Eddyfi Technologies
Beyond current

Getting Started with

SHARCK HR

Contents

1. Introduction

This user guide covers the following probes:

- SHARCK-HR-10PLUS-060 (E and R)
- SHARCK-HR-6PLUS-033 (E and R)

Most pictures in this guide refer to the SHARCK-HR-10PLUS-060 model, but they are also valid for the SHARCK-HR-6PLUS-033 model.

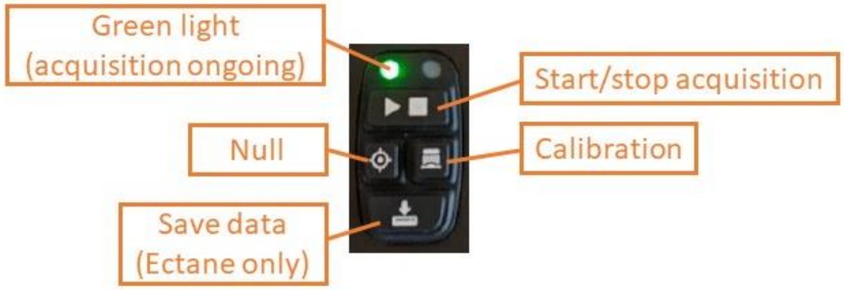
2. Probe Description

2a. Sharck HR

1. Keypad
2. Metallic wheel for camber adjustment
3. Laser coverage indicators
4. Spring loaded ceramic sensors
5. Spring loaded encoder

Figure 1. Sharck HR features

Keypad:



2b. Key characteristics

Type of defect	Stress corrosion cracking (SCC) Hydrogen induced cracking (HIC) Fatigue cracks ERW welds (LoF and hook cracks) A.O. Smith FW (LoF, cold weld)
Number of elements	60 (SHARCK-HR-10PLUS-060) 33 (SHARCK-HR-6PLUS-033)
Number of rows	3
Minimum pipe diameter	254 mm (10 in) (SHARCK-HR-10PLUS-060) 152 mm (6 in) (SHARCK-HR-6PLUS-033)
Coverage	75 mm (3.0 in) (SHARCK-HR-10PLUS-060) 37 mm (1.5 in) (SHARCK-HR-6PLUS-033)
Minimum instrument requirement	64 channels
Detection capabilities	Axial only From 1.5 x 0.25 mm (0.06 x 0.01 in)
Sizing capabilities	Axial only From 6 x 0.25 mm (0.06 x 0.01 in) Up to 3 mm (0.12 in) deep
Lift-off Tolerance	Up to 1 mm (0.04 in)
Depth sizing accuracy	± 0.3 mm (0.012") 80% certainty, 95% confidence

Maximum operating temperature	50 °C (122 °F)
Maximum scan speed	600 mm/s (24 in/s)
Permeability compensation	Yes - B up to X70 grades

3. Magnifi setup

I) Make sure to use Magnifi 4.8R22 or a more recent version.

II) In Magnifi, click *Open setup* and select the file SHARCK-HR-10PLUS-060 from the Default Master List.

III) Connect the 160-pin ECA probe connector to the instrument (Ectane or Reddy).

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

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, before getting to the inspection site.

I) Go to the backstage of Magnifi in the *General* tab.

II) In the *Project/Inspection* menu, select a project folder and an inspection Sub-folder .

III) In the *Acquisition* menu, select the *Prefix* filename option.

IV) Click *Create New List*.

V) 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 an example of data file list based on the following parameters:

Selected parameters:

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

Resulting data file list:

Prefix	Index
SCC	010
SCC	012
SCC	014
SCC	016

VI) Click *Create*

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

VIII) 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.

IX) Once the setup parameters and preferences are settled and the probe has been calibrated (see section 6), uncheck *Setup Mode* Setup Mode in the *Home* menu.

X) 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:

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

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

For more information on data analysis, refer to section 8 of this user guide.

- At any time during the inspection, the user can click *Add data* or *Delete data* at the bottom of the data file list. Data files 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 data files with a new prefix, go back to the backstage and click *Create New List*.

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

5. Layout

1. C-Scan: Visualization of the cracks with material permeability and lift-off compensations. Each horizontal line corresponds to a channel of the probe.

   ➔ Used to localize crack indications quickly.

2. Strip chart: Superimposed strip charts, each of them representing 1 of the probe's 60 channels.

   ➔ Used to display the profile of the cracks, measure their length, and localize the strongest indications (deepest cracks).

3. Lissajous window: Impedance signal of the channels underneath the cursor in the C-scan.

   ➔ Used for depth measurement of axial cracks.

4. Compensated Depth: Depth measurement of axial cracks with a <u>regular</u> depth profile, up to 3 mm (0.12 in), with compensation for lift-off and permeability.

5. SCC Depth: Depth measurement of SCC colonies with <u>irregular</u> depth profiles, up to 3 mm (0.12 in), with compensation for lift-off and permeability.

