Quantifying Wheel Tread Damage using MRX Surface Crack Measurement System

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Overview

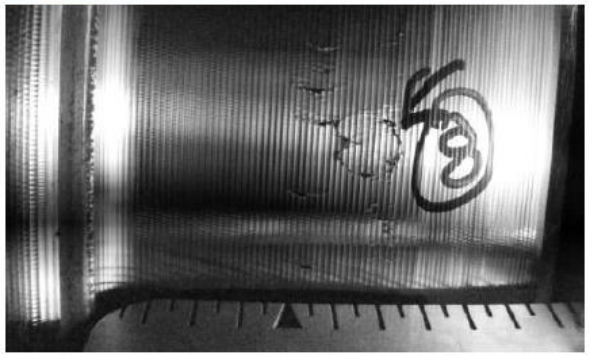
- Wheelset maintenance
  - Wheel tread damage
  - Challenges
- Surface Crack Measurement technology
- Summary and application of Wheel SCM Hand-Held Unit
  - Specification
  - Validation
  - Example outputs
- Data uses and case studies

Wheelset Management

- Wheelsets account for a large proportion of a fleets whole-life costs
- Wheelsets are routinely maintained to ensure safe operation and prolong life
- This includes measurements to inspect:
  - Roundness
  - Profile shape
  - Rim thickness
  - Visual inspection of surface damage

Wheel Tread Damage

- Surface damage is difficult to classify through visual inspections
  - Not possible to establish depth of damage
- Wheelsets are re-profiled to remove any identified damage
- Crucial balance exists between:
  - Removing enough material to eliminate the damage
  - Minimising cut depth to preserve the rim thickness
- Taking multiple smaller cuts increases time at wheel lathe



Challenges

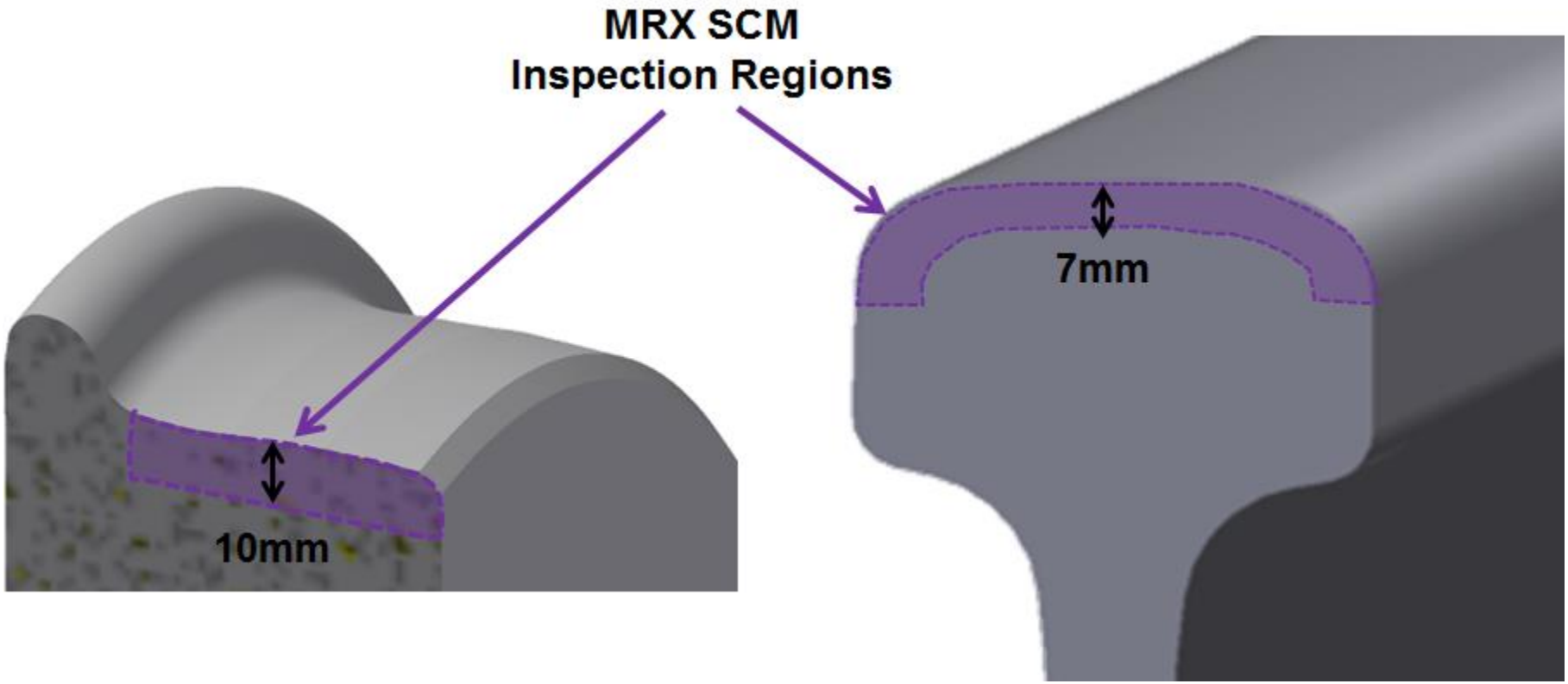
- Ability to reliably and accurately quantify the depth of damage on the wheel tread
- Assist in decision making and management of wheel surface damage
- Reduce the time the vehicle is on the wheel lathe
- Prevent excessive material removal to maximise wheelset life
- Reduce whole-life costs

