VILLARI

# CERTIFIED WIRELESS CRACK DETECTION ON STEEL STRUCTURES

## 24/7 monitoring of critical assets for signs of damage with wireless scalable sensor technology

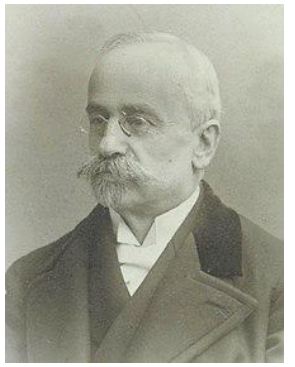
# COMPANY INTRODUCTION

- We deliver wireless monitoring systems to detect fatigue crack growth in steel structures
- Company originates from a PhD project at Delft University of TechnologyInstalled base of 1700+ sensor strips on different structures including large-span highway bridges, overhead travelling cranes, and ship-to-shore cranes
- External certification by DNV: “Statement of Qualified Technology”

Deployed by global industry players

# Villari sensor technology is based on passive magnetic flux leakage due to geometric and inverse magneto strictive effects

Emilio Villari (25.9.1836 – 20.8.1904) was an Italian experimental physicist and a professor at the University of Bologna and later Naples who contributed to studies on ferromagnetic field changes to mechanical stress

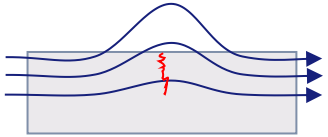


## Earth's magnetic field

Earth's **magnetic** field induces local magnetic fields in steel structures

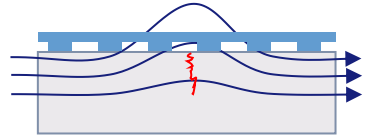
## Stable on steel

Intact geometries exhibit a **stable** magnetic field



## Changes when crack

Cracks cause **passive** magnetic flux **leakage** (passive MFL) directly above the crack due to geometric and inverse magnetostrictive effects (the Villari effect)



## Villari sensor

A one-dimensional array of Villari sensors) near the growing crack **detects** a variation which is translated to crack growth with **analytics** (patented)

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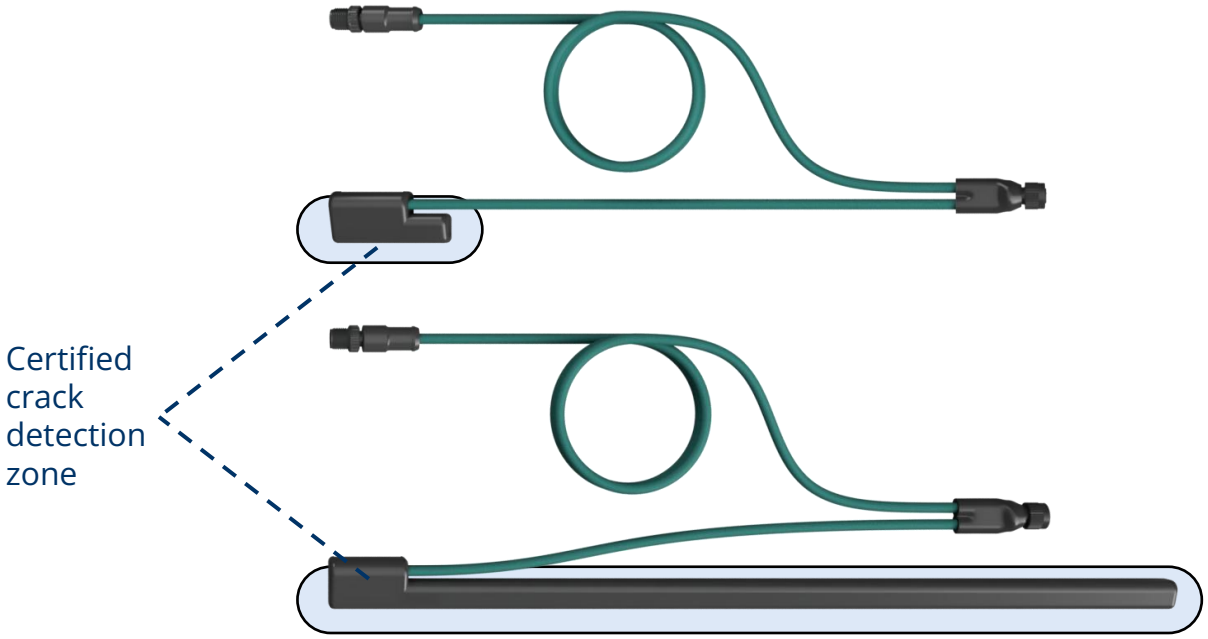
# VILLARI TRANSMITTER AND SENSOR PROBES

