the region of interest. If the option “Take a screenshot with report entry” is checked in the backstage, a screenshot will be taken at this point.



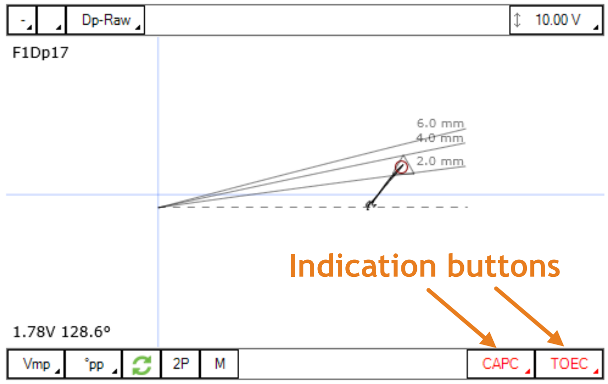


Figure 20. Add indication buttons. The indication code of the button can be changed by clicking the small arrow at the lower right corner of the button

In the backstage of Magnifi, make sure the selected Table Profile in the Report options is Sharck Array. With this option, the report will include the measured depth, position and local lift-off.

This will trigger two events (if the “Defect Tuning”  option is selected):

i) Data within the cursors are scanned and the cursors get centered over the indication giving the deepest sizing.

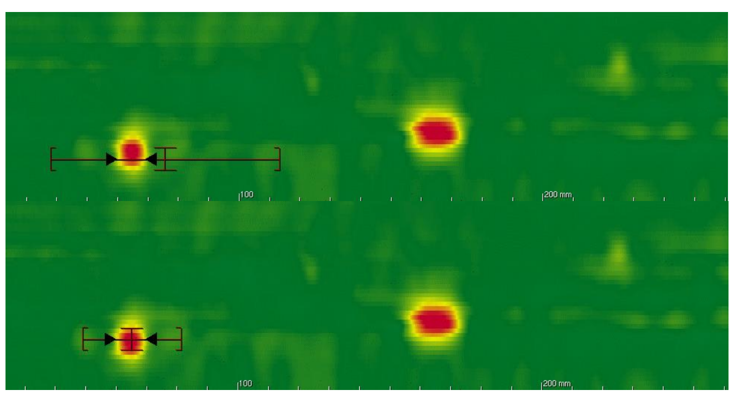


Figure 21. Cursor positioning prior to (top) and after (bottom) clicking the indication button

ii) The TECA Tune Calculations window opens.

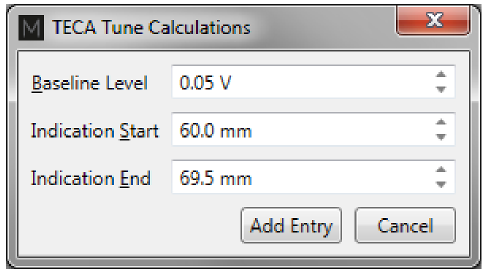


Figure 22. TECA Tune Calculations window

II) In most cases, the automatic process will give the optimized results, so no adjustment is needed in the TECA Tune Calculations windows. However, in the rare cases that the automatic process is not optimal, this window gives the user the choice to adjust some parameters, making sure the sizing is accurate. If such a case happens, the user can manually adjust:

i) The baseline level, if it seems incorrect on the Lissajous. This can occur if there is a lot of background noise or if there is a rapid change of material properties near the crack or if the cursors are set too tight around the crack signal.

