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# Optimisation of Wheelset Maintenance – Current Research Activities

Modern Railways

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# Background

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- Wheelsets are expensive:
  - Manufacturing
  - Reprofiling
  - Inspections
  - Renewal
  - Environmental impact
  - Costs of trains out of service
- Strong demand to reduce the rate of wheel damage
  - Extend wheel reprofiling intervals
  - Better wheelset life
  - Lower costs

# Wheelset Research

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- Research projects relating to wheelset damage and maintenance practices include:
  - Influence of changes in material properties on observed damage
  - Optimisation of wheelset maintenance to reduce whole-system costs
  - Investigating the influence of route and vehicle design and maintenance policy on wheel tread damage
  - Assessment of alternative wheel profiles, considering both whole-system costs and running safety
  - Categorisation of wheel damage mechanisms to improve identification and selection of appropriate mitigation
- This presentation provides an overview of some of these research areas

# Survey of Wheel Tread Damage

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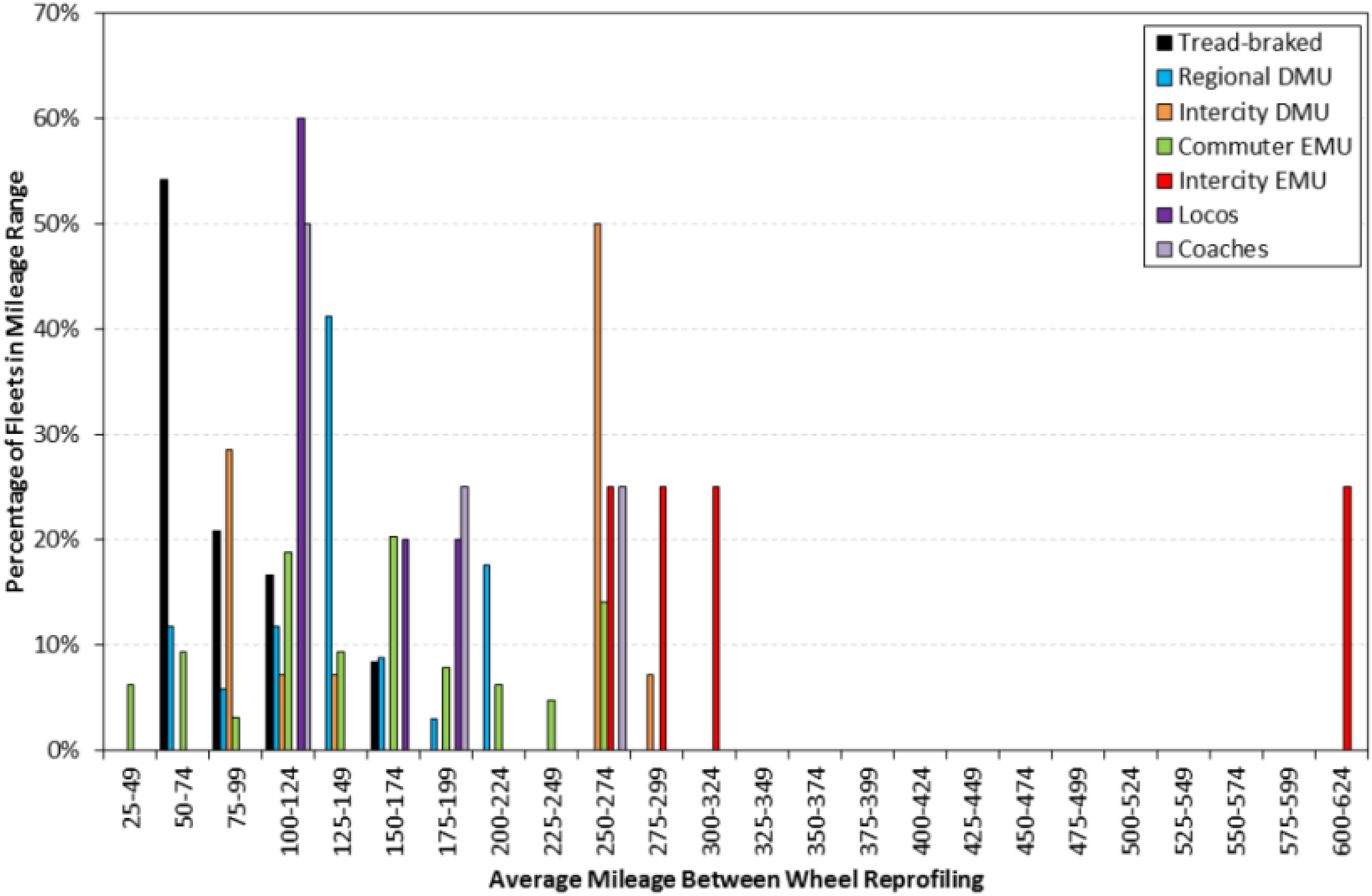
- Wide-ranging survey of wheel tread damage types and maintenance practices undertaken in-collaboration with RSSB, WMG, V/T SIC and ATOC
- Questionnaire review on passenger fleets
  - Wheel tread damage
  - Wheelset maintenance
  - Excellent response, >90% of all UK passenger vehicles
- Follow-up visits/calls to depots and wheel lathes
  - Detailed discussions and observations of damaged wheels
- Collate and analyse responses
  - Fed back to check data and identify any inconsistencies
- 'Workshops' held at maintenance depots
  - Presented results
  - Further discussions and feedback