## Transmitter

- Wireless Communication module (LoRaWAN)
- Minimum 5 years of battery life
- IP67, UV resistant, suitable for harsh environments
- 5 minutes installation time, clamps with magnet or fastening straps
- Maximum of 20 probes connected to 1 transmitter
- Total cable length max 30 meters
- Sample rate between 1 and 6 hours
- Operating temperature between -40°C and +80°C

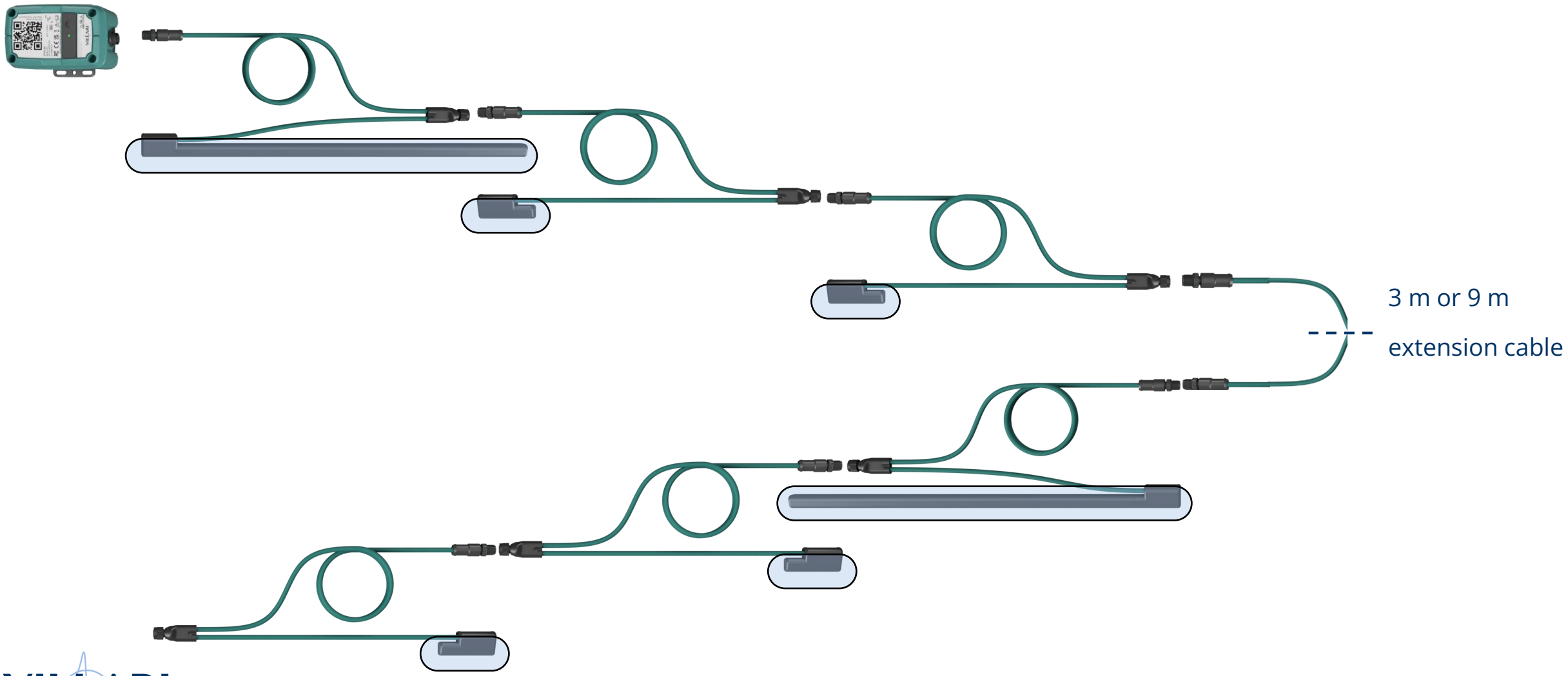

## Sensor Probes

- Short version: 75 mm detection range
- Long flexible version: 500 mm detection range
- Detect early-stage crack growth within a 30 mm diameter around the strip
- Rapid & long-lasting glue bonding