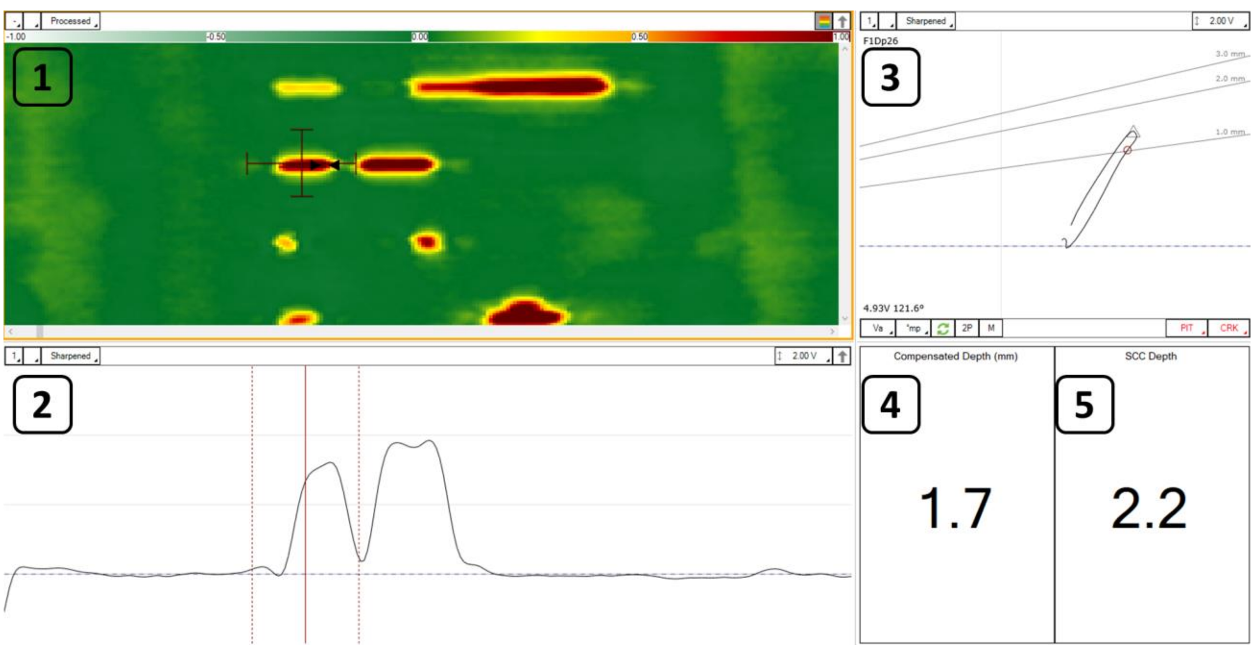


Figure 2. Sharck HR acquisition and analysis layout

Note: To change the settings of any of these windows, select it and go to the Current View menu.

6. Probe calibration

To ensure proper calibration:

I) The probe must be connected to the Reddy or Ectane instrument.

II) The instrument must be turned on.

III) The setup file must have been loaded for at least 10 minutes.

IV) The environment must be at controlled room temperature (around 20°C / 68 °F)

> Tip: Calibration should be done at the hotel/office prior to going to the field to perform the inspection if the outside temperature is very hot or very cold.

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

I) Hold the probe in the air, away from any metallic surface, and click *Null* .

II) In the *Sharck* menu (or using the probe keypad), click *Calibration* .

III) Keep the probe in the air and click [Air reference block] in Magnifi or on the probe. Keep the probe still while data is acquired.

IV) Put the probe in the middle of the aluminum plate supplied with the probe. Adjust the wheel camber and apply pressure to ensure that all elements are in close contact with the surface. Click [Aluminum] in Magnifi or on the probe. Keep the probe still while data is acquiring.

V) Put the probe on the carbon steel surface. Adjust the wheel camber and apply pressure to ensure that all elements are in close contact with the surface. Click [Carbon Steel] in Magnifi or on the probe. Keep the probe still while data is acquired.

VI) Click [Calibrate].

VII) Close the Sharck calibration window.

Figure 3. The three probe calibration steps

7. Acquisition

I) Use the metallic wheel on the probe to adjust the camber of the silicone wheels according to the surface to inspect.

II) Null the probe in air.

III) Align the front surface of the probe with the beginning of the area to scan (Figure 4).

IV) Start the acquisition.

V) Move the probe in the direction where the lasers point. Apply enough pressure on the probe during the acquisition to make sure that all elements are in good contact with the inspected component at all times.

VI) Stop the acquisition.

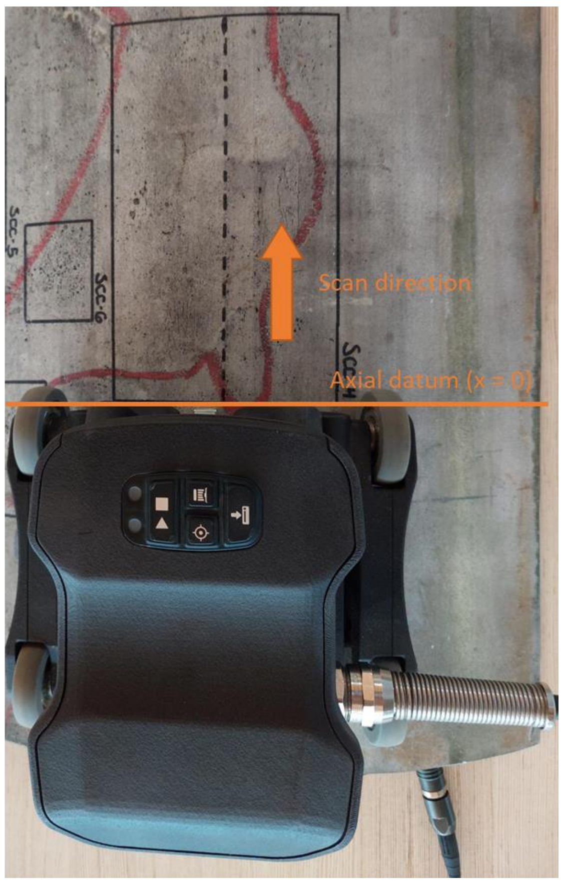


Figure 4. Recommended position of the Sharck-HR at the start of a colony inspection: the front of the Sharck-HR is aligned with the axial datum line.