Surface Crack Measurement

- MRX's Surface Crack Measurement (SCM) technology has been in use on rails for over 8-years
  - 2014: Technology adapted to measure surface cracking on wheels
  - 2015: Awarded funding through RSSB Rail Operator Challenge Competition to further develop and validate the technology for use on wheels
    - Collaboration with Bombardier Transportation and University of Huddersfield and Arriva Trains

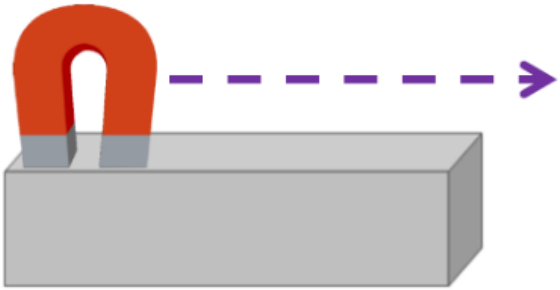
SCM Technology (1)

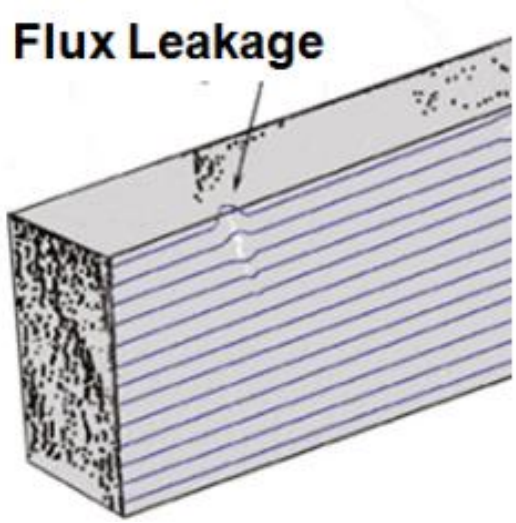
- Quantifies the depth of defects in the top 7 mm of the rail surface and top 10 mm of a wheel surface



SCM Technology (2)

- Specimen surface is magnetised
- This introduces lines of magnetic flux into the specimen
- These lines travel undisturbed through a defect free specimen
- If a defect is present, the flux cannot travel easily through it, causing flux to leak at the position of the defect
  - Sensors measure and record the leaking flux
  - Data analysed to quantify the severity of the damage