# Reprofiling Intervals



# Reprofiling Intervals

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- Typical wheelset reprofiled 3 or 4 times
  - Depends on damage type and depth
  - Scheduled at a distance interval, or based on condition monitoring
  - Wheelset renewed at minimum diameter
  - Average reprofiling interval is a good indicator of wheel life
- Longest fleet-average interval ≈ 10× shortest
- Intercity trains generally better than commuter trains
  - Operating conditions (speed, curve distribution)
  - Wheel materials
- Older tread-braked trains are worst
- Potential for costs savings and improved fleet availability

# Example EMU Wheel Life

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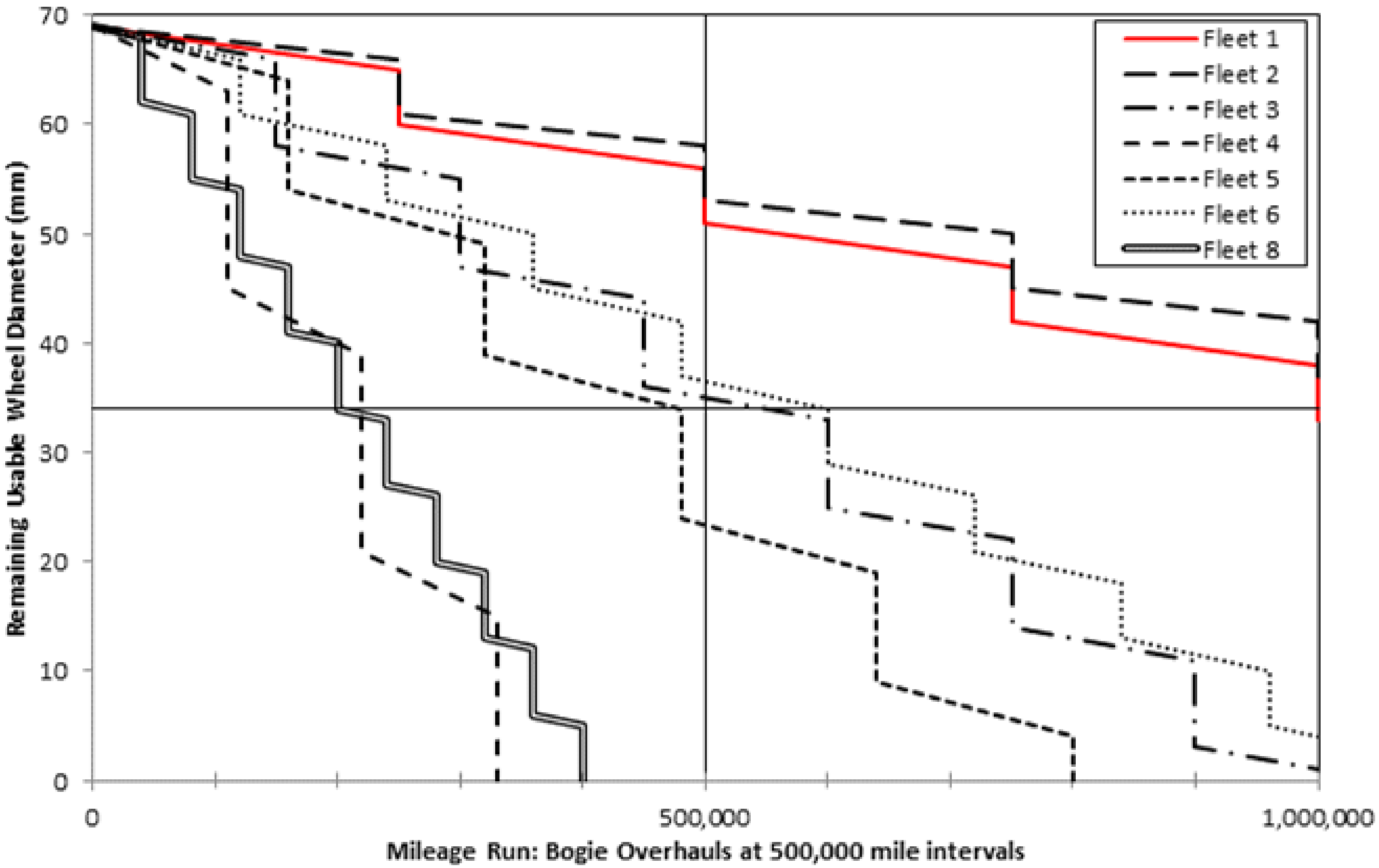
- Similar train architecture – various route characteristics and maintenance practices/constraints



