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Use of Magnetic Flux Techniques to Detect Wheel Tread Damage

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Inspiring tomorrow's professionals



Overview

- Background
- Wheel tread damage
- SCM development
- Theory of SCM
- Wheel handheld unit
- Damage types
- Summary
- Acknowledgements



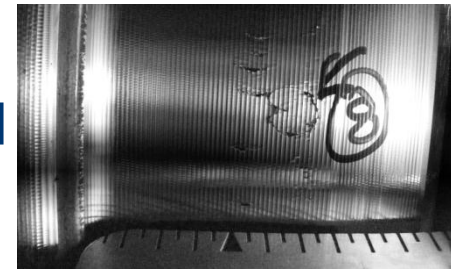
Background

- Wheelset 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



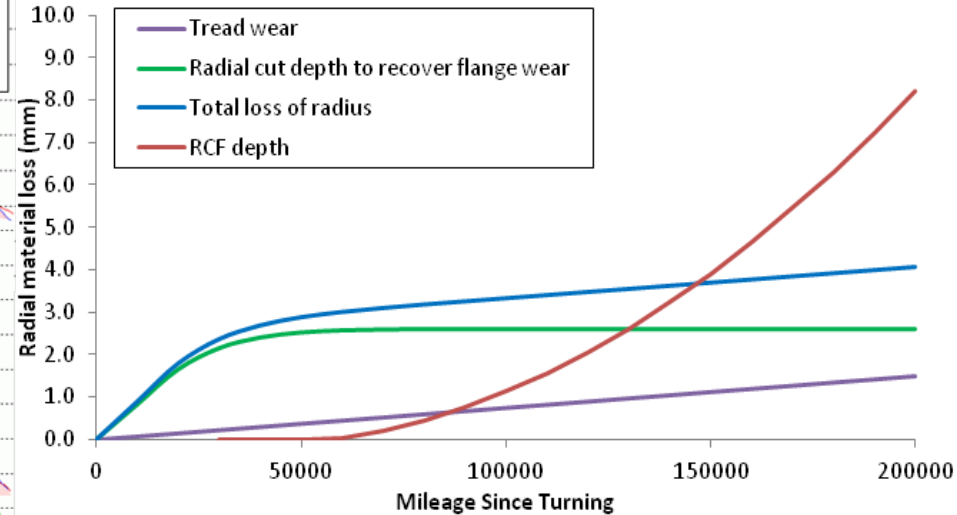
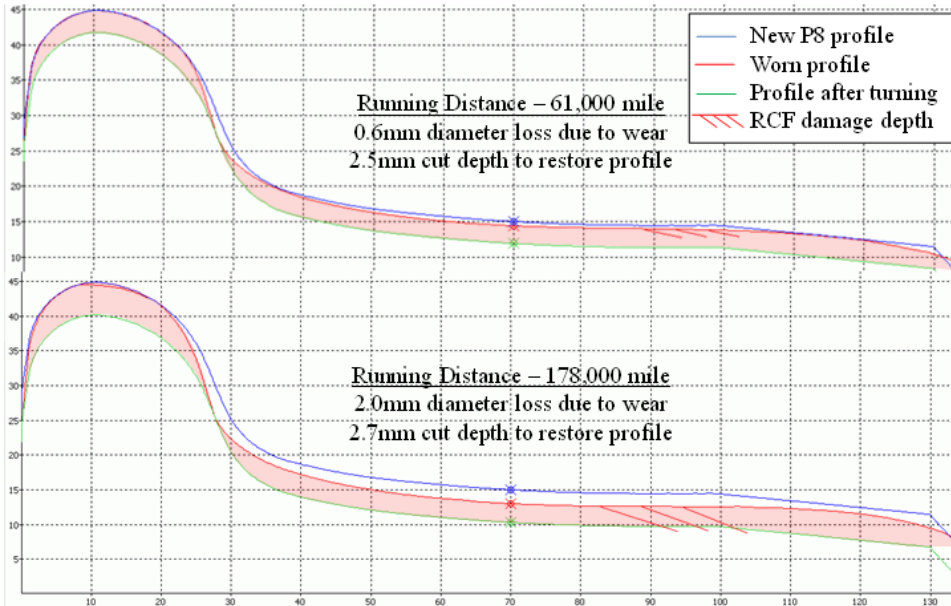
Wheel Tread Damage