8. Analysis

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

> ***Note: The Sharck HR is designed specifically to detect and measure the depth of cracks oriented along the axis of the pipe. Other crack orientations can be detected, but their depth measurement will not be accurate. To measure the depth of transverse cracks, a second scan should be done with the probe rotated by 90 degrees, to align the scan direction with the axis of the cracks.***

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 with the accuracy of the depth sizing.

> ***Note: If a C-scan contains multiple SCC colonies, a user material calibration should be performed locally for each colony, in order to always compensate for the local permeability.***

I) Place the C-scan cursor on a "clean" area of the C-scan (i.e., area without any SCC, corrosion, or major permeability variations). Open the horizontal cursor in a way to include only clean material on all 60 channels of the C-scan. If possible, this clean area should be located near the SCC indications to analyze.

Alternatively, place the cursor directly on the SCC indications to analyze, and extend the width of the cursor to include clean material on both sides of the SCC.

The data points inside the horizontal cursor will be used to evaluate the material permeability on every individual channel. <u>To compensate properly, it is very important that every channel contains more data from clean material than from SCC within the width of the horizontal cursor.</u>

Figure 5 on next page shows a few examples of correct and incorrect C-scan cursor positioning for the user material calibration.

II) Once the C-scan cursor has been properly places, go in the *Sharck* menu, then click on

.

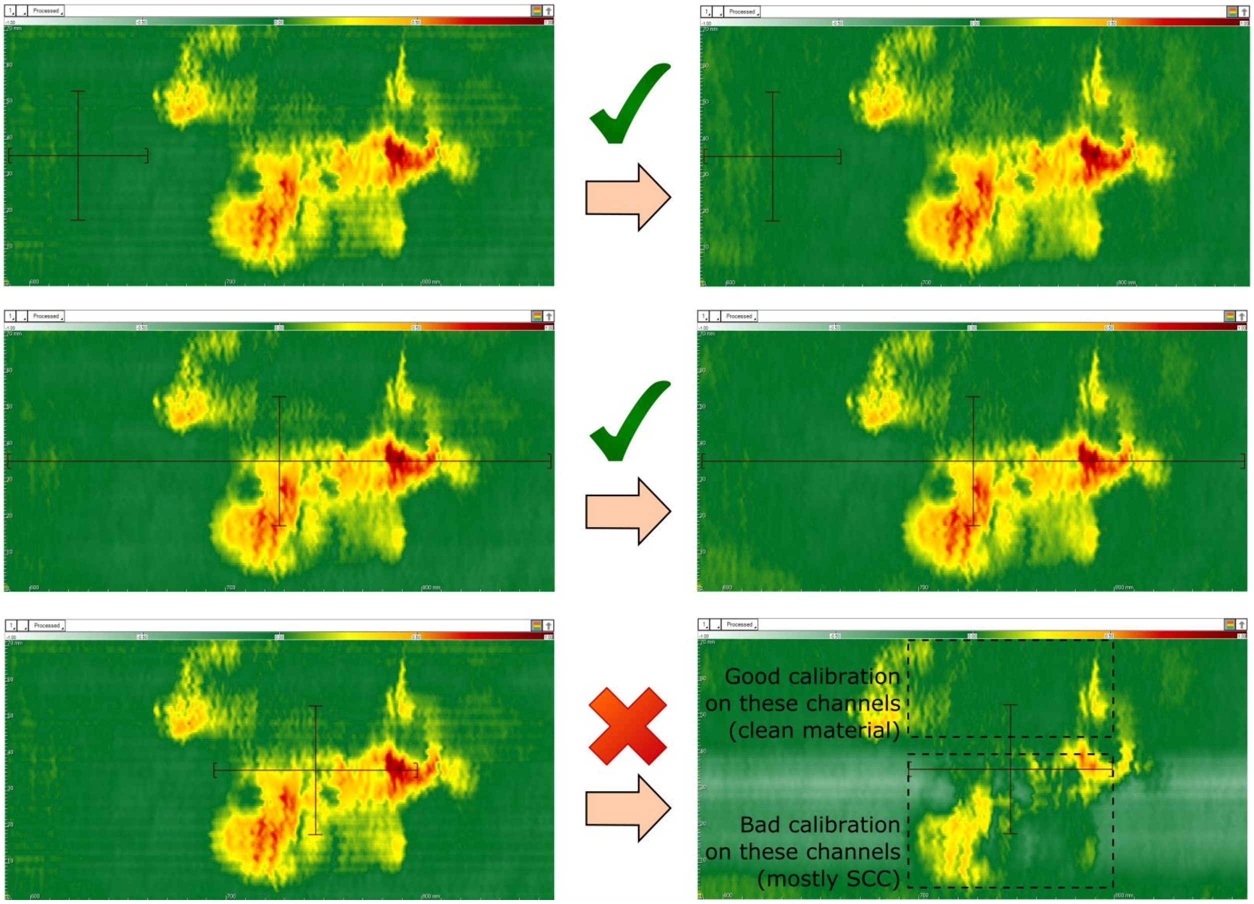


Figure 5. Top: Good user material calibration, with the C-scan cursor located in a clean, defect-free area directly besides a SCC colony; Middle: Good user material calibration, with the cursor located on the SCC colony, and opened wide enough to include more clean material than SCC indications on all channels; Bottom: Bad user material calibration. The top half of the C-scan is calibrated correctly because the area within the width of the horizontal cursor is mostly clean, but the bottom half of the C-scan contains mostly SCC indications within this width. The white color in these channels is an indication of a bad user material calibration.

8b. Detection of axial cracks

The detection of cracks is done mainly using the Processed C-Scan, in which the lift-off is automatically compensated. Alternatively, the Sharpened C-scan contains a sharpening process that is automatically applied to enhance the signal of the individual cracks and increase the resolution of the image.