# Interaction of Wear and Damage

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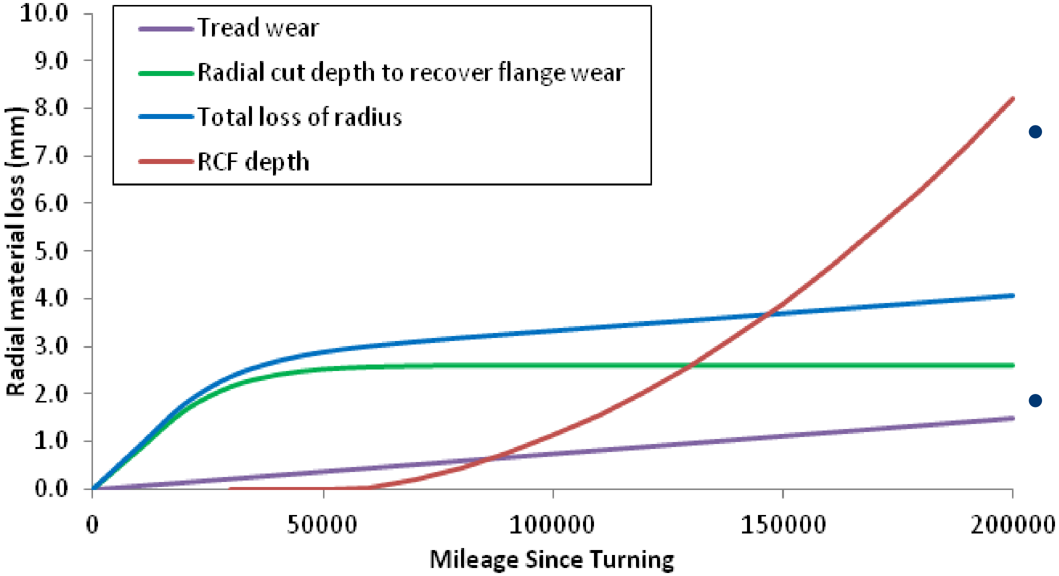
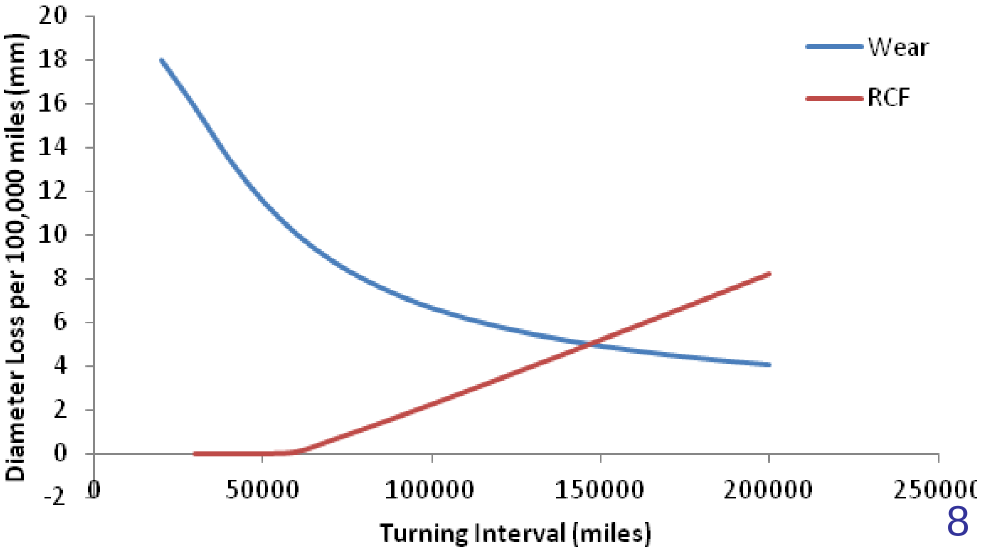