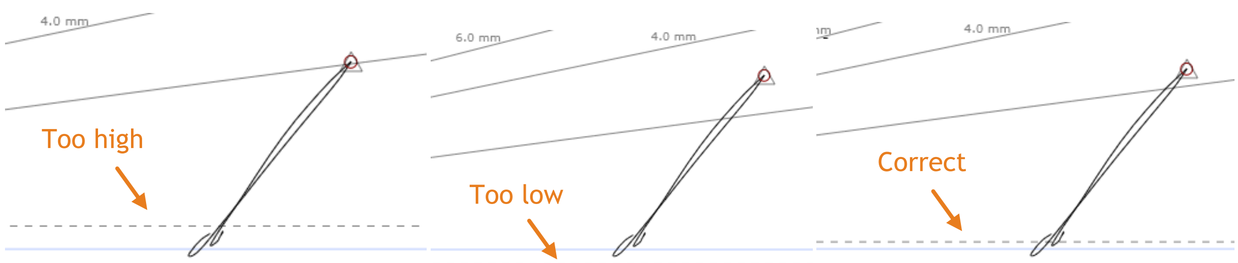


Figure 23. Baseline level (dashed line). Set too high (1), too low (2), or correctly (3)

ii) The start and/or end of a crack. The start/stop position might not be correct for intermittent cracking but also cracking occurring at the edge of the scan. The gray arrows on the C-scans will move as these parameters are adjusted (Figure 17).

I) **Click "Add Entry" to add the analyzed indication in the report or click "Cancel" to close the TECA Tune Calculations windows without adding the indication to the report.**

Note1: If a datafile contains no defect indication, you can click 

Note2: To add or remove indication codes, go to Setup → Indication.

8d. Detection of transverse cracks

The detection of transverse crack can rapidly be done using the TR strip chart, at the bottom of the default layout. Note that the TR strip chart is not compensated for the lift-off. If lift-off is detected, it is recommended to reduce the scale of the strip chart to avoid missing a defect.

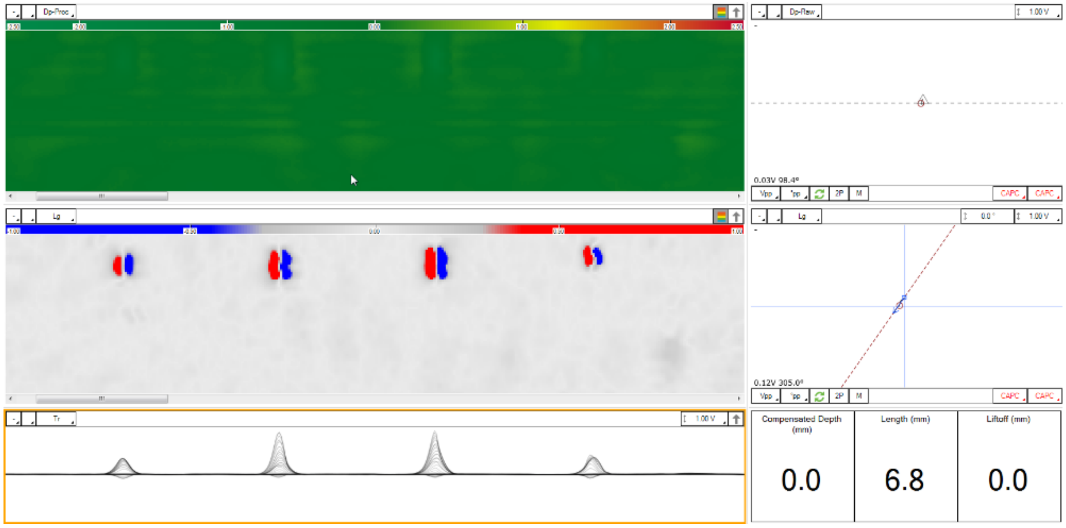


Figure 24. Detection of transverse cracks (four in this example)

If you wish to see the approximated length of a transverse crack and its position, select the TR C-scan.

