

LEAVES ON THE LINE – A GRIPPING REALITY (PART 2)

Institution of
**MECHANICAL
ENGINEERS**

Railway Division (South Western Centre)

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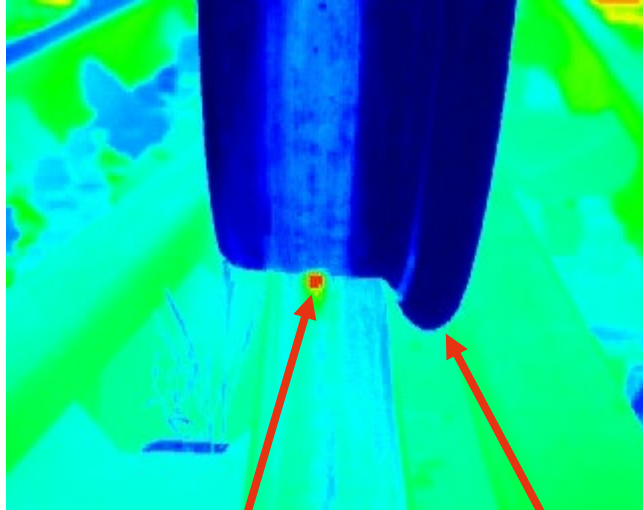
Committee Member, IMechE Railway
Division (South Western Centre)

Improving the world through engineering



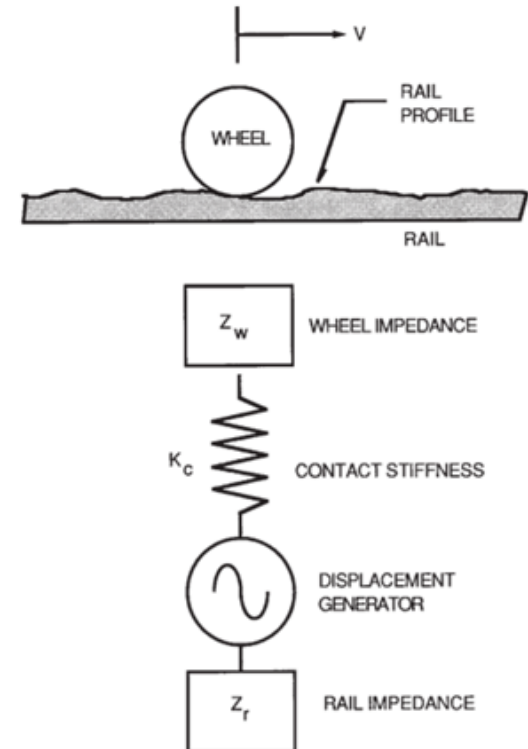
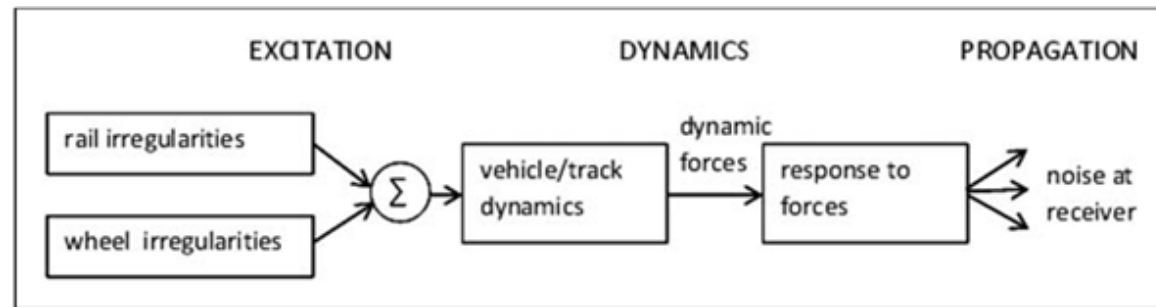
WHAT IS THE RAIL-WHEEL INTERFACE?

- The contact area between a train wheel and the rail it is running on – about the size of a five pence coin
- Understanding the dynamic interaction between the wheel and rail while the vehicle is in motion is paramount for wheel/rail design and maintenance – there are many ways of measuring this



Contact Area

Flange Area



IF ONLY IT WAS SO EASY!



RECAP... SAND – THE ULTIMATE GRIPPING STUFF?



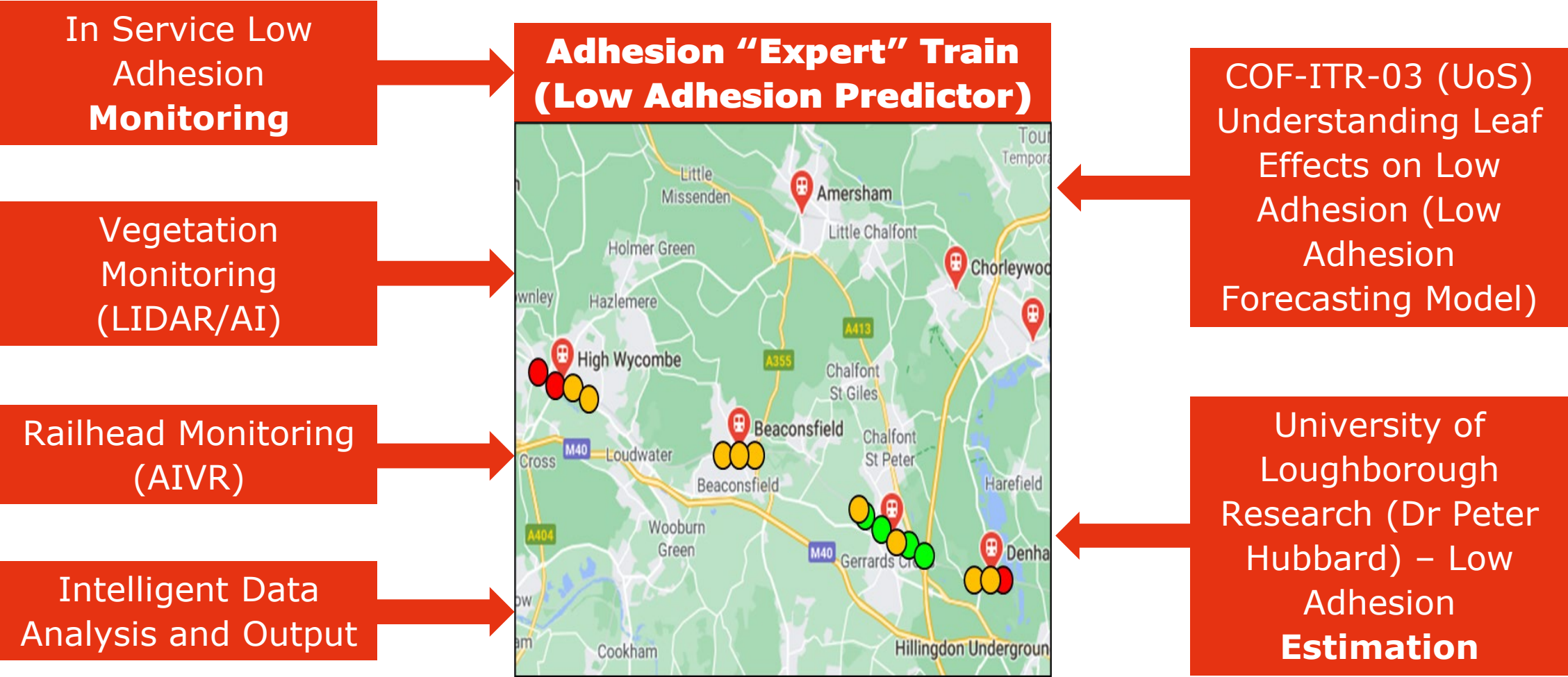
RECAP... LEAF LAYER TESTING (1 OF 2)



LEAF LAYER TESTING (2 OF 2)



VISION – ADHESION ‘EXPERT’ TRAIN



CLASS 165 WSP MODIFICATION – IN SERVICE LOW ADHESION MONITORING

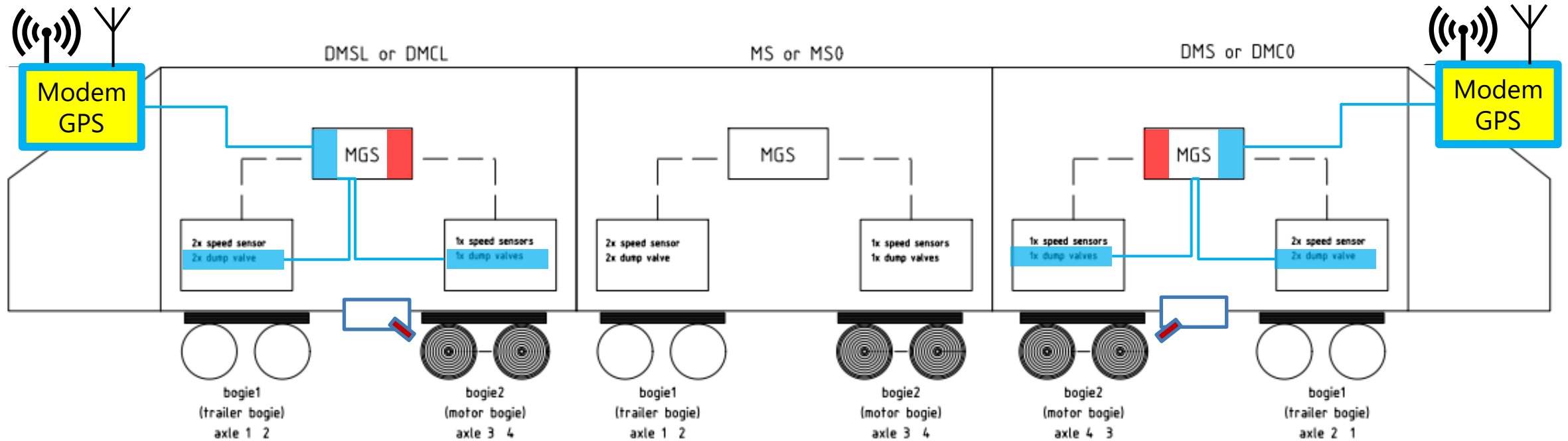


KNORR-BREMSE

Chilternrailways

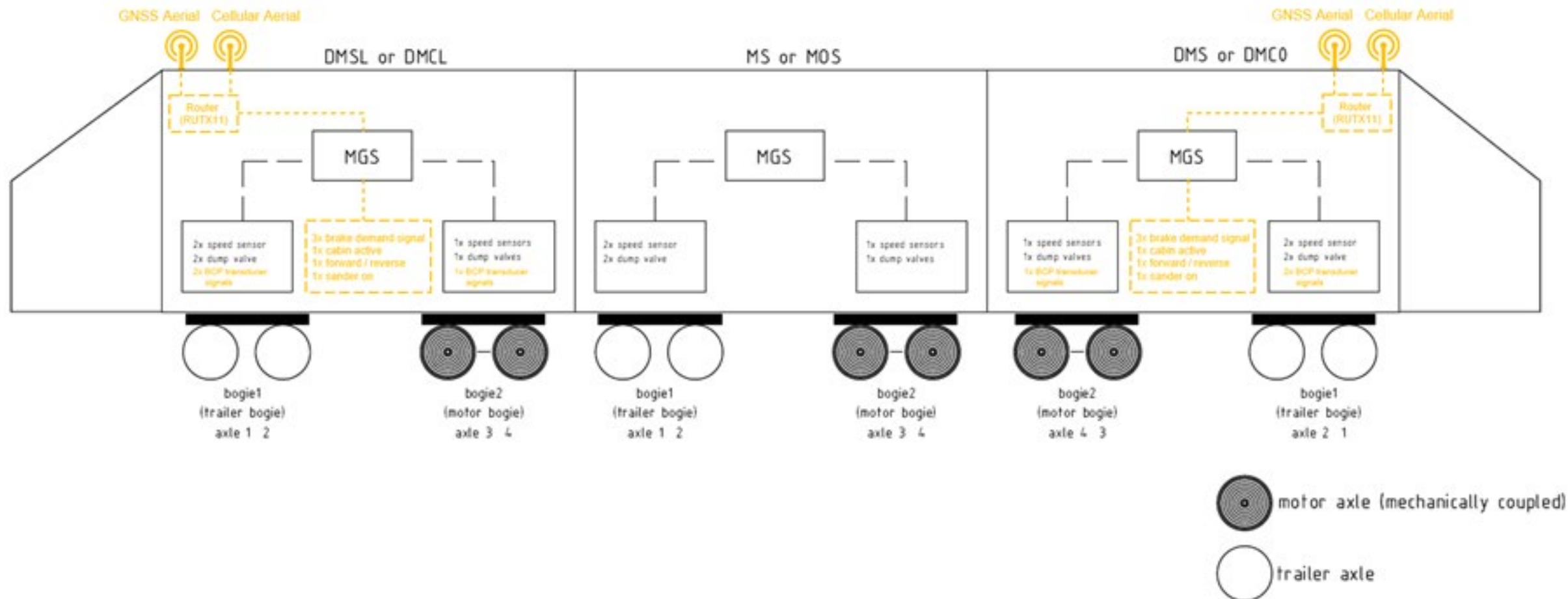
CLASS 165 WSP MODIFICATION – OVERVIEW

 = Add extra 'main' card to run the adhesion calculation



- Modem with GPS in Cab roof
 - Ethernet run under train to cab from ESRA rack
 - Ethernet cards added to ESRA rack
- Gather parameters to understand adhesion
- Gather as much system data as possible
- Lead Car at each end
 - Replace dump valve with ASV1-1 dump valve and wiring
 - three inputs to ESRA rack

CLASS 165 WSP MODIFICATION – SCHEMATIC



CLASS 165 WSP MODIFICATION – DYNAMIC TESTING



KNORR-BREMSE

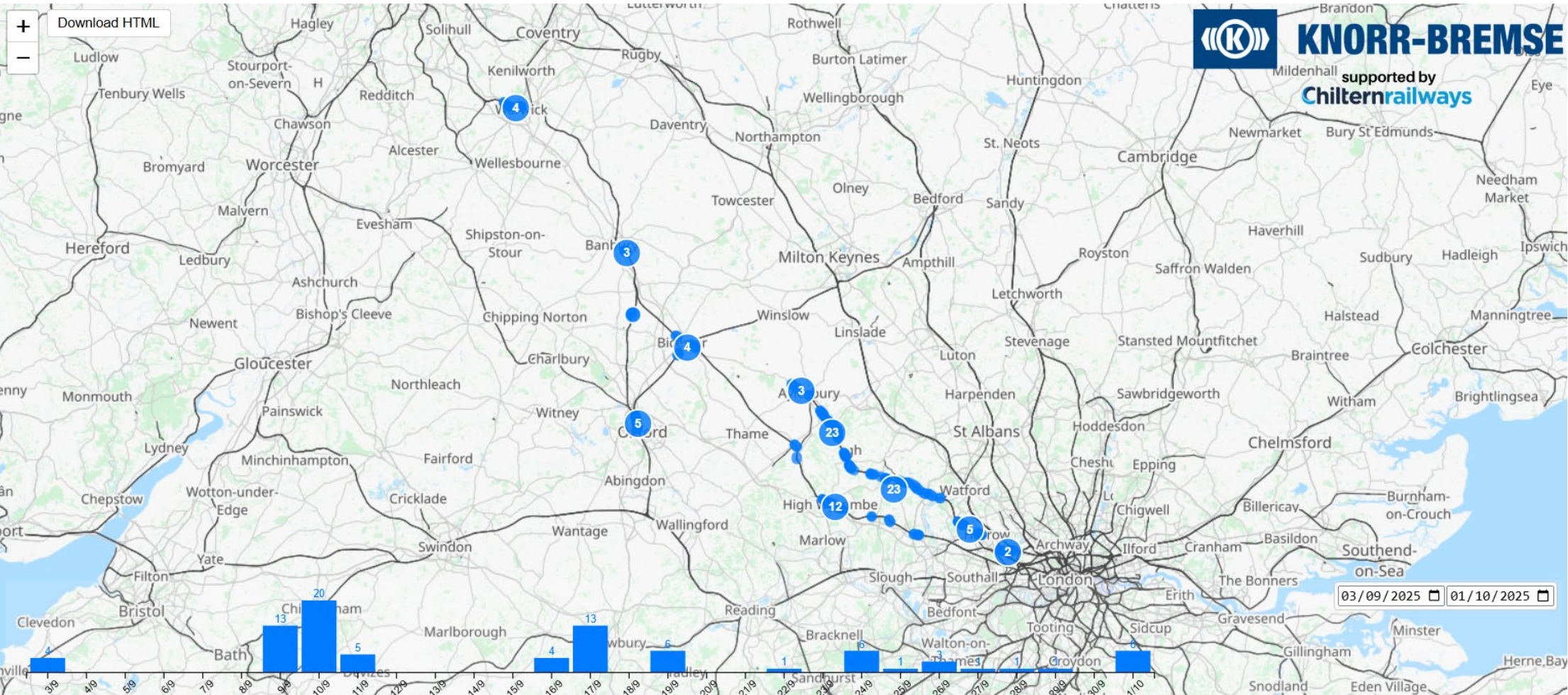
Chilternrailways

CLASS 165 WSP MODIFICATION – DYNAMIC TESTING



KNORR-BREMSE DATA INSIGHTS – VISUALISATION

WHEEL SLIDE EVENTS – SEPTEMBER 2025



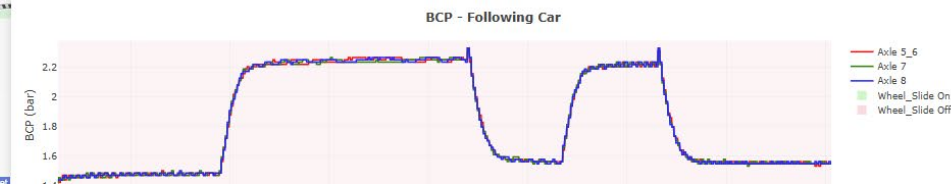
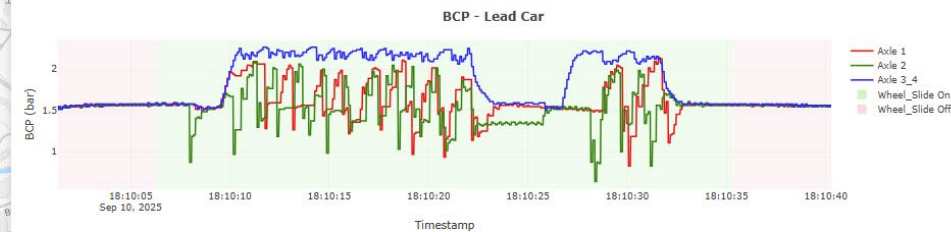
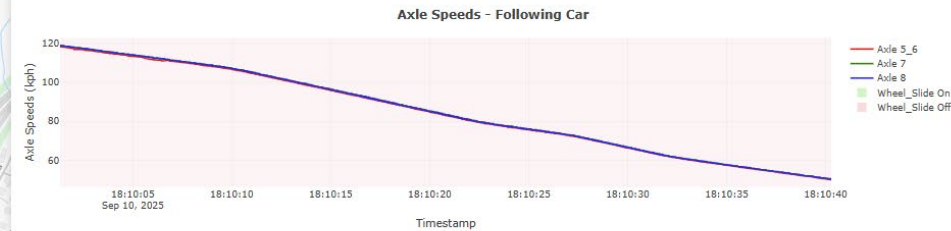
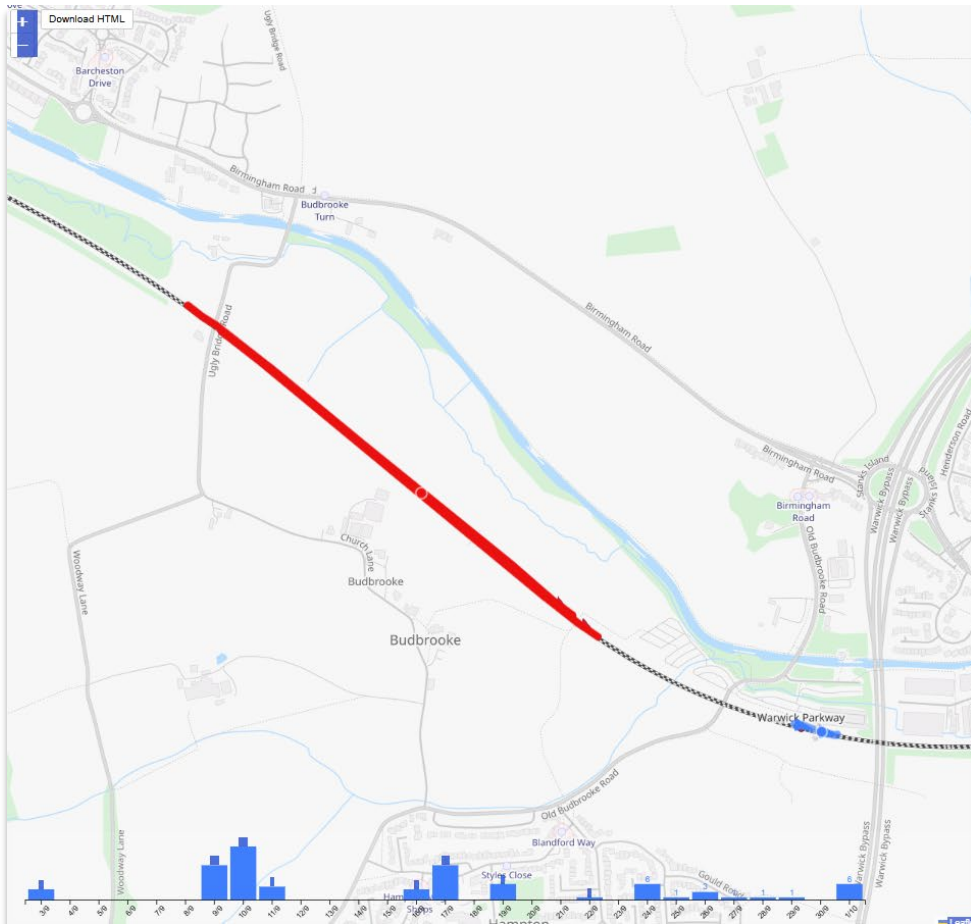
KNORR-BREMSE DATA INSIGHTS