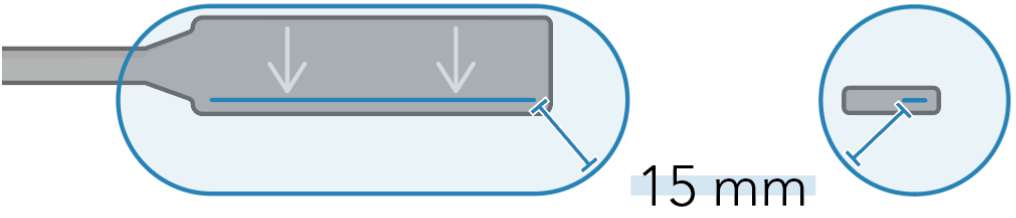
# EXAMPLE SETUP

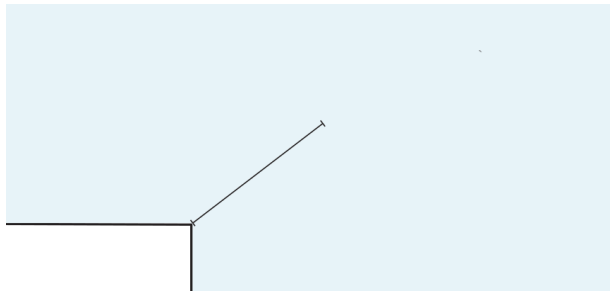
## 1x Transmitter | 2x 500 mm flex probes | 4x 75 mm rigid probes | 1x extension cable

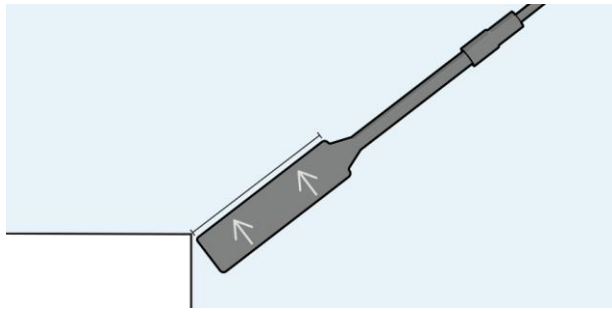


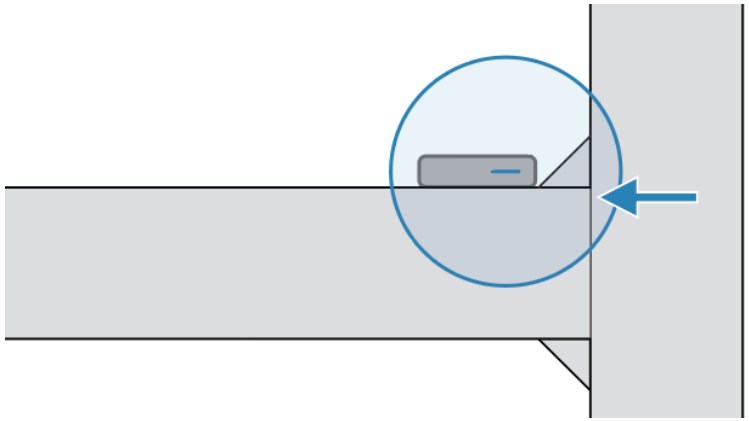
# POSITIONING OF STRIPS AND DETECTION ZONE

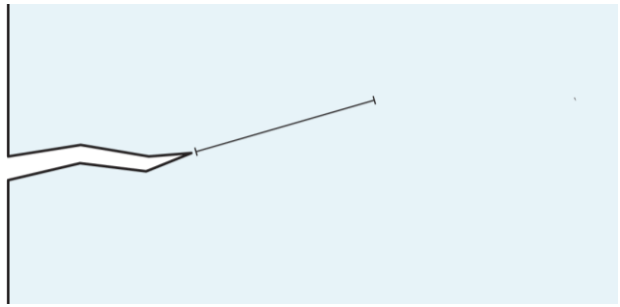
## Crack growth does not have to be parallel to strip length and is also detected below the surface