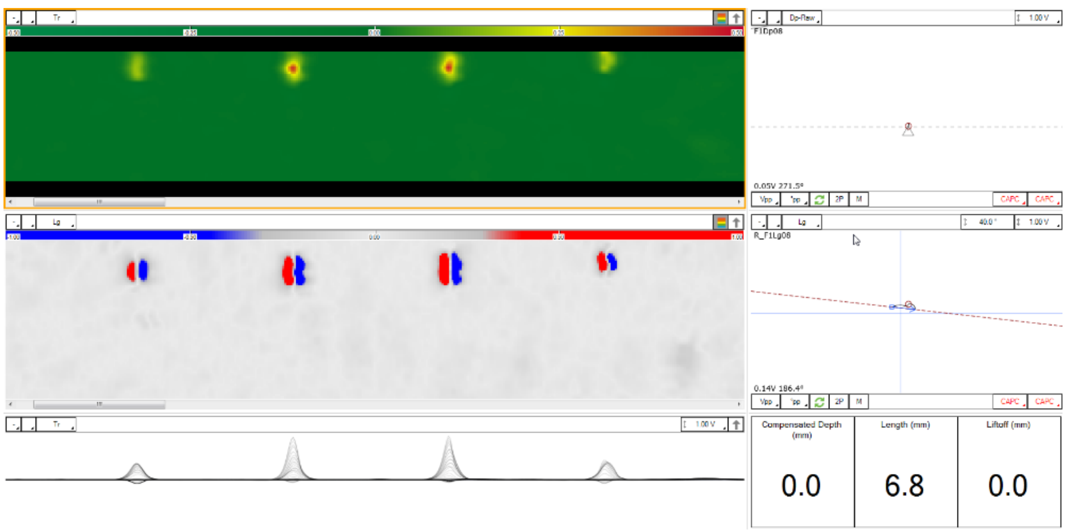


Figure 25. Transverse cracks visible on TR C-scan

If a transverse crack is detected an additional scan along the defect will be necessary (if the geometry enables it) to obtain sizing information.

9. Maintenance

9a. Protection from abrasive surfaces

If the component to be inspected is abrasive or rough, it is recommended to protect the probe with a tape (polyolefin, Teflon or other non-conductive abrasion resistant material). If the sample has a flat surface, the tape can be put directly on the probe fingers. The lift-off compensation will ensure a good measurement even if not all fingers are in contact with the surface, as long as the lift-off is 3 mm (0.12 in) at most.

Figure 26. Protective tape applied on probe active area

If the weld cap is too high, causing a lift-off superior to 3 mm (0.12 in), it is best to put it on the sample, to allow the probe sensors to be in contact with the surface.

Figure 27. Protective tape applied directly on weld

9b. Butt weld probe maintenance

When used on dirty surfaces, dust can accumulate on the encoder wheel and between the fingers. To clean the encoder, unscrew it with a small flathead screwdriver from the probe housing and clean it with a soft cloth or air spray. To clean the fingers, disassemble the removable frame to loosen the fingers and remove the dust between them with a soft cloth or air spray. Make sure to reassemble all the parts prior to carrying out further inspection.

Figure 28. The encoder and the removable frame can be dismantled to clean the probe. Supporting wheels can also be remove if necessary

Figure 29. With the 1st frame removed, the fingers are looser and can therefore be separated for an easy cleaning

9c. Fillet weld probe maintenance

To clean the fingers of the fillet weld probe, follow the same procedure as the one for the butt weld probe. Since the encoder is spring-loaded, it is not possible to remove it from the probe housing.

Figure 30. Both modules have a removable frame to help the fingers cleaning

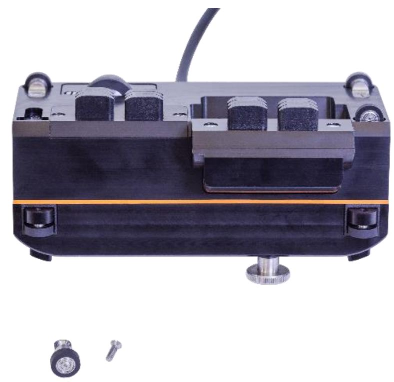


Figure 31. Guiding and supporting wheels can also be unscrewed if it is necessary to clean them

10. Encoder calibration

If the encoder resolution included in the Magnifi setup is different from its real resolution, the data in the C-scan will be slightly distorted (misalignment of indications and zigzag shapes, see Figure 32 below). The length measurement and defect positioning can be affected.

