



Fibre Optic Movement Sensing

an emerging tool for large scale rail system
condition monitoring

www.focus-sensors.com

Who am I?



- Optical sensors R&D background
- Co-founded Focus Sensors in 2016
- Our aim is to monitor infrastructure with infrastructure
- Developed own hardware and software platform based on Indus™
- On rail since 2019



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The Challenge for Network Rail

- Thousands of assets
- £13.4bn maintenance, £19.0bn renewals in CP7 *
- Monitoring in progress
- Issues remain

Intrusion/Trespass

S&C Condition

Rail Condition

Earthworks Condition

Wheel Fault

Cable Interference

Drainage Condition

**Monitor all the railway
all the time**

Fibre Sensing



Fibre Optic Acoustic Sensing (FOAS) – (vibrations)

‘Traditional’ Fibre Sensing

- Intruders
- Rockfall events
- Wheel Defects
- Rail Head Condition
- Earthquake
- Cable Theft
- Cable maintenance

Fibre Optic Movement Sensing (FOMS) – (movement)

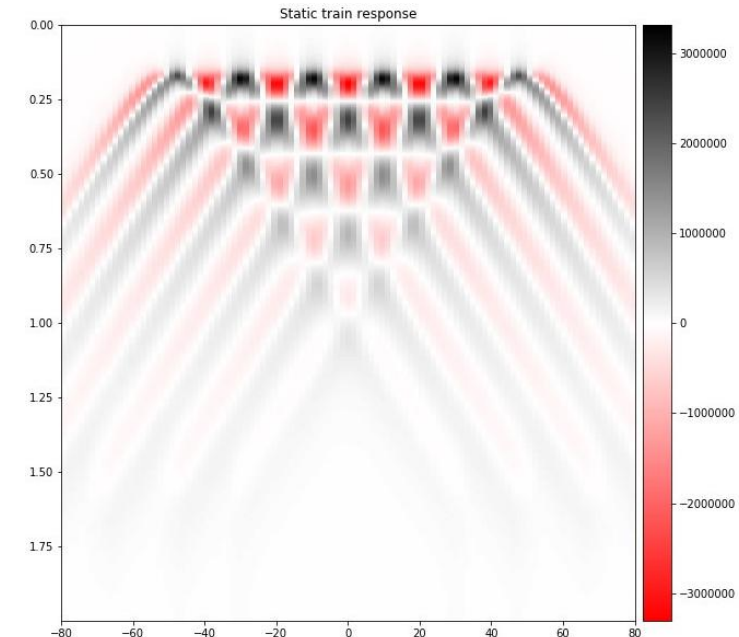
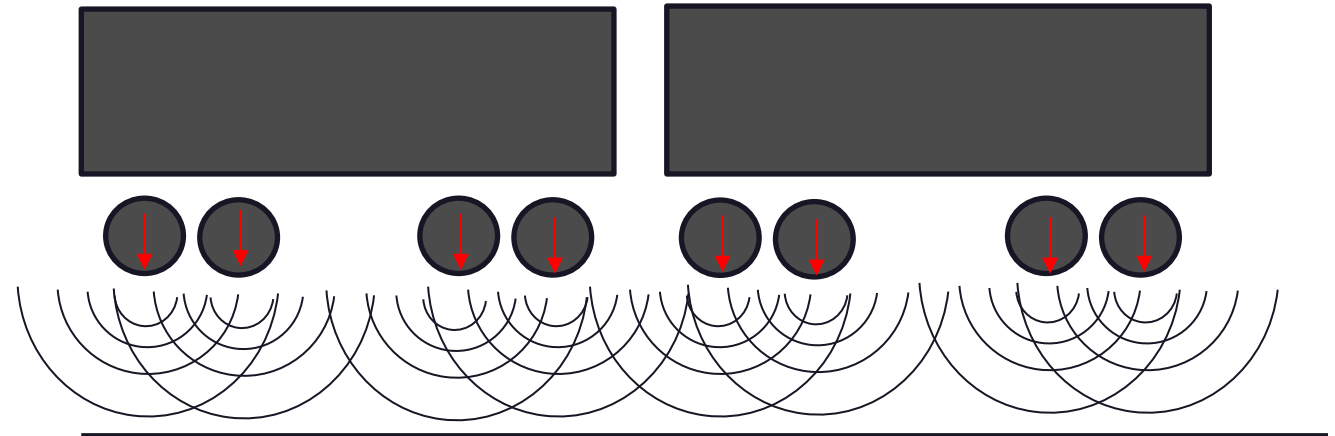
Unique to Focus Sensors

