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Quantifying Wheel Tread Damage using MRX Surface Crack Measurement System

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- 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

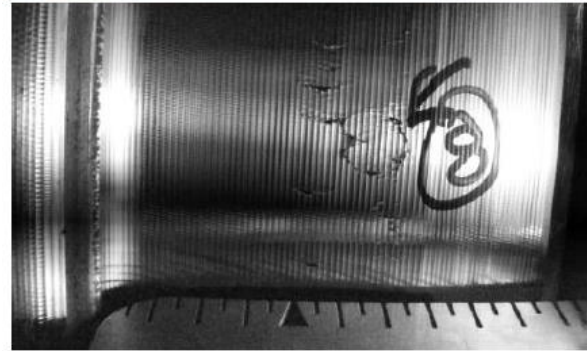
Wheelset Management

- 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

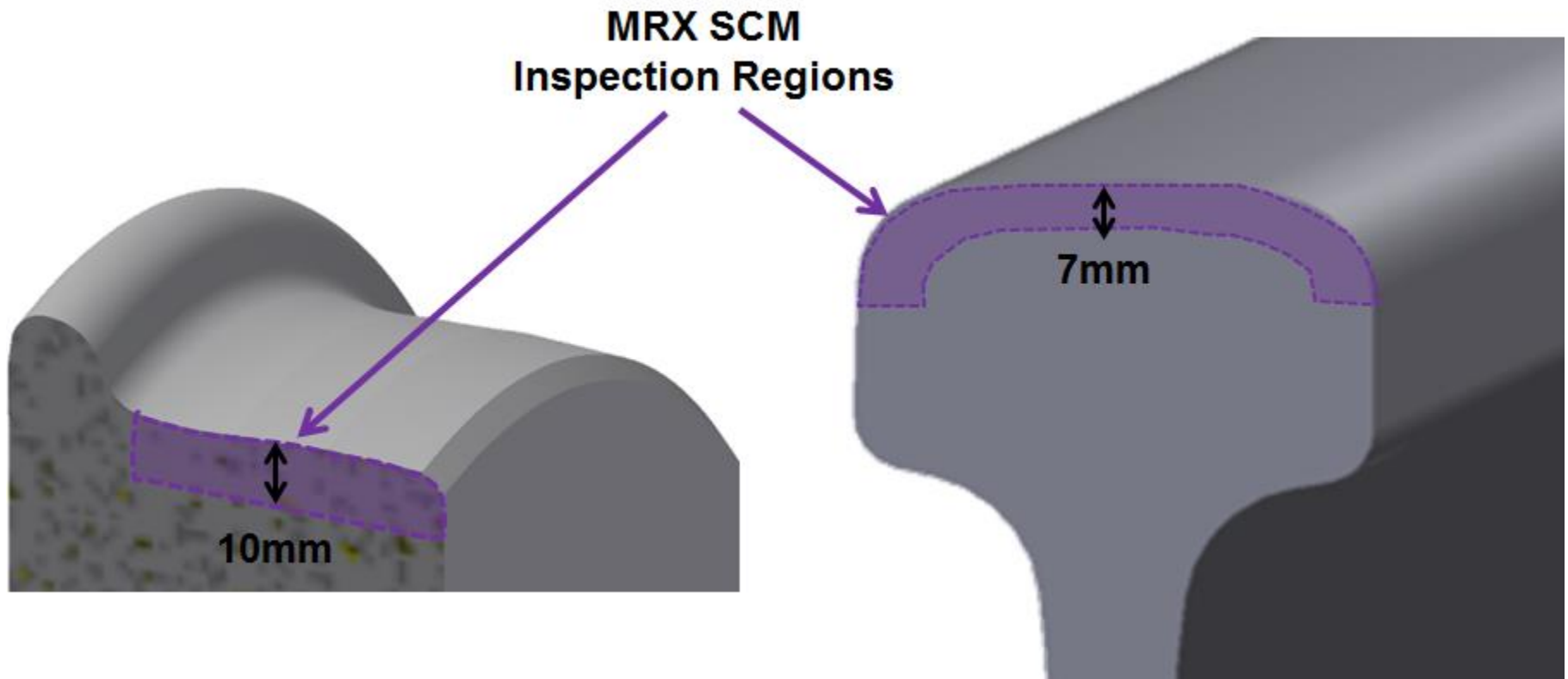
Surface Crack Measurement

- 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



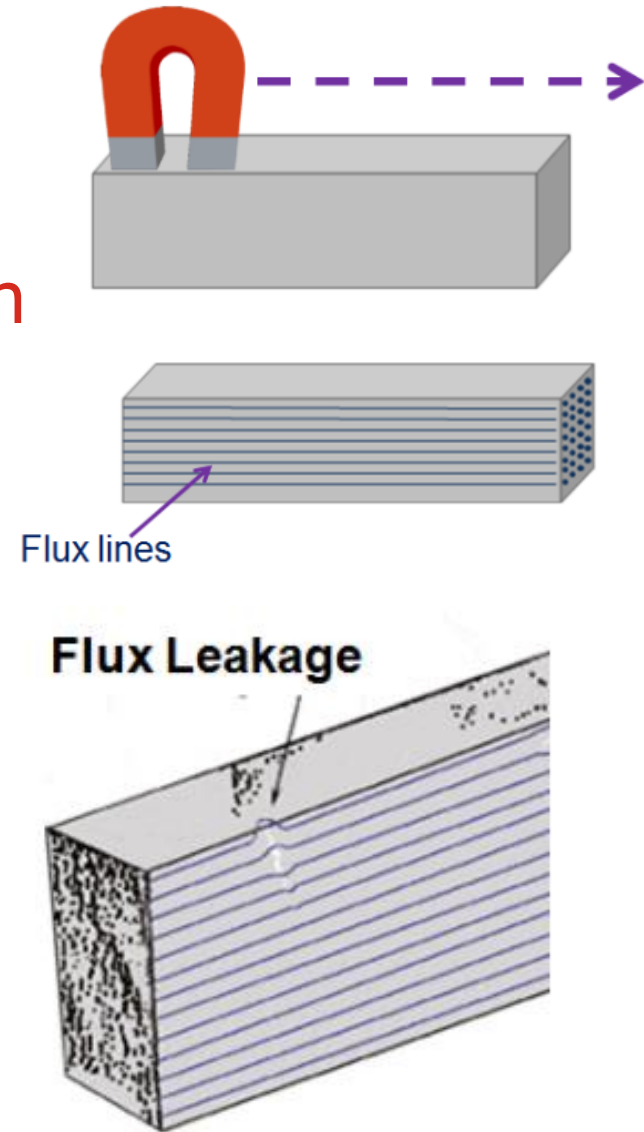
SCM Technology (1)