In such a case, a simple calibration can be performed to apply a correction factor to the encoder resolution:

I) Start an acquisition.

II) Move the probe in a straight line and on a flat surface and stop the acquisition.

Note1: A longer travel distance will lead to a more precise calibration.

Note2: It is not required to scan a metallic surface for this calibration.

III) Measure precisely the traveled distance.

IV) In the *Calibration* menu, click on the *Encoder* calibration button.

V) Enter the measured traveled distance and click Enter.

VI) Click *Calibrate* and click *OK*. The correction factor is now applied to the setup configuration.

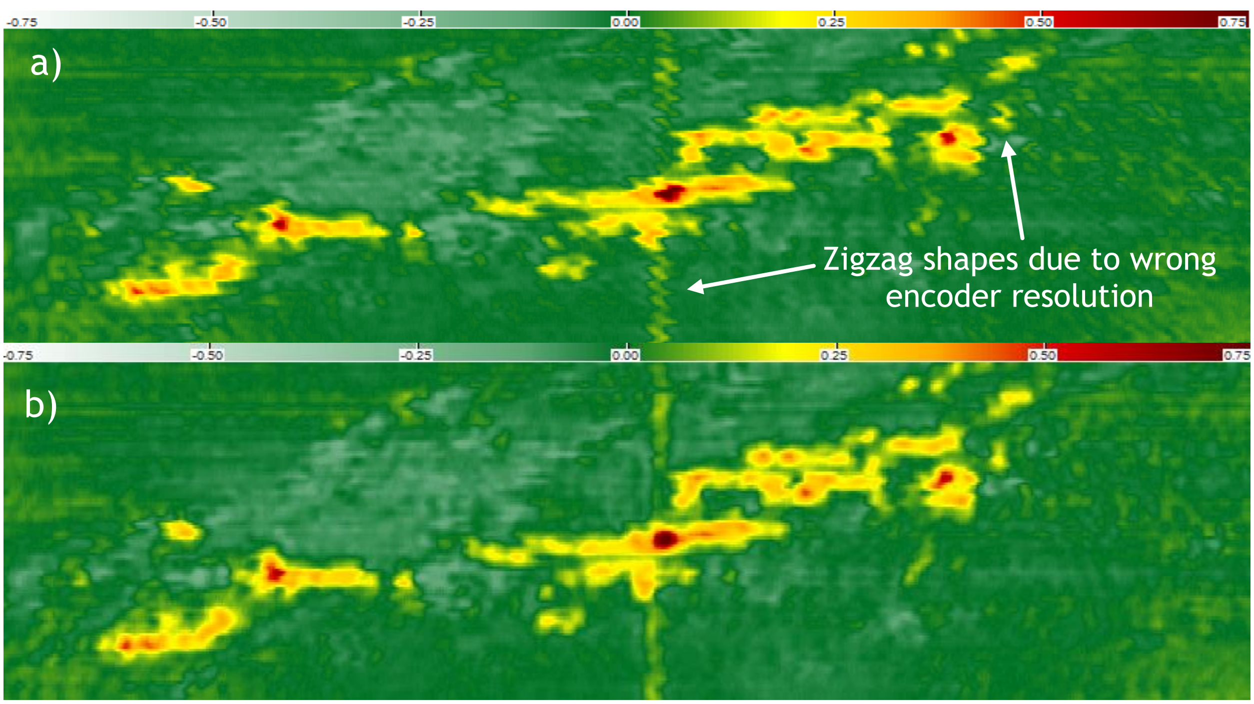


Figure 32. a) Before encoder calibration (small error on the encoder's resolution); b) after encoder calibration