LONG WHEEL SLIDE INTO WARWICK PARKWAY

Wheel Slide

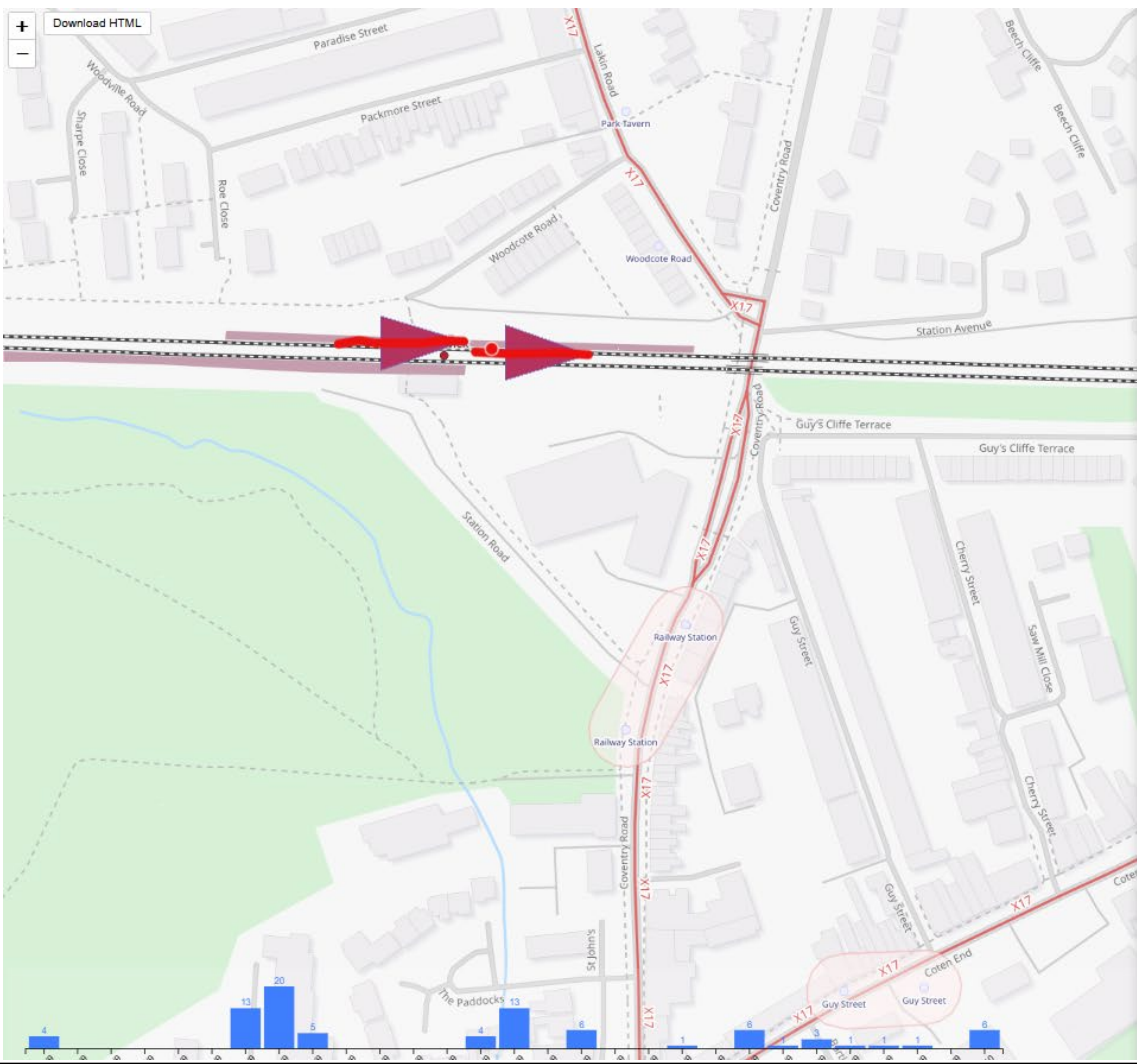
Time: 2025-09-10 18:10:01.319316
Duration: 39 s

Temp: 14.7 °C
Wind: 14.0 km/h
Rain: 1.8 mm
Cloud cover: 100 %

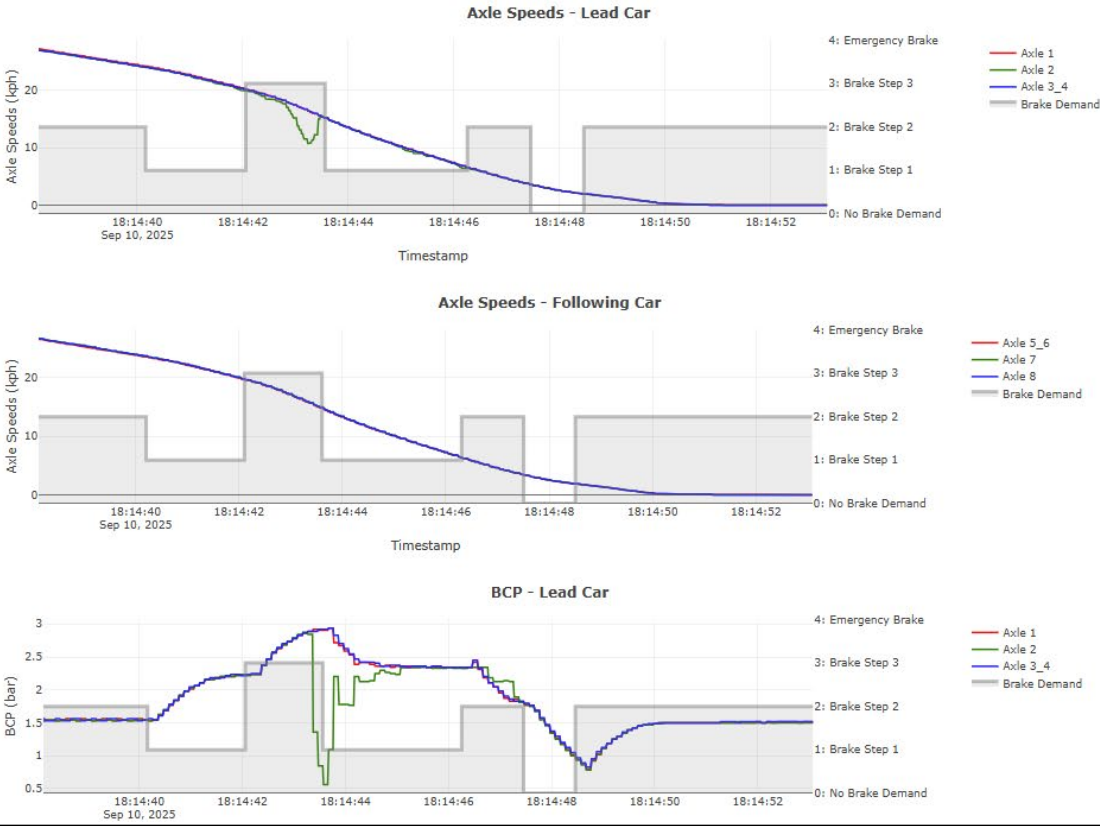


KNORR-BREMSE DATA INSIGHTS

SAME DAY INTO WARWICK PARKWAY (SHOWING BRAKE DEMAND)



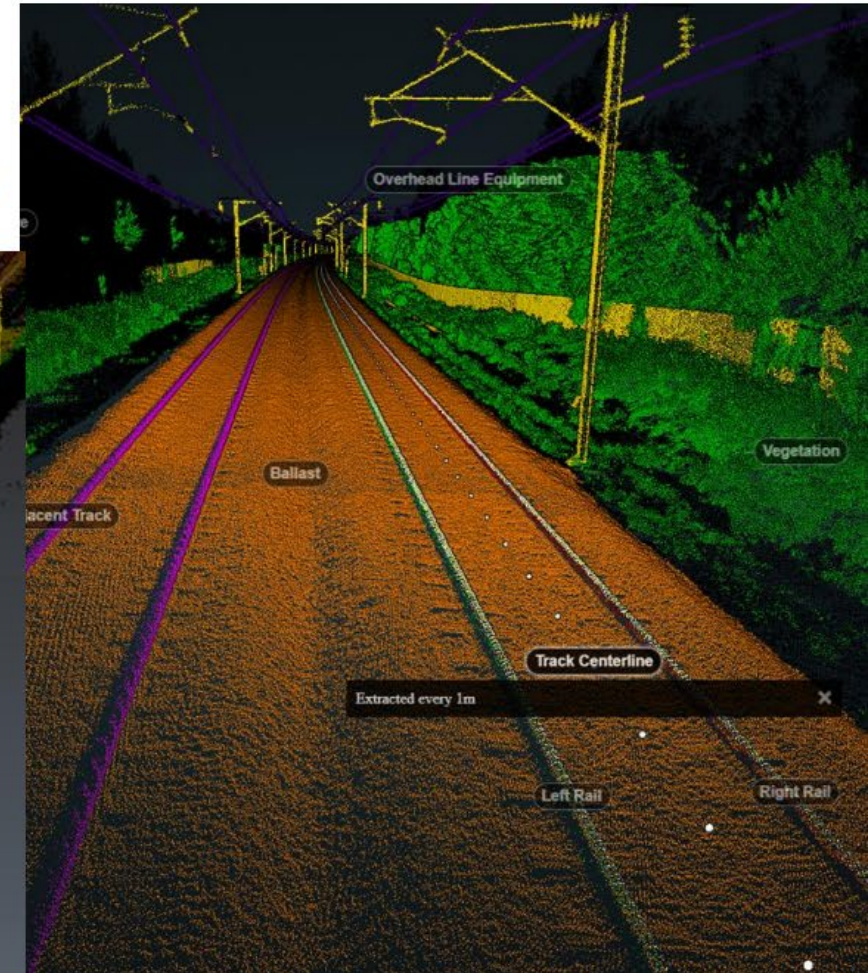
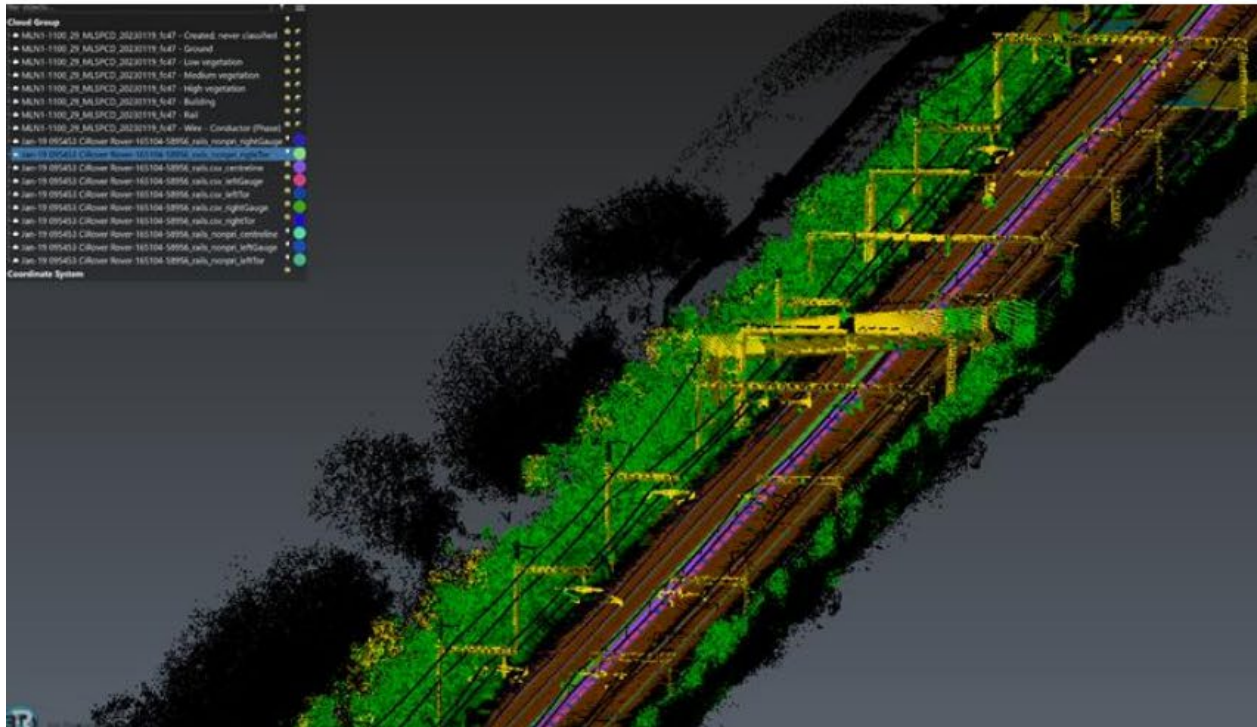
Reason: CABIN Active on router 5



VEGETATION MONITORING – LIDAR/AI (CORDEL)

Applying AI to LiDAR – classify & map the assets Cordel

LiDAR means outputs all-weather, anytime of day/ night
Our AI analyses LiDAR at scale, automating categorisation
into Structure, Platform, Vegetation, Ballast, OLE, fences...
Accurate location to join-up with other data (legacy/ 3rd party)



VEGETATION MONITORING – LIDAR/AI (CORDEL)

Example installations for data capture on NR

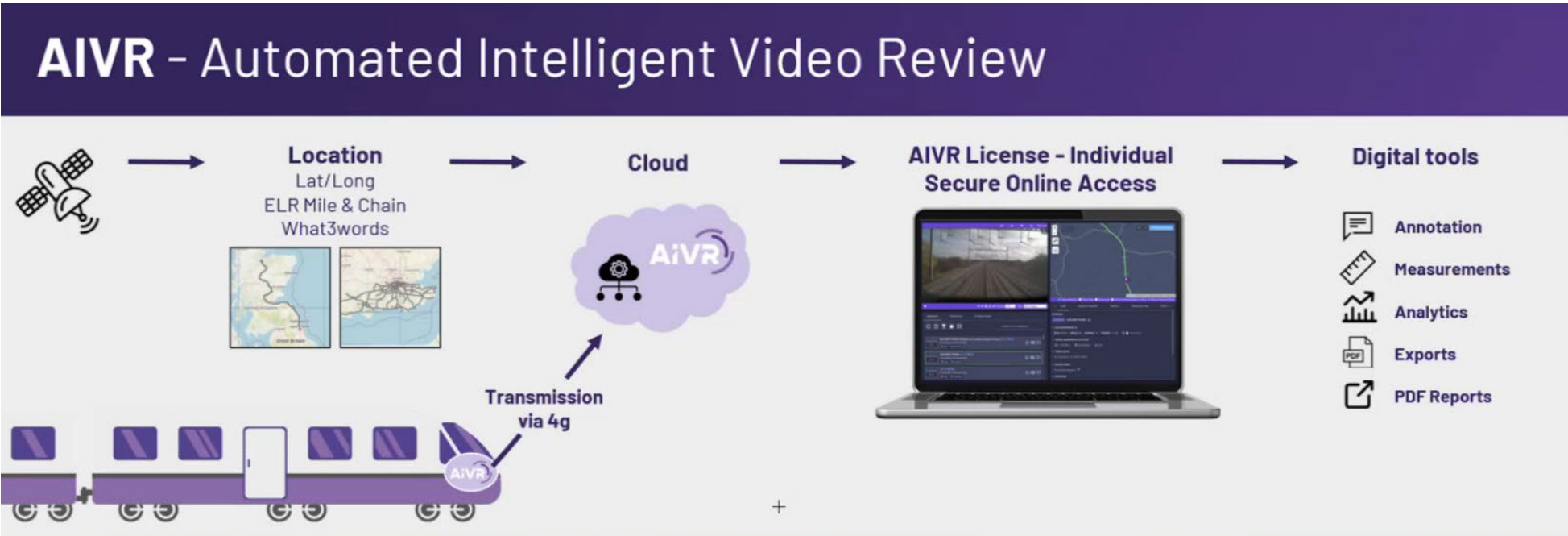


On Class 165 (left), in normal passenger service since Oct 2022, automated capture and upload of up to 110GB of LiDAR & video per sensor system per day

Or Rugged bolt-on option for yellow machines (below)



RAILHEAD MONITORING – AIVR (ONE BIG CIRCLE)



Different ways that AIVR captures video data



AIVR Go - Mounted temporarily inside cab windscreen.



AIVR TLC - External SIG housing that fits temporarily on Tail Lamp Bracket (mounted by hand).



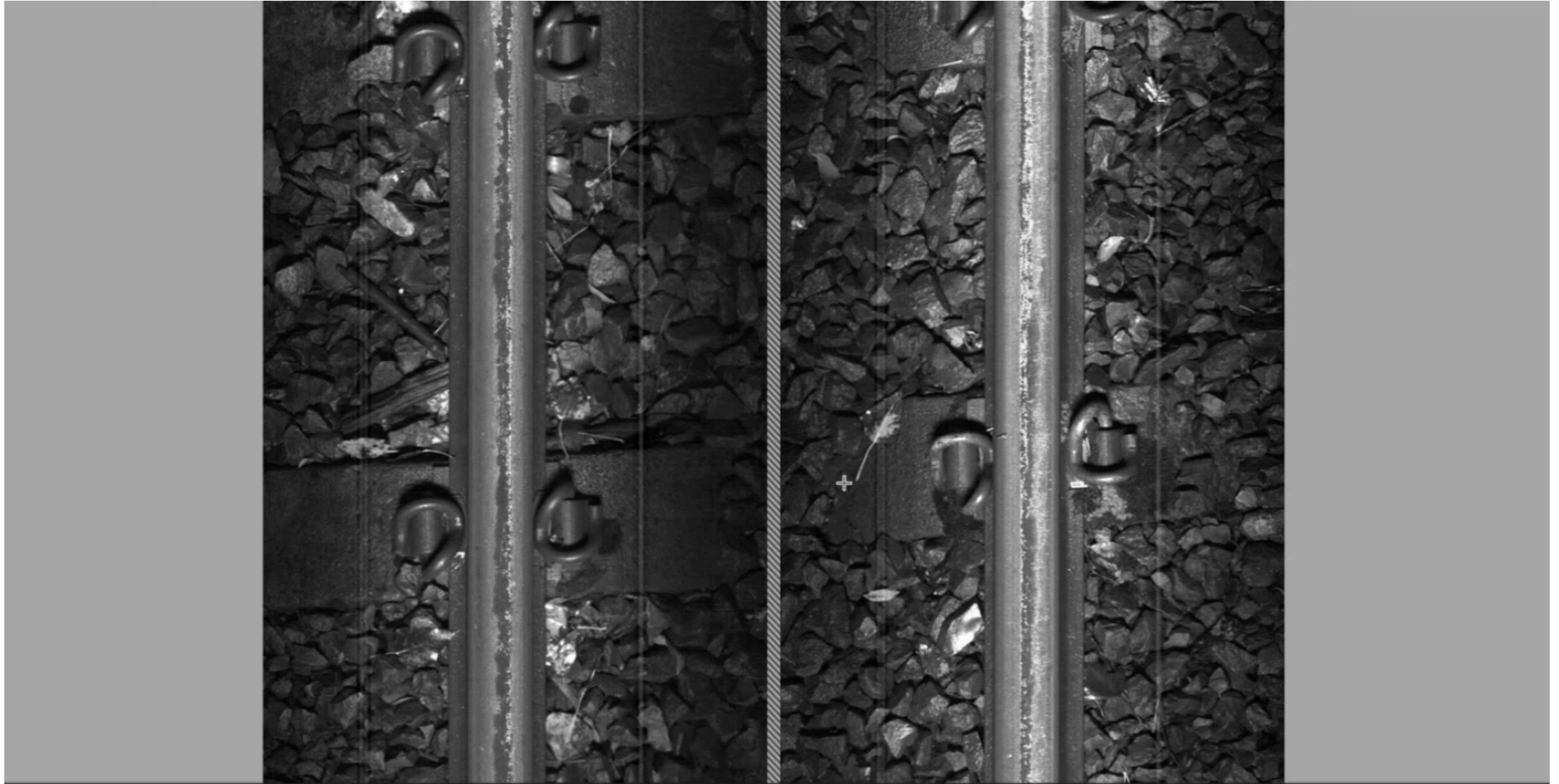
AIVR Connect - Integrated permanently with FFV on Measurement or in-service train.