- 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



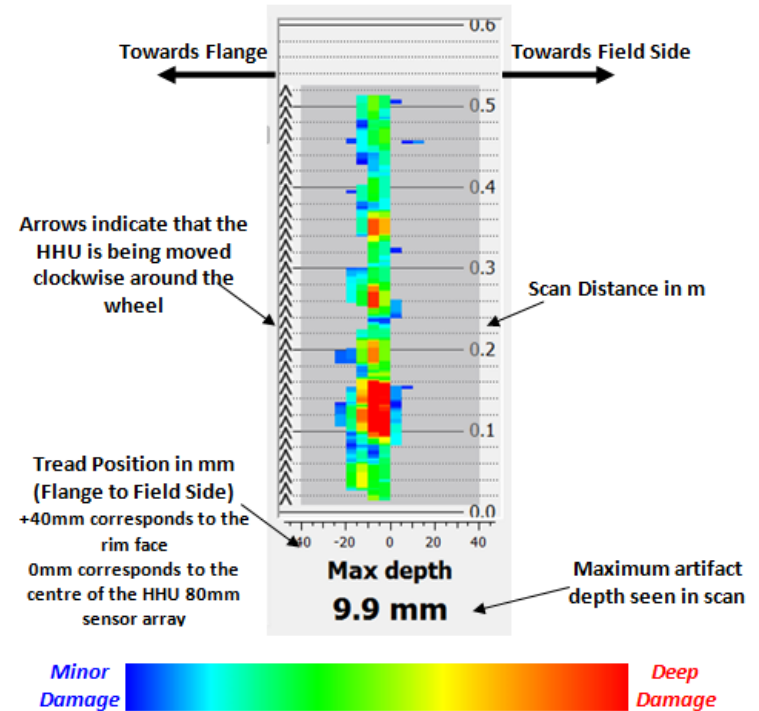
Wheel SCM Hand-held Unit

- 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



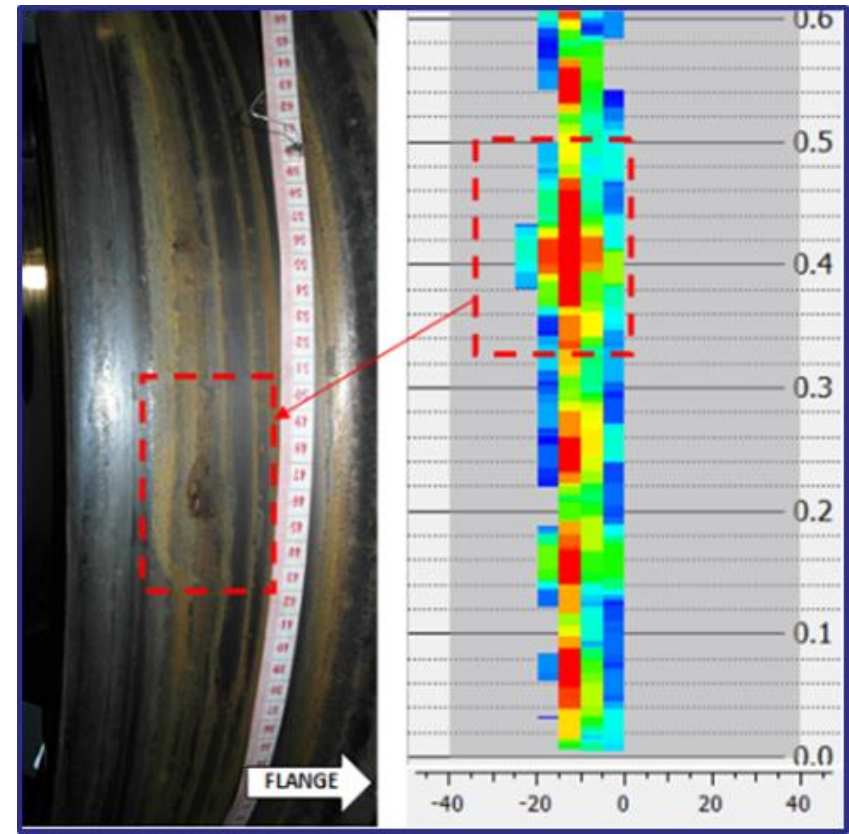
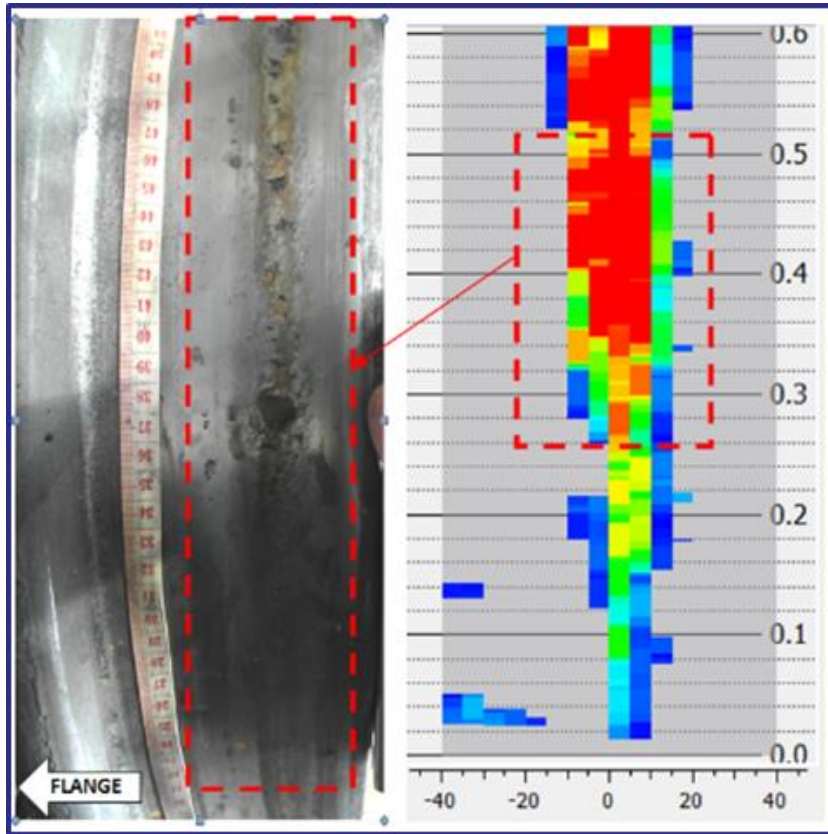
SCM HHU Output