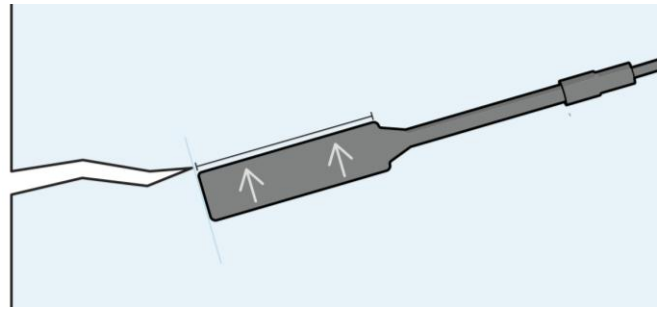


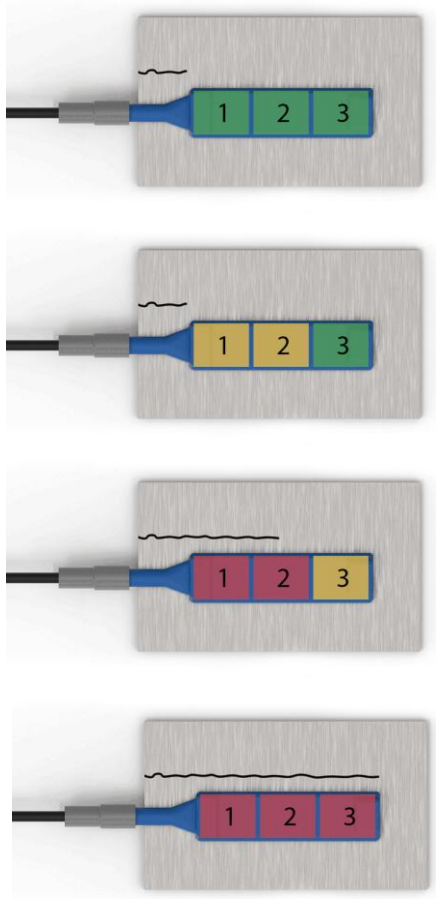




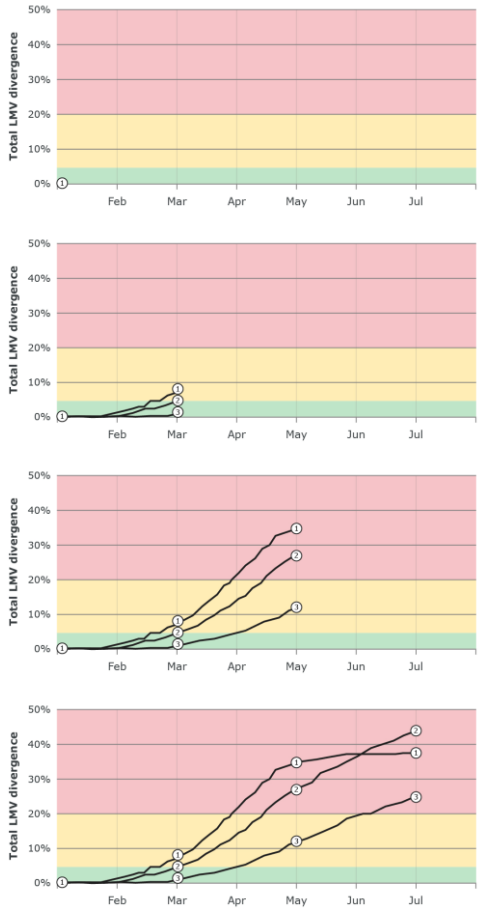




# SENSING CAPABILITIES OF THE SENSOR STRIPS: SCHEMATIC EXAMPLE




*Example placement when there is already a crack*




*Sensor output in the dashboard*

1. The strip is installed, reference measurement is taken
2. Before the crack growth is detectable with conventional technologies, the sensor starts to detect local variations
3. Crack growth starts to be detectable with NDT, sensor strip turns red on zone 1 & zone 2. The zone 3 starts to turn yellow.
4. Crack continues to propagate, change in magnetic field stabilizes at zone 1 and continues to rise at zone 3.