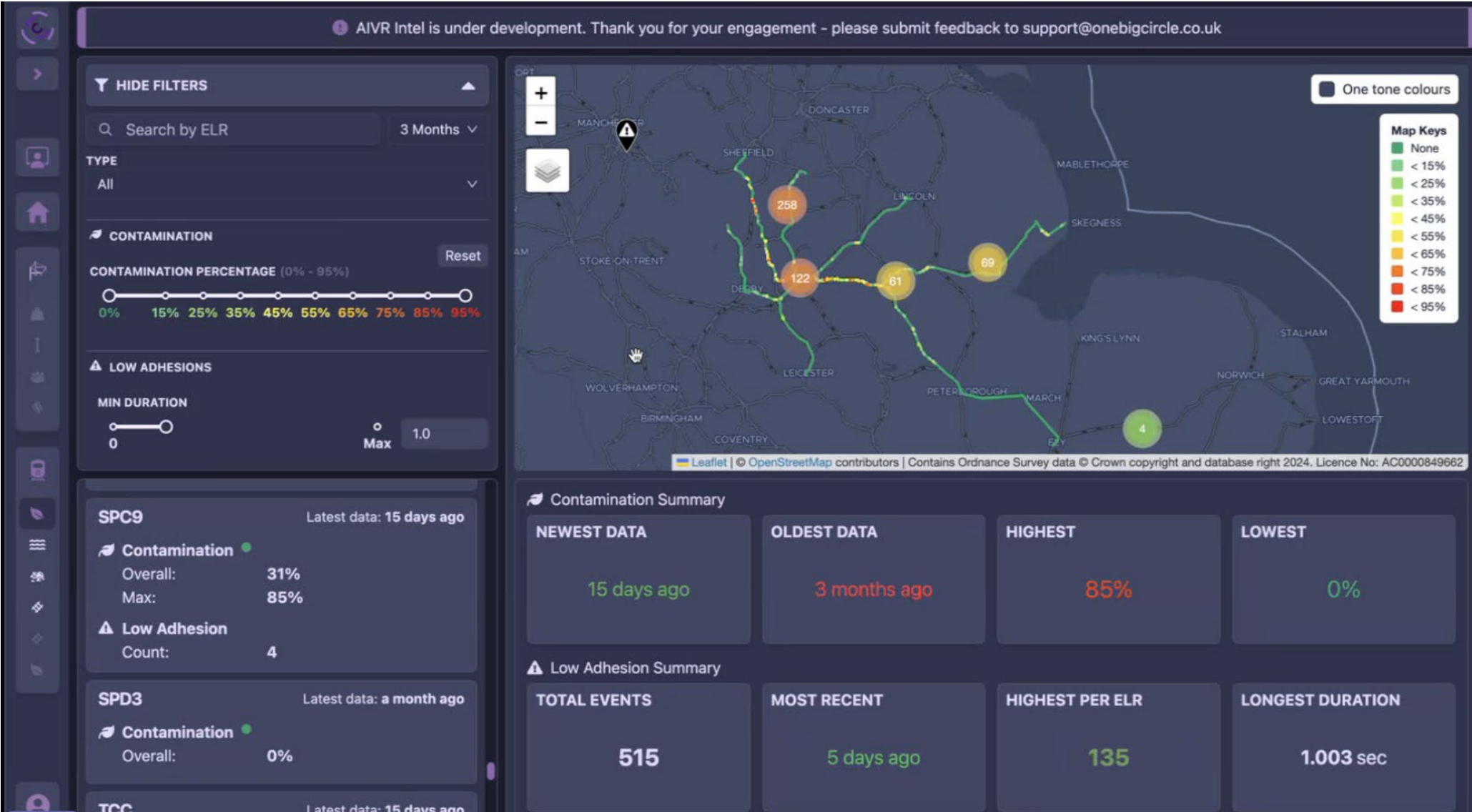
AIVR Focus - Line scanning cameras on in-service vehicle.



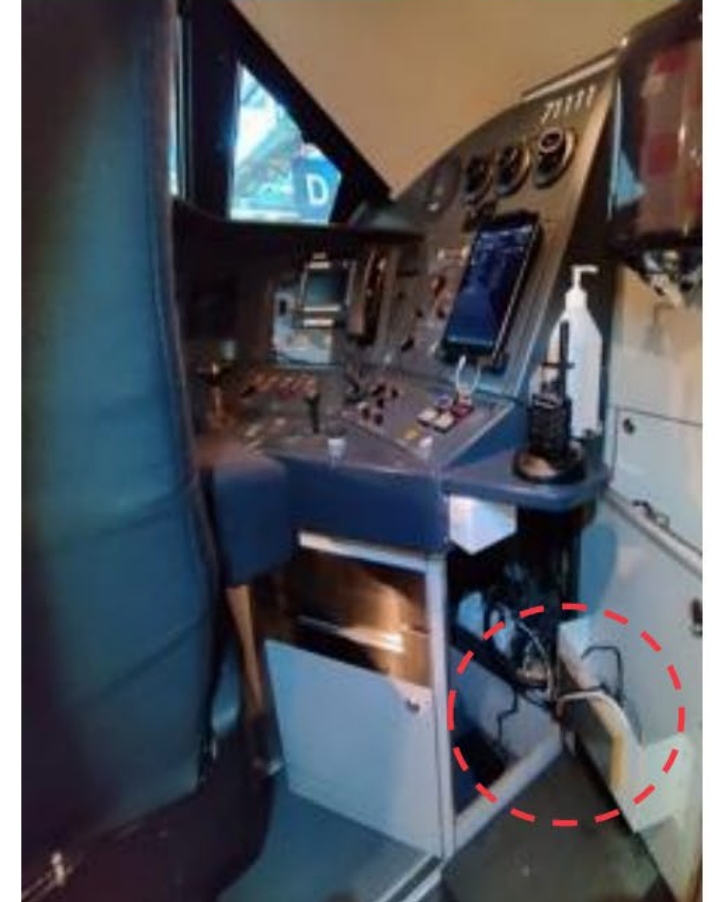
RAILHEAD MONITORING – AIVR (ONE BIG CIRCLE)



RAILHEAD MONITORING – AIVR (ONE BIG CIRCLE)



DATA ANALYSIS, VALIDATION AND PREDICTION OUTPUT (CEMIT)



DATA ANALYSIS, VALIDATION AND PREDICTION OUTPUT (CEMIT)

Monitor track geometry with the **CEMIT track** application



DATA ANALYSIS, VALIDATION AND PREDICTION OUTPUT (CEMIT)

Summary of fleet

Train Overview

Selected Train Class

SE

24 Hours

7 Days

14 Days

30 Days

90 Days

180 Days

Kiwi Rail

Train of Class

↑

Ride Comfort

Rate of Change

No. of Critical Alerts

Hrs in Operation

Review Details

5 Trains

70%

-11%

12.8

32.5 hrs

↓

SE3288

71%

-7%

19

30 hrs

Review Details

↓

SE3311

65%

-14%

22

43 hrs

Review Details

↓

SE3324

72%

-14%

16

21 hrs

Review Details

↓

SE3327

74%

-9%

7

36 hrs

Review Details

—

SE3380

No Data

No Data

0

No Data

Review Details

Train

Switch

Track

Depots

GRPS

Profile

Train class / Fleet

Shows percent of normal rides

Within chosen timeframe

time frame

Within chosen timeframe

Within chosen timeframe



University of
Sheffield

Low Adhesion Research and Solutions: Laboratory to Field

Professor Roger Lewis

School of Mechanical, Aerospace and
Civil Engineering



A WORLD
TOP 100
UNIVERSITY

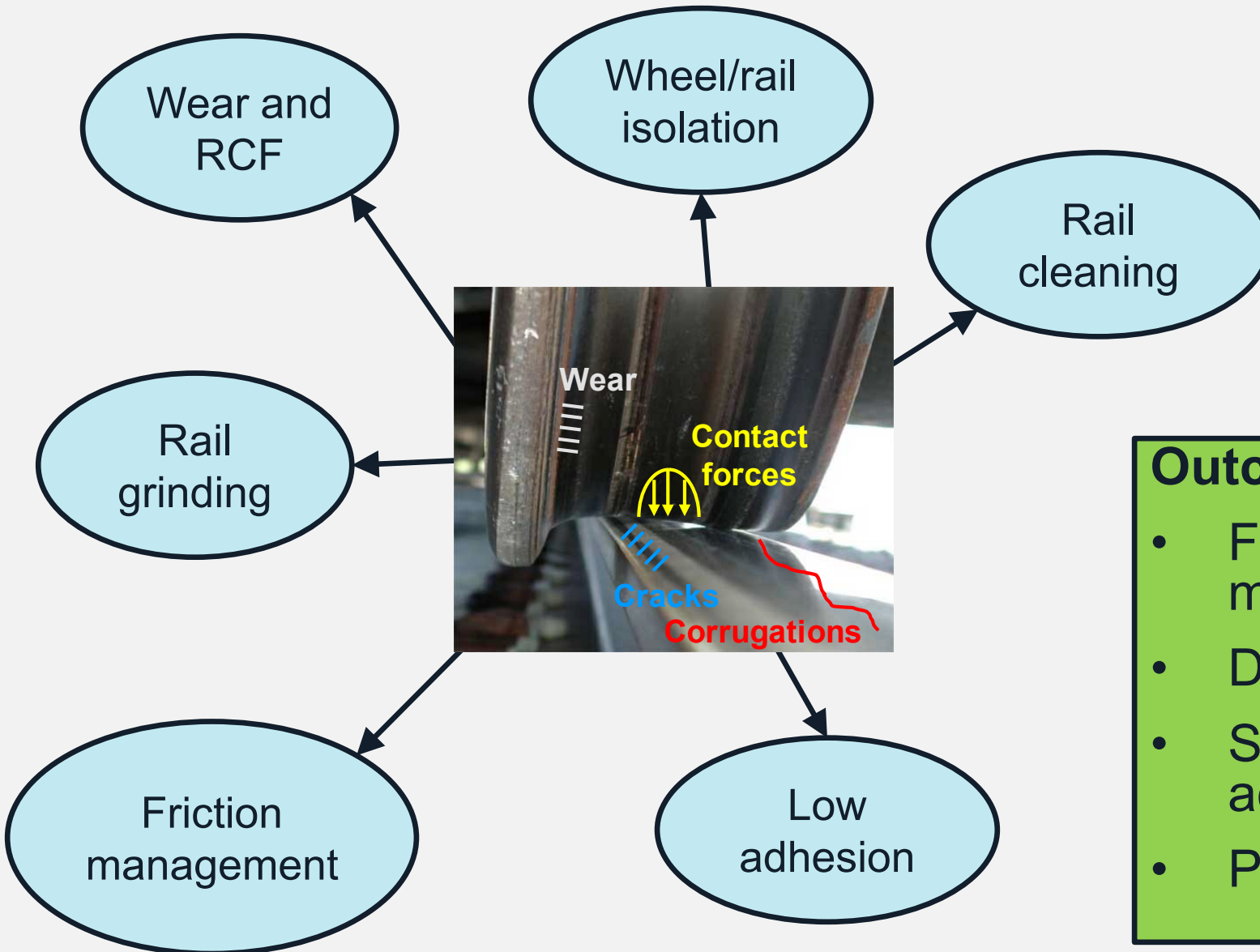
Outline

- Our research and testing scales
- Causes of low adhesion
- Low adhesion mitigation
- Railhead cleaning
- Forecasting low adhesion
- Summary

The background of the slide features a blurred image of a person's hand holding a pen and writing on a notepad. The entire image is covered with a semi-transparent blue filter. The text is centered over the image.

Our Research and Testing Scales

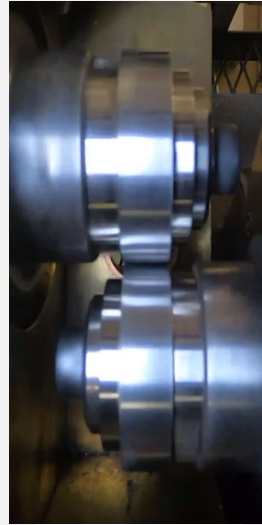
Wheel/Rail Interface Research



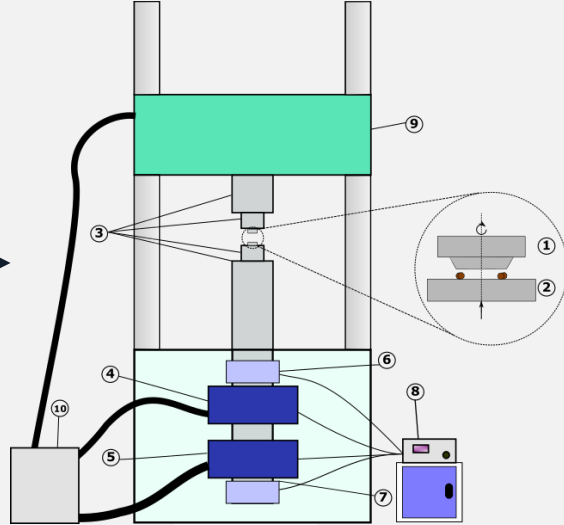
Outcomes:

- Fundamental understanding of mechanisms
- Development of solutions
- Standard test development across scales
- Predictive models

Facilities and Scaling-Up



Twin Disc



HPT



Full-Scale Rig



Field Tests

RIRL1

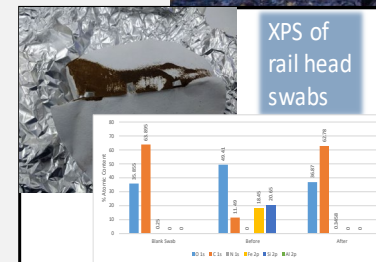
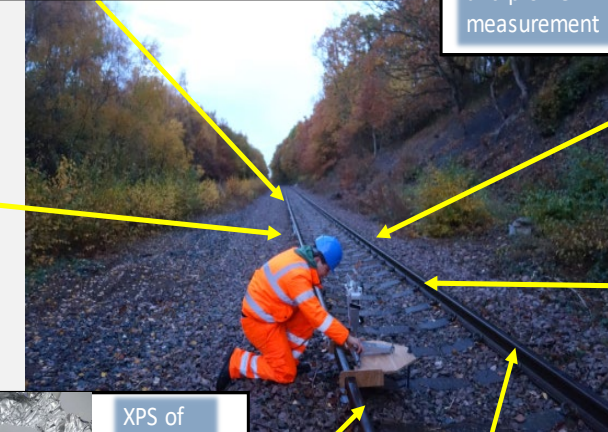
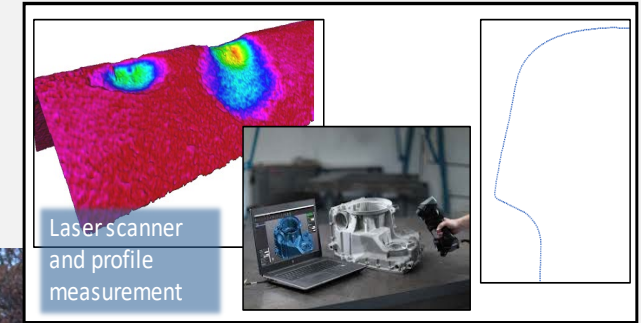
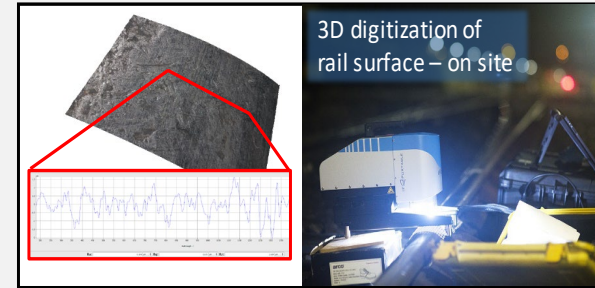
Fundamentals
of friction,
wear and RCF

RIRL6

Applied research
on components/
systems close to
market

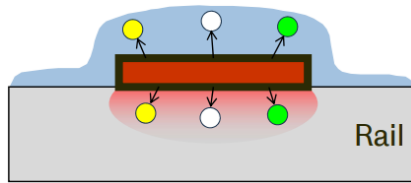
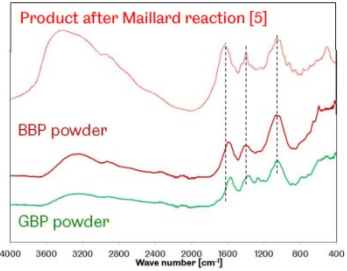
Field Testing and Measurement

- Vehicles and track at Wensleydale Railway
- Measurement approaches in place for:
 - Rail roughness
 - Rail head friction
 - Chemistry – FTIR and LIBS

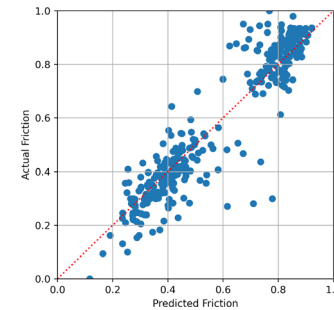


Strategic Partnership with RSSB

Fundamental: understanding leaf layer chemistry and “wet-rail” mechanisms



Machine learning approach for friction estimation



Low RRL

High RRL

Themes:

- Wheel/rail friction fundamentals
- Friction forecasting
- Railhead cleaning
- Traction enhancement

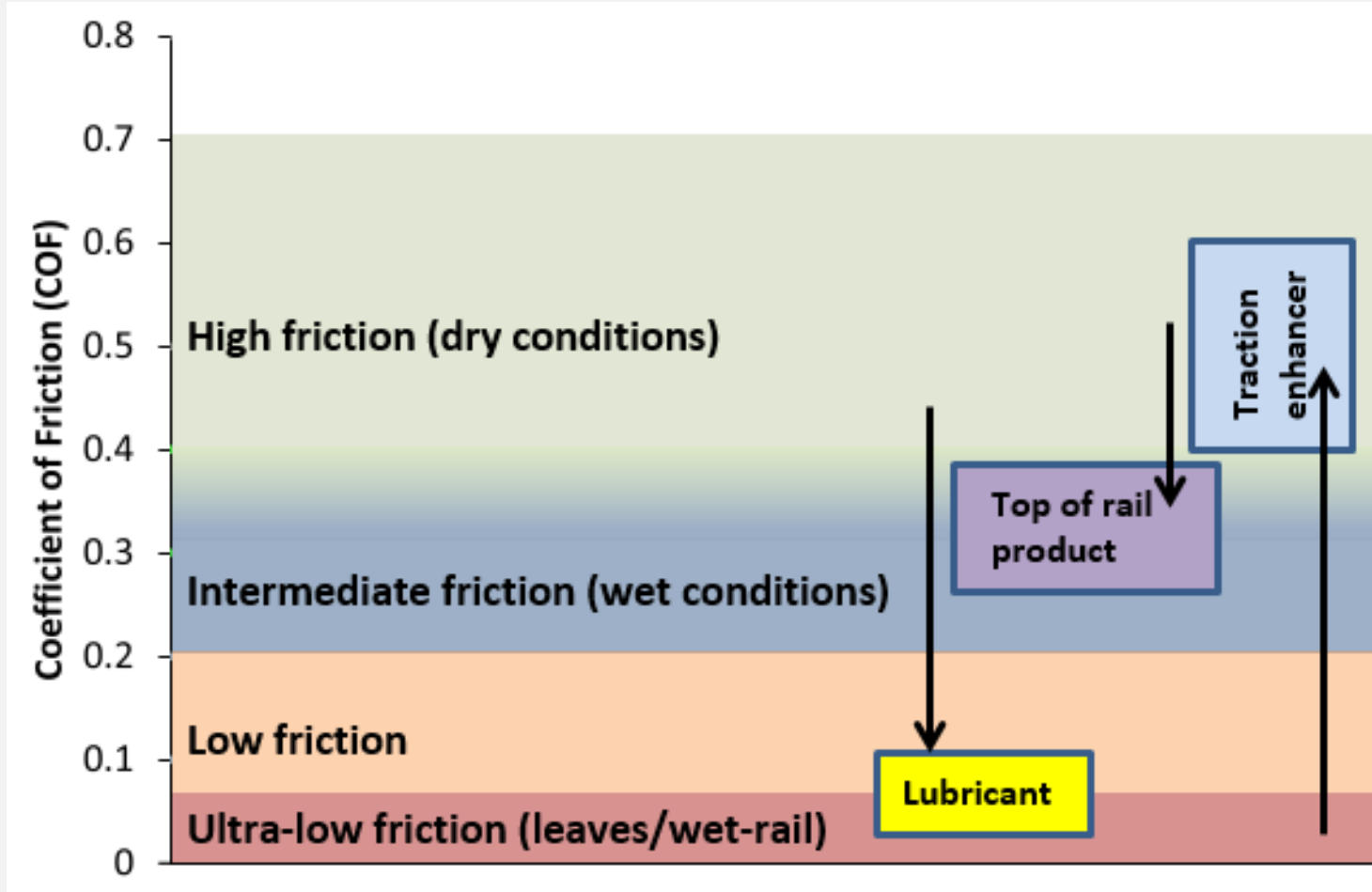
Innovative wheel/rail cleaning technology to improve braking and traction



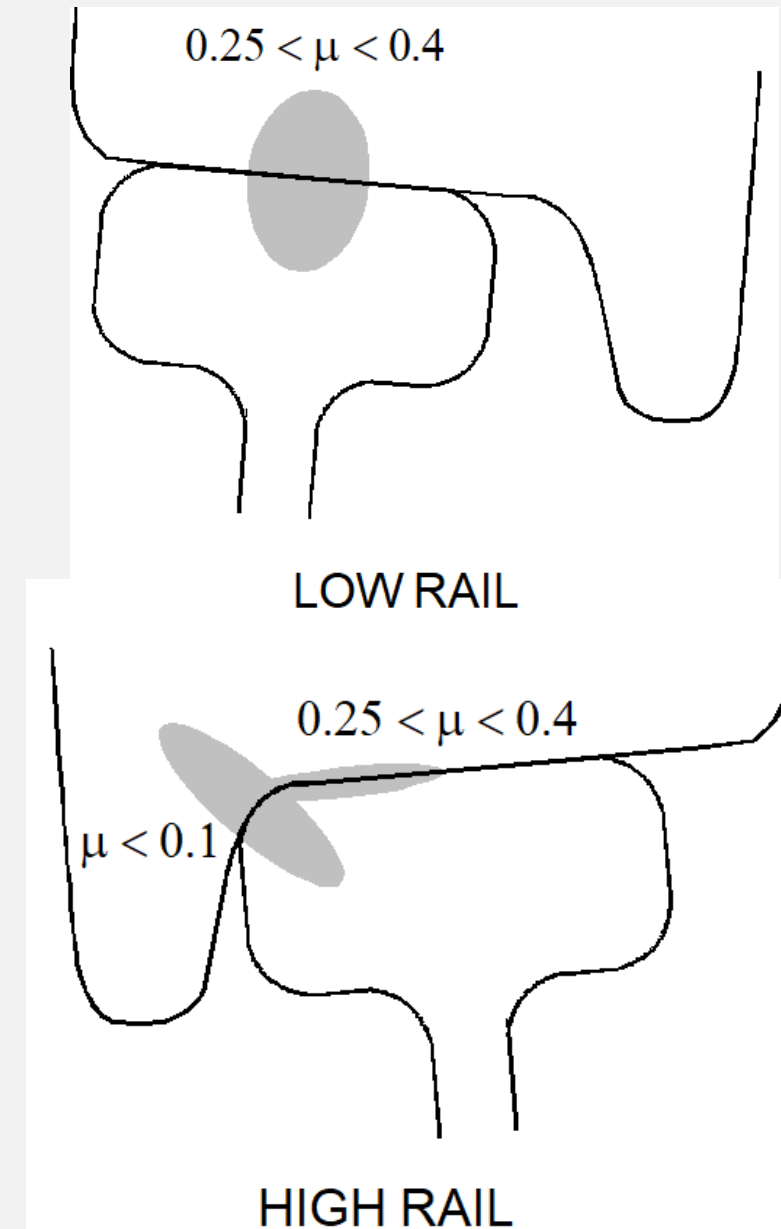


Causes of Low Adhesion

Friction Regimes



- Approximate friction required for good braking and traction is 0.1
- This will vary between vehicles though