- Earthworks condition
- Drainage condition
- S&C condition
- Asset monitoring

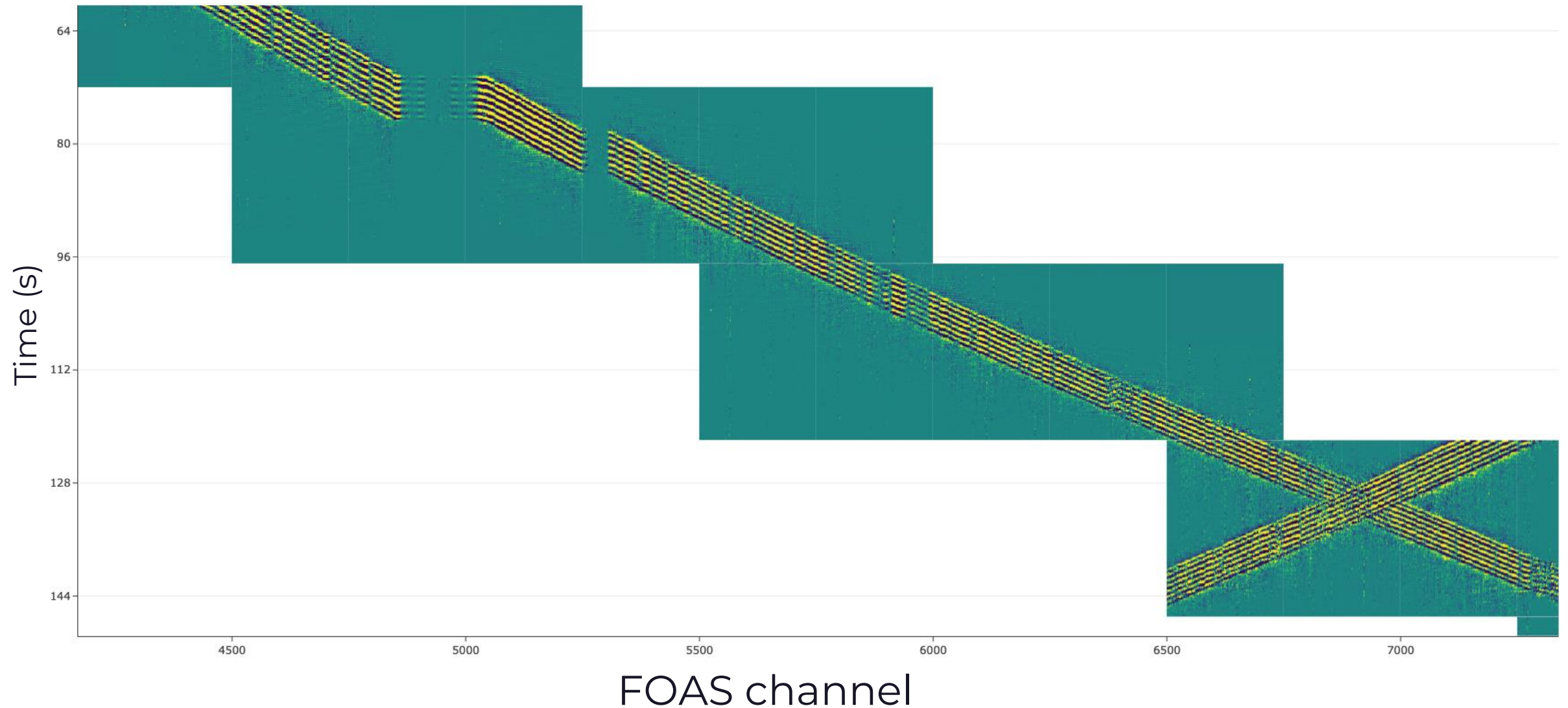
Existing telecoms fibres | Every metre monitored | 80km per hardware Web Dashboard/Email/SMS/json feed | Sensing as a Service | host 3rd party algorithms

FOAS signals

- Trains are heavy
- Each wheel acts as a point force on the free surface (i.e. the ground)
- This creates seismic waves
- The waves are coupled into the fibre and detected