- 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



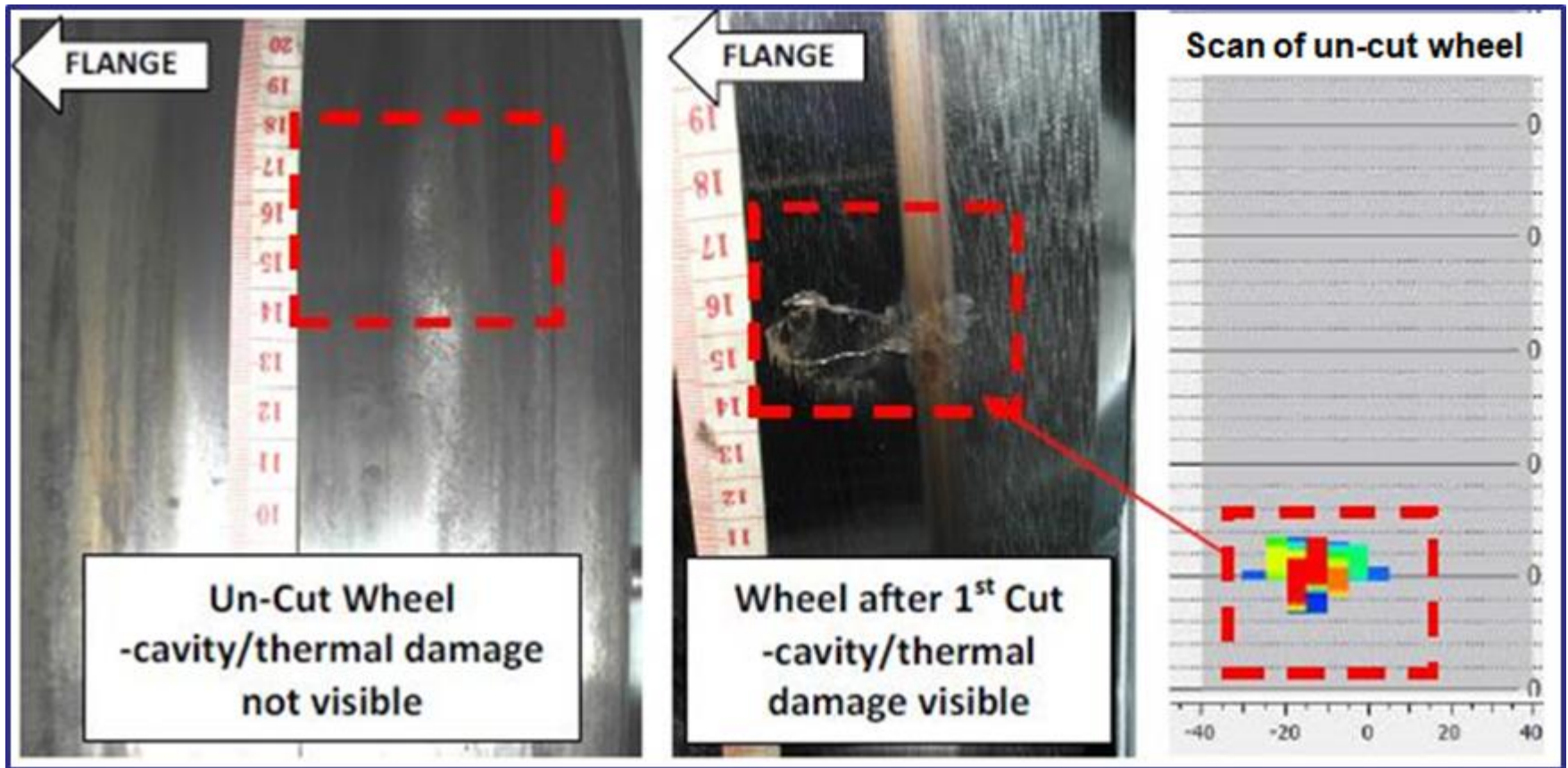
Example Outputs (1)