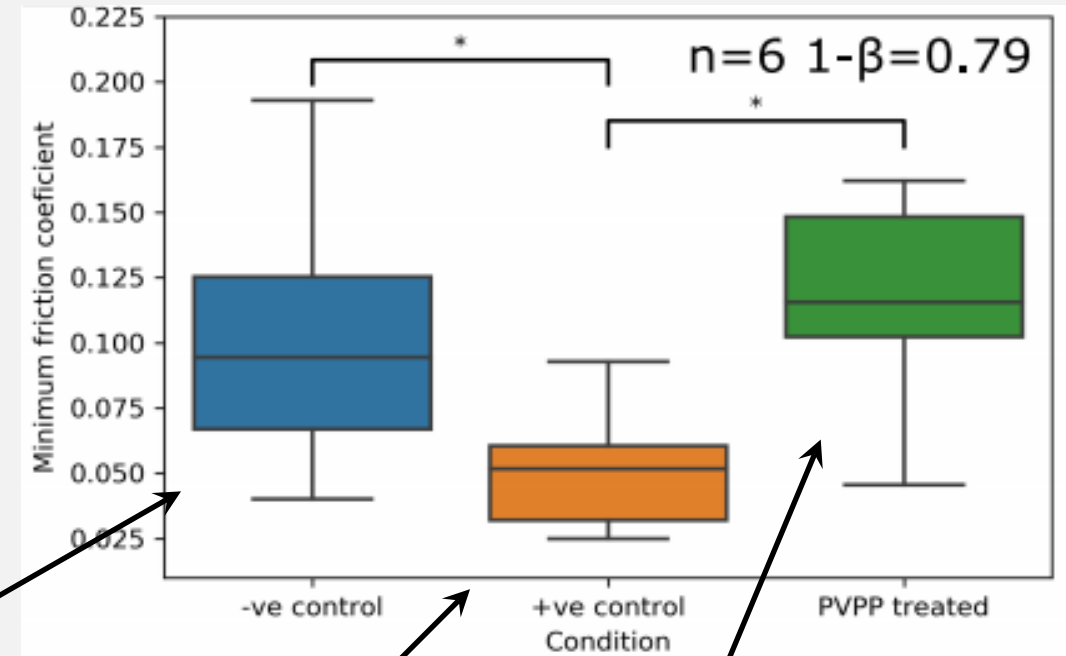
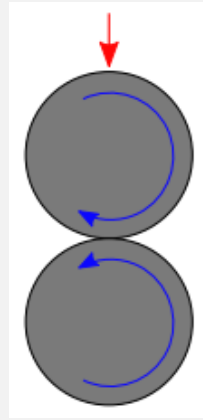
Leaves

A hand holding a pen is positioned over an open notebook. The notebook's pages are filled with handwritten text in a cursive script. The entire image is overlaid with a semi-transparent blue filter. The word "Leaves" is written in a large, white, sans-serif font across the middle of the image.

Low Friction Mechanisms – Role of Tannins

Effect of leaf tannins on friction:

- Friction tests carried out using twin disc simulation of wheel/rail interface
- When tannins removed from leaf extracts, friction increases significantly, to a similar level as water (results replicated across ball-on-flat, MTM and twin-disc test)
- Work published:
<https://royalsocietypublishing.org/doi/pdf/10.1098/rspa.2020.0057>

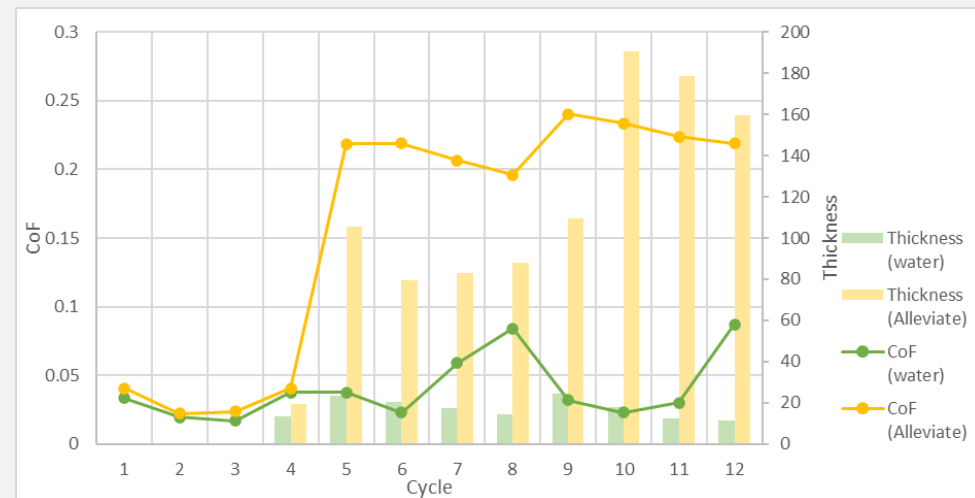
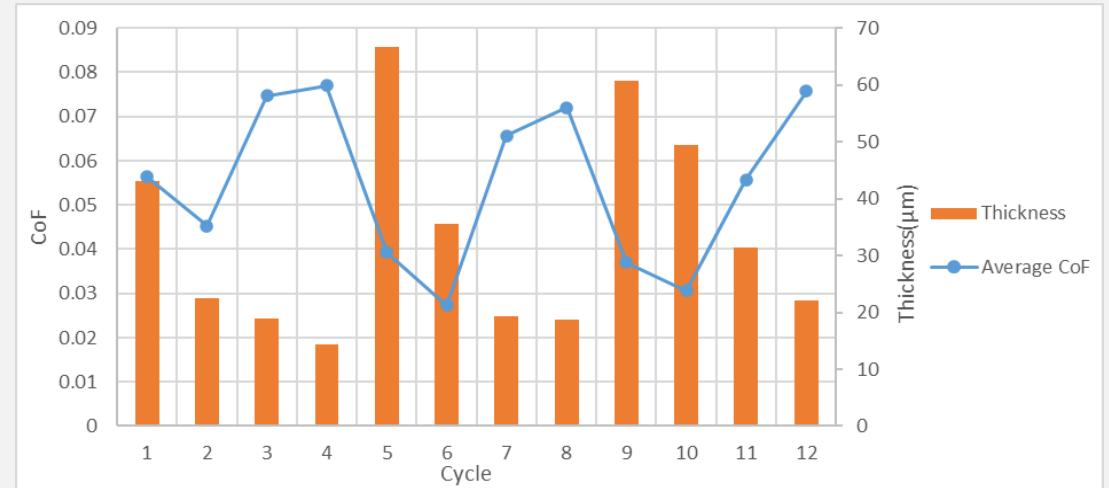
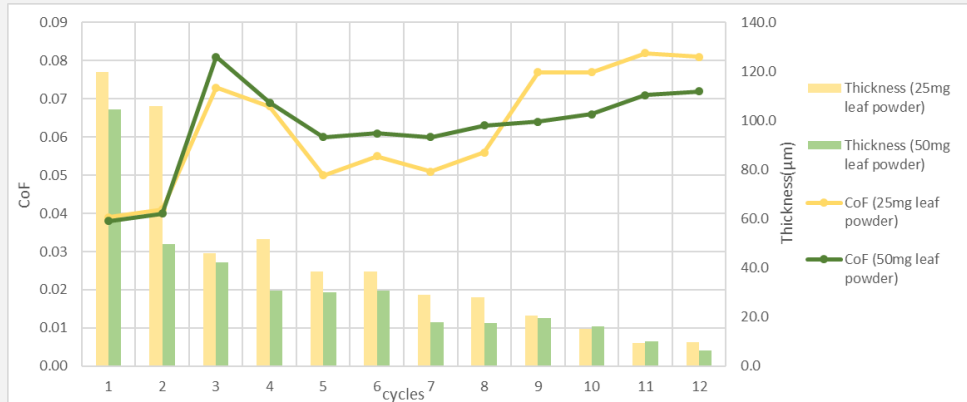
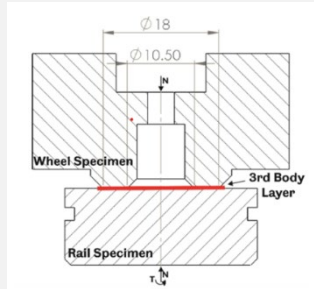


Higher
friction
with just
water

Ultralow friction with
tannins in leaf
mixture

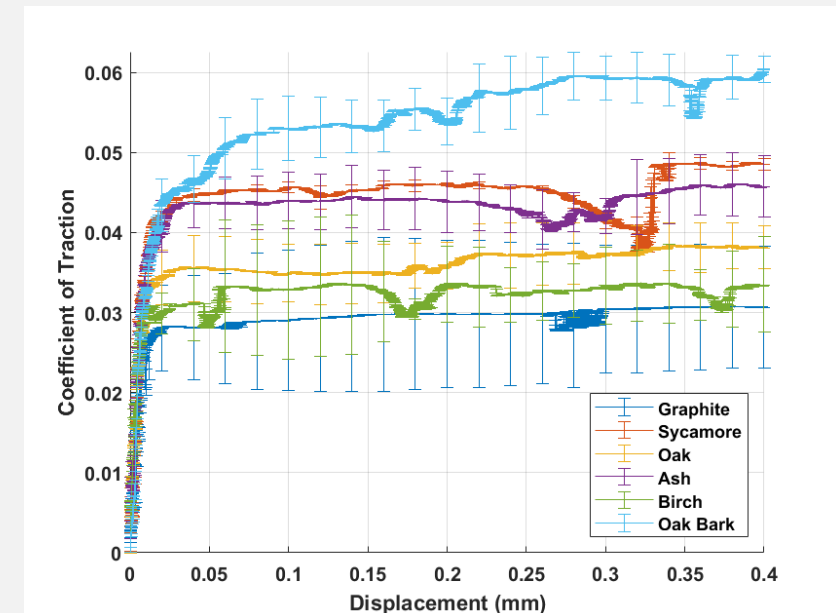
Higher friction
with tannins
removed

Leaf Layer Growth and Depletion



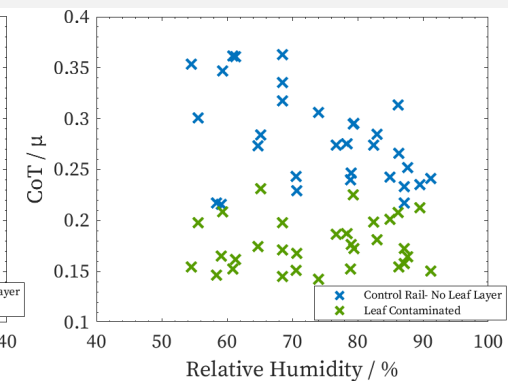
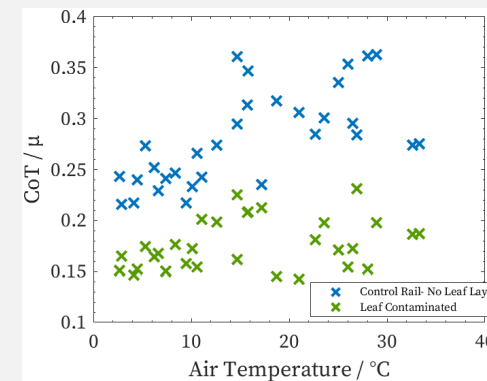
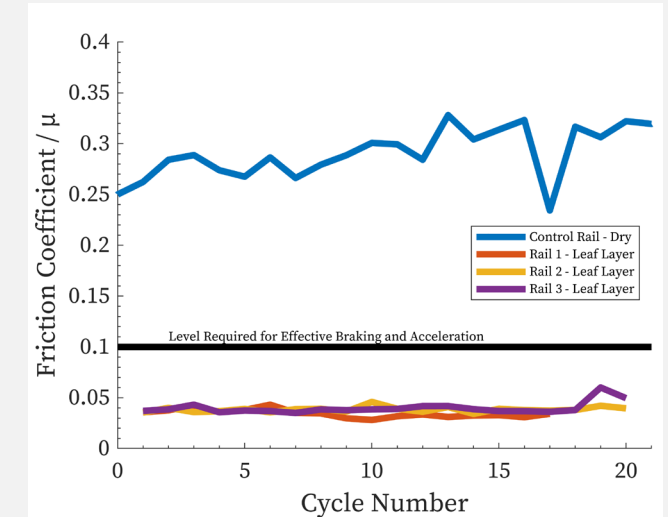
Leaf Layer Creation and Bonding

- Chemistry of leaf layer formation, bonding and low friction mechanisms being studied in the lab and field
- Hypotheses developed
- Laboratory and field experiments being undertaken
- Leaf fall and mobility also being considered
- Aim is to identify which trees cause the biggest issues



Environmental Effects on Friction

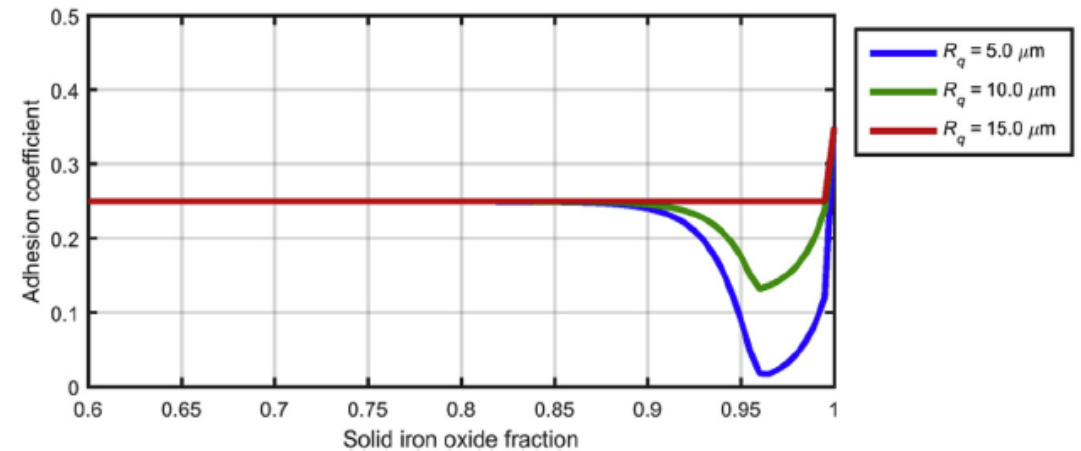
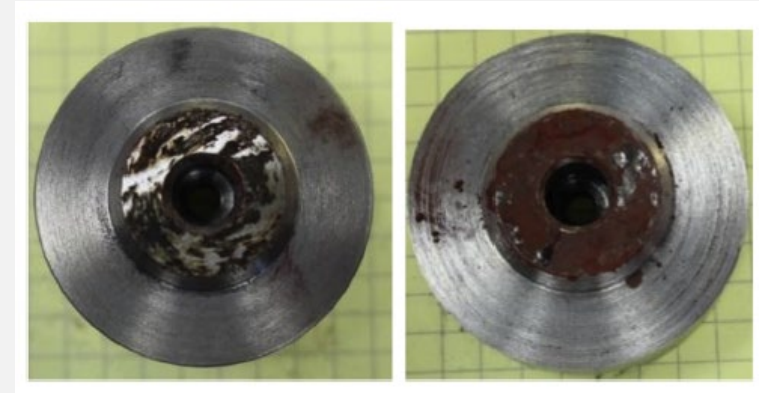
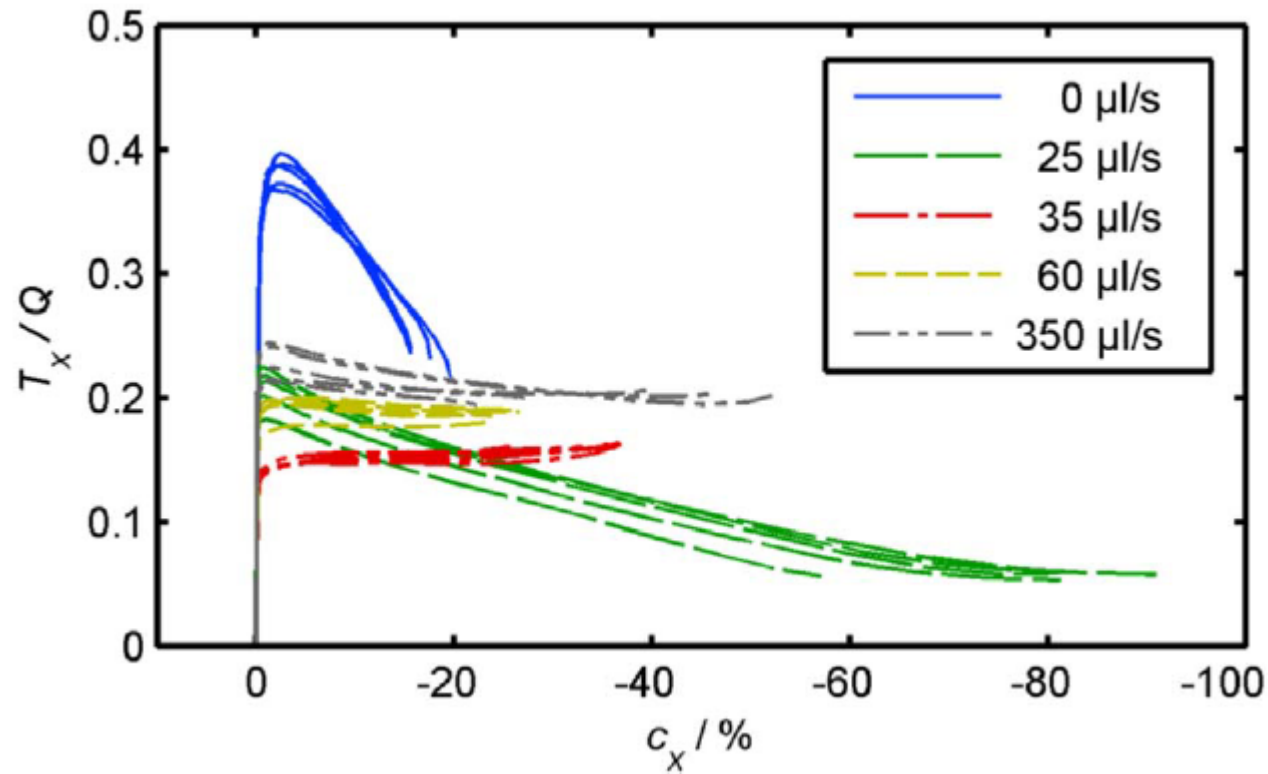
- Full-scale rig used to create leaf layers for the first time
- Created layers tested in the Laboratory for Verification and Validation in an environmental chamber



Wet-Rail

A hand holding a pen is positioned over a notepad. The notepad contains handwritten text, including 'Wet-Rail' and 'Wet-Rail' repeated several times. The background is a solid blue color.

Wet-Rail



Measured adhesion T_x/Q as a function of longitudinal creep c_x in tram wheel test rig experiments as a function of the water flow rate at 4.2 kN normal force and 5 m/s rolling speed.

A hand holding a pen over a document, with the text 'Non-Visible Contamination' overlaid.