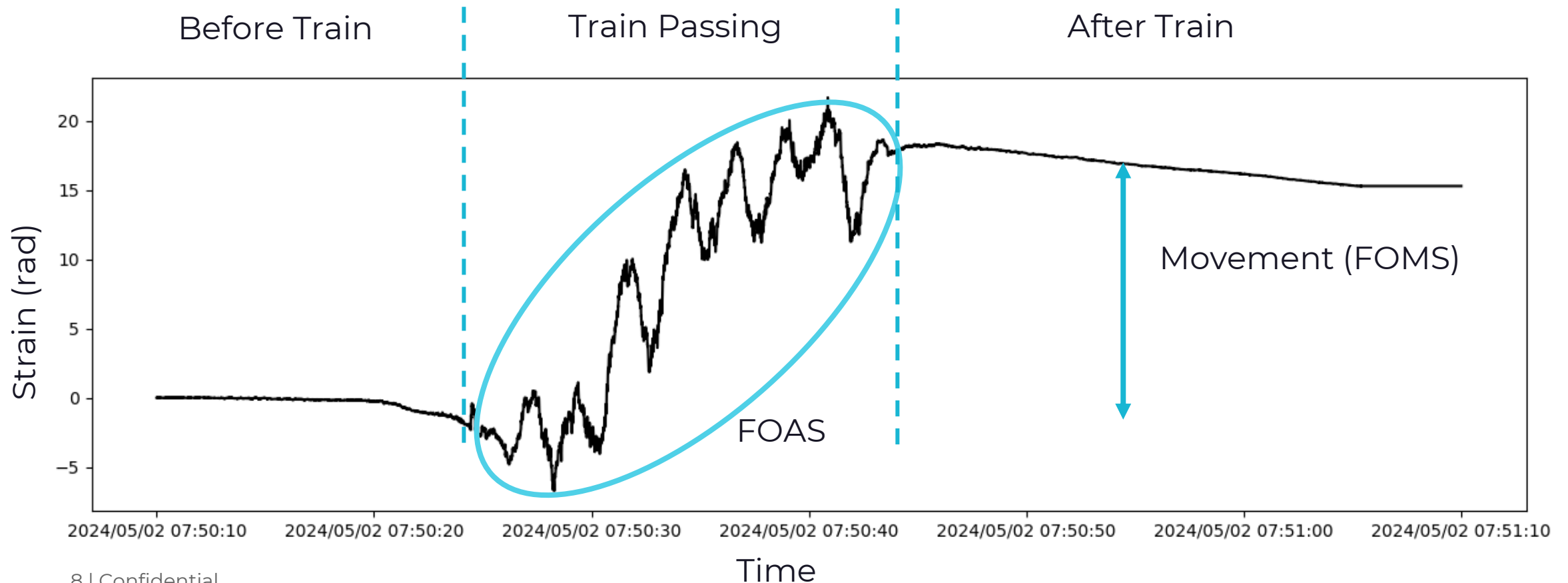


Example FOAS signal



Example Fibre Optic Movement Sensing

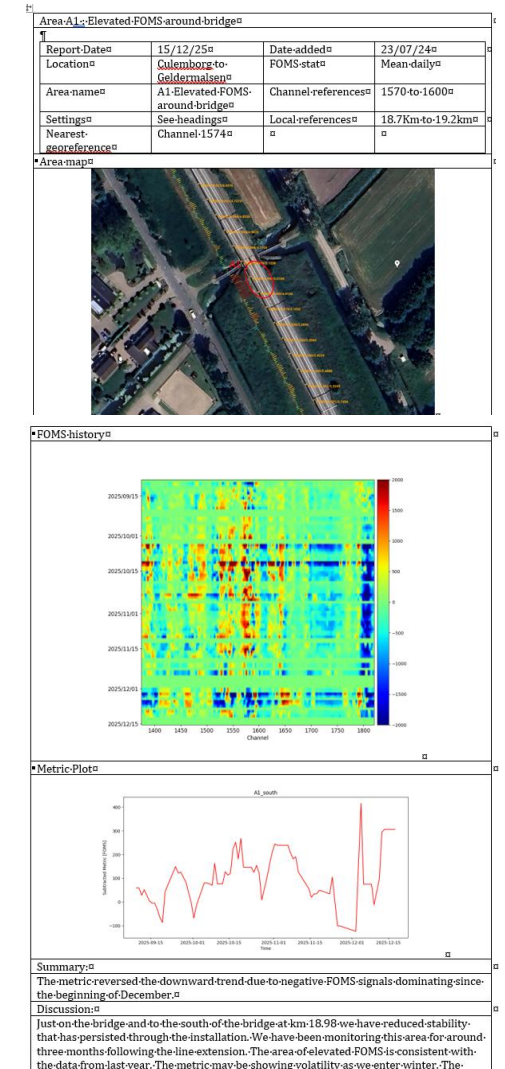
- Train passage also causes inelastic ground movement
- Some of this is coupled into the fibre