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



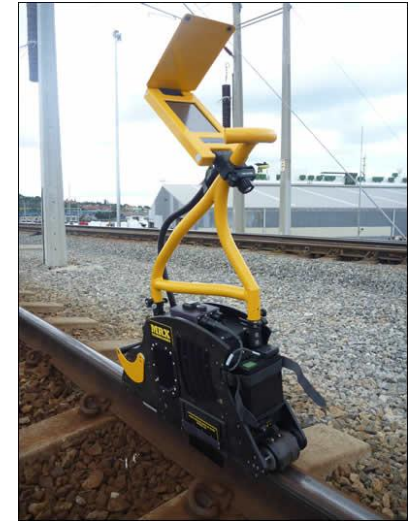
Cut Depths

- Example radial material loss during turning



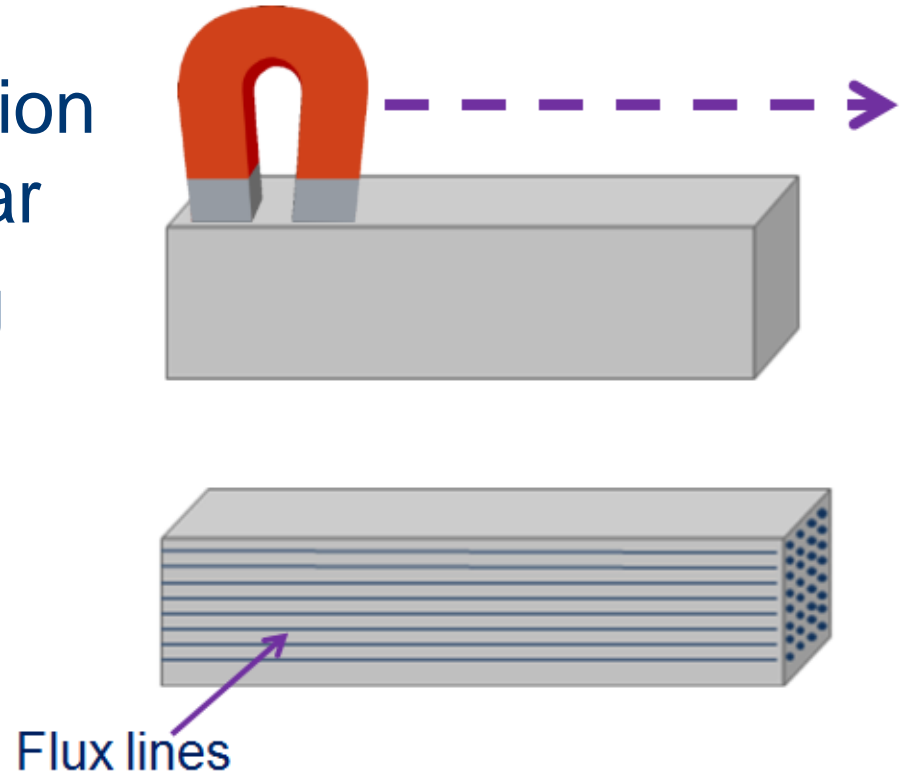
SCM Development

- MRX's Surface Crack Measurement (SCM) technology has been in use on rails for 8+ years
- Technology has been adapted to measure surface damage on wheels using a hand held device
- Funding awarded through the RSSB/Future Railway '*Rail Operator Challenge Competition*' to validate and further develop the product in collaboration with:
 - Bombardier Transportation
 - Institute of Rail Research, University of Huddersfield
 - Arriva Trains