- Following initial flange wear - depth of cut on the lathe to restore the profile shape remains constant
- RCF cracks propagate more rapidly as the mileage increases




- Deeper cut required to remove RCF damage at higher mileages
- Optimum turning interval exists where material removal to restore profile shape is the same as required to remove RCF damage

# Cut Depth to Recover Flange Wear

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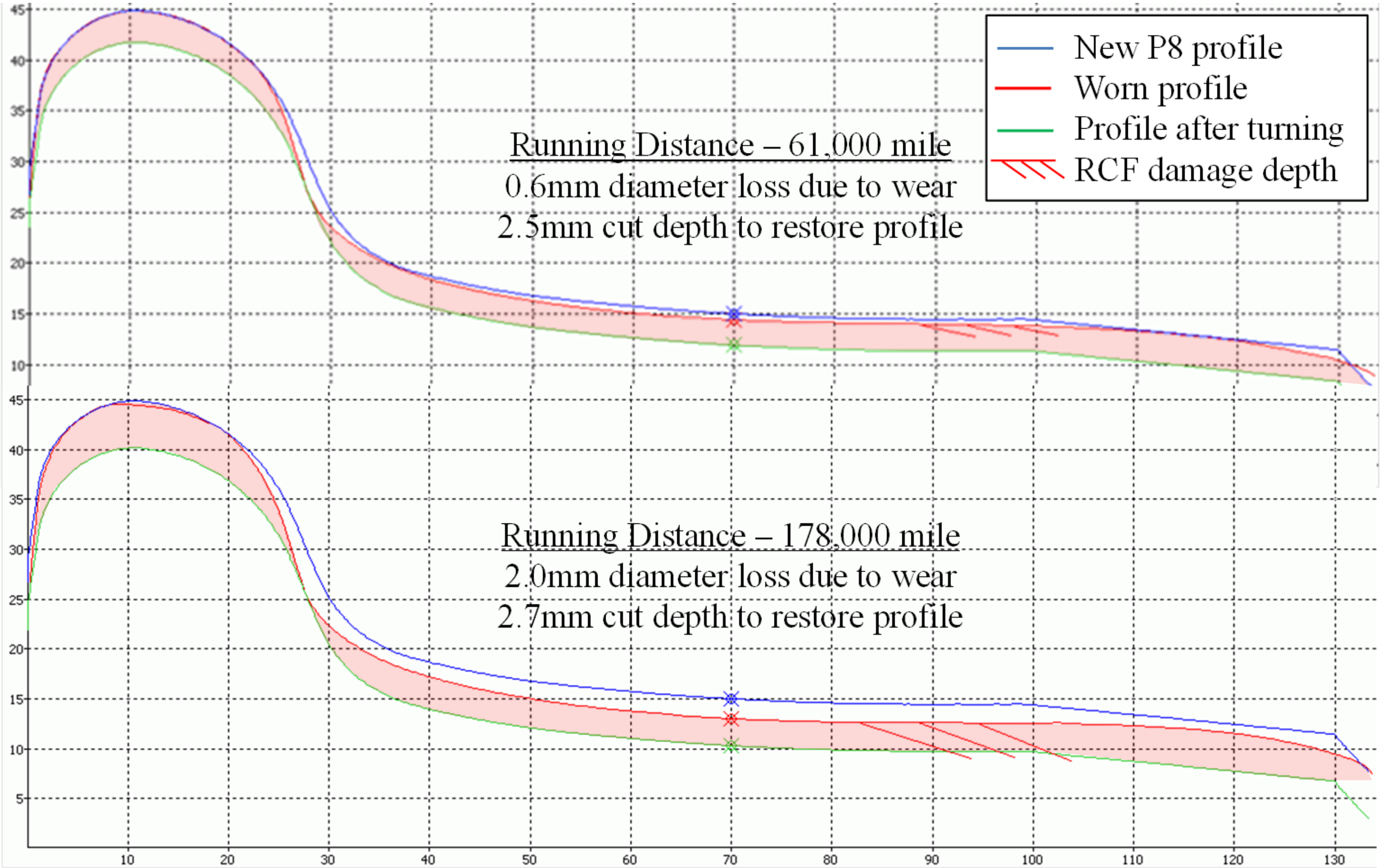
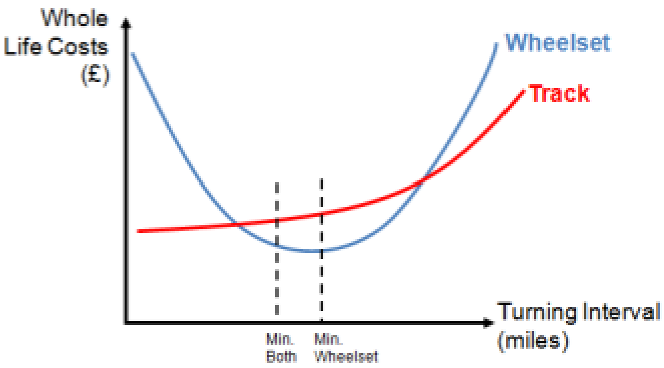
- Example radial material loss during turning to recover profile shape