FOMS service : Alert – Monitor - Alarm



- Pre-installation; Installation; Georeference
- Areas of Interest (AOI) identified
- Automatic alarms
- Bi-weekly report and roundtable with customer
- E.g. 18 month install, 24 AOI, automatic alarms sent, zero false negatives or positives





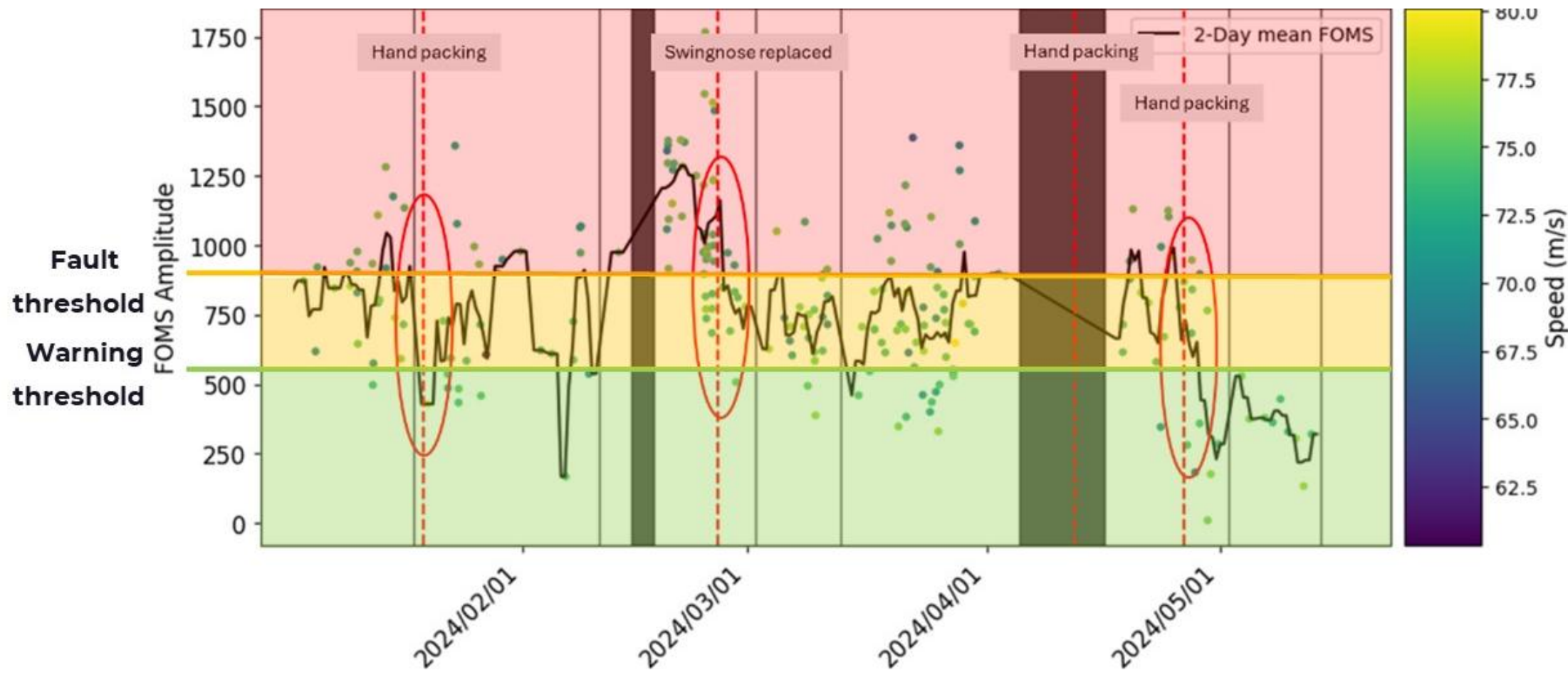