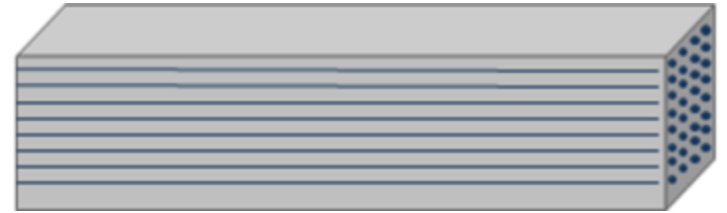
Theory of SCM – 1

- Magnetic Particle Inspection (MPI) and SCM are similar
- They involve magnetizing the specimen surface
- This introduces lines of magnetic flux into the specimen

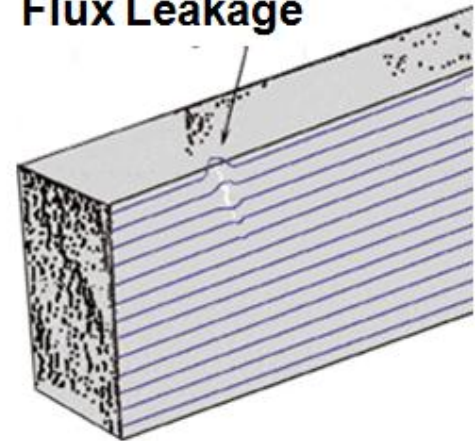


Theory of SCM – 2

- In a defect free specimen, these lines travel undisturbed through the specimen
- If a defect is present, the flux cannot travel as easily through it
- This causes some flux to leak at the position of the defect



Flux Leakage



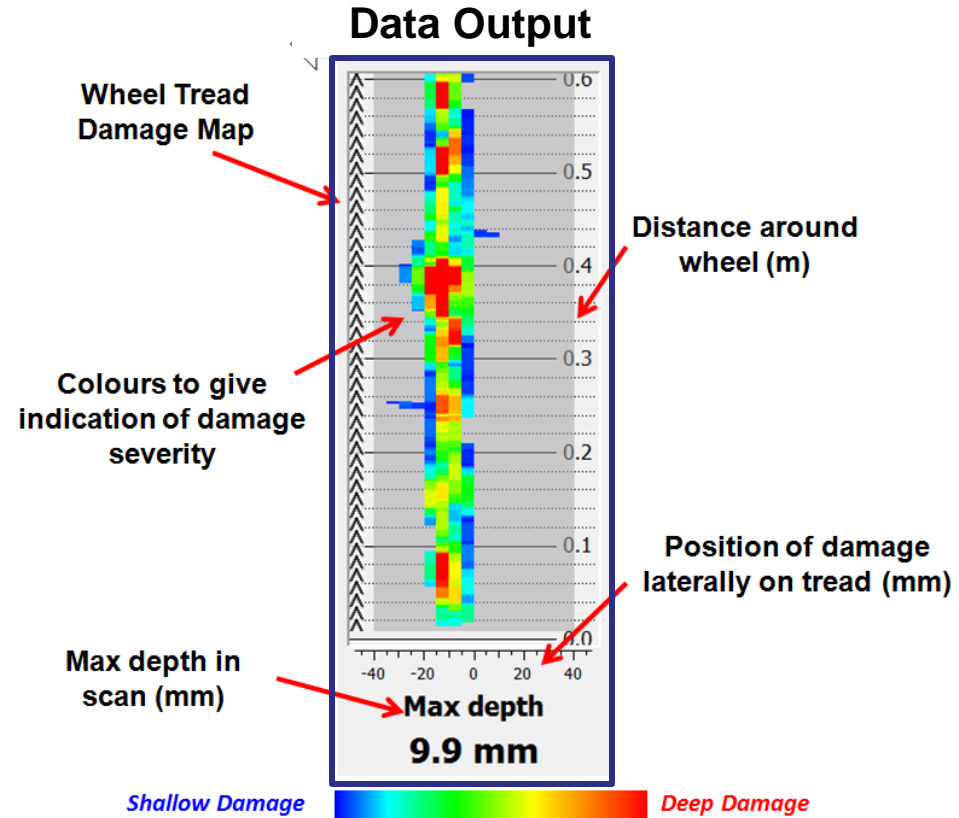
Wheel Handheld Unit – 1

- Wheel SCM uses 16 magnetic field sensors to measure and record the leaking flux
- Reports the depth of the deepest artifact in the scan
 - Amount of material to remove from the wheel to eliminate the damage