- Rolling contact fatigue
- Thermal cracking and cavities



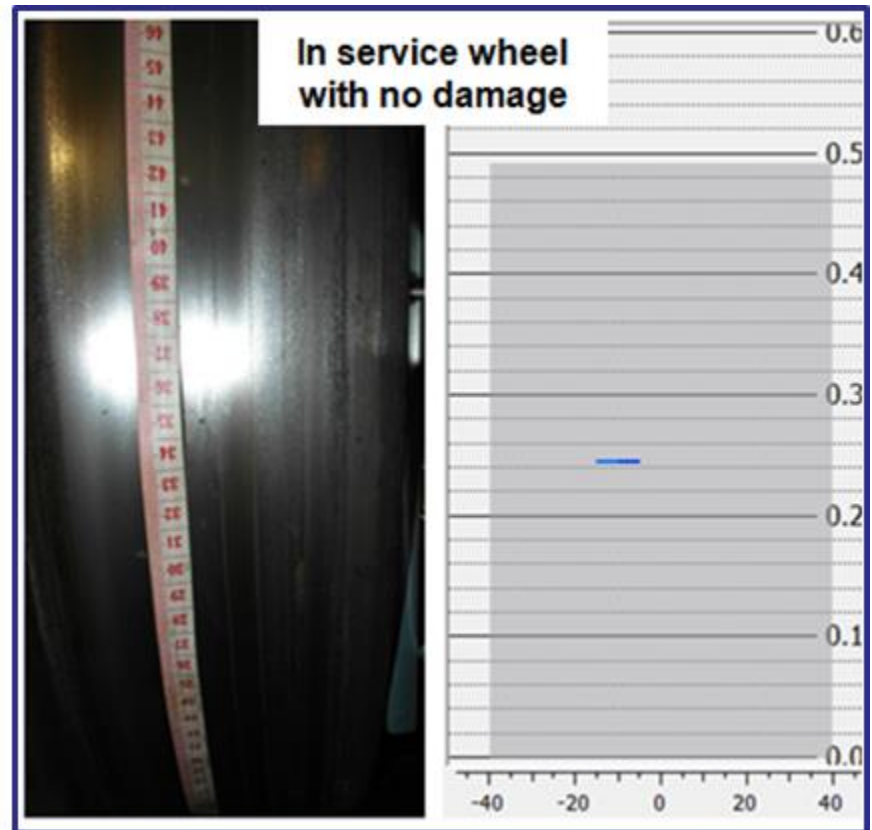
Example Outputs (2)