FOMS Use Case Examples

Example 1 : Switches & Crossing

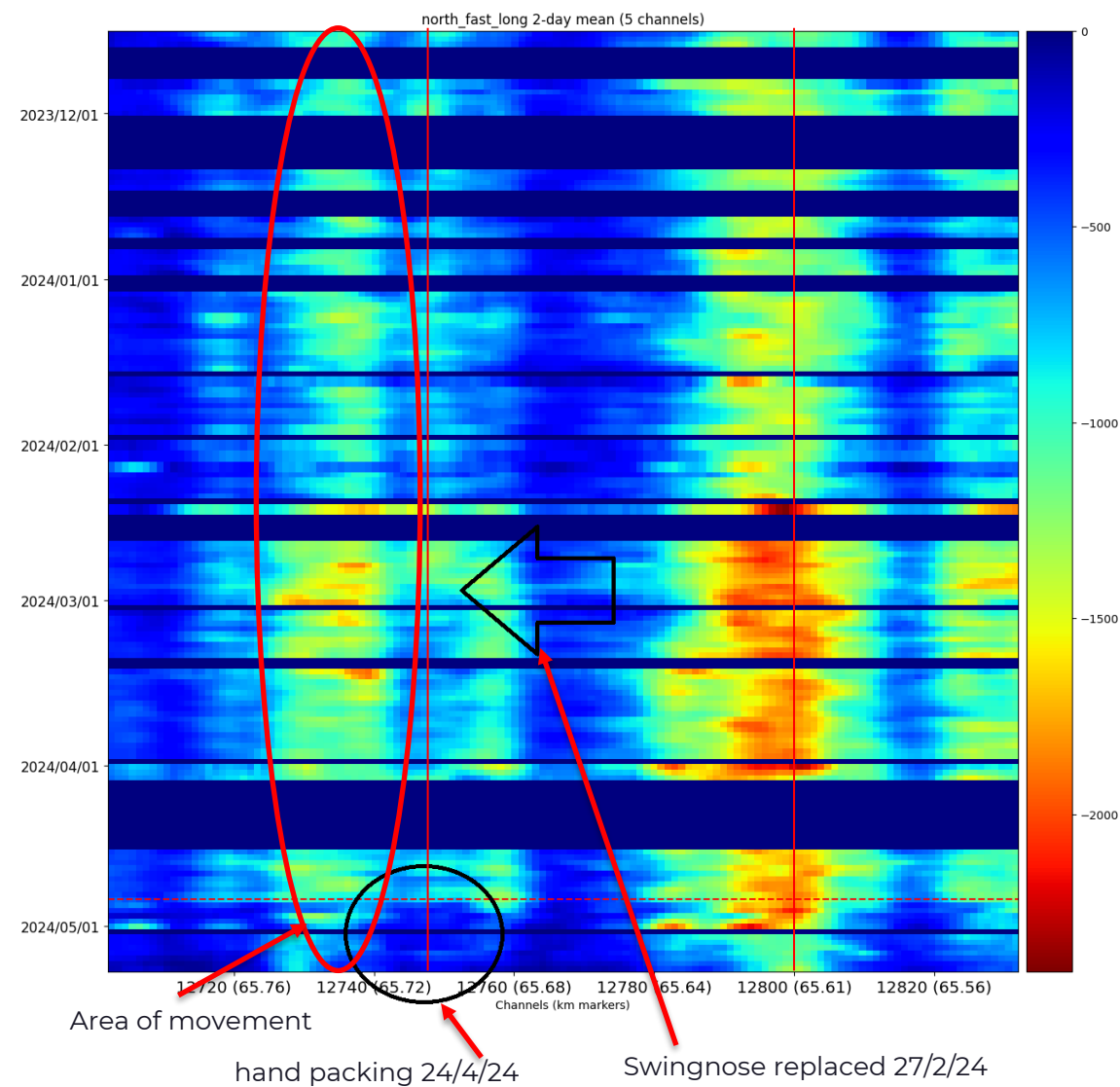
S&C monitoring at highspeed | Overview



Example 1a | Point machine void



Example 1b | S&C the bigger picture

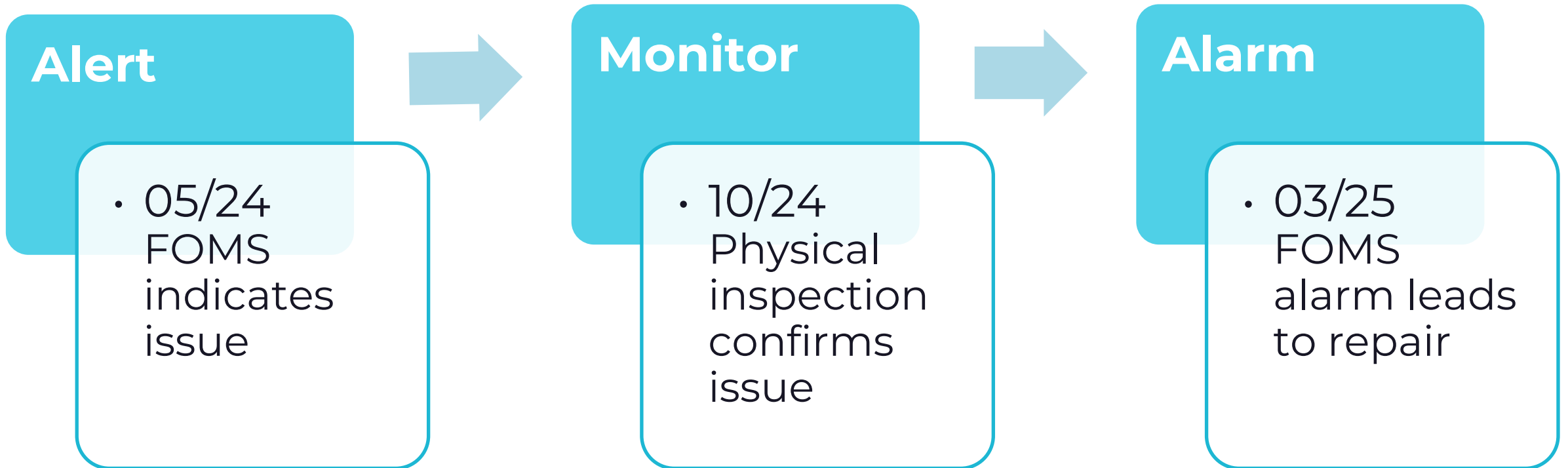




FOMS Use Case Examples

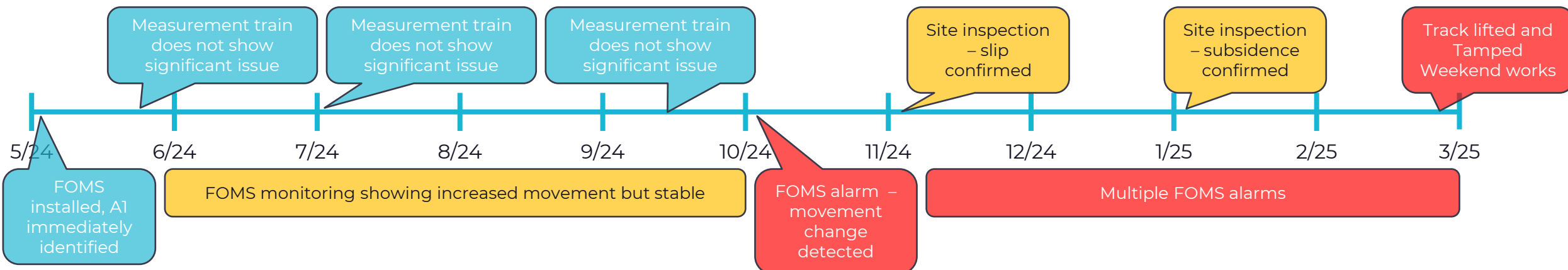
Example 2 : Subsidence

A1 : Subsidence @ km | Overview



A1 : Subsidence @ km [redacted] | Detail

- FOMS detected elevated track movement south of bridge
- Identified 2 weeks after FOMS was installed
- Was not identified by other means for 6 months
- 10 months after FOMS identification the track was lifted and tamped