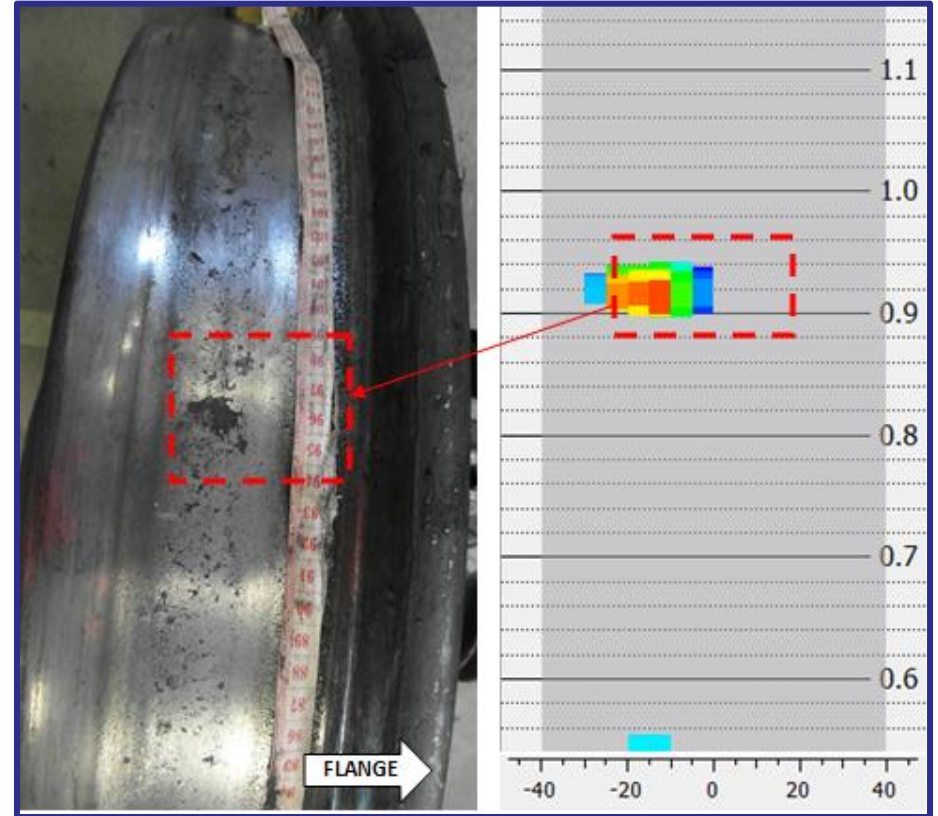
Wheel Handheld Unit – 2

- Handheld unit specification:
 - 1mm = Lower Detection Limit (shallowest artifact)
 - 10mm = Upper Detection Limit (deepest artifact)
 - +/-0.5mm = System Accuracy