The green color represents the base material (amplitude close to 0.00 V). Cracks and crack-like defects are associated to a positive signal that is proportional to their depth (in increasing order of crack depth: yellow, orange, bright red, dark red). Areas of corrosion with missing material are generally associated to a negative signal and displayed in white in the C-scan:

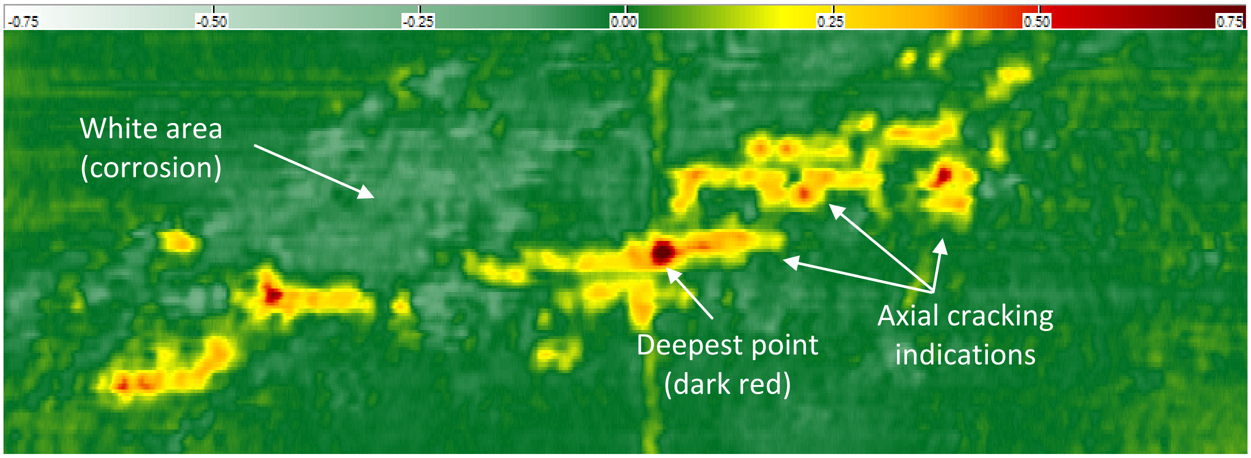


Figure 6. Processed C-scan used for the detection of cracks

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 corrosion, permeability variations or other surface conditions. For most typical cases of crack indications, the color scale should be adjusted between ±0.50 V and ±2.00 V for optimal results.

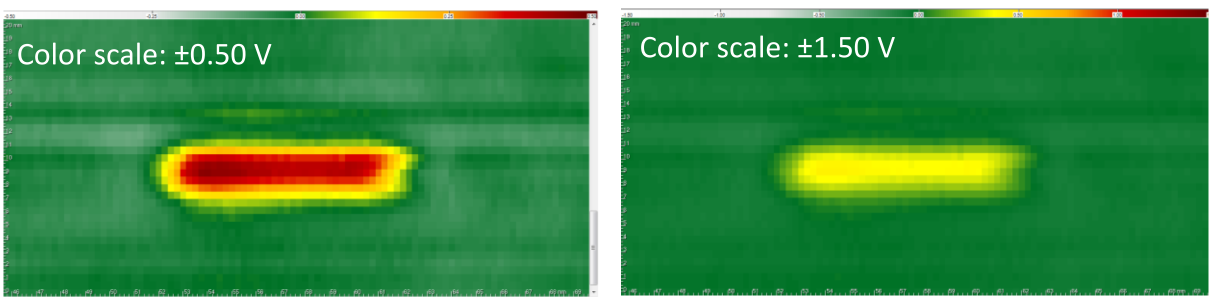


Figure 7. Same crack displayed with 2 different color scales

The strip chart below the C-scan represents a cross-section (side-view) of the C-scan. It can be used to visualize the depth profile of the cracks. The options to display a single channel, all channels inside the C-scan vertical cursor, or all 60 channels are available in the *Current View* menu.

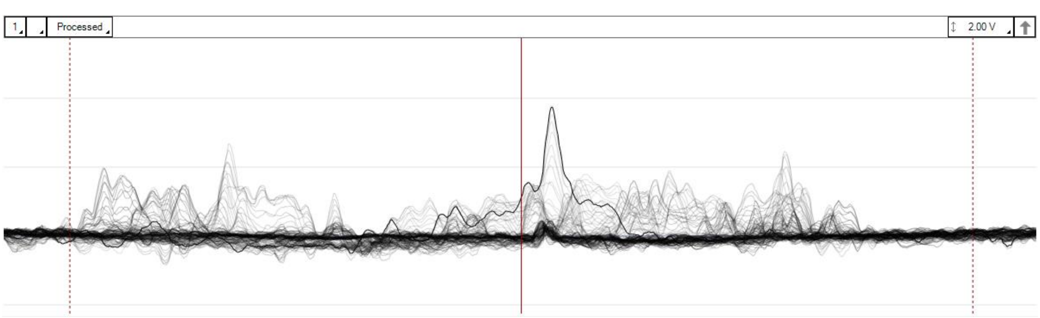
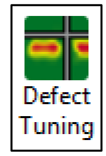


Figure 8. Strip chart window displaying all 60 channels from the C-scan in Figure 6.

8c. Depth sizing and reporting of axial cracks



Magnifi contains a powerful analysis tool that allows the automatic localization and depth sizing of the deepest crack within a given SCC colony. To facilitate its use, make sure the *Defect Tuning* button in the *Sharck* menu is left unchecked.