# Wheelset Maintenance Costs

- Important to understand potential costs and savings from implementing measures to extend wheelset life
- Knowledge of the dominant damage mechanisms, constraints and costs are essential for identifying benefits and cost impact
- Tools such as RSSB/NR's *Wheelset Management Model (VTISM)* can help to support a business case




# Categorisation of Damage

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- RSSB research project T963 developed a *Wheel Tread Damage Guide*
- This guide provides:
  - Common basis for categorising wheel tread damage
  - Information on causes and mechanisms of wheel tread damage
  - Methods for managing wheel damage, maximising life and minimising costs
  - Industry case studies


SPARK

# Observations

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- Route characteristics and maintenance practices have a large influence on wheelset life
  - In some cases more significant than the design parameters of the train
- Maintenance constraints resulting from design aspects are also important
  - e.g. bearing life, bogie overhaul periodicity and parity limits
- Maintainers who keep detailed wheel condition and maintenance records, managed and optimised their practices, achieved much better wheel life than those who did not

# Observations

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- Reprofiling may be scheduled on a regular-interval preventive basis, or using condition monitoring techniques:
  - Both methods can be effective
  - Mileage-based reprofiling tends to be carried out more frequently, but may remove less material on the lathe
- Obvious ‘quick wins’ could give good financial return:
  - Solving WSP problems to prevent flats
  - Provision of effective flange lubrication
  - Best practice at the wheel lathe to optimise cut depths
- With flats and flange wear solved, RCF is often the limiting damage mechanism:
  - Can be managed by preventive reprofiling at an optimised interval
  - Can be reduced by the use of an alternative wheel profile, suspension characteristic or premium wheel steel

# RCF Cracks in Wheels

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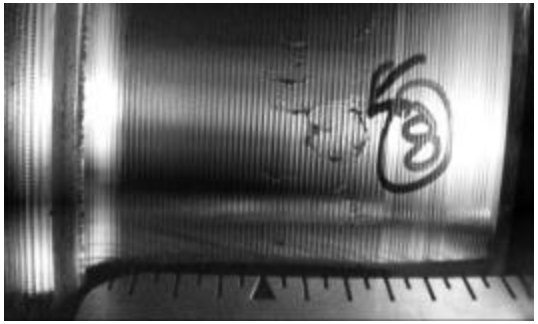
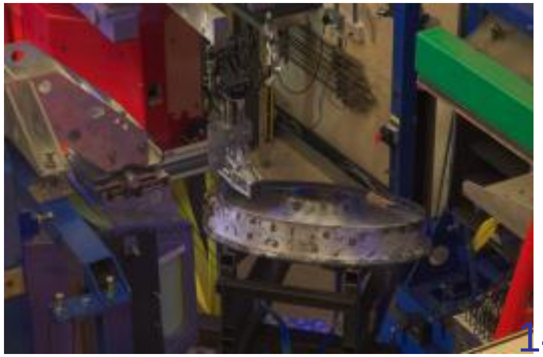
- Many factors influence RCF crack growth rates in wheels
  - Material properties, train type, operating/environmental conditions, position of wheelset on train
- Research being conducted to investigate changes in material properties and residual stresses during the life of a wheel
- Neutron diffraction used to measure distribution of strains and stresses in 3 entire railway wheels
- Initial results suggest that stresses are redistributed within the wheel rim during its life as material is removed and plastic flow occurs





# Conclusions

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- Benefits of managing and analysing wheel condition and maintenance records have been demonstrated
  - Bringing together maintainers of similar fleets helped to share best practice
  - It is expected that wheelset life can be improved on many fleets, with resultant cost savings
- A guidance document for optimising wheelset life has been developed
  - To assist maintainers in categorising and reducing wheel damage
  - Available to RSSB members though SPARK
  - Some maintainers have incorporated this into their maintenance documentation
- Feedback is requested to support future development