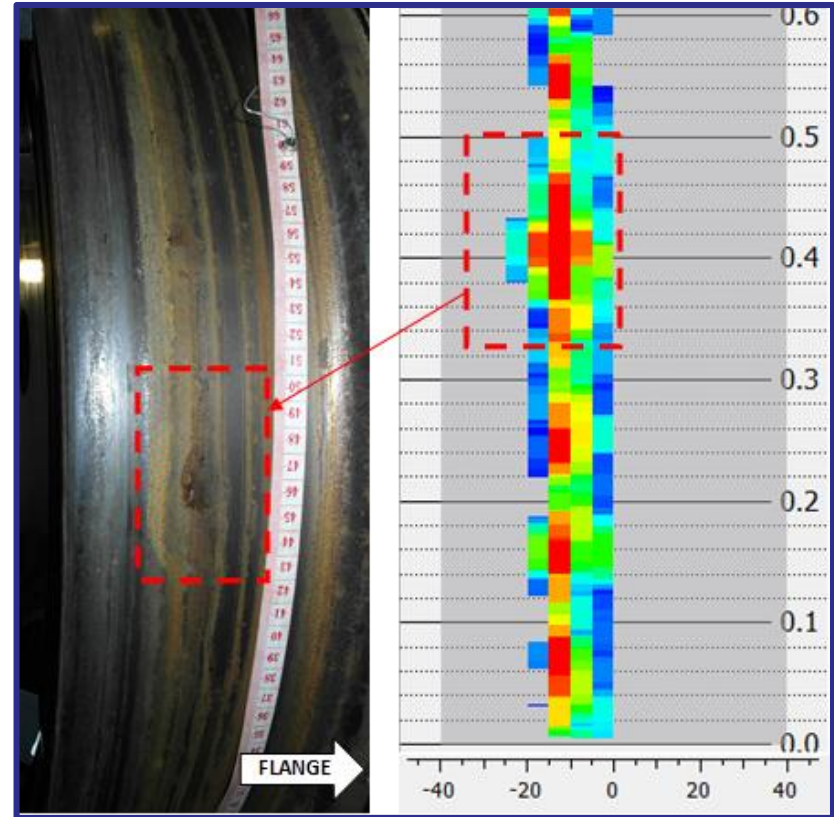
Damage Types – 1

- Surface breaking and near-surface damage
 - Cracking and cavities



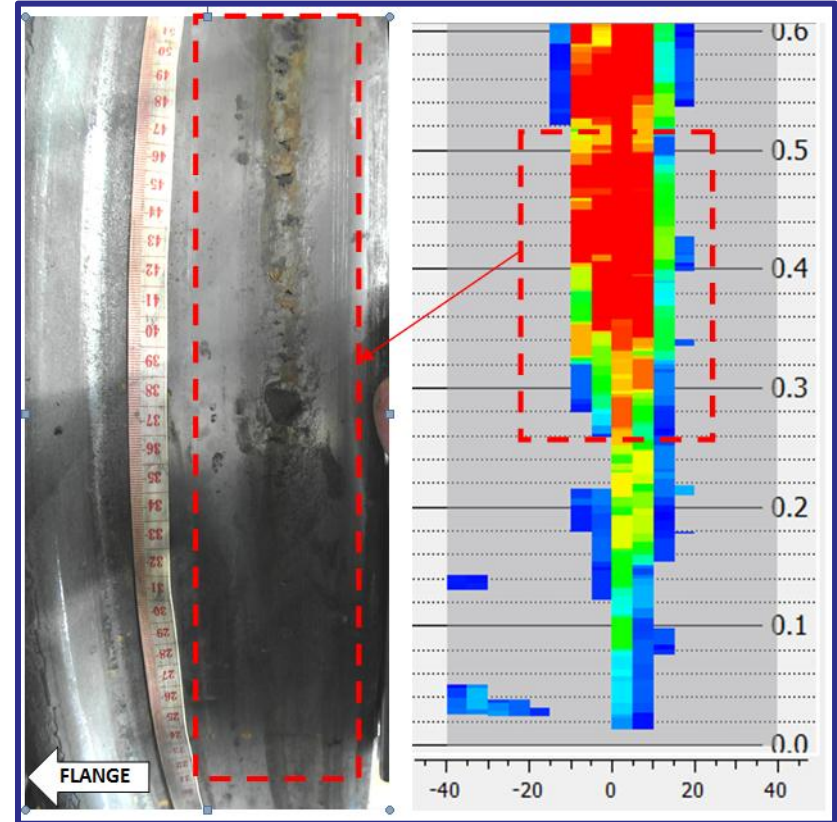
Damage Types – 2

- Surface breaking and near-surface damage
 - Rolling contact fatigue (RCF) cracking