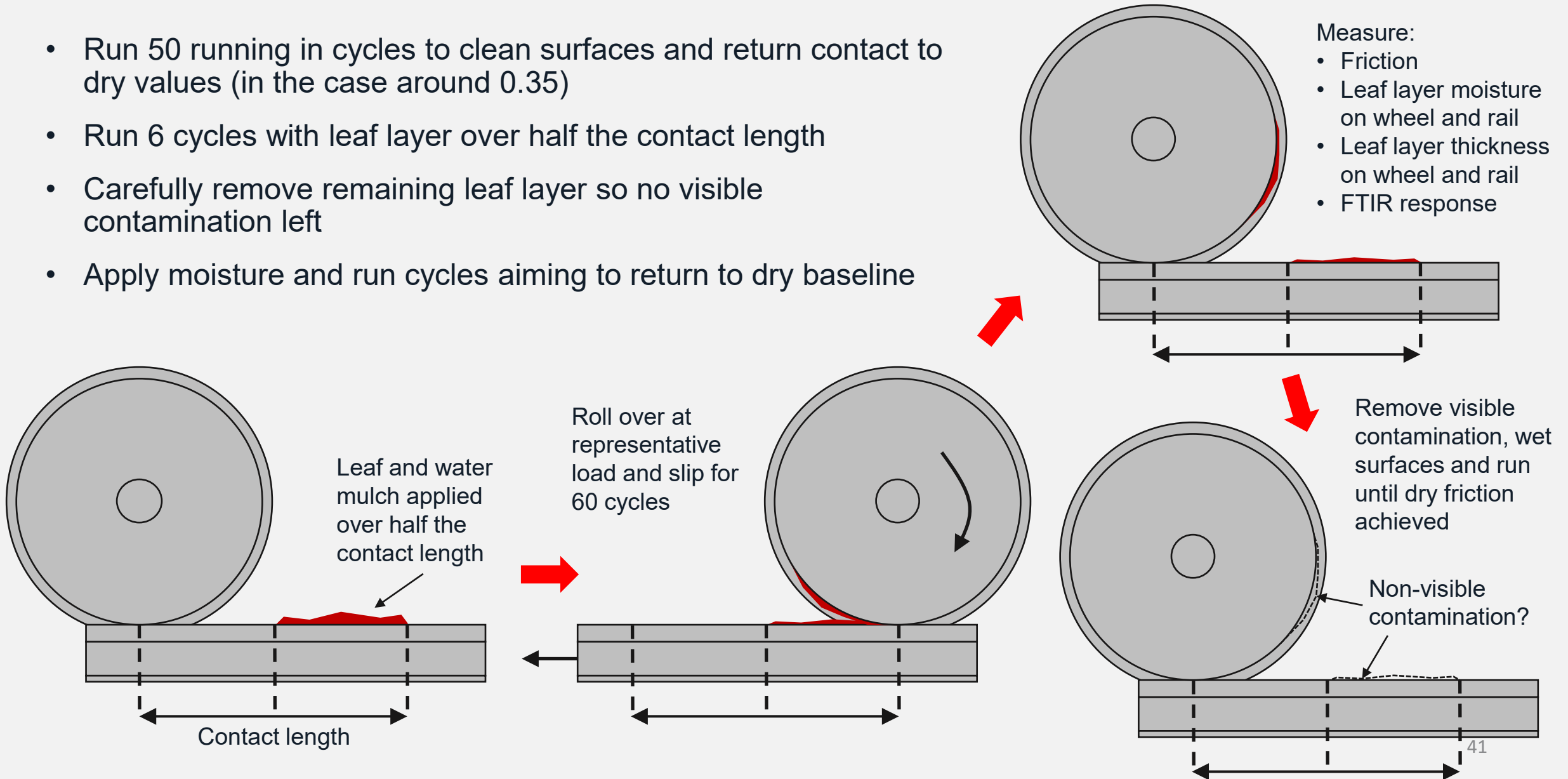
Non-Visible Contamination

Leaf Layer Test Approach

- Run 50 running in cycles to clean surfaces and return contact to dry values (in the case around 0.35)
- Run 6 cycles with leaf layer over half the contact length
- Carefully remove remaining leaf layer so no visible contamination left
- Apply moisture and run cycles aiming to return to dry baseline

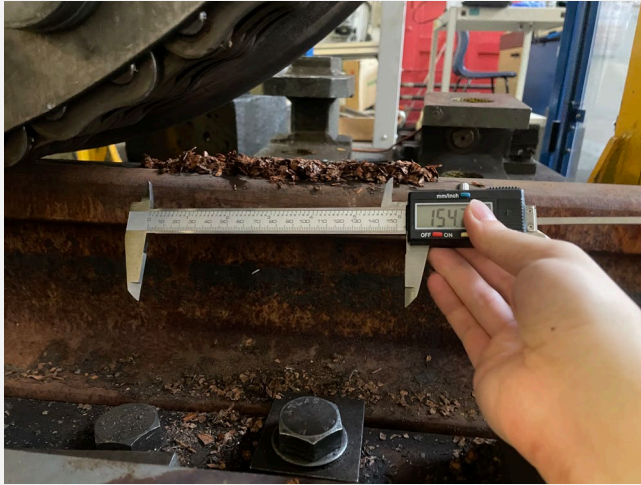
Measure:

- Friction
- Leaf layer moisture on wheel and rail
- Leaf layer thickness on wheel and rail
- FTIR response



Results: Leaf Layers

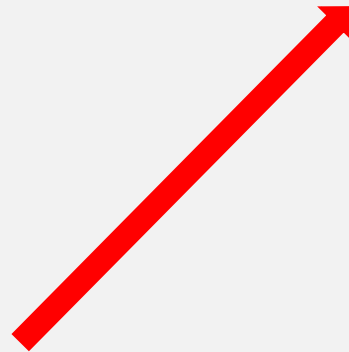
After running-in cycles complete, leaf and water mulch applied over half the contact length



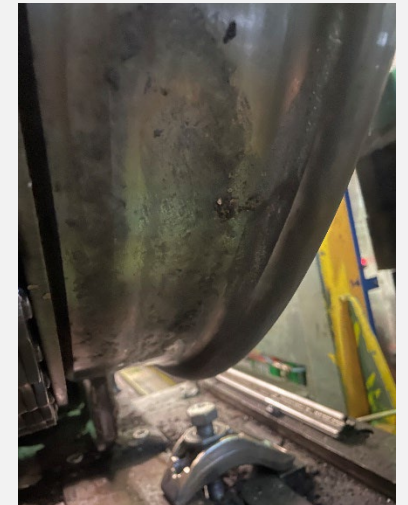
By cycle 60 very little visible leaf material present in rail running band, leaf layer still present on wheel



Leaf material quickly transfers to wheel material so layers form on both surfaces

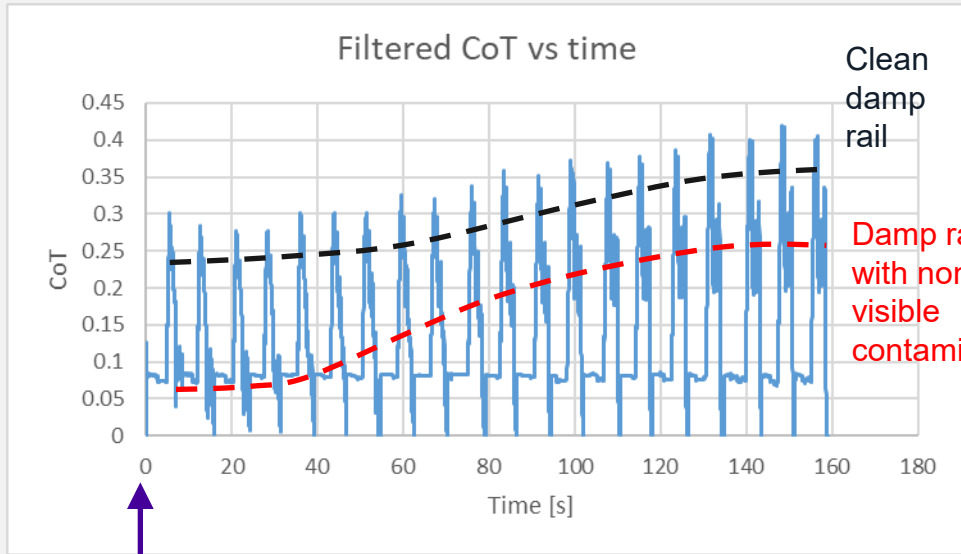
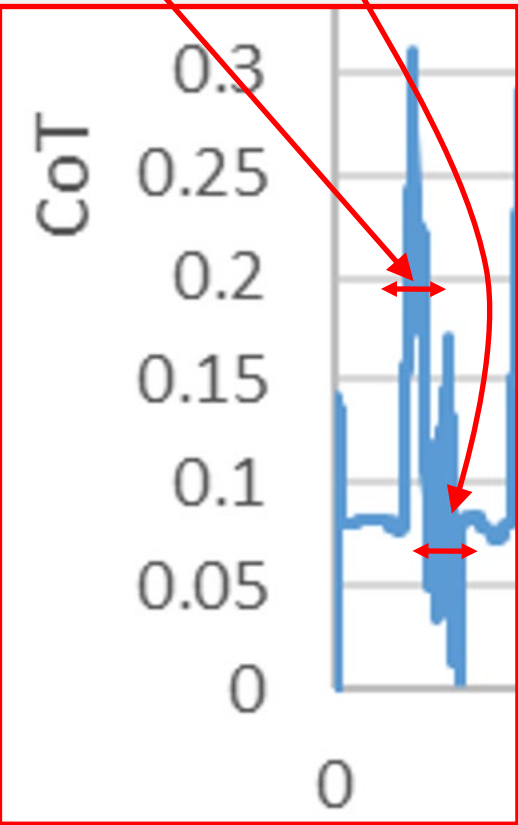


Remaining visible leaf layer removed from wheel and rail



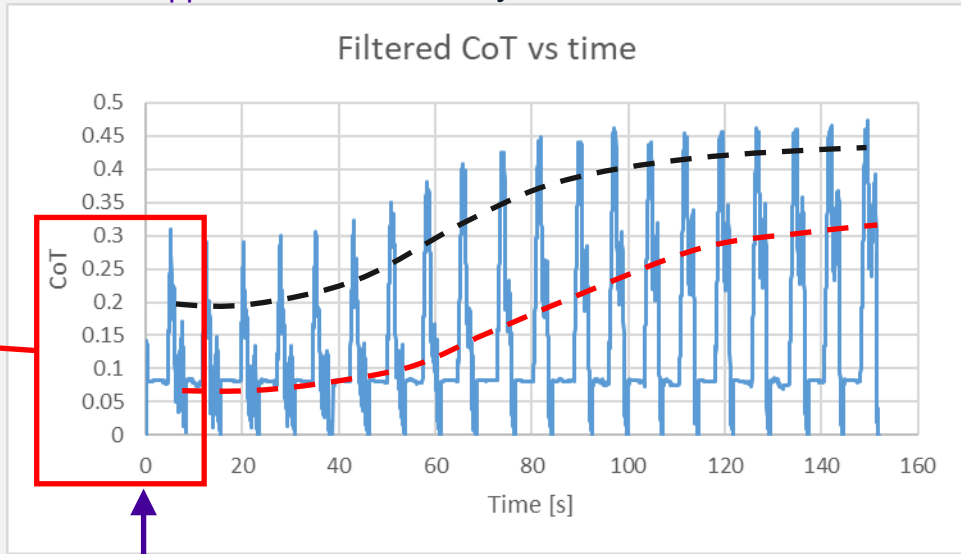
Results: Non-visible Contamination

Clean damp rail
Damp rail with non-visible contamination



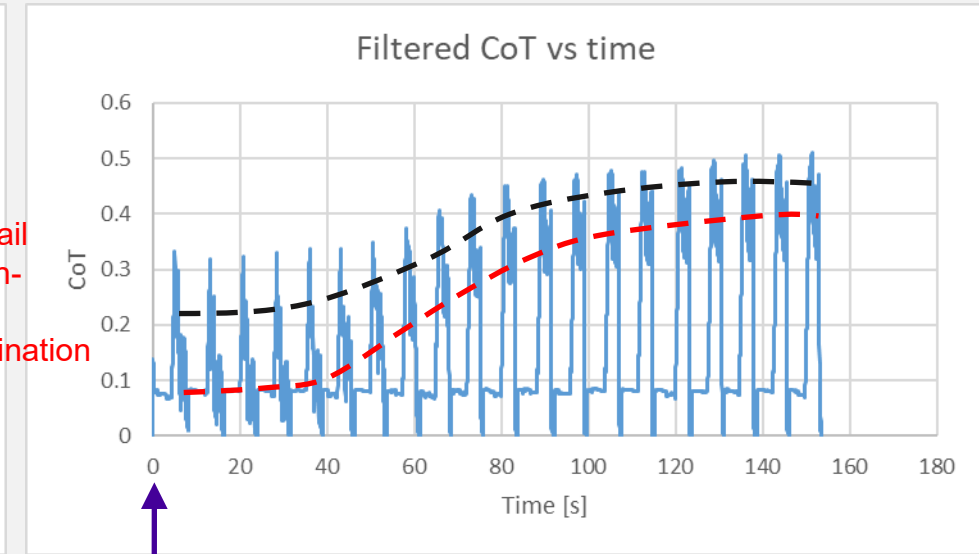
Water applied

0-20 cycles



Water applied

21-40 cycles



Water applied

41-60 cycles

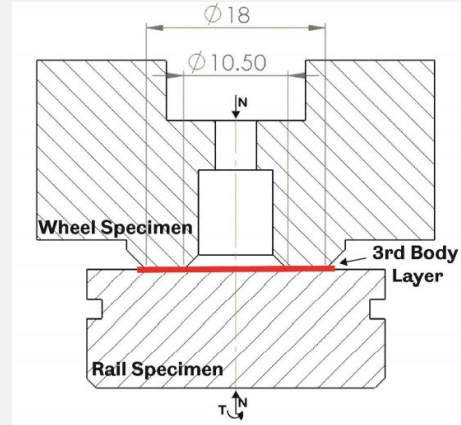
- Clean damp rail give initial friction of around 0.2 – in line with wet testing elsewhere
- Damp rail with non-visible contamination gives very low friction which rises as the contact dries out
- When rewetted after each block of 20 cycles the friction reduces to very low values again though.
- The non-visible contamination persists and remains active for at least 45 cycles

A hand holding a pen over a document with a blue overlay.

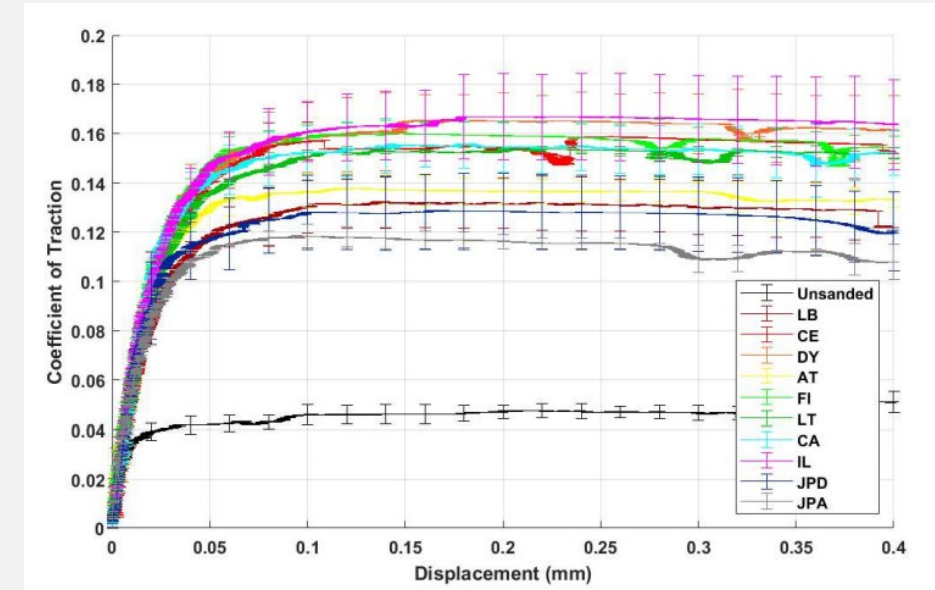
Low Adhesion Mitigation

Mitigation Optimisation – Sanding

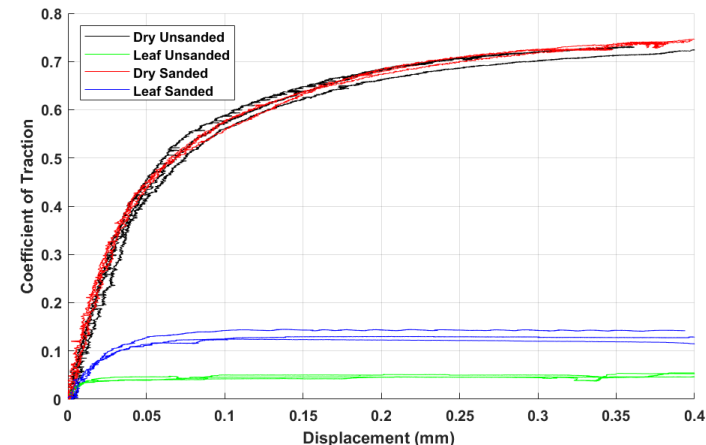
- Work on characterizing different sand particles using new HPT test technique
- Collaborations developed with Newcastle University, Knorr Bremse and Siemens
- Linking characteristics to friction behaviour
- Studying effects of sand on wheel/rail isolation – important for train detection
- Modelling for sand in small and full-scale contacts



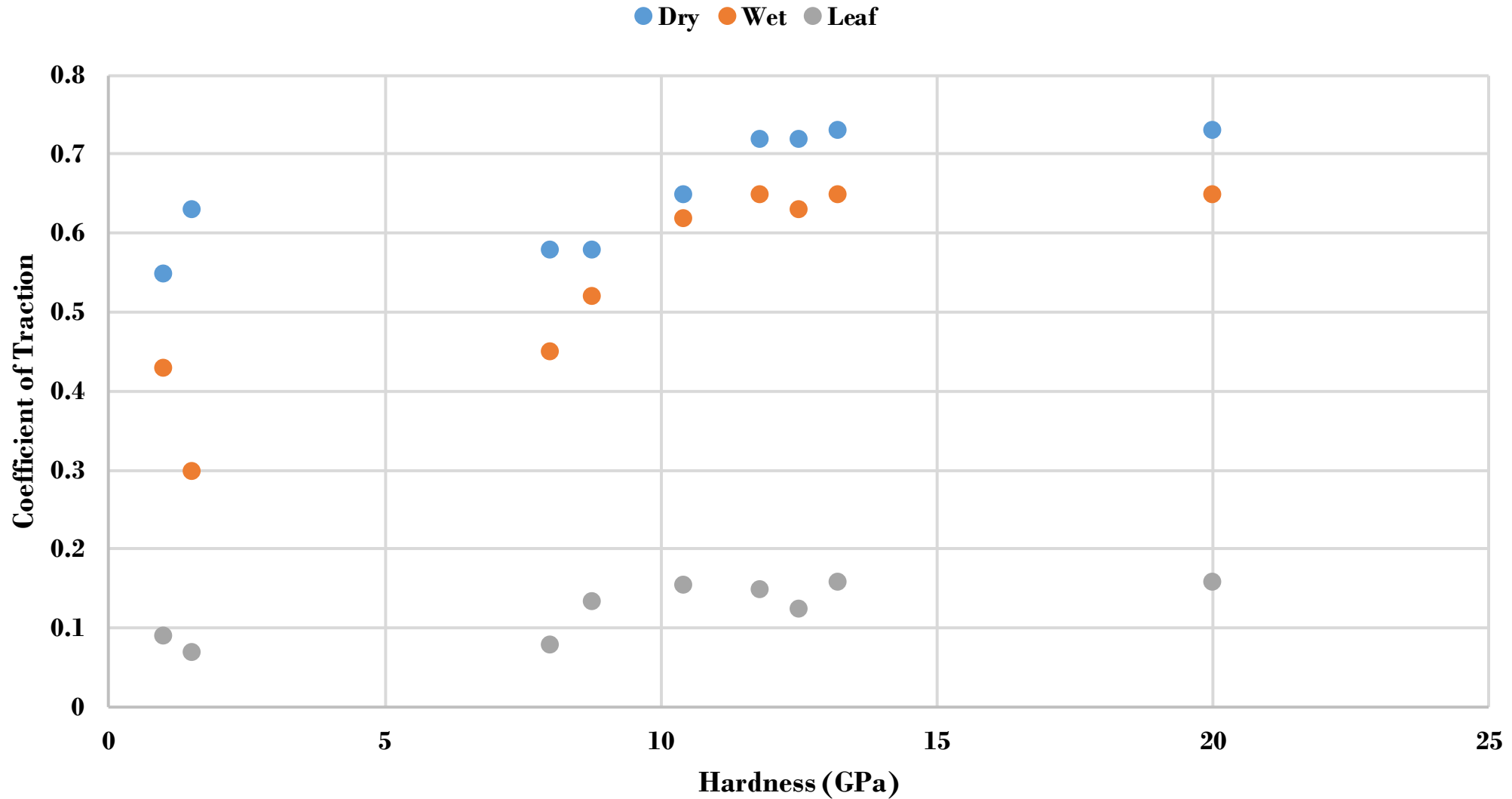
Baseline tests



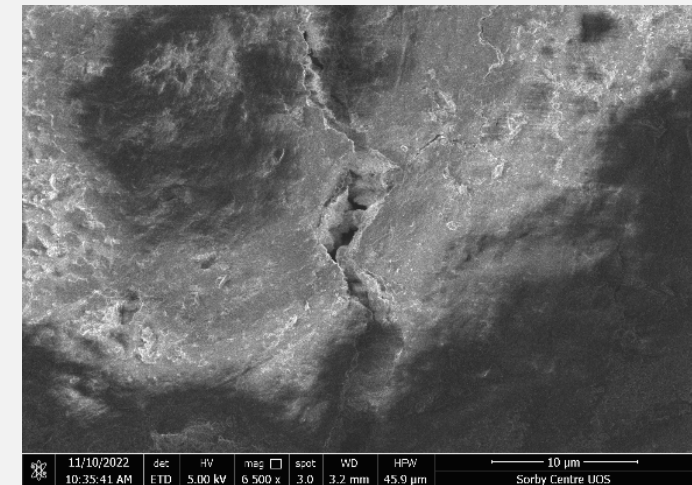
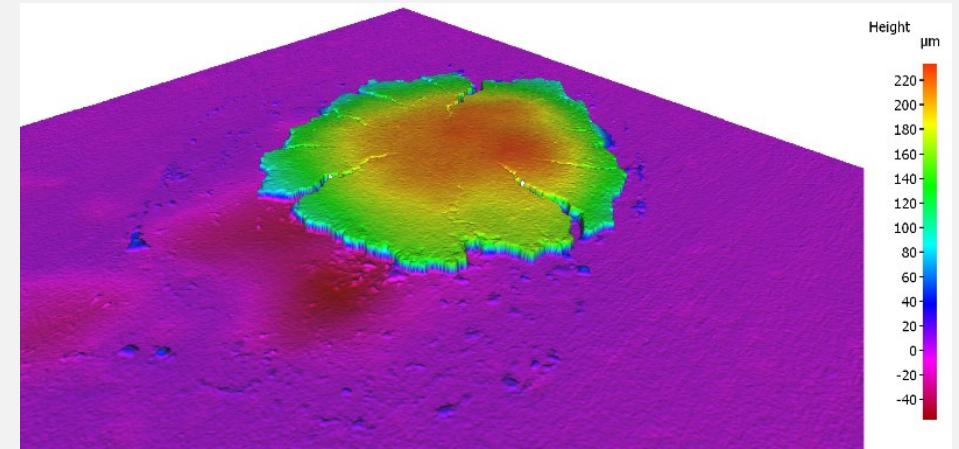
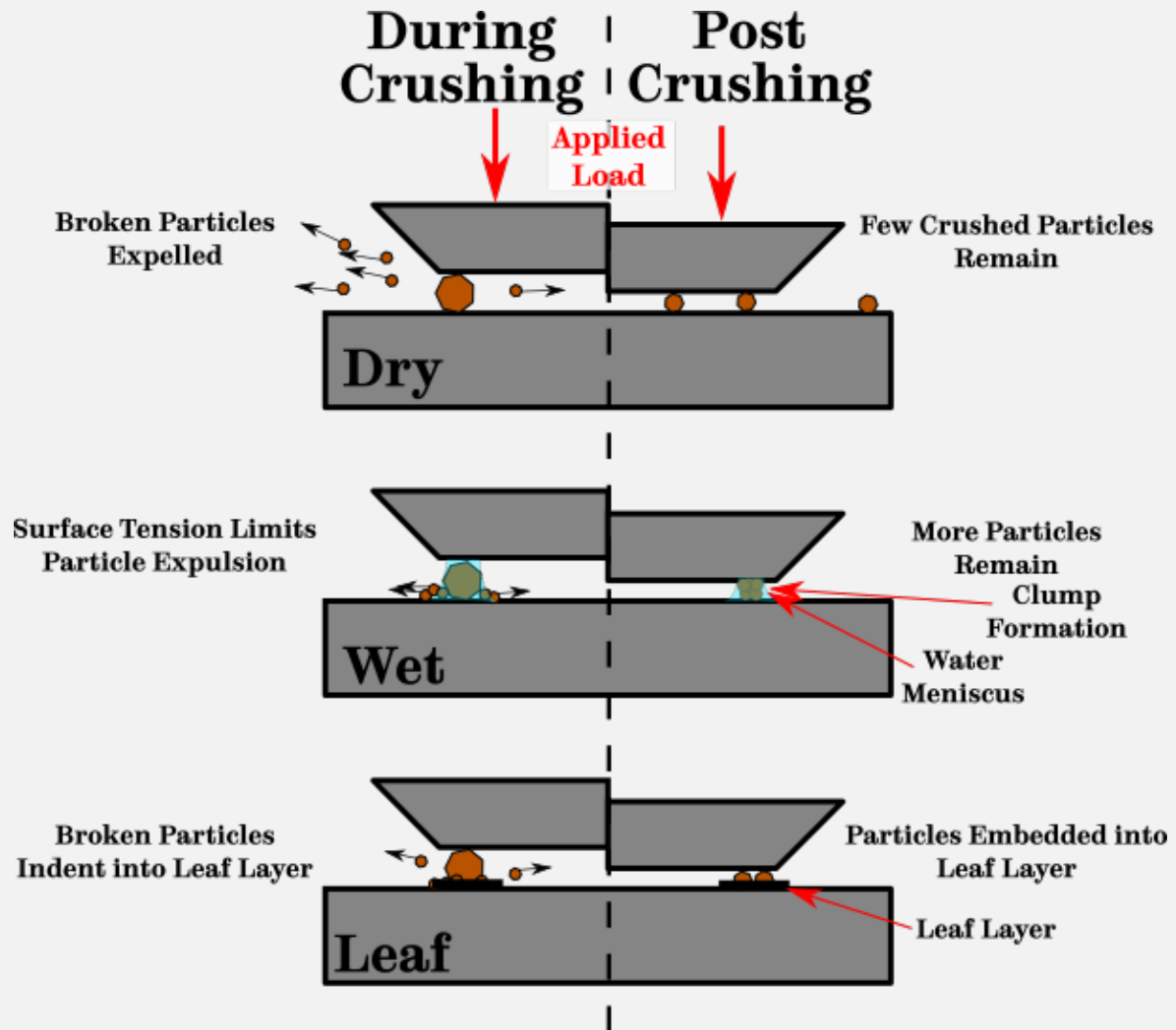
Leaf layers with different sands