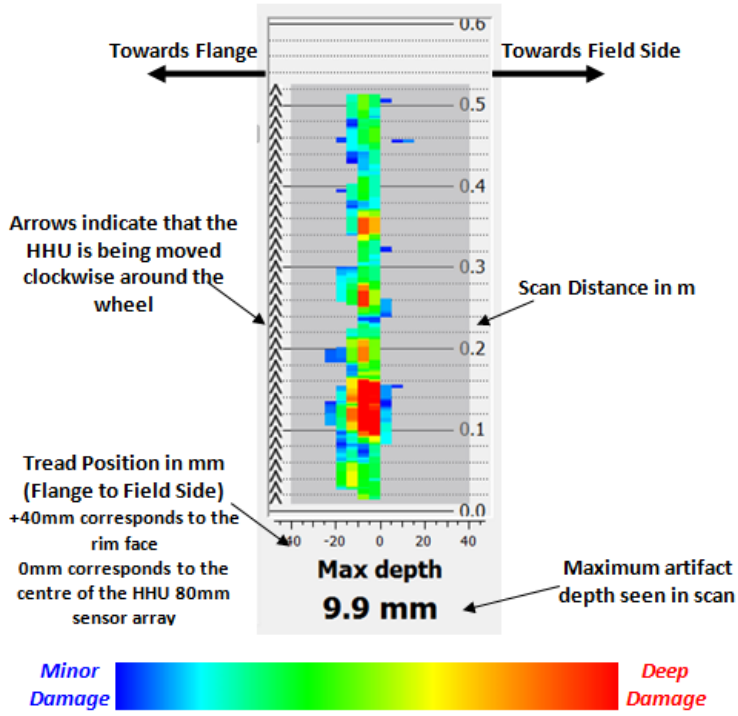


Wheel SCM Hand-held Unit

- SCM Hand-held unit (HHU) uses 16 magnetic field sensors to measure and records leaking flux
  - Detects defects from 1 mm to 10 mm in depth
- Reports the depth of the deepest defect
  - Amount of material to remove from the wheel to eliminate the damage

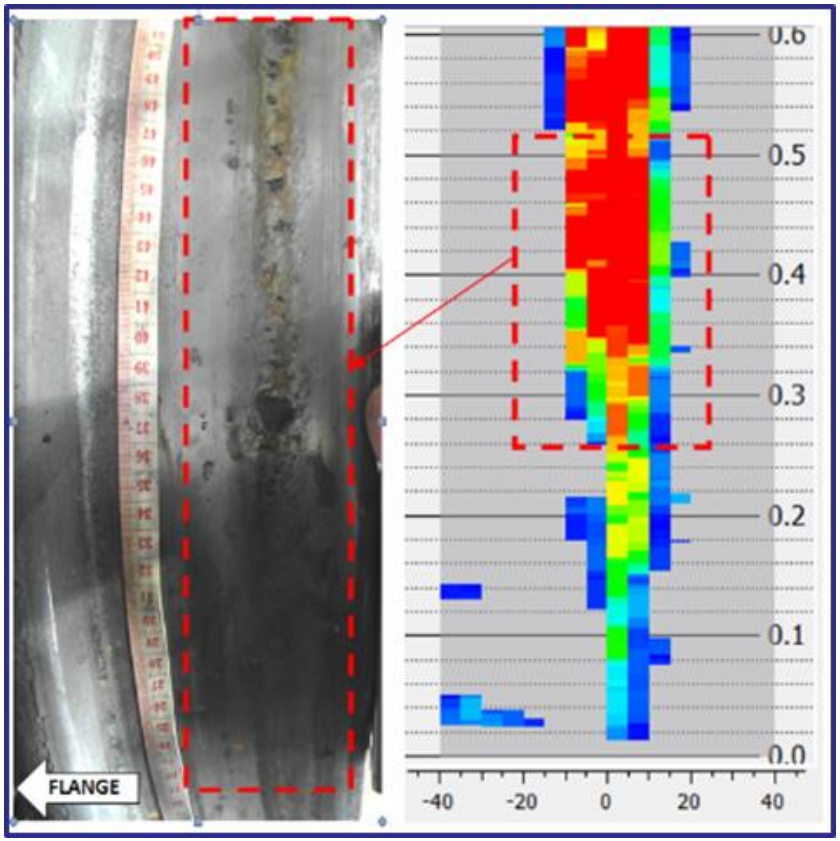
SCM HHU Output

- Measured damage is output from the software as a damage map
  - Data can also be exported to a csv file for further assessment of importing into asset management database