The software uses the area delimited by the C-scan cursor as the region of interest for the detection of the deepest crack indication. Simply by changing the position and size of the cursor, the user can choose to localize and measure the deepest indication either in an entire SCC colony, or to focus only on a sub-area of a colony. The position of the deepest crack within the cursor area is automatically indicated by a double triangle ▶◀:

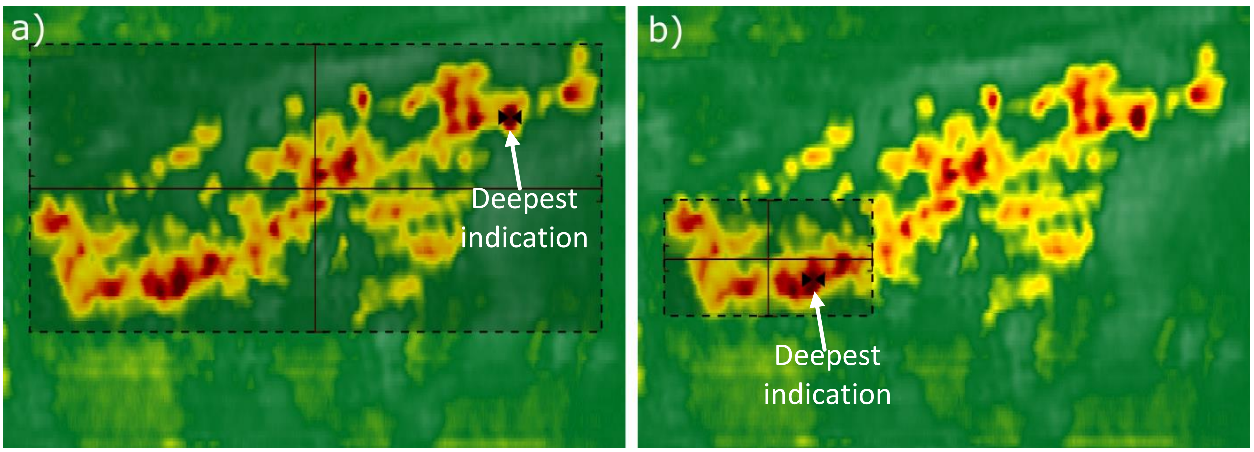


Figure 9. Magnifi will localize and measure the depth of the deepest crack within a) the entire SCC colony; b) only the lower-left section of the colony. For the situation in b), the analysis tool can be used multiple times to localize and measure individually the deepest cracks within the other sub-colonies.

Before analyzing either an entire SCC colony or a smaller sub-colony, Magnifi needs to define a reference baseline in order to measure the maximum signal amplitude within the region of interest and convert it into a depth measurement. This reference baseline is displayed as a horizontal dashed line in the Lissajous and the strip chart windows. It is obtained from the "clean" (i.e., defect free) material surrounding the cracks.

Defining the baseline correctly is key to obtain an accurate depth sizing of the cracks. To achieve this, Magnifi offers two different options:

I) <u>Automatic baseline calculation</u>:

To use this option, go to the *Sharck* menu and make sure the *Lock Baseline* button is left unchecked.

The baseline calculation requires that the horizontal C-scan cursor is opened large enough to include clean material on both sides of the SCC colony. The signal from this clean material forms the "root" of the cracks signal in the Lissajous.

The width of the cursor should be at least twice that of the colony. This will allow Magnifi to define the reference baseline with the data points from the clean surface. If the horizontal cursor is not opened large enough, Magnifi will use signal from SCC to define the baseline, which will lead to an under-sizing of the crack's depth.

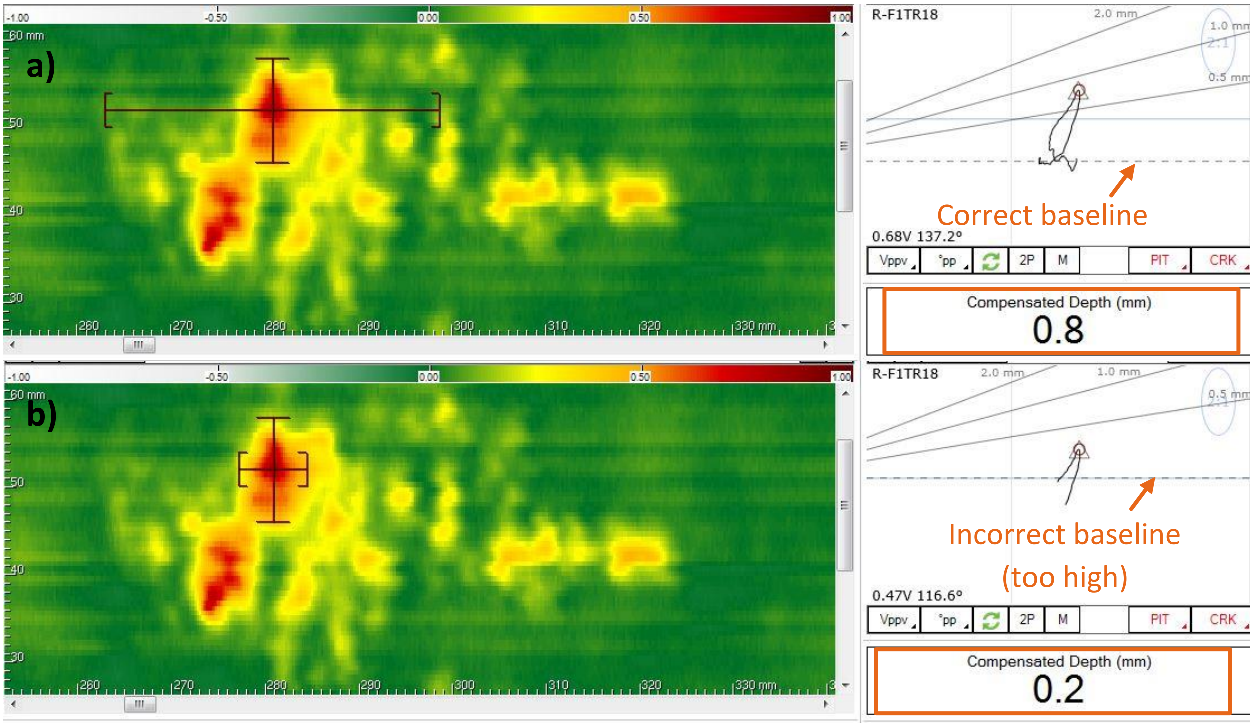


Figure 10. a) The horizontal cursor includes enough clean material on both sides of the SCC indication, allowing a correct baseline calculation and an accurate depth sizing of the crack (0.8 mm); b) Horizontal cursor too narrow, leading to an incorrect baseline calculation and major under-sizing of the crack's depth (0.2 mm).