A1 : Subsidence @ km [REDACTED] | FOMS benefits



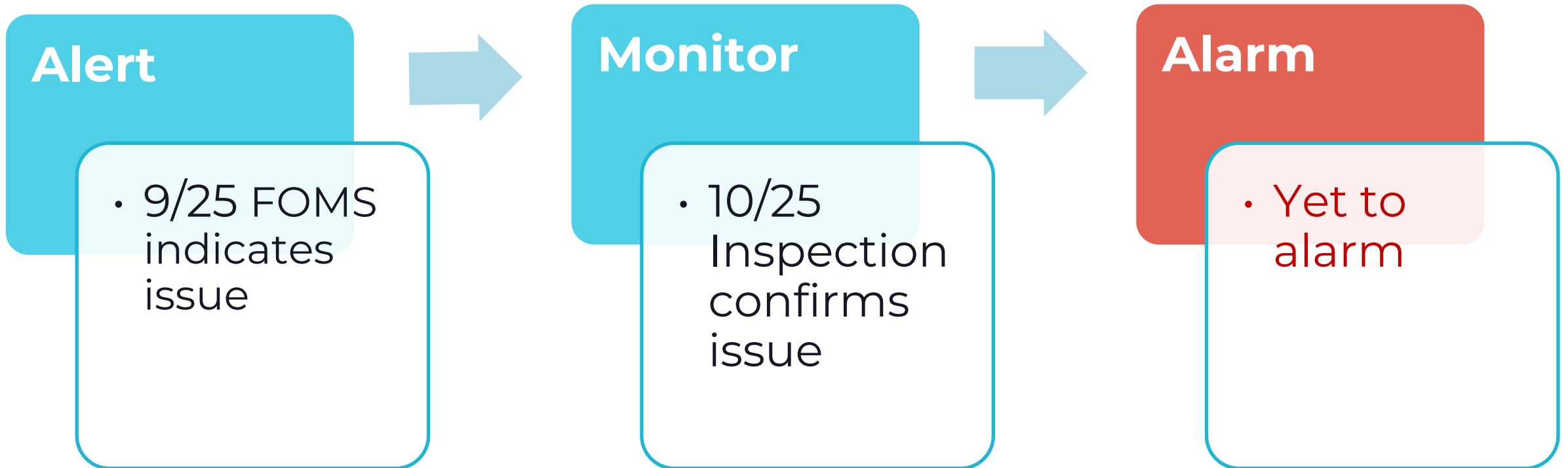
- Alert
 - FOMS drew attention to km [REDACTED] months before any other system
 - This allowed monitoring of the area, improving safety
- Monitor
 - FOMS monitored for changes every day, adding to confidence that nothing catastrophic had changed
- Alarm
 - FOMS automatic alarm indicated significant changes that require maintenance in the area



FOMS Use Case Examples

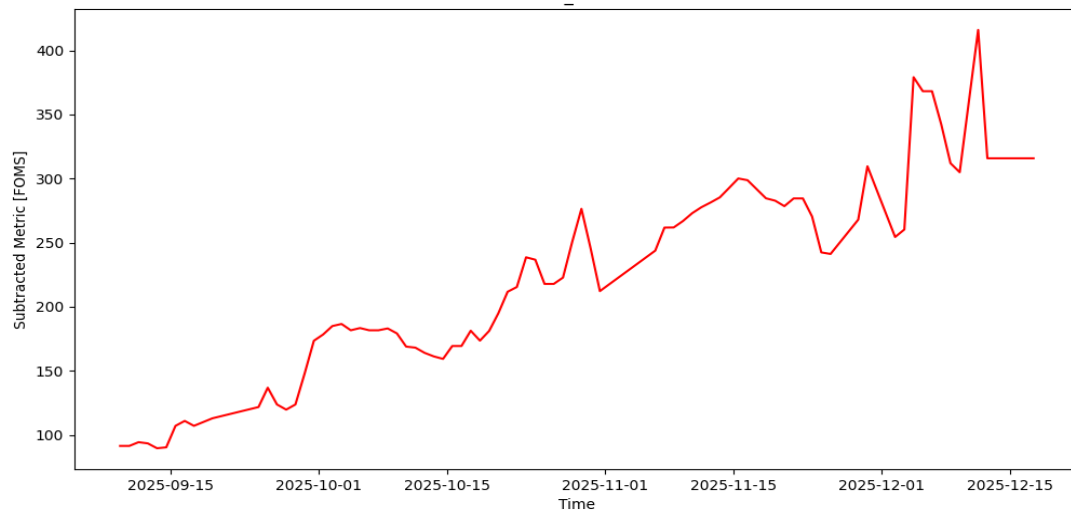
Example 3 : Drainage condition

A20 : Issue @ km [REDACTED] | Overview



A20 : Issue @ km [redacted] | Detail

- Elevated movement identified on open track
- External inspection later conformed instability
- Monitored for change