# AUTOMATED ANALYSIS IN AN ONLINE DASHBOARD


Overview drawing with sensor locations

1. All sensor locations are marked, and coloured according to the analysis results
2. Overview photos of selected sensor unit
3. Selected sensor strips photo with lay-over of analysis data plotted in which the colors represent the analysis of sensor data over time

- Historical data with analysis since installation available that can be exported to excel
- Automated warnings when crack growth is detected (telephone or e-mail)

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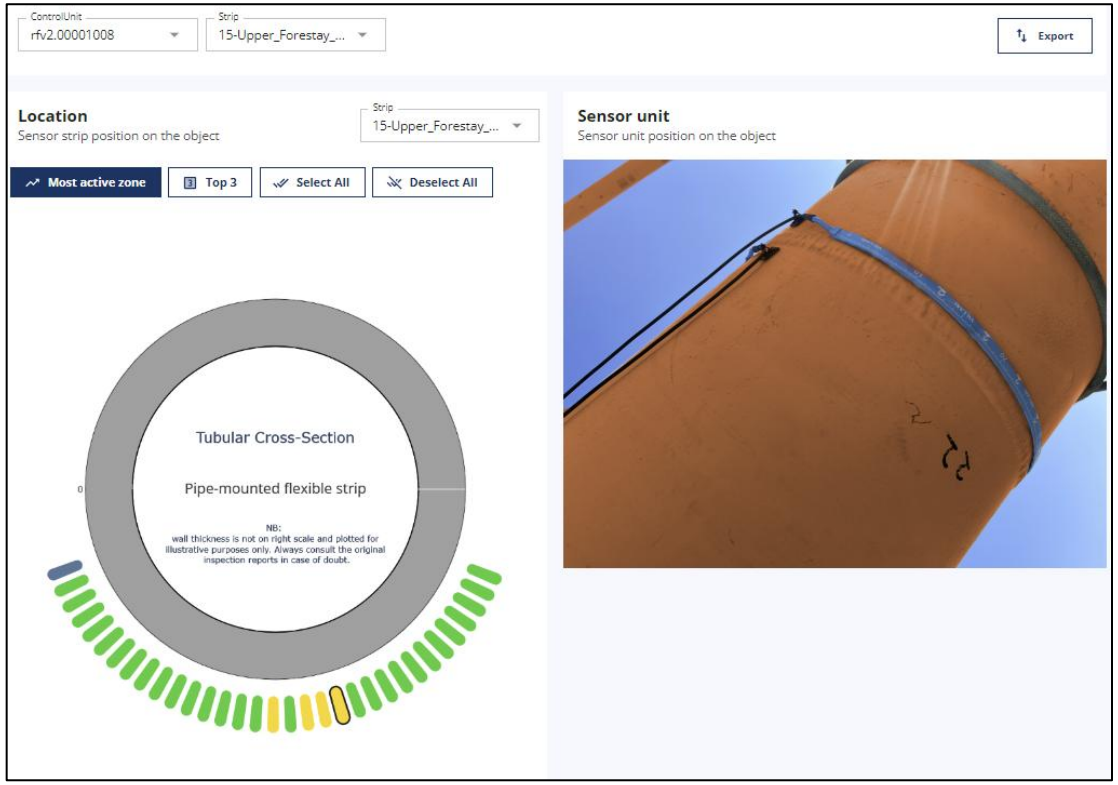
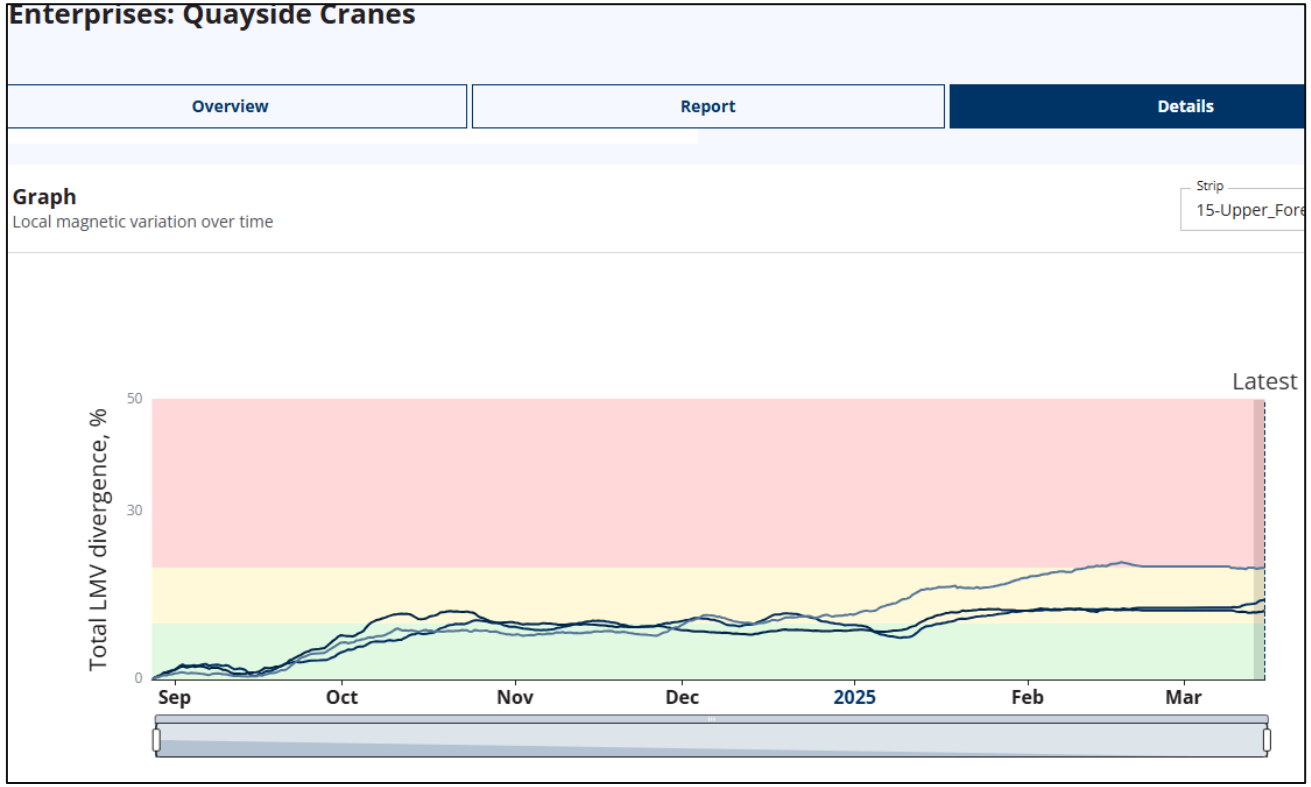
# AUTOMATED ANALYSIS IN AN ONLINE DASHBOARD