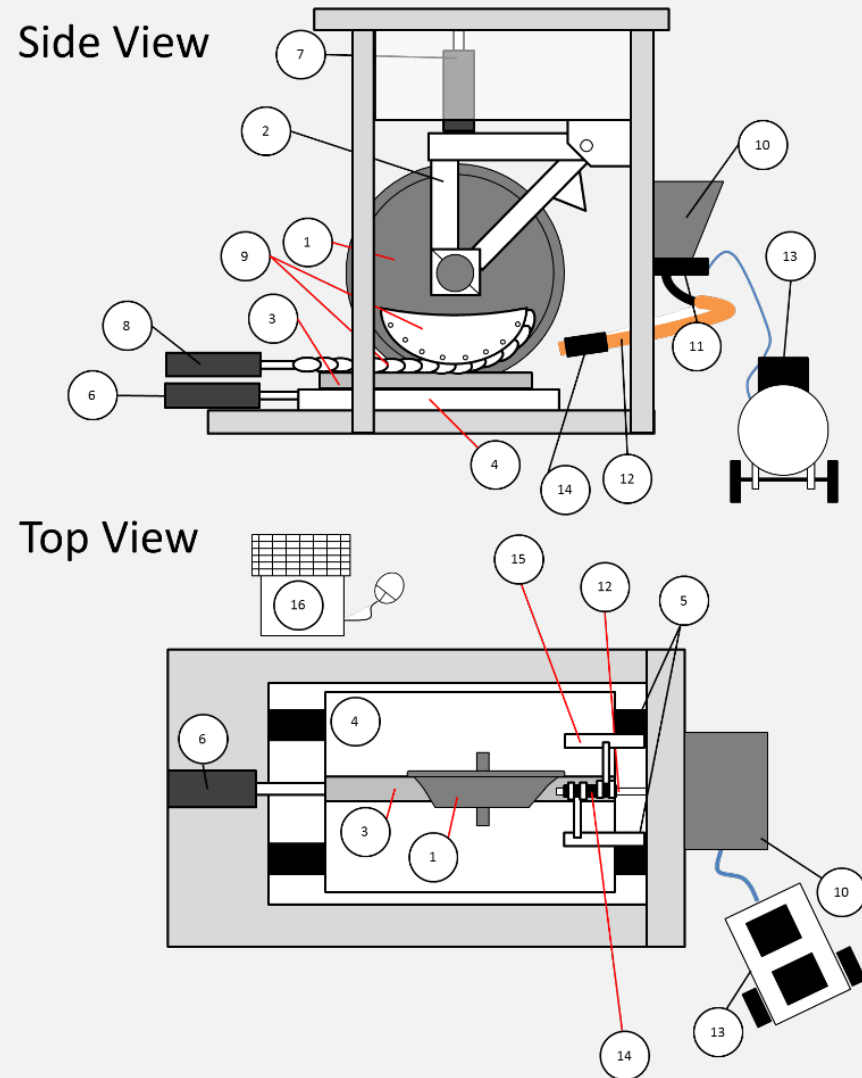
Particle Characteristic Effects – Hardness



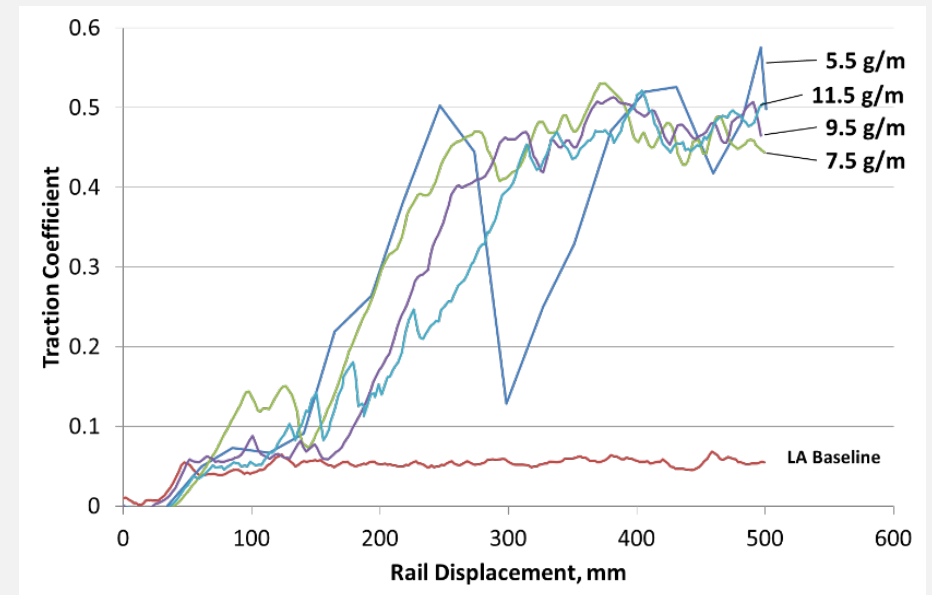
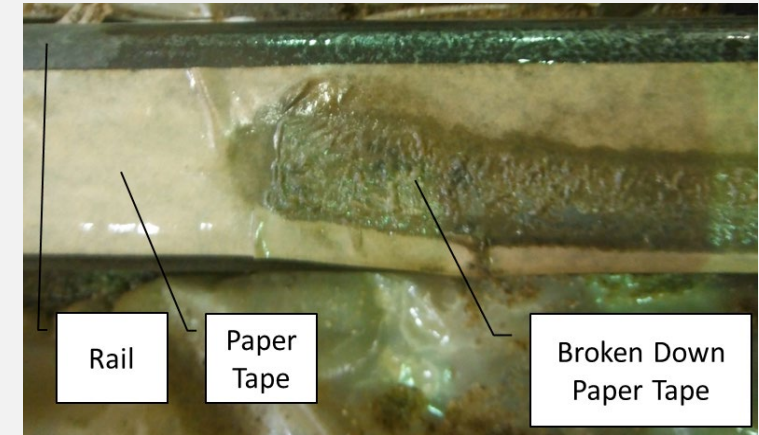
Sand Particle Crushing



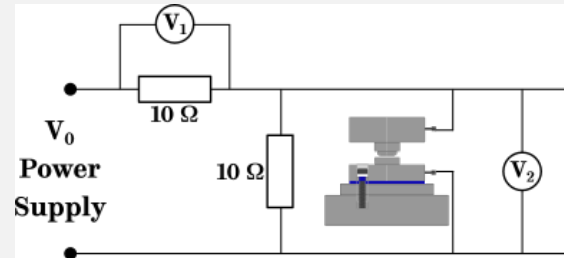
Full-Scale Rig Friction Testing



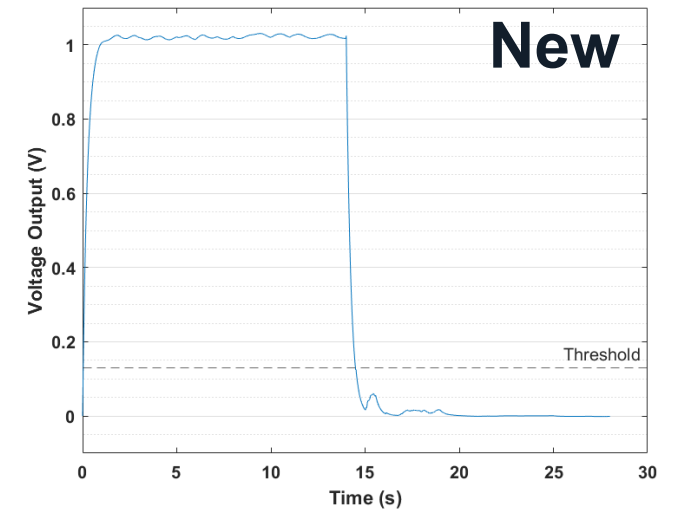
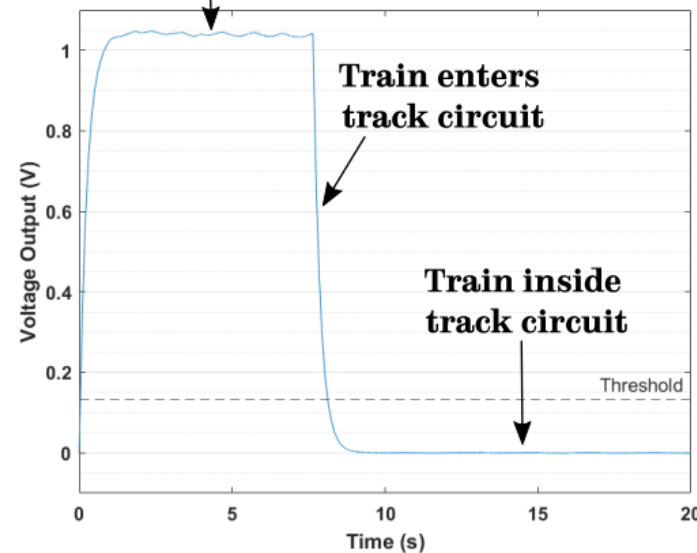
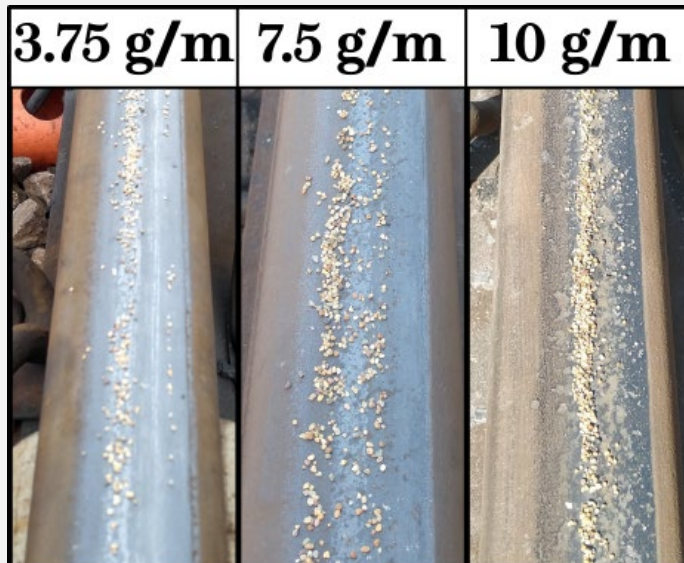
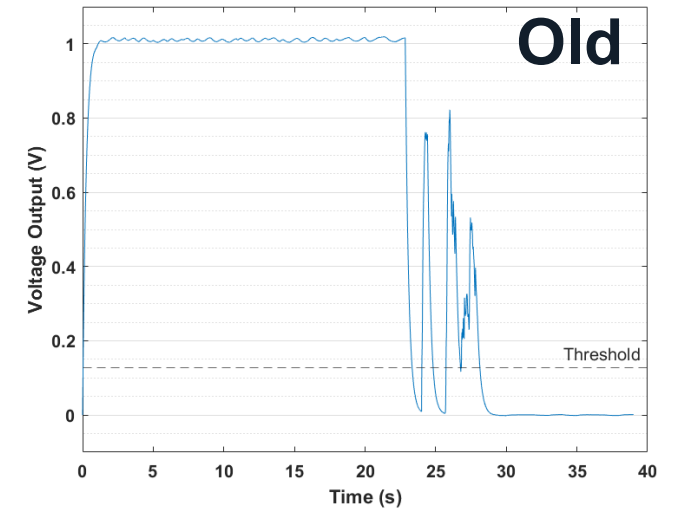
Wet paper tape
used for low
adhesion
simulation



New Conductive Particles

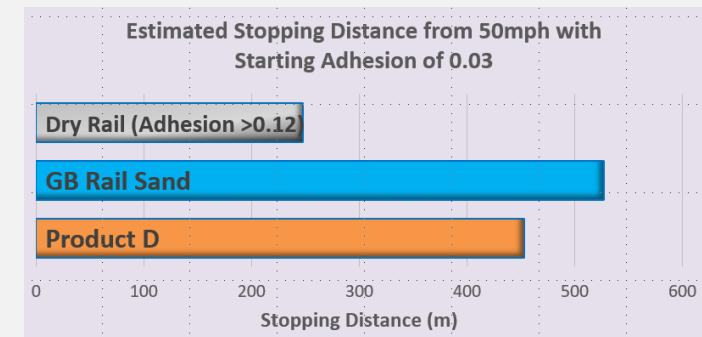
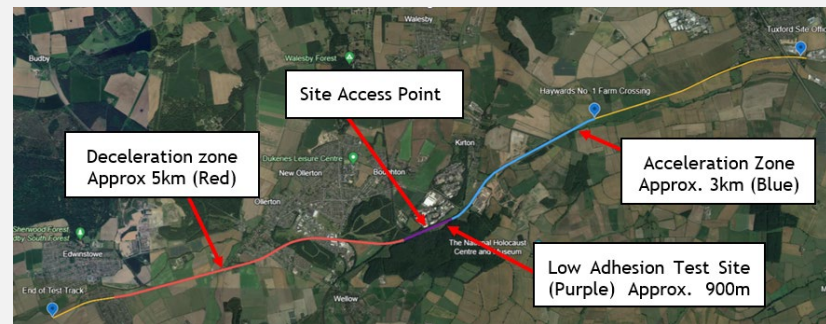


**Train outside
track circuit**



New Conductive Particles

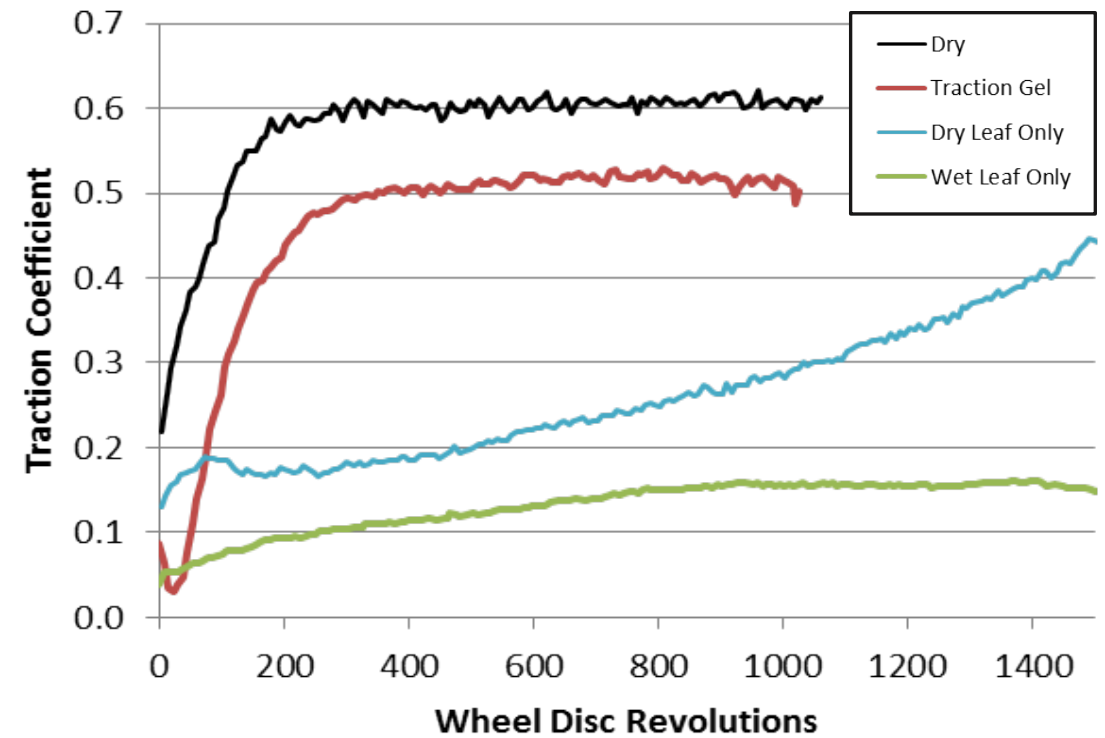
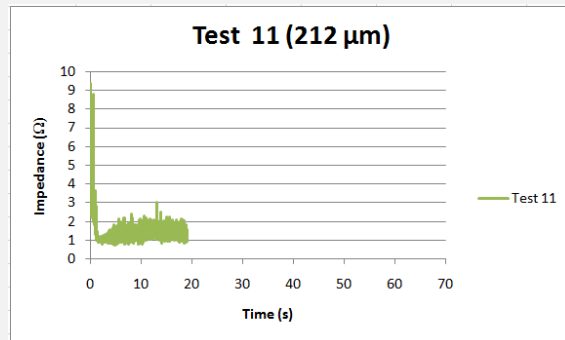
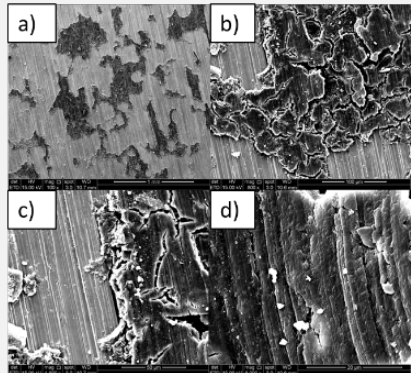
- Work carried on to check influence of conductive particles on IBJs
- Field testing with particles applied from UoS Class 142s to study effect on isolation with contamination layers
- Full brake testing at 50mph at Tuxford
- New particles overcome issues with GB rail sand and still improve traction when braking on contamination



Traction Gels

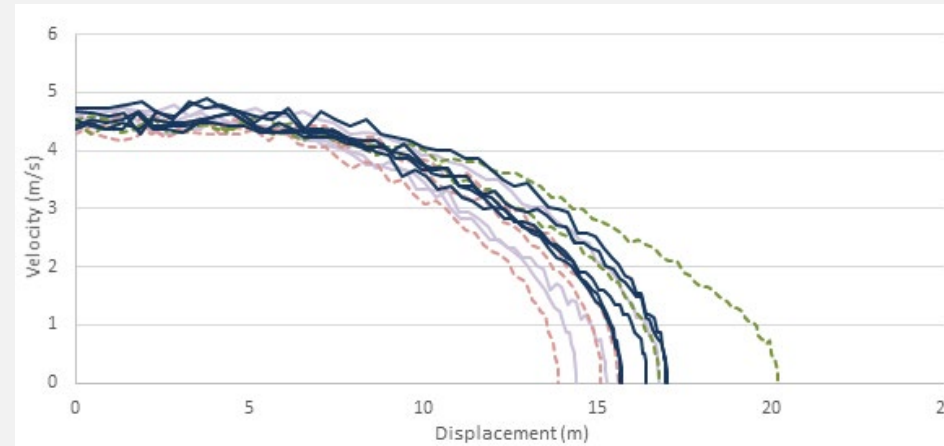
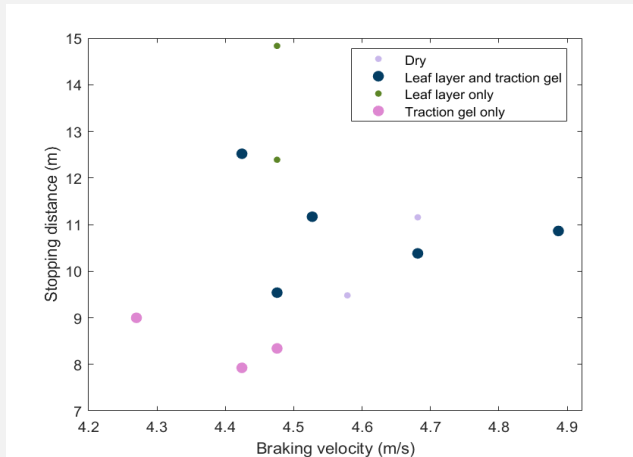
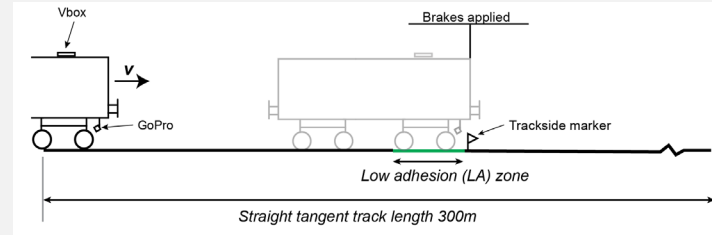


- Twin disc tests
- Generated leaf layer
- Different sized particles in gel tested – friction recovery key criteria
- Isolation also measured



Traction Gels

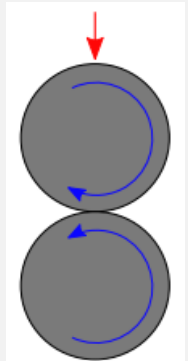
- Development of low adhesion simulation techniques
- Development of standard test approaches for laboratory and field for assessing traction gel performance
- Development of economic framework for traction gel use



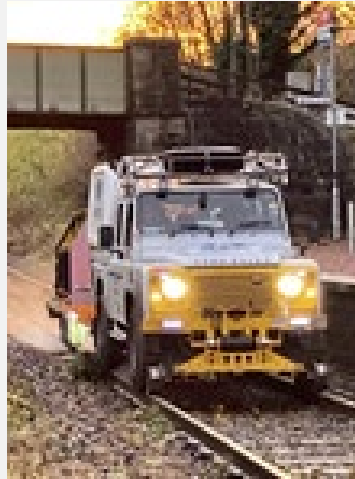
A hand holding a pen over a document with a blue overlay.