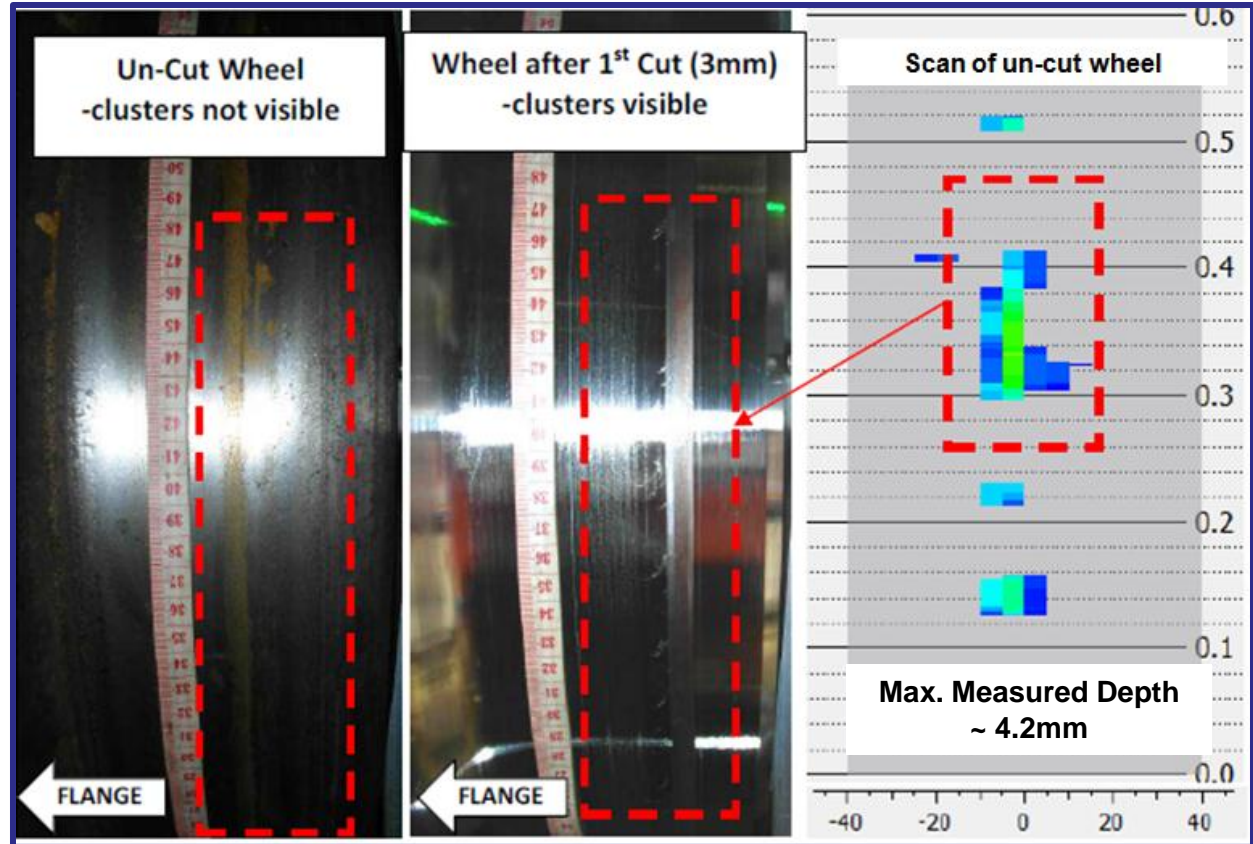
Damage Types – 3

- Surface breaking and near-surface damage
 - Rolling contact fatigue (RCF) cracking
 - Thermal cracking and cavities