Logboek monitoring Zuidwestboog Meteren:



Logboek monitoring Zuidwestboog Meteren:



locatie 9



locatie 10





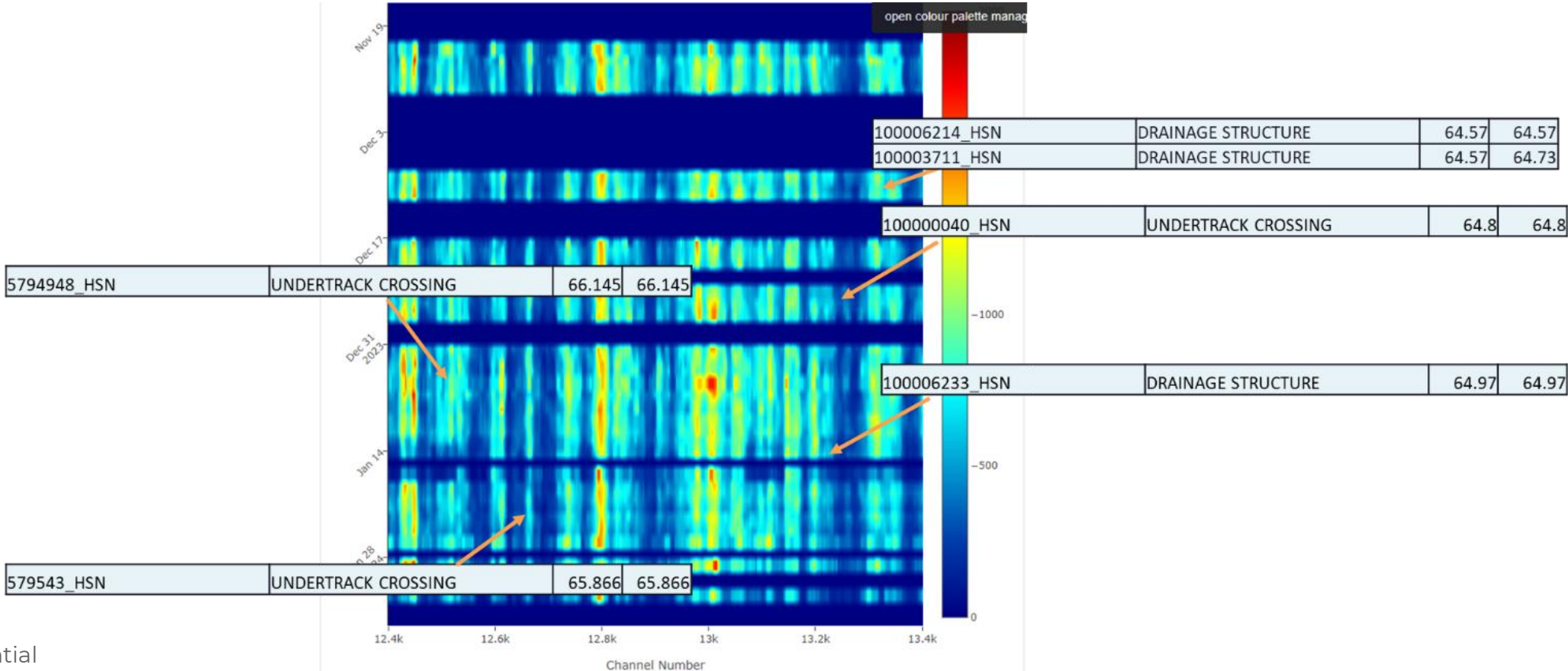
FOMS Use Case Examples

Example 4 : Asset Monitoring

Example 4 | Asset Monitoring



- Each asset provides a separate FOMS signal which can be monitored for degradation
- 1330 assets are monitored over 38km at high speed





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