Railhead Cleaning

Low Adhesion – Cryogenic Railhead Cleaning



Twin Disc



Field Tests



Network Trials

RIRL1

RIRL6

Kinetic Energy
from compressed
air stream and
pellets

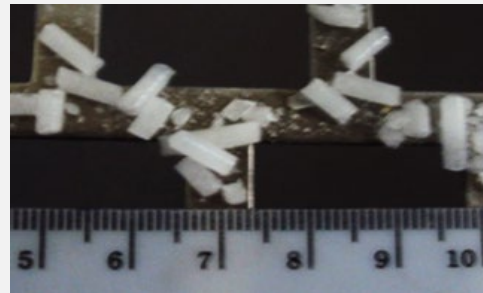
Sudden expansion
of gas aids in
removal of coating

Thermal shock
causes
cracking/weakening
of coating

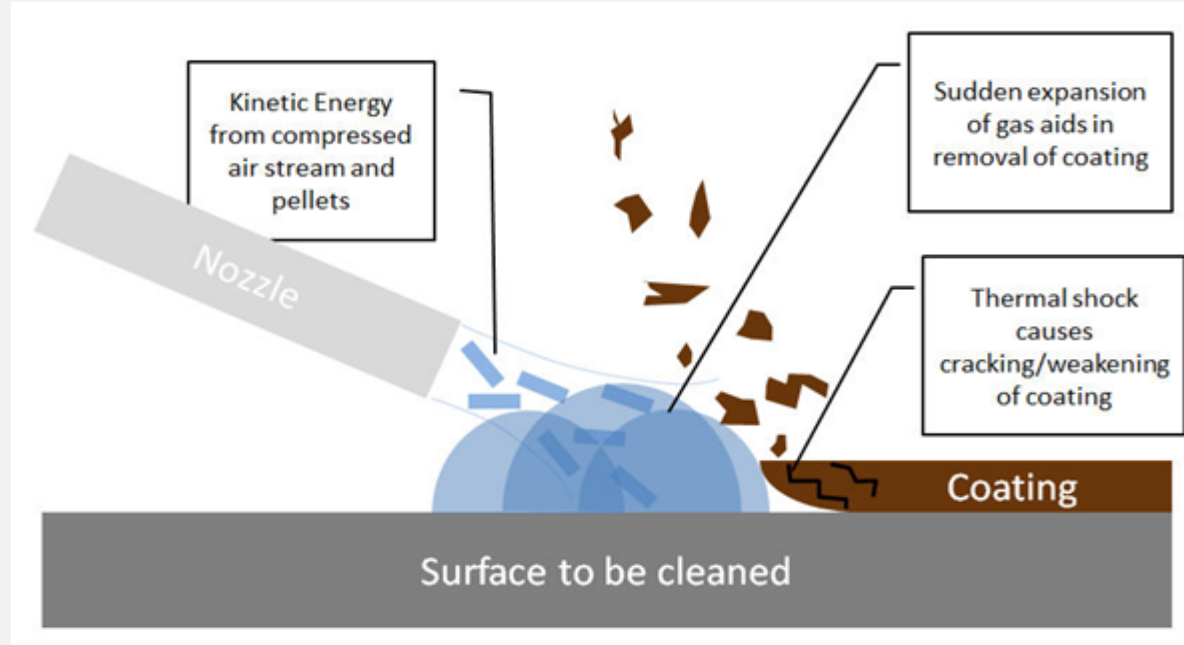
Nozzle

Coating

Surface to be cleaned

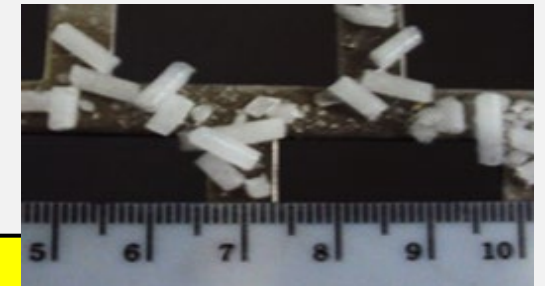


Low Adhesion – Cryogenic Railhead Cleaning



Dry-Ice Pellets:

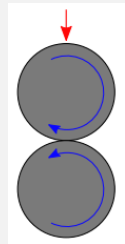
- Food grade
- From CO₂ captured from other processes
- Can be:
 - delivered
 - made in depot
 - made on board



Benefits:

- No residue
- Easy replenishment and maintenance
- No effect on to rail infrastructure (IBJs or ballast - can go over S&C)
- Deals with liquid and solid contaminants
- Flexible application - flow rate and nozzles easily varied; multiple nozzles possible

Rail Head Cleaning using Dry-Ice



Lab testing – small
and full-scale



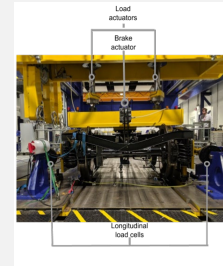
RRV
10mph



NEXUS
RHTT
30mph



Northern
Class 155
Passenger
40mph



HAROLD
full-scale
rig 60mph

Northern
Class
153, on
live
Network



UoS Sheffield Trains
on Network Rail
routes

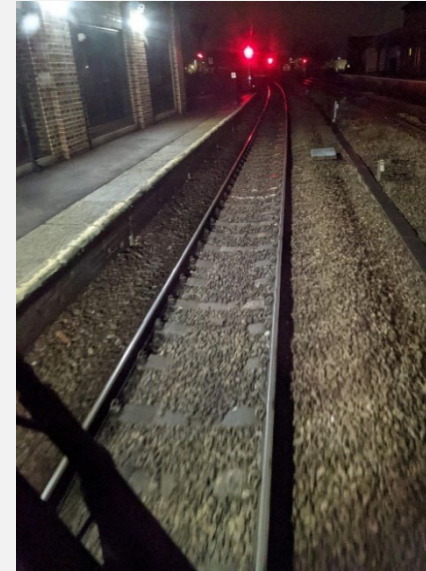


Dry-ice Pellet
Generation System

Rail Head Cleaning using Dry-Ice

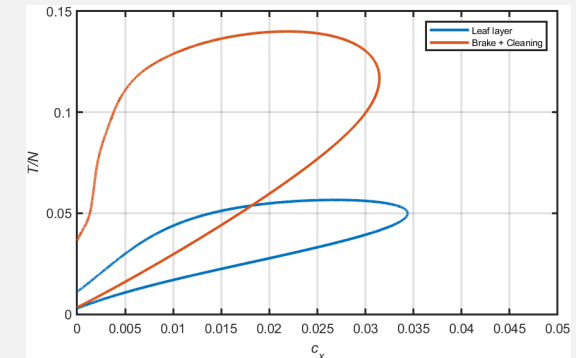
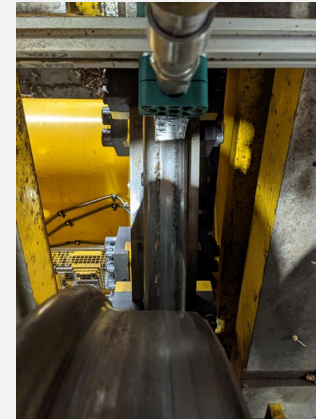
Network Train Trials

- Equipment fully installed onto Class 153
- Trialled over 3 nights - 4 loops per night
- Cleaned at line speed
- ½ mile prior to and post each station
- Braked before and after cleaning



High speed full-scale tests

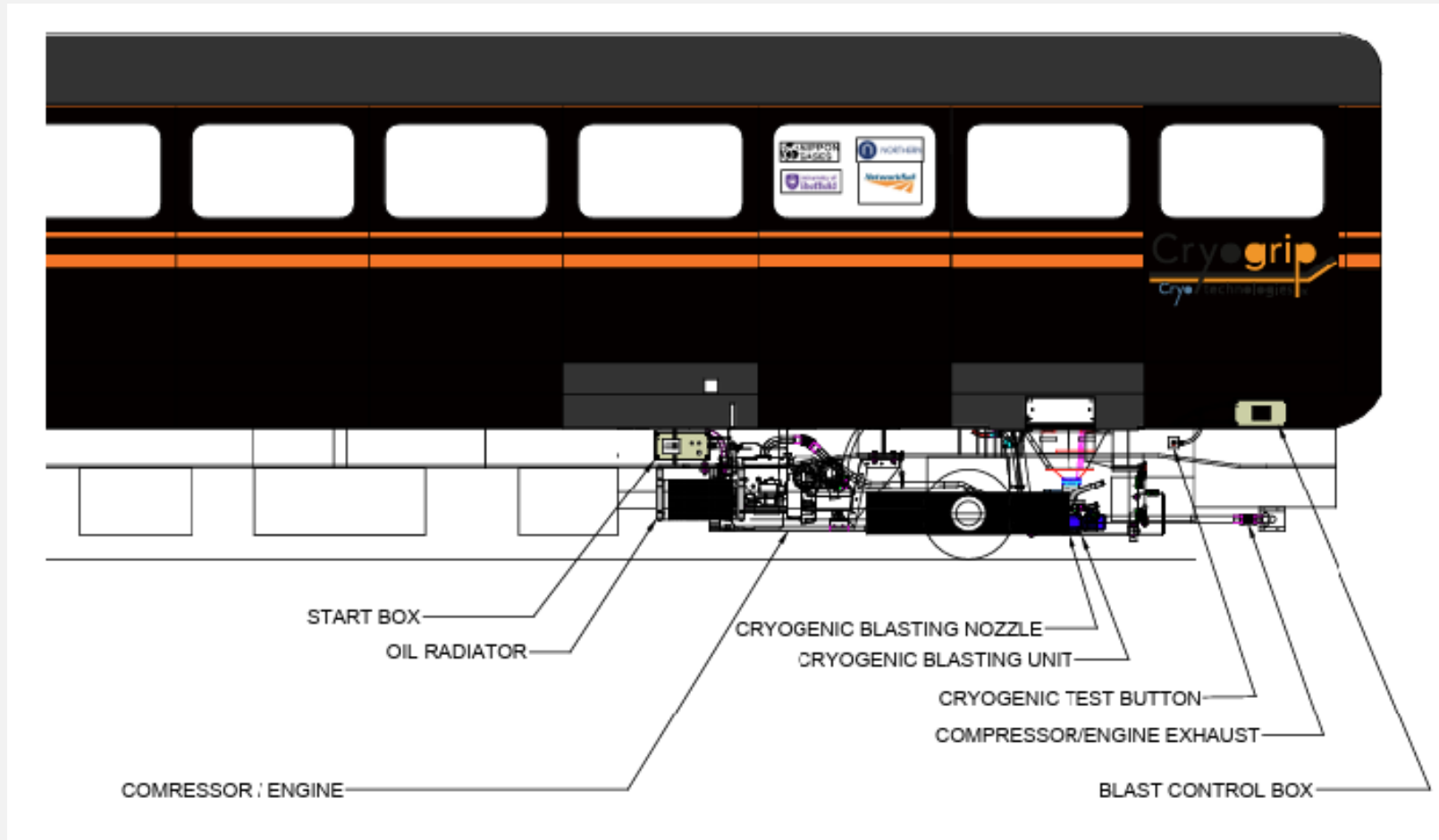
- Layers created on full-scale HAROLD rig and cleaned at 660mph before brake tests were carried out



Rail Head Cleaning using Dry-Ice

Passenger Train System

- Standalone system fitted to a Class 142
- Approved to go on Network Rail routes



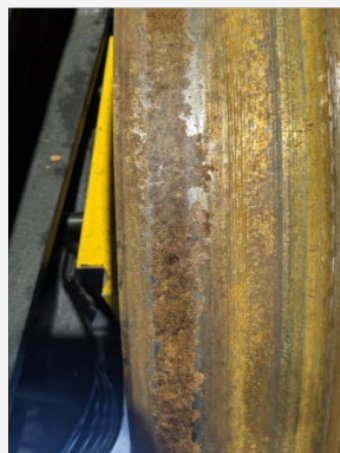
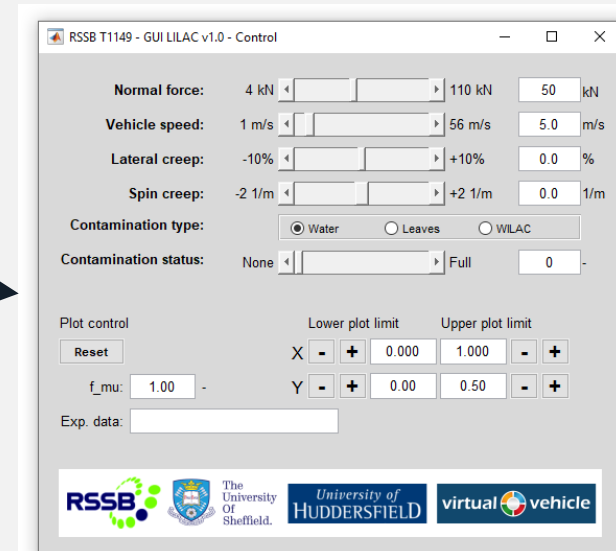
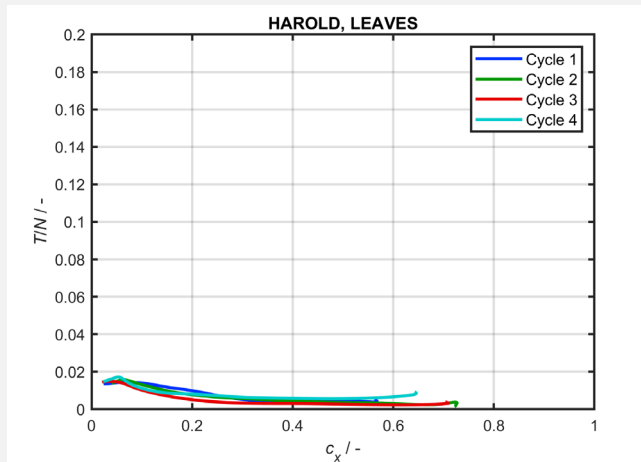
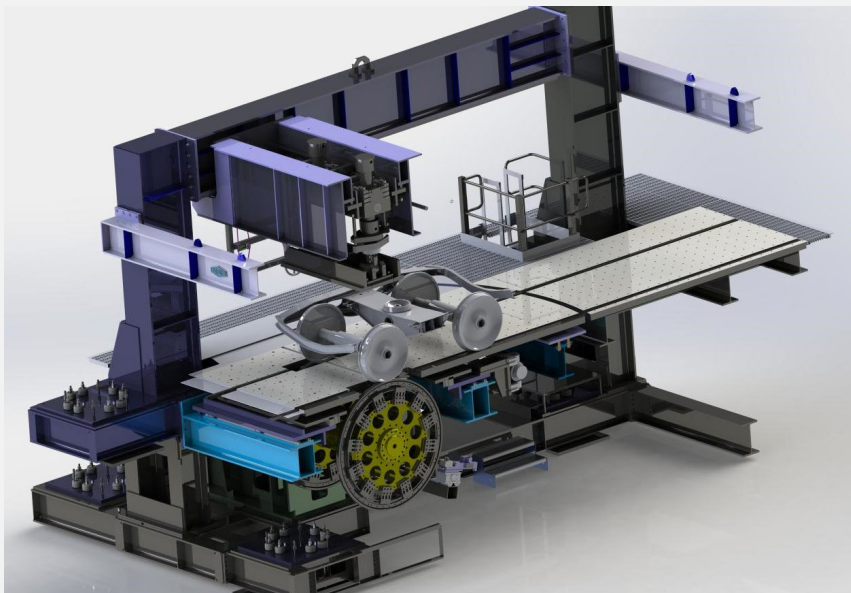
Rail Head Cleaning using Dry-Ice



A hand holding a pen over a document with a blue overlay.

Low adhesion Forecasting

Predictive Models – LILAC



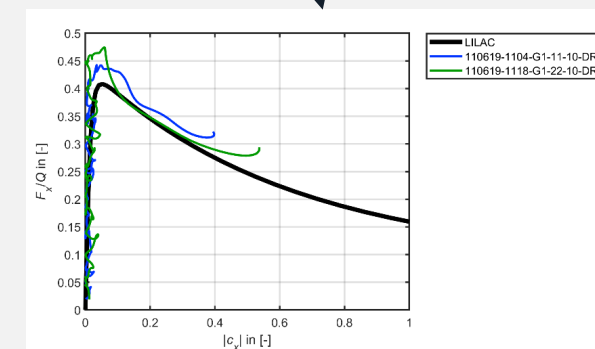
Leaf film pre-test



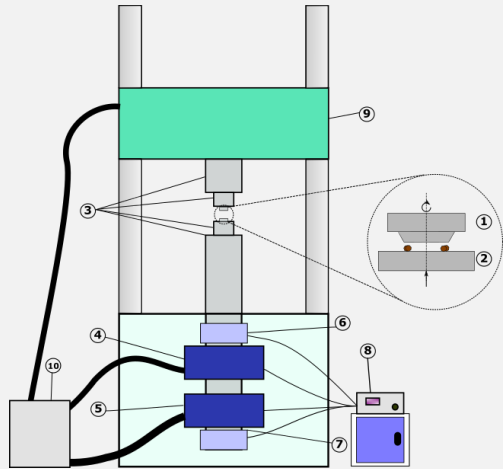
Leaf film post 1 test



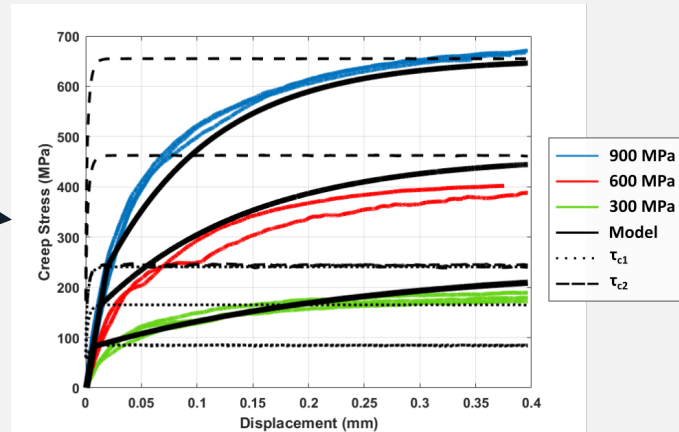
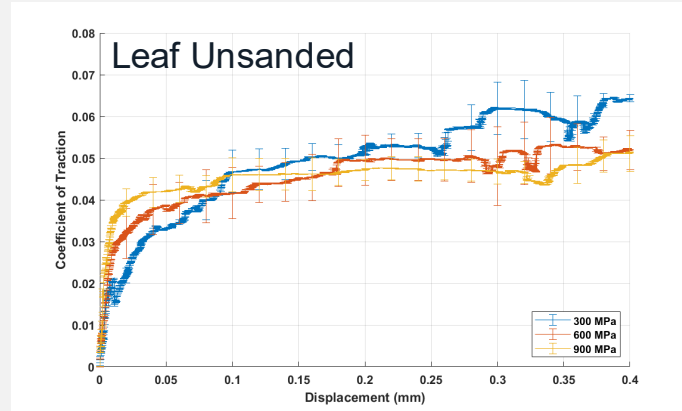
Remaining leaf film post 3 tests