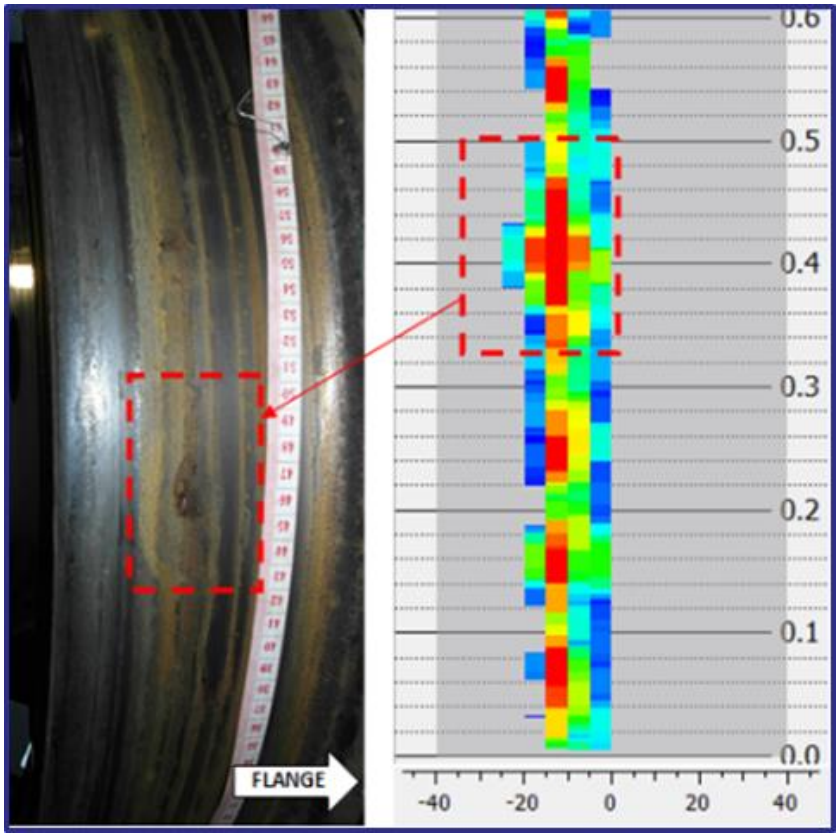


Example Outputs (1)