- SCM HHU reveals damage not visible on uncut wheel surface

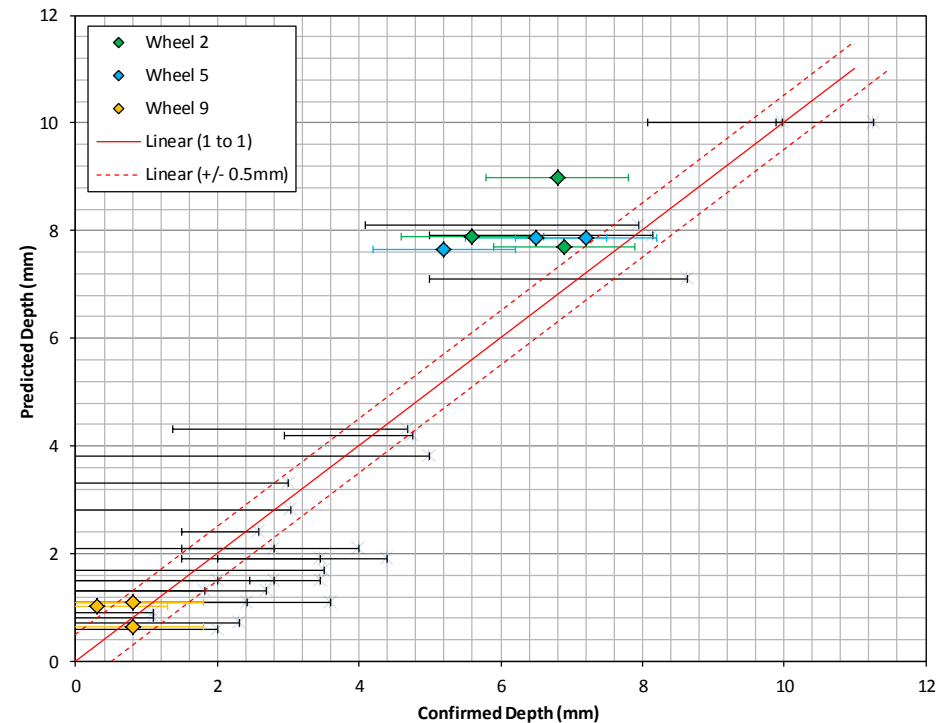
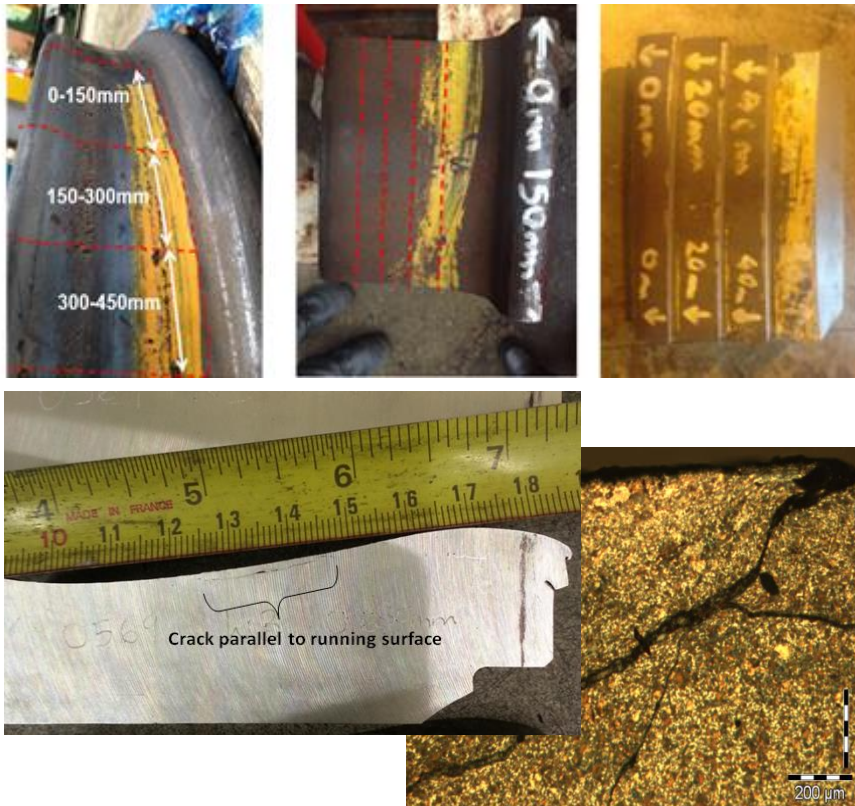


Example Outputs (3)