Friction Prediction for Sanding



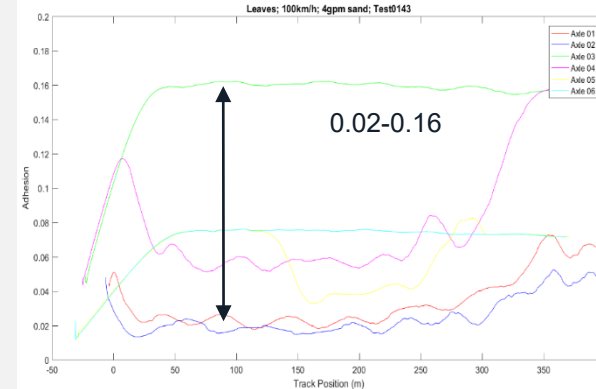
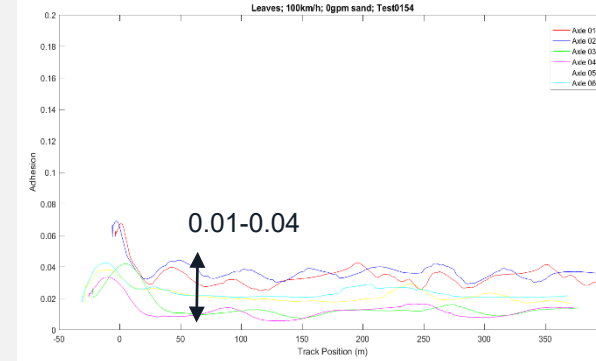
HPT friction tests with sand and leaves



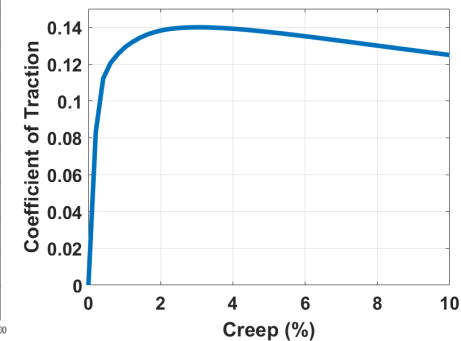
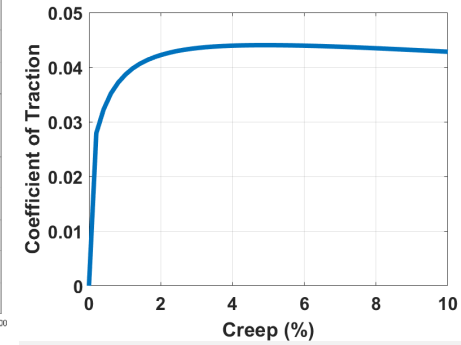
Parameterisation of ECF with HPT data



Advanced Lab Train Data

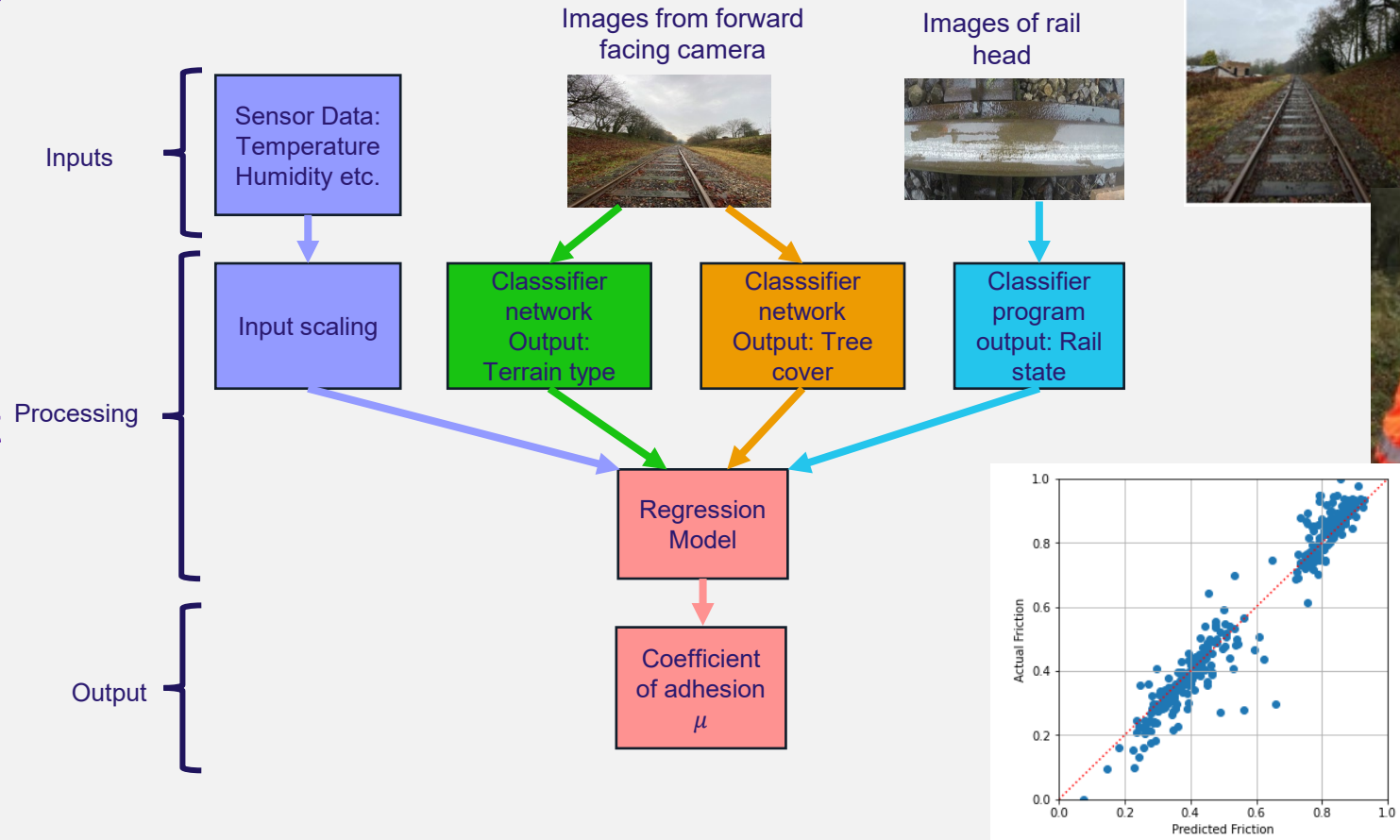


ECF Predictions

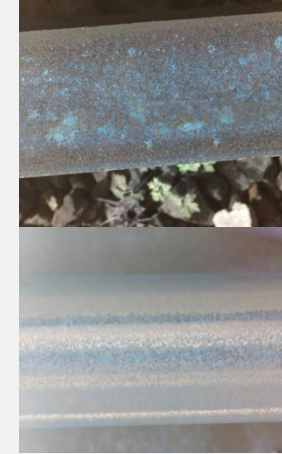


Machine Learning for Friction Prediction

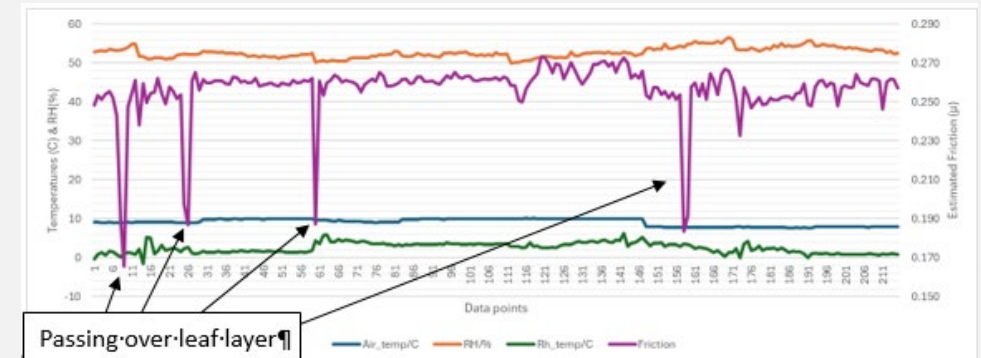
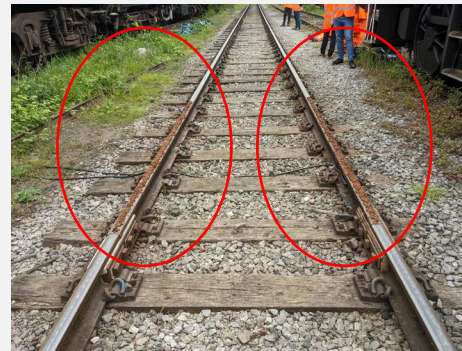
- Aim to develop tool that predicts friction based on data captured around track – images, environment etc.
- Proof of concept carried out capturing static images and friction data
- Moving on now to trail on a train



Machine Learning for Friction Prediction



- Estimations validated using tribometer
- Works on leaf layers now
- Being taken forward in a project with TfL this year
- Licensed by Rivelin Rail



Low Adhesion Risk Model

- Low adhesion risk model developed based on site attributes
- Based around case study route (Chiltern)
- Working on new routes now and comparison with further data from other sources

Parameter		Range				
		3	2	1	0	
Delay frequency						
Tree coverage	Tree species	-	-	Problematic species present	Problematic species not present	4
	Overhanging the line (overhanging/not overhanging)	-	-	overhanging	not overhanging	2
	Linear spread (or density) along the line (packed or spread)	high	medium	low	no trees	10
	Distance from track in m	less than 3m	between 3m and 5m	between 5m and 10m	over 10m	5
Local terrain	Depth of trees (away from track)	over 10m	between 3m and 10m	less than 3m or single tree depth	no trees	8
	Embankment/flat/cutting-shallow sides/cutting-steep sides	steep, high cutting	medium cutting	flat, no cutting	track is raised	9
Key track features	Gradient	1/265 or steeper	between 1/265 and 1/429	less steep than 1/429	flat	7
	Train speed limits	100 or greater	90 - 75	74 - 60	59 or less	3
Service	No. of lines running through station	4	3	2	1	1
Local area	Rural or urban	-	-	Rural	Urban	6
Total						

	<=	49
	between	50
	>=	101



Case Study Sites																	
1 - Gerrards Cross	2 - High Wycombe	3 - Beaconsfield	4 - Great Missenden	5 - Princes Risborough	6 - Claverdon	7 - Leamington Spa	8 - Bearley	9 - Hatton	10 - Old Hill	11 - Chorleywood	12 - Lapworth	13 - Wembley Stadium	14 - Rowley Regis	15 - Wendover	16 - Islip	17 - Kidderminster	18 - Oxford Parkway
3	3	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	0	1	1	1	0	1	1	0	0	1	0	1	0	0
3	3	2	3	1	1	1	1	1	2	2	2	2	2	1	1	2	1
3	3	3	3	2	3	2	3	2	3	3	2	2	3	3	3	2	2
3	1	2	1	1	1	1	1	2	2	2	3	2	1	1	2	1	1
3	3	3	2	1	1	1	1	1	2	1	2	2	1	1	1	2	1
3	1	3	1	3	0	3	0	0	3	3	1	3	3	3	0	0	0
3	2	3	2	2	3	2	1	2	0	1	3	3	0	2	3	0	0
3	3	3	0	3	0	2	0	2	1	0	1	3	0	0	0	0	0
0	0	0	1	1	1	0	1	1	0	1	1	0	0	1	1	1	1
135	102	117	96	77	63	72	57	63	97	96	99	101	79	79	71	66	47

A hand holding a pen is positioned over a document, with a blue overlay covering the entire image. The word "Summary" is written in white text across the center of the image.

Summary

Summary

- Low adhesion mechanisms quite well understood except those for non-visible contamination
- Some data on low mitigation – sanding and traction gels, less for other mitigations – more testing needed
- New railhead cleaning methods emerging
- Friction prediction and forecasting tools developed



NORTHERN

Managing Low Adhesion

Rob Cummings

Seasonal Performance Improvement Manager



Go do your thing

Autumn



Safety Incidents:

Signals Past at Danger (None in 2025, 8 since 2008)

Station Overruns (17 in Autumn 2025)

Wrong Side Track Circuit Failures

Delays

Northern incurred 87,500 delay mins in Autumn 2025, an 8.5% improvement on 2024.

Wheel flats

Peaked in 2018 with 308 units stopped with flats during the Autumn Season. Has since diminished as fleets have been withdrawn and other fleets upgraded. Now less than 20 per season.

Signals Passed At Danger



Salisbury October 2021



Talerddig October 2024

Pihotos: Rail Accident Investigation Branch

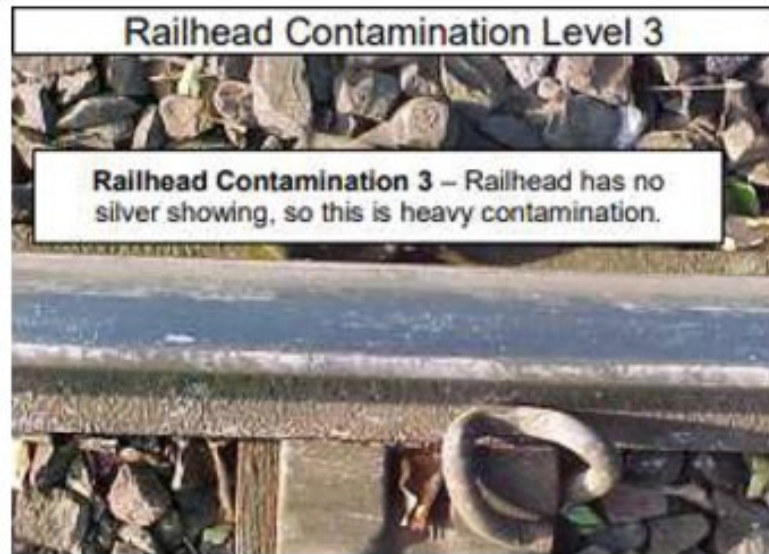
Problem Statement



- Circular air currents generated by the front of a moving train pick up leaves and drop them onto the railhead in front of the train wheels.
- The wheels then crush these leaves at very high pressure onto the top of the rail forming a Teflon like coating.
- Add in a little moisture, dew or light rain, coupled with compressed leaf debris on the rail that reduces the adhesion between wheel and rail, causing the wheels to slip or in extreme cases lock up and slide.



- 
- Trains with steel wheels running on steel rails - Low Friction System
 - The contact point between the wheel and rail is approximately the size of a five pence coin
 - All the traction and braking forces of a train are transmitted through this small area.
 - In autumn the advantage enjoyed by the railway becomes its' Achilles Heel as low adhesion caused by leaf fall impacts on our ability to brake and accelerate trains at the same rate as during the rest of the year.

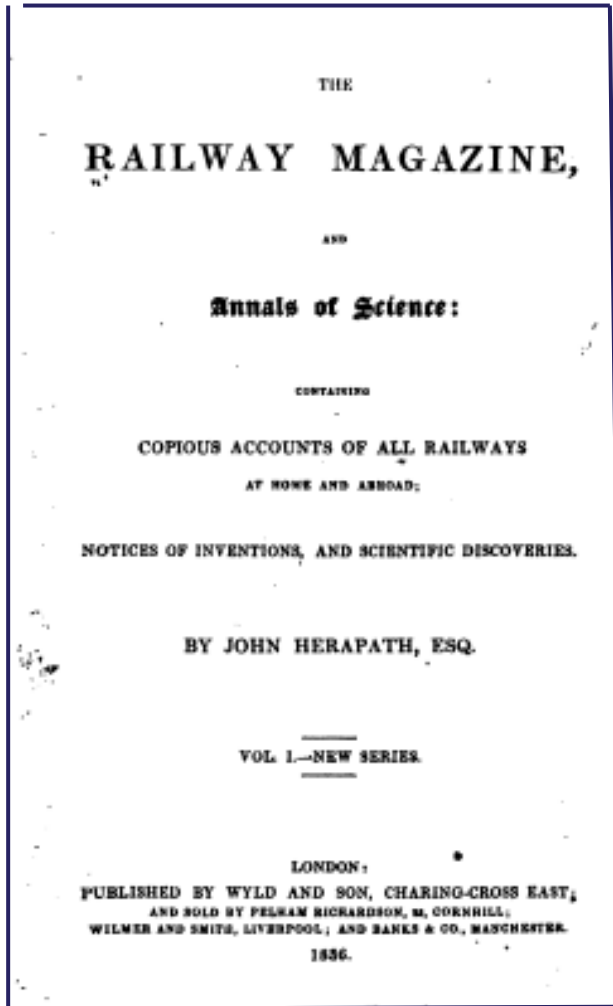


Go do your thing

Photos: Network Rail



A new problem?



In Railway Magazine there is an 1836 Article describing (albeit with a different form of contamination) how dry contamination isn't problematic, how very wet weather can clear it off, but damp weather is the most problematic (describes the modern-day issue).

Refers to a locomotive struggling up the Whiston Plain Bank (this location still exists on the Northern network between Liverpool and Manchester) and refers to two men on the front of the locomotive throwing sand on the rails.

"A remedy, however, I think it would not be difficult to find"

What else has changed?



- The replacement of first generation locomotive hauled trains and Multiple Units with lightweight DMUs and EMUs in the 1970/80s.
- These trains were not fitted with sanding equipment.
- Modern units fitted with disc brakes, and some use a combination of disc and rheostatic brakes.
- Higher adhesion demands to support higher acceleration and braking of modern rolling stock. come to the fore.
- More lineside vegetation

It first became a problem in...

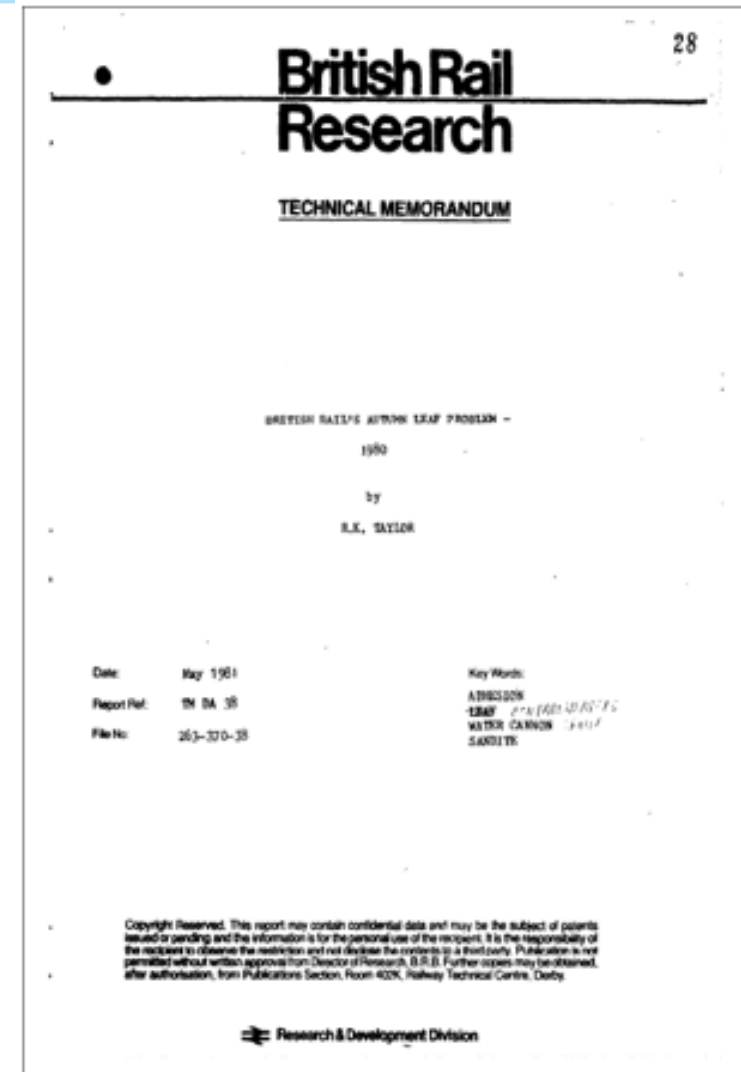
BR Research Paper in 1980

Followed problems with new fleets introduced on Merseyrail and South Western and with first generation trains on Chiltern.

Recommendations Implementation of a tree clearance programme ensuring the complete removal and burning (!) of debris

Also suggested a sprinkler system in the four foot at high-risk locations which sprays water onto the railhead to replicate heavy rainfall.

Go do your thing

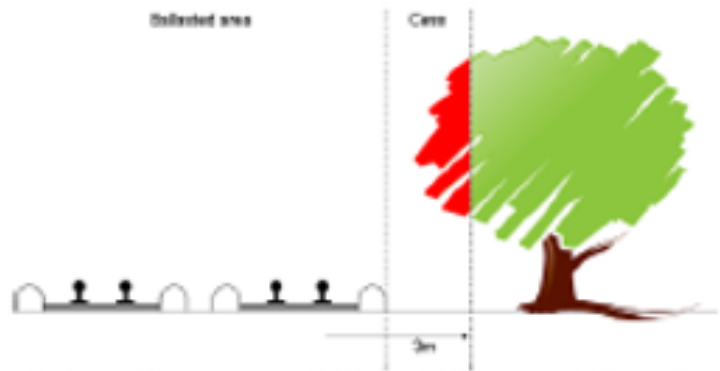


Vegetation – How did we get here?

- End of steam traction removing the risk of lineside fires
- Reductions in maintenance budgets
- Changes to maintenance practices
- Legislation
 - 1983 Wildlife and Countryside Act
 - Clean air acts
- Objections from lineside stakeholders

The Old Network Rail Standard

NR/L2/TRK/5201



– Schematic representation of the vegetation structure when linespeed <60mph; **red**, prohibited; **green**, allowed.

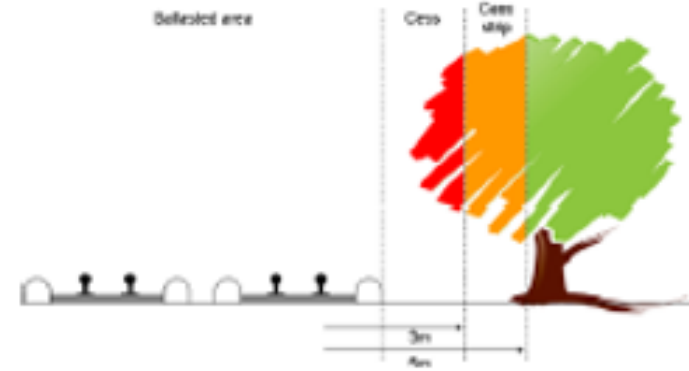