- Rolling contact fatigue

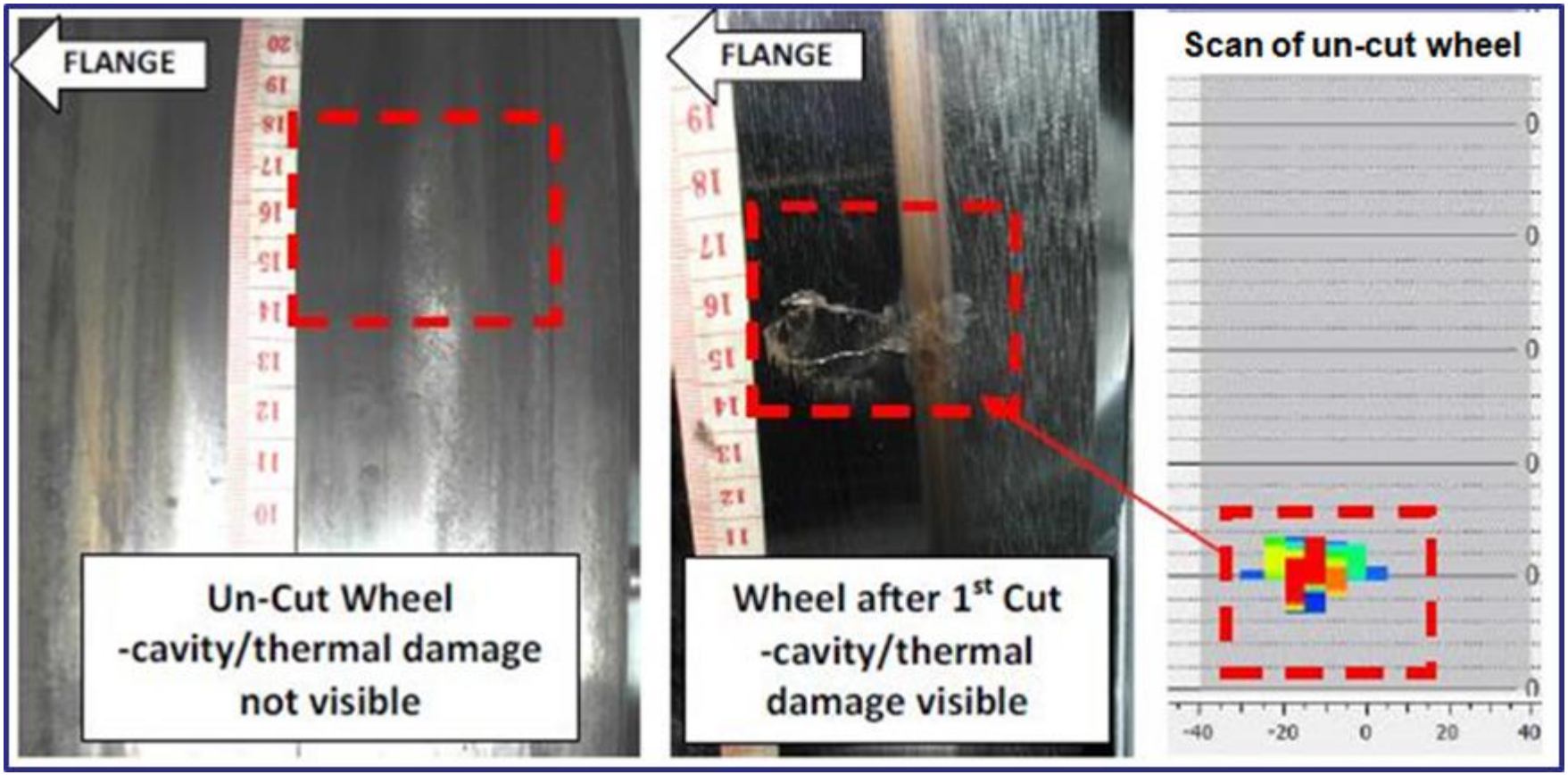


- Thermal cracking and cavities



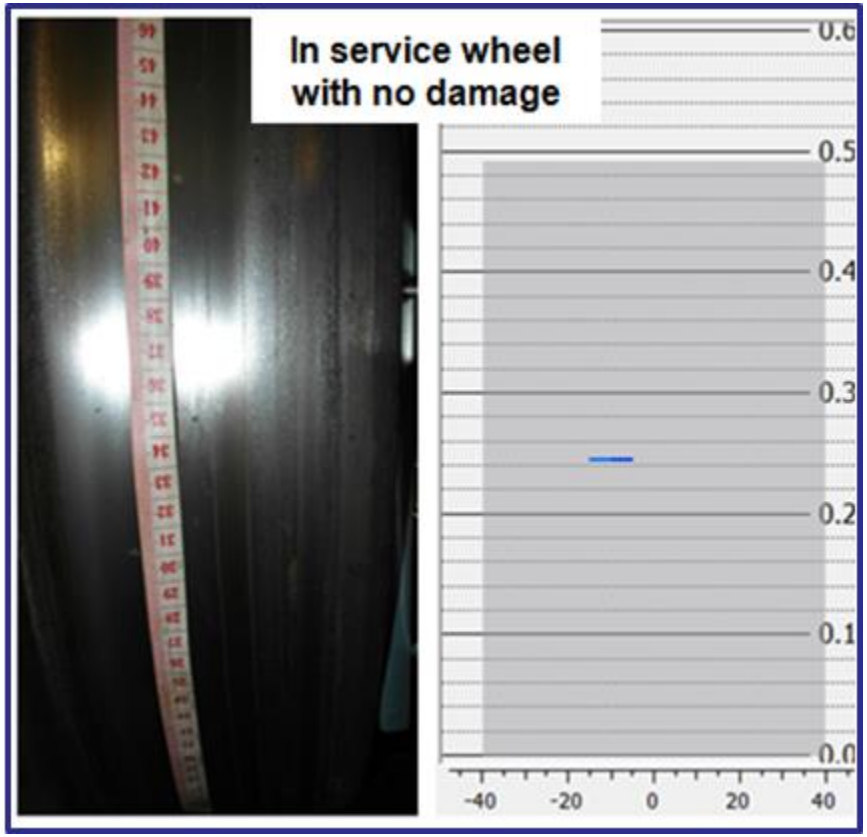
Example Outputs (2)

- SCM HHU reveals damage not visible on uncut wheel surface



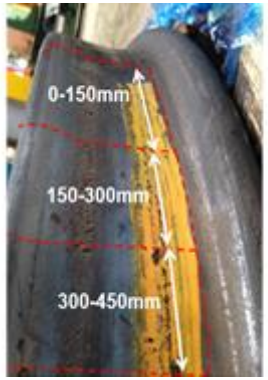
Example Outputs (3)