II) <u>Manual baseline adjustment</u>:

To use this option, go to the *Sharck* menu and make sure the *Lock Baseline* button is checked (grayed).

The manual baseline adjustment is particularly useful to analyze large SCC colonies without much clean material surrounding the indications. Locking the baseline ensures that Magnifi never recalculates the baseline: it will stay at the same level in the Lissajous, independantly of the C-scan cursor's position and size. The user is responsible of adjusting it by dragging it manually in the Lissajous window.

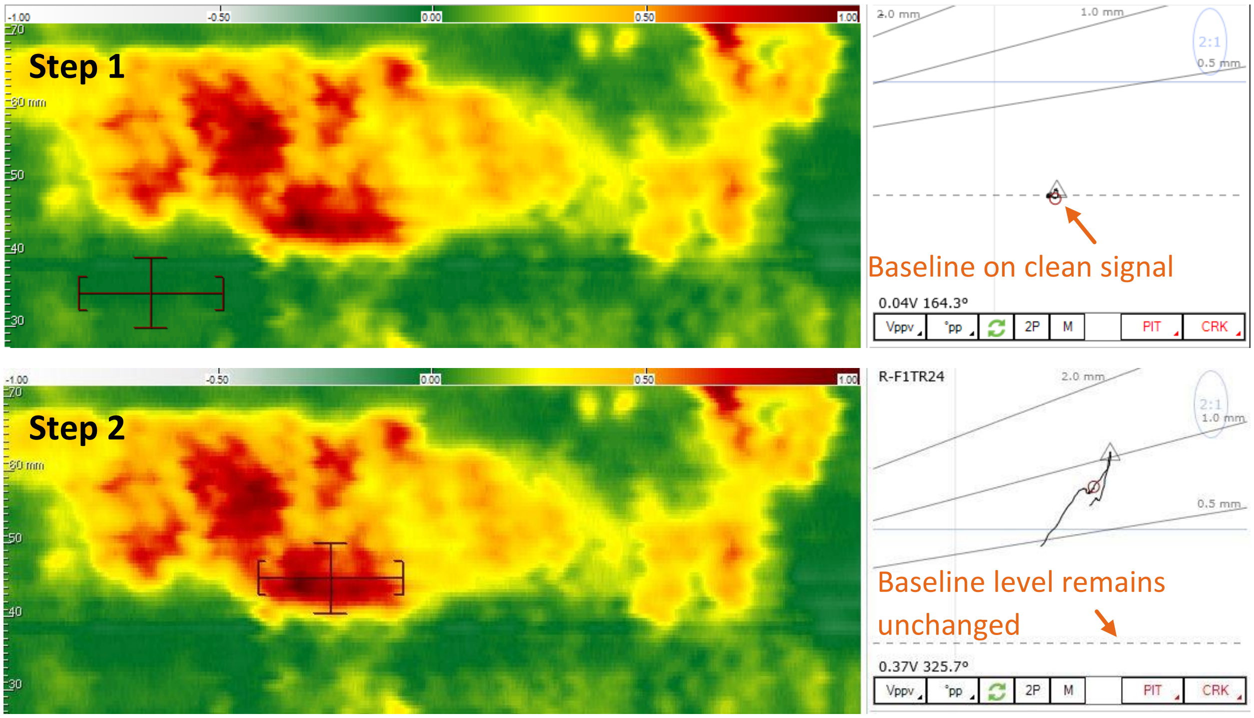


Figure 11. Step one: place the cursor on a clean area and adjust the position of the baseline on the "clean" signal by dragging it in the Lissajous; Step two: move the C-scan cursor on the indication to be measured. The baseline level will remain unchanged, and the depth sizing will be accurate as long as the baseline is not moved again.

To the more practiced users, Eddyfi recommends to always keep the baseline locked and adjust it manually before reporting an indication (option II). When analyzing a large area or a large SCC colony, it is important to make sure that the baseline level remains the same within the whole area covered by the C-scan cursor. For that reason, it is recommended to analyze smaller sub-colonies individually, and adjust the baseline manually each time. This will lead to more accurate depth measurements.

Finally, the presence of corrosion or strong variations of permeability can make the baseline more difficult to adjust. In these cases, the stripchart below the C-scan can be of great help:

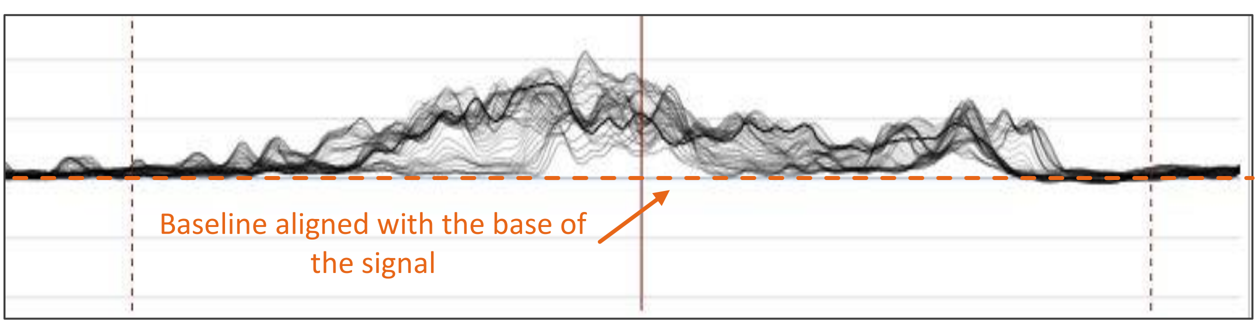


Figure 12. Using the strip chart view can be useful to position the baseline at the right level.