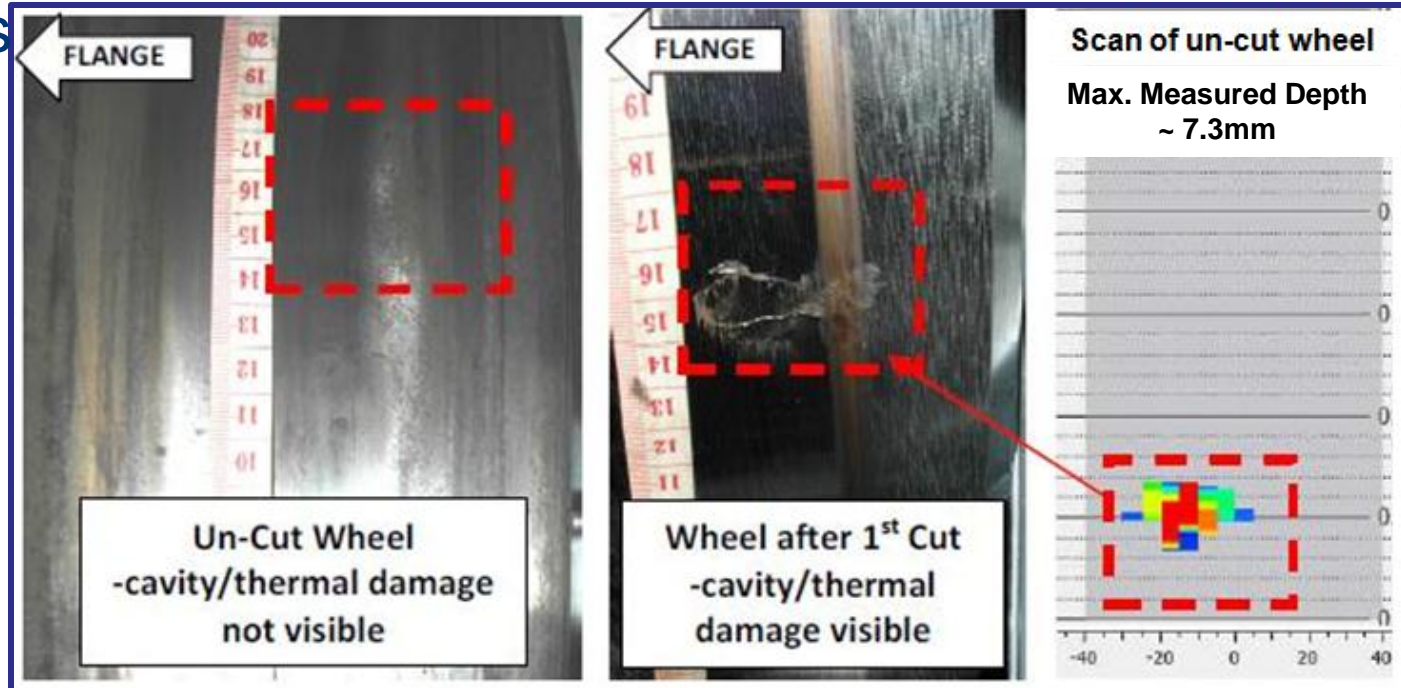
Non-visible Damage – 1

- HHU reveals damage not visible on uncut wheel



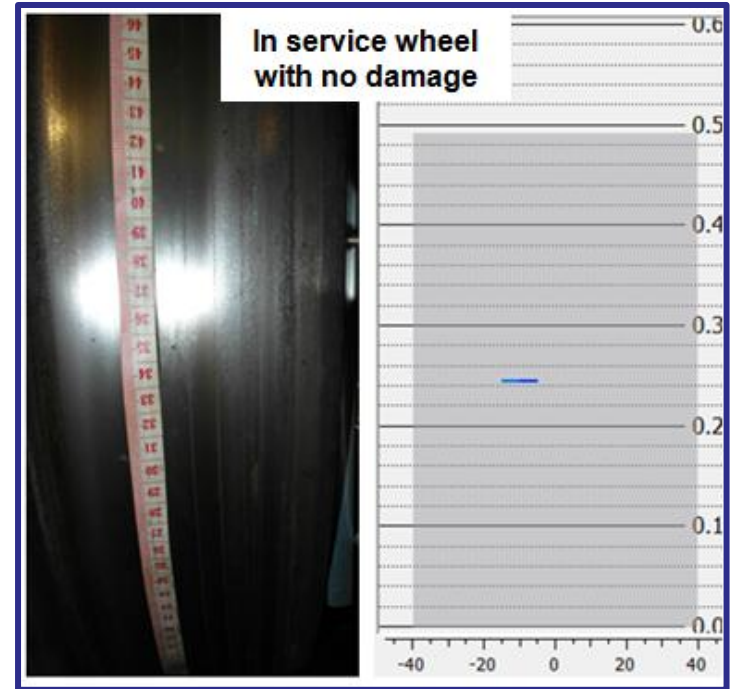
Non-visible Damage – 2

- HHU reveals damage not visible on uncut wheel



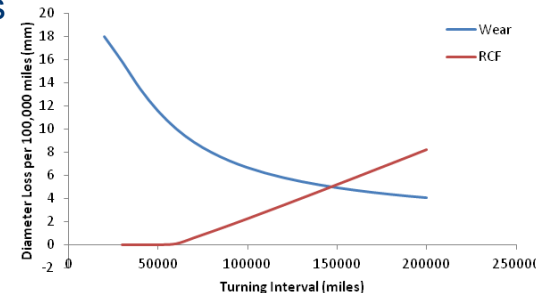
Damage Free Wheel

- Confirms when wheel is damage free



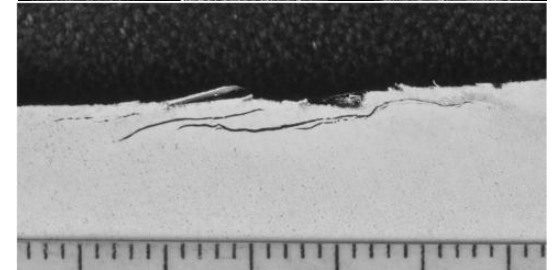
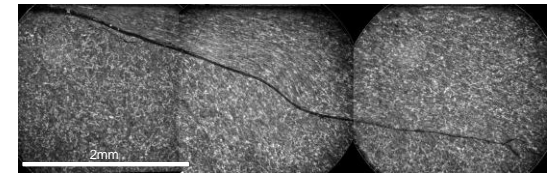
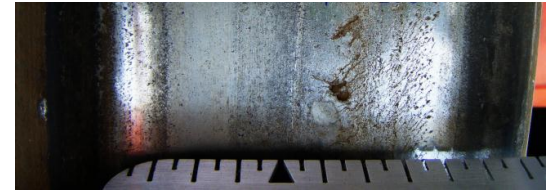
Summary

- SCM technology has been adapted to evaluate surface and sub-surface defects in wheels
- Potential uses include:
 - ***Replacing visual inspection during routine maintenance exams***
 - Repeatable, not reliant on judgement
 - Reveals damage that is not obvious/visible on uncut tread
 - ***Optimisation of cut depths at wheel lathe***
 - Reduce risk of overcutting and also saves time removing defects
 - ***Trending to understand RCF development and growth rates***
 - Improved planning of maintenance
 - Highlight problem wheels/vehicles
 - ***Supporting specific case studies***
 - New profiles, steels etc. (monitor performance)



Next Steps

- Further wheel lathe trials to confirm damage depth readings and access constraints etc.
- Further developments of prototype HHU
- Assessment of scrap wheels:
 - Samples to be examined optically to determine deformation depth, crack length and crack depth
 - Micro-hardness testing
 - Correlation HHU readings with measured damage
- Business case detailing the benefits of the data for trending and maintenance planning



Acknowledgments

- The results and findings presented were developed as part of the RSSB/Future Railway managed '*Rail Operator Challenge Competition*'



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- For further information visit us at the blue-sky village exhibition or contact:
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