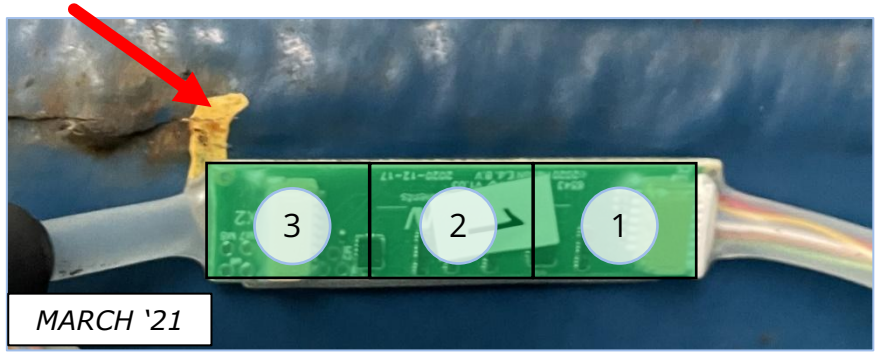
## Closeup images combined with a live data stream provide actionable insights

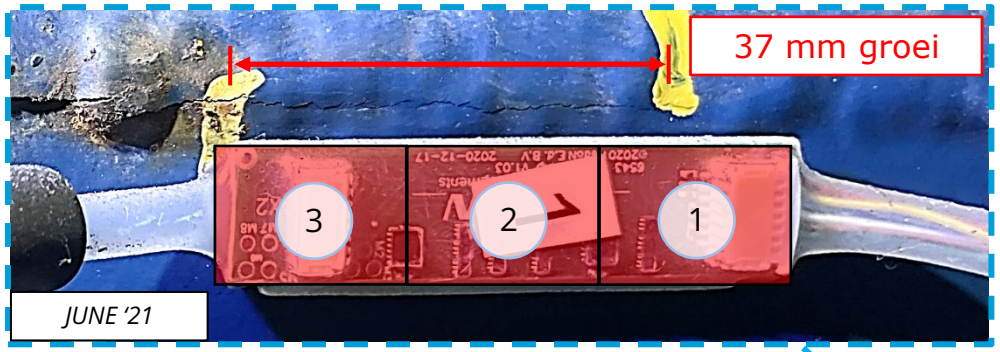


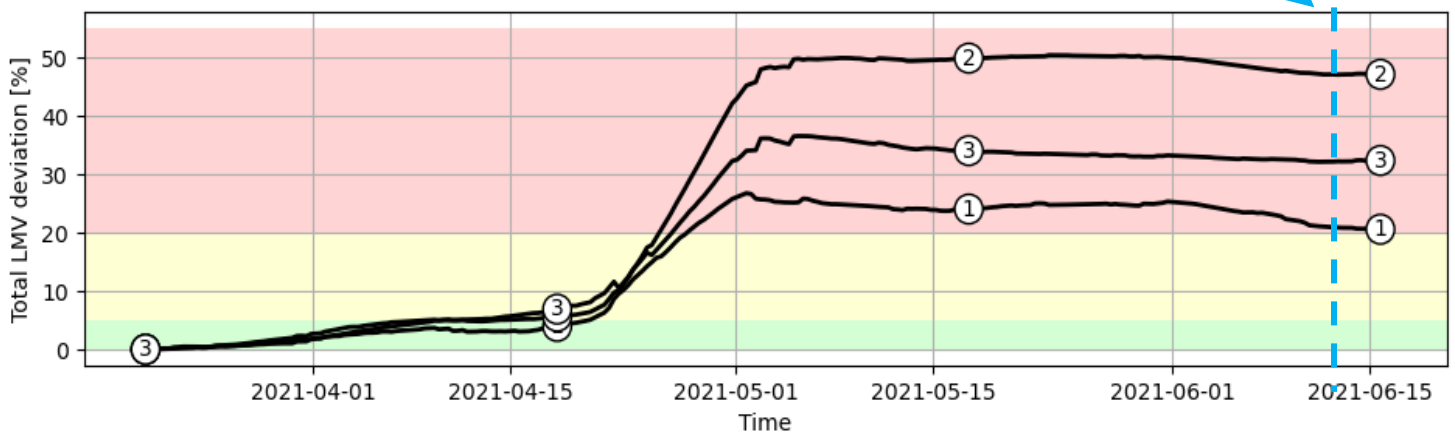
# CLIENT USE CASE : REACTIVE PLACEMENT

## Continuously measure crack propagation in order to schedule inspection & repairs



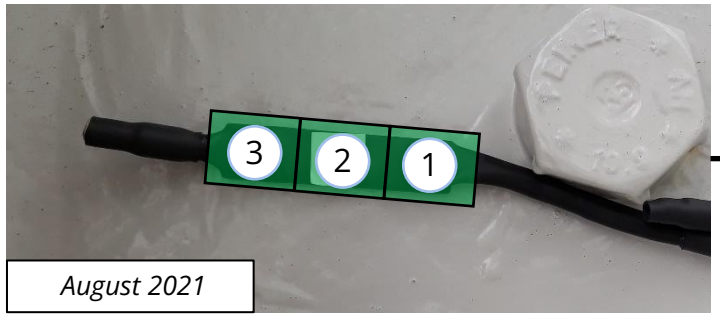



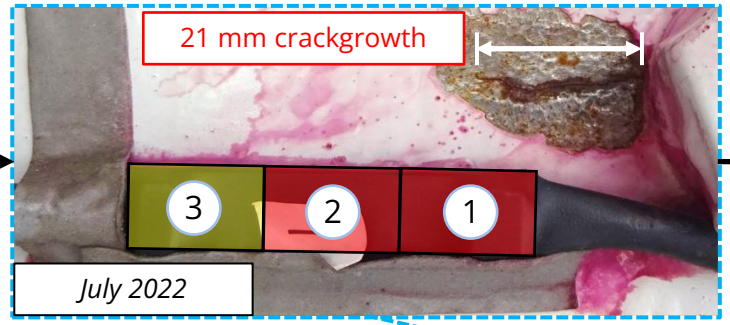

- Detectable crack growth can be both root and toe initiating (sub-surface) cracks
- Extensive documentation available upon request including both laboratory and field results
- Proven algorithm for crack detection, certified by DNV
- Specification sheet available upon request