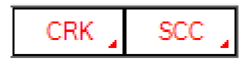
In summary, the procedure to measure the depth of axial cracks and add them to the report goes as follows:

I) Place the cursor on the SCC indication to be measured and adjust its size to cover only the region of interest (either an entire SCC colony or a smaller sub-area).

Note: If a data file contains no defect indication, you can click 

II) Make sure the baseline is correctly adjusted (either automatically or manually).

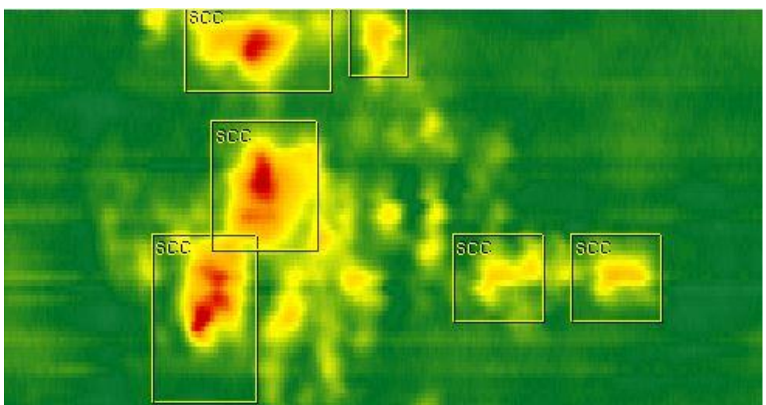
III) Use the indication code buttons in the lower right corner of the Lissajous window (for example "CRK" or "SCC") to add the automatic analysis tool inside the region of interest. If the option "Take a screenshot with report entry" is checked in the backstage, a screenshot will be taken at this point.



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

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. See below an example of the information reported in the case of an analysis by individual SCC sub-colonies:

Note: In Magnifi 4, the depth indicated in the report is always the Compensated Depth for regular crack profiles, even if the colony was identified as SCC during the analysis.



#	File name	Code	Size	Lift-Off (mm)	X pos. (mm)	Y pos. (mm)
1	SCC-001	SCC	0.9 mm	0.1	274.5	37.3
2	SCC-001	SCC	0.9 mm	0	281	52
3	SCC-001	SCC	0.8 mm	0	280.3	67.2
4	SCC-001	SCC	0.5 mm	0	293.3	68.9
5	SCC-001	SCC	0.4 mm	0.1	306.3	41.8
6	SCC-001	SCC	0.5 mm	0	319	41.8

Figure 13. Summary table displayed on the first page of the report, containing information about all the defects that were reported in the current inspection. This is usually followed by individual screenshots and information of all the reported defects.

8d. Length measurement of axial cracks

The Sharck HR does not automatically measure the length of the cracks. However, it can be measured manually:

I) In the C-scan, put the cursor on the axial crack to be measured

II) In the strip chart, adjust the width of the cursor to the length of the crack's signal

III) The center position of the cursor (X and Y) is displayed at the bottom of the screen. It corresponds to the position of the crack relatively to the beginning of the scan.

IV) The aperture of the horizontal cursor (Δx) is also displayed at the bottom of the screen. It corresponds to the length of the crack.