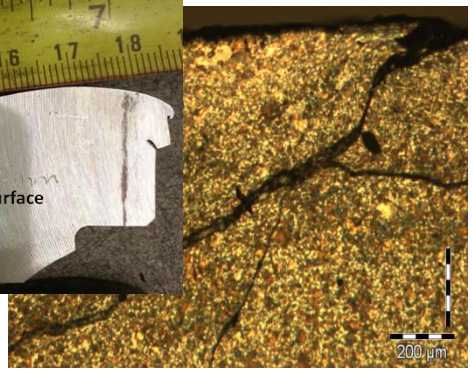
- SCM HHU confirms wheel is damage free

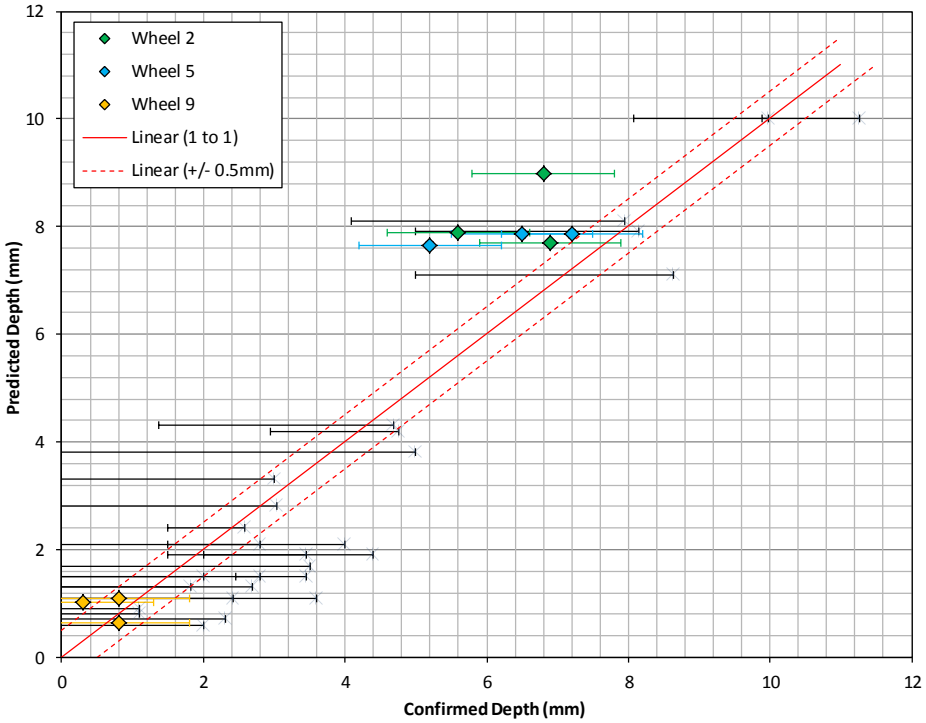


Validation

- Reported damage has been validated through a combination of depot trials and sectioning of scrap wheels





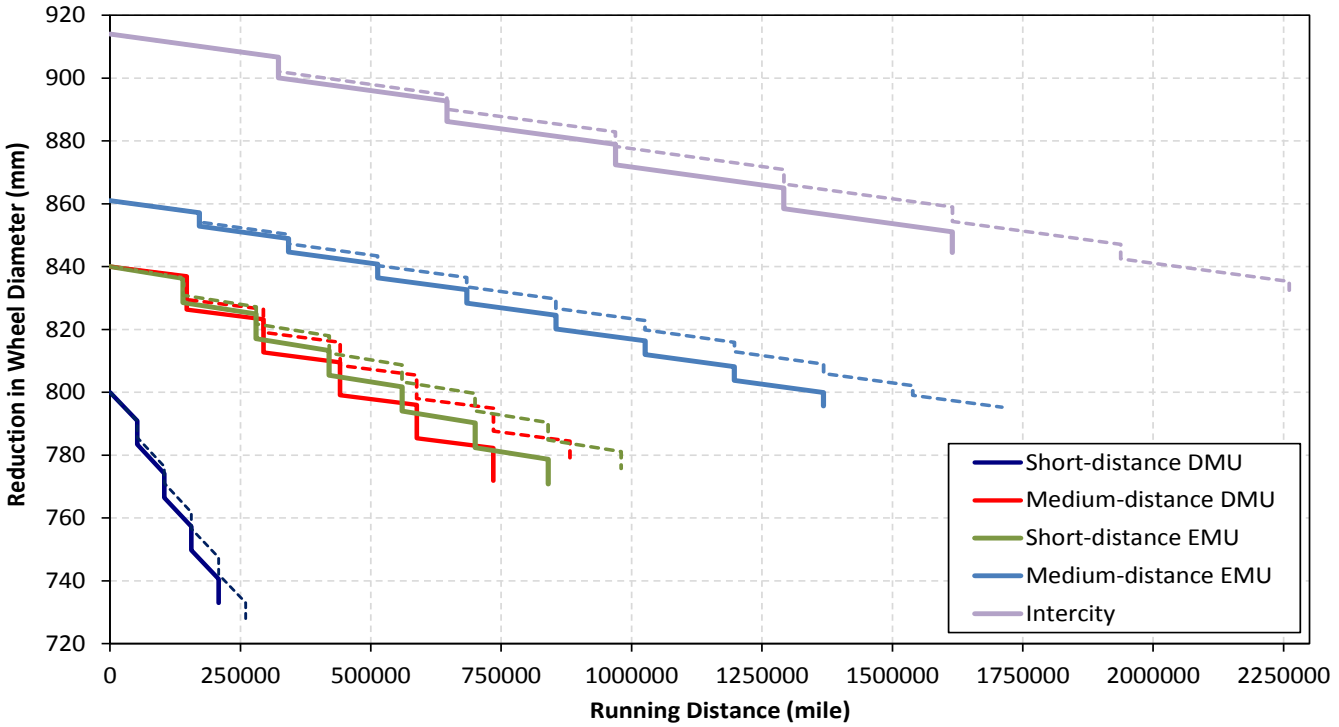


Typical Data Uses

- Routine exams to replace visual inspection
  - Repeatable, not reliant on experience/judgement
  - Reveals damage that is not obvious/visible on uncut tread
- Optimise wheel lathe cut depths
  - Reduce risk of overcutting, saves time chasing defects
  - Minimum cut depth to maintain parity
- Understand RCF development and growth rates
  - Plan maintenance in advance (rather than reactionary)
  - Highlight problem wheels/vehicles
  - Optimise periodic turning intervals
- Support engineering decision making
  - Monitoring performance of vehicle changes
  - Evaluate impact of changes quicker and more reliably

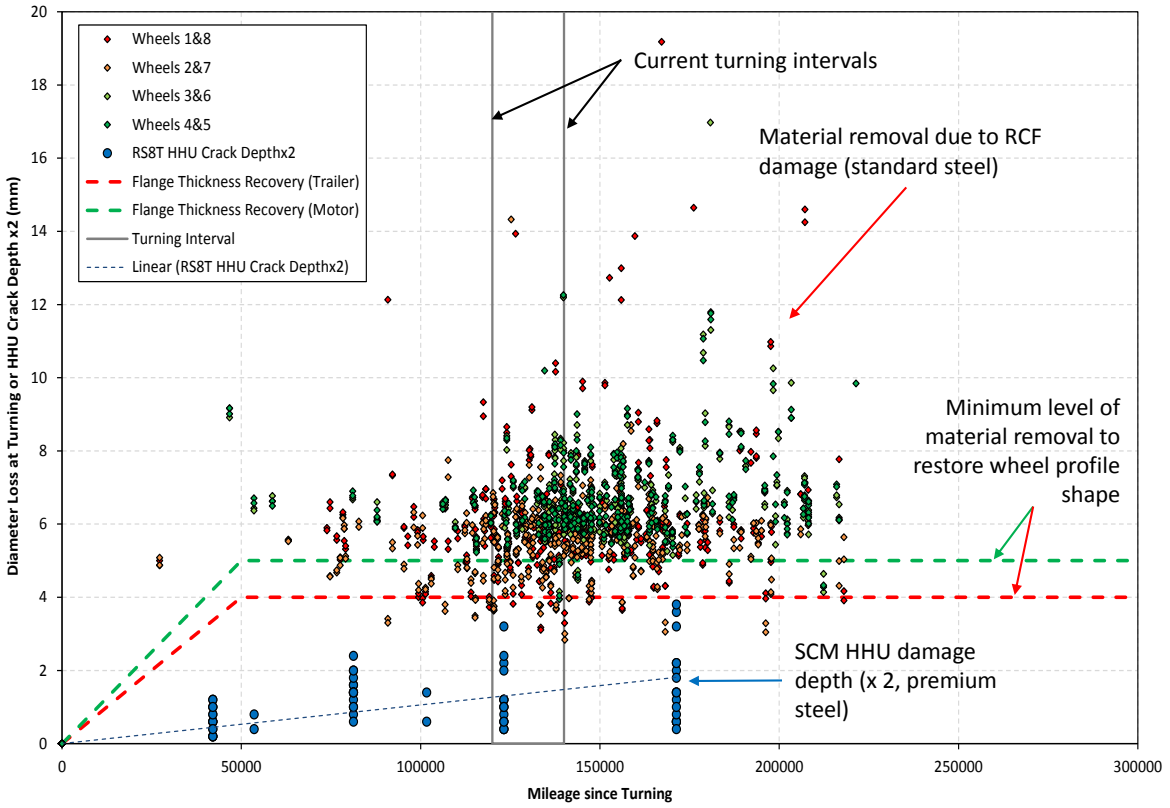
Case Study (1)

- Extending wheelset life due to less material removal during reprofiling
  - Potential to increase wheelset life by ~26% and reduce costs by ~2% - 8%



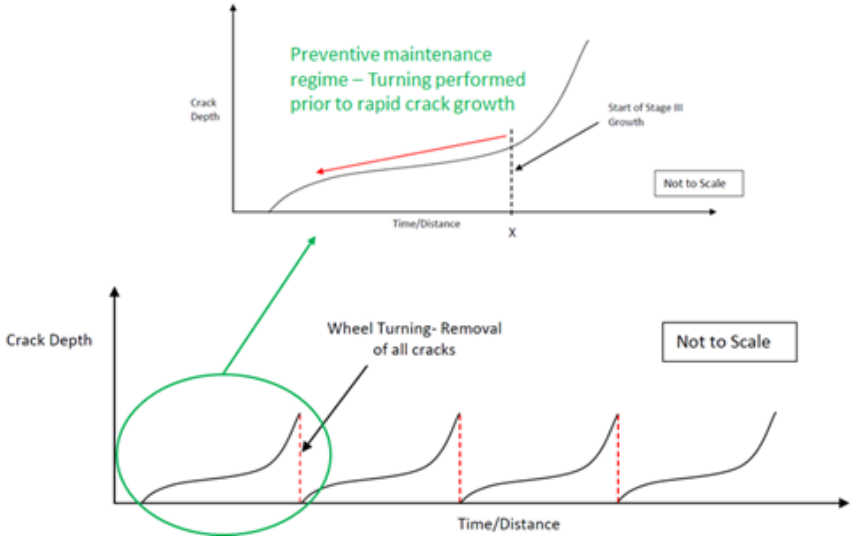
Case Study (2)

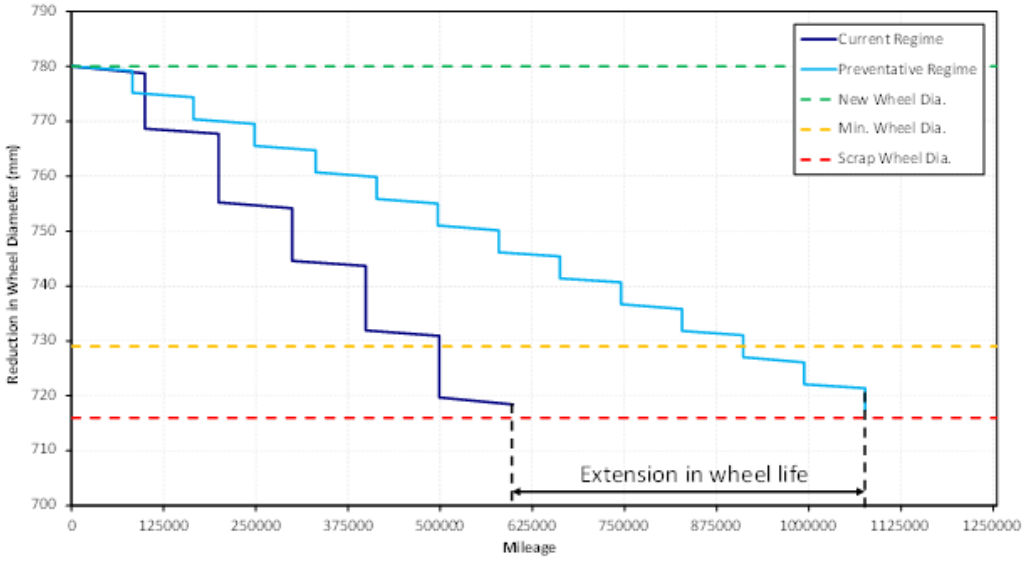
- Quantify benefits of changes to rolling stock
  - Support future engineering decisions
  - Repeatable measurement of the severity of damage
  - Potential to trend data to quantify performance



Case Study (3)

- Monitor crack growth and optimise wheel turning interval
  - Identify dominant damage mechanisms and growth rates
  - Confirm wheelsets requiring largest cuts
  - Potential increase in wheelset life by 80% and ~7% reduction in costs





Conclusions

- SCM technology has been adapted to evaluate surface and sub-surface defects in wheels
- Outputs from the developed SCM HHU have been validate through a combination of depot trials and sectioning of scrap wheels
- Benefits of using SCM HHU during routine wheelset maintenance has been demonstrated and quantified