- SCM HHU confirms wheel is damage free



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

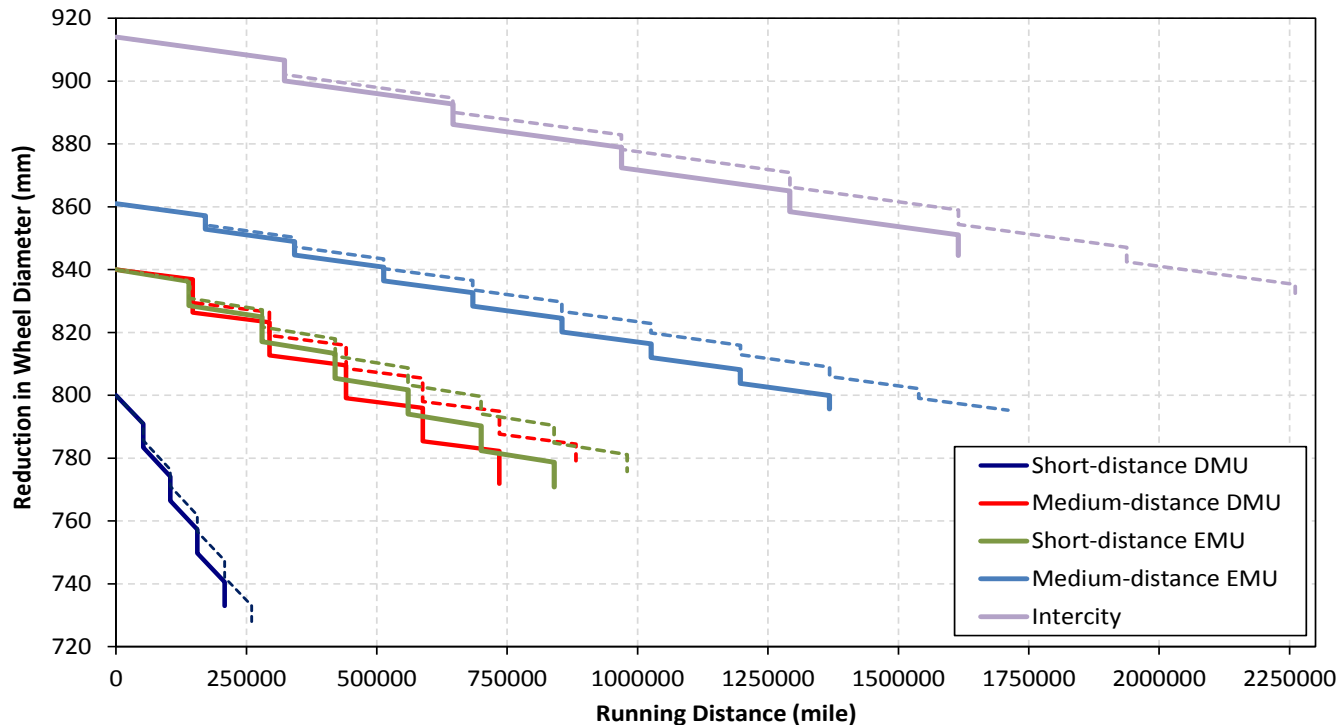


Typical Data Uses

- **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

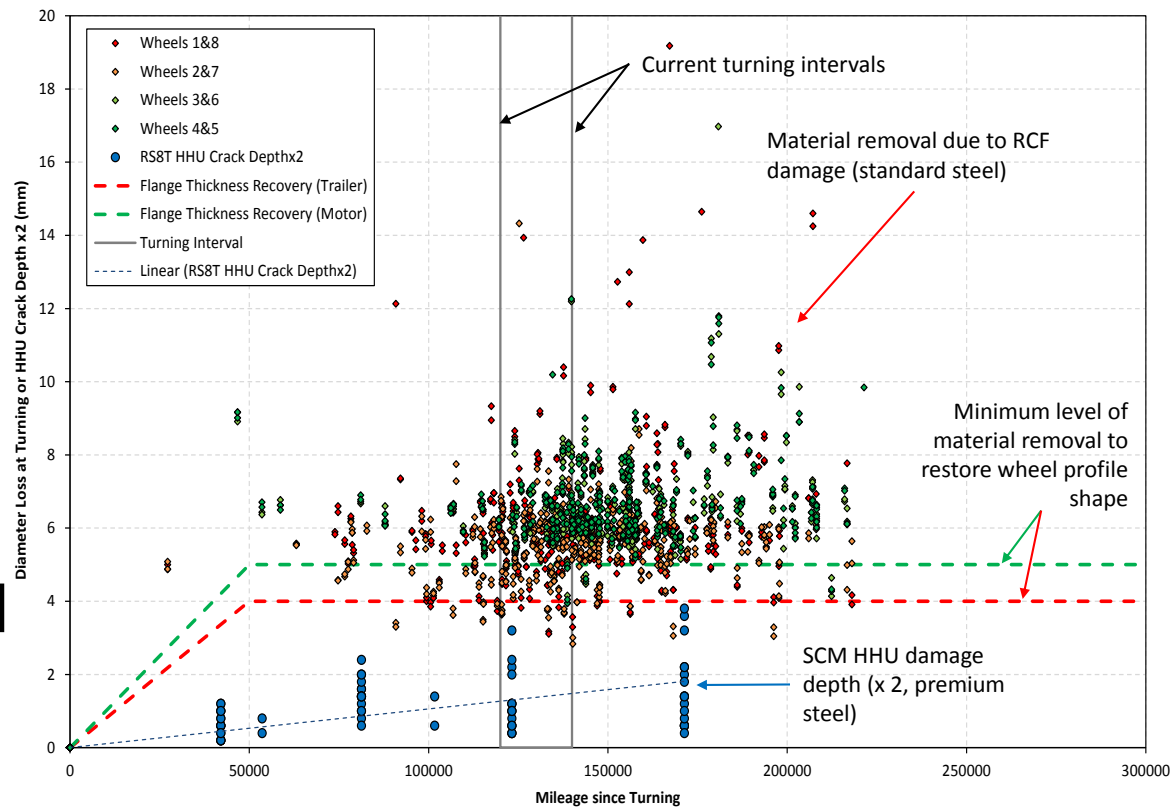
Case Study (1)