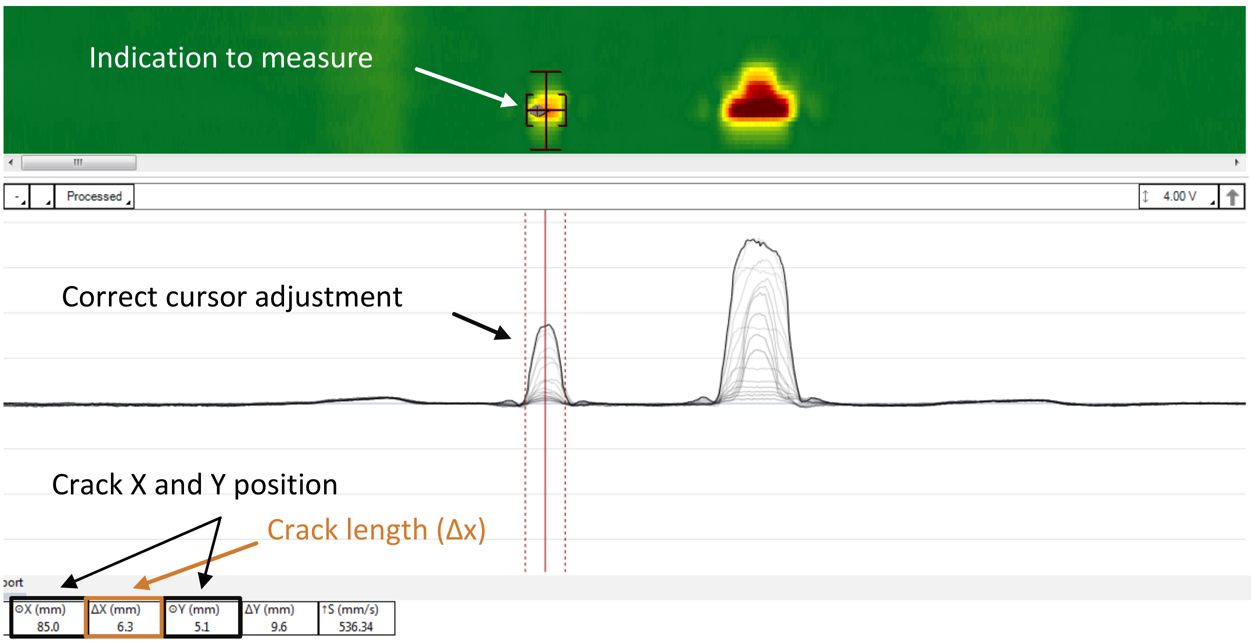


Figure 14. Position and length measurement of an axial crack

In a similar way, the size of SCC colonies can be measured by opening the horizontal and vertical C-scan cursors around it:

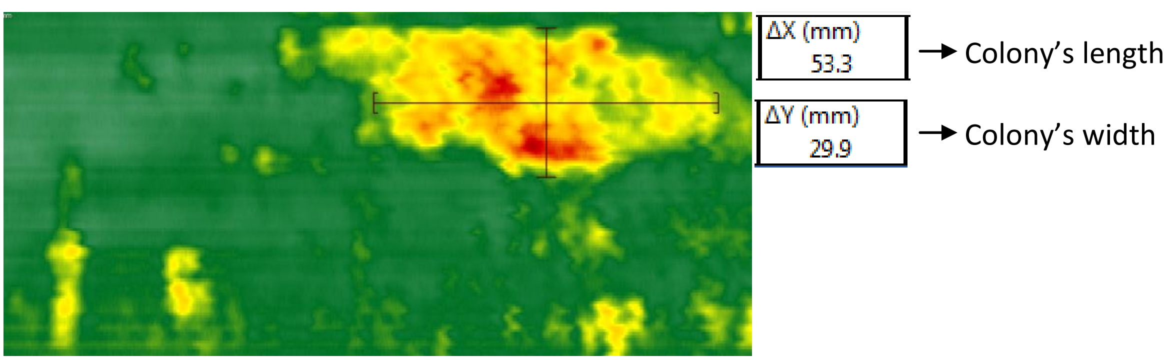


Figure 15. Measurement of a SCC colony

9. 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 as in Figure 16 below). The length measurement and defect positioning can be affected. This can happen with time if the encoder wheel wears out, reducing its diameter.

In such cases, 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.

Note 1: A longer travel distance will lead to a more precise calibration.

Note 2: 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.

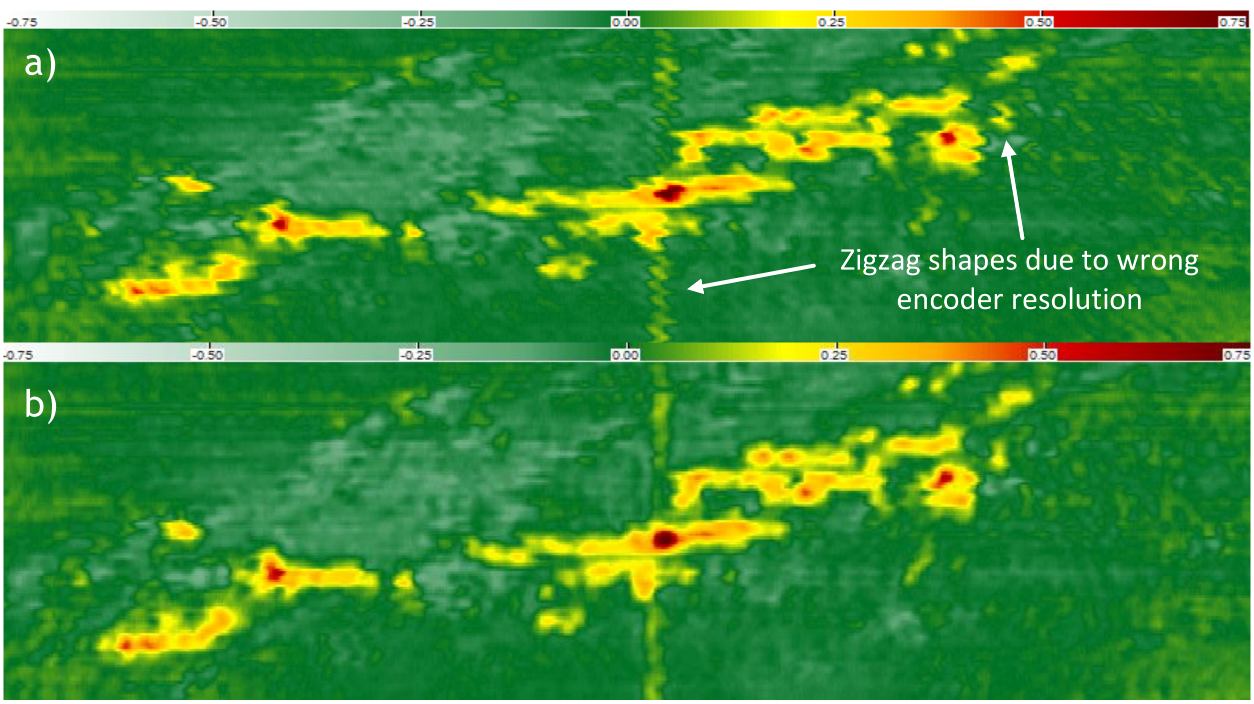


Figure 16. a) Before encoder calibration (small error on the encoder's resolution); b) after encoder calibration.

The information in this document is accurate as of its publication. Actual products may differ from those presented herein.

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Eddyfi Technologies

Beyond current