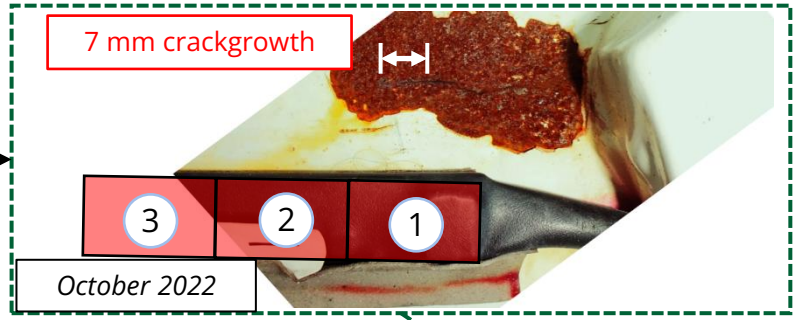


# CLIENT USE CASE : PREVENTIVE PLACEMENT

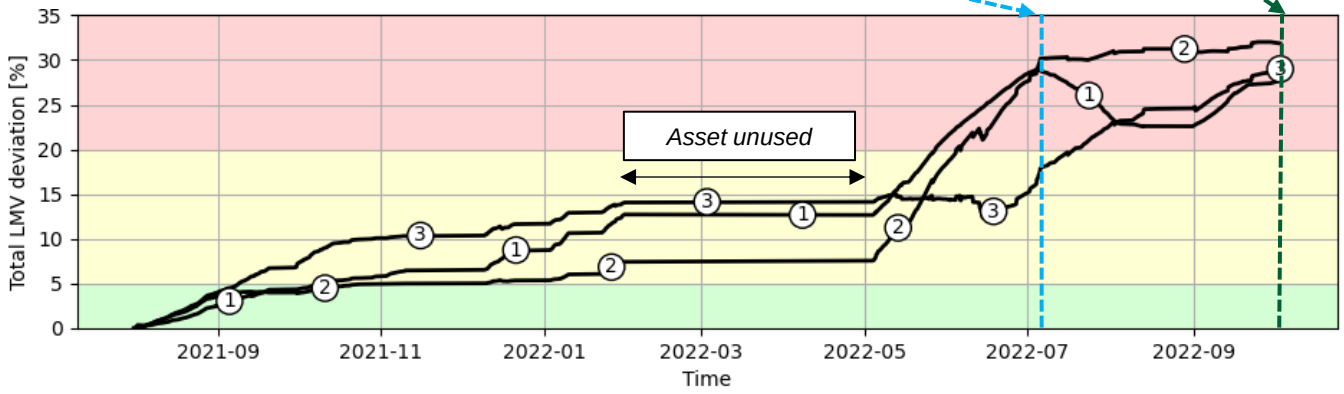
## Placing sensors on an asset as it reaches end-of-life




- Installation without a detected crack in Aug ‘21
- During inspection in July ‘22 a 21 mm crack was found using penetrant dye inspection, Villari at this point already measured significant changes
- Moderate activity was detected by Villari in October ‘21, nine months before NDT discovered a crack
- Afterwards: no crack growth was visually reported but after Villari looked at its own data and thoroughly inspected the pictures taken an additional 7 mm crack growth was found



# A REVOLUTIONARY SOLUTION

## HIGH ACCURACY

Competitive with state-of-the-art NDT methods such as PAUT or TOFD

## WIRELESS

No need to bring cables during installation to connect the sensors units to the grid

## LONG BATTERY LIFE

Up to 5 years battery life for each sensor unit

## ATTRACTIVE PRICING

Smart technology with low-cost electronics allow for affordable monitoring

## NO SURFACE PREPARATION

Apply our sensors directly on top of painted steel (no paint removal necessary)

## ALWAYS UP-TO-DATE

Continuously updated online dashboard with automated warning e-mails or calls

## PLUG AND PLAY

Highly flexible design allows application in many different configurations

## LIMITED DATA PROFILE

Intelligent physics interpretation keeps data volume below 15 kB per month

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# Would you like to learn more?

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