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



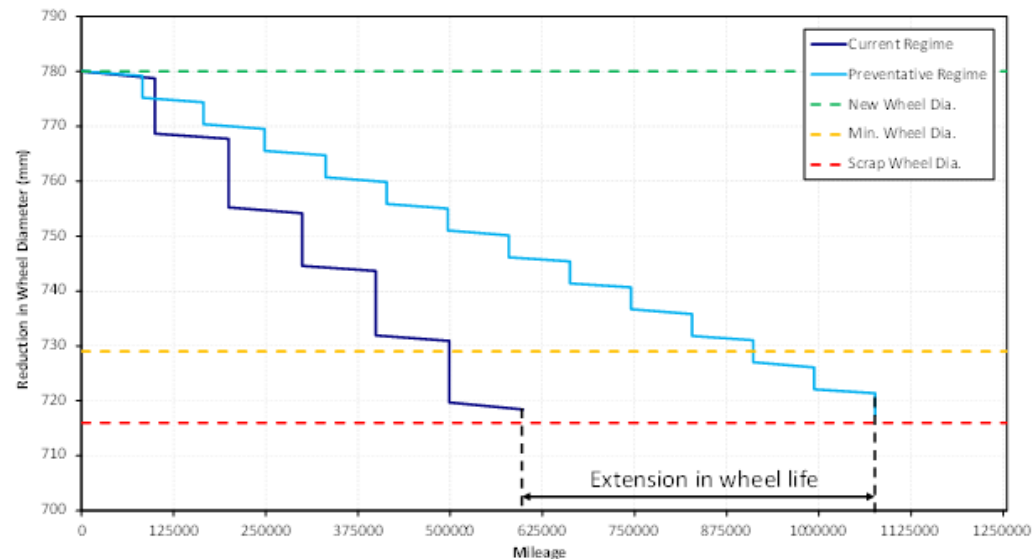
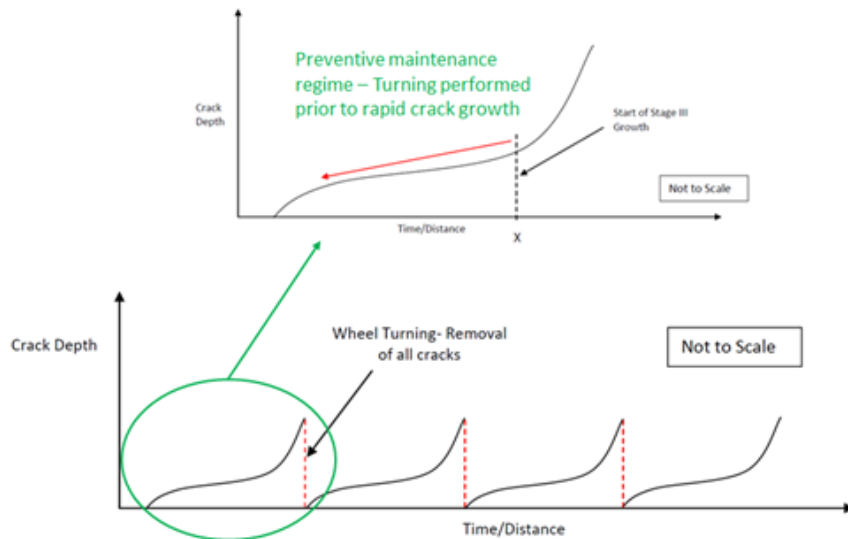
Case Study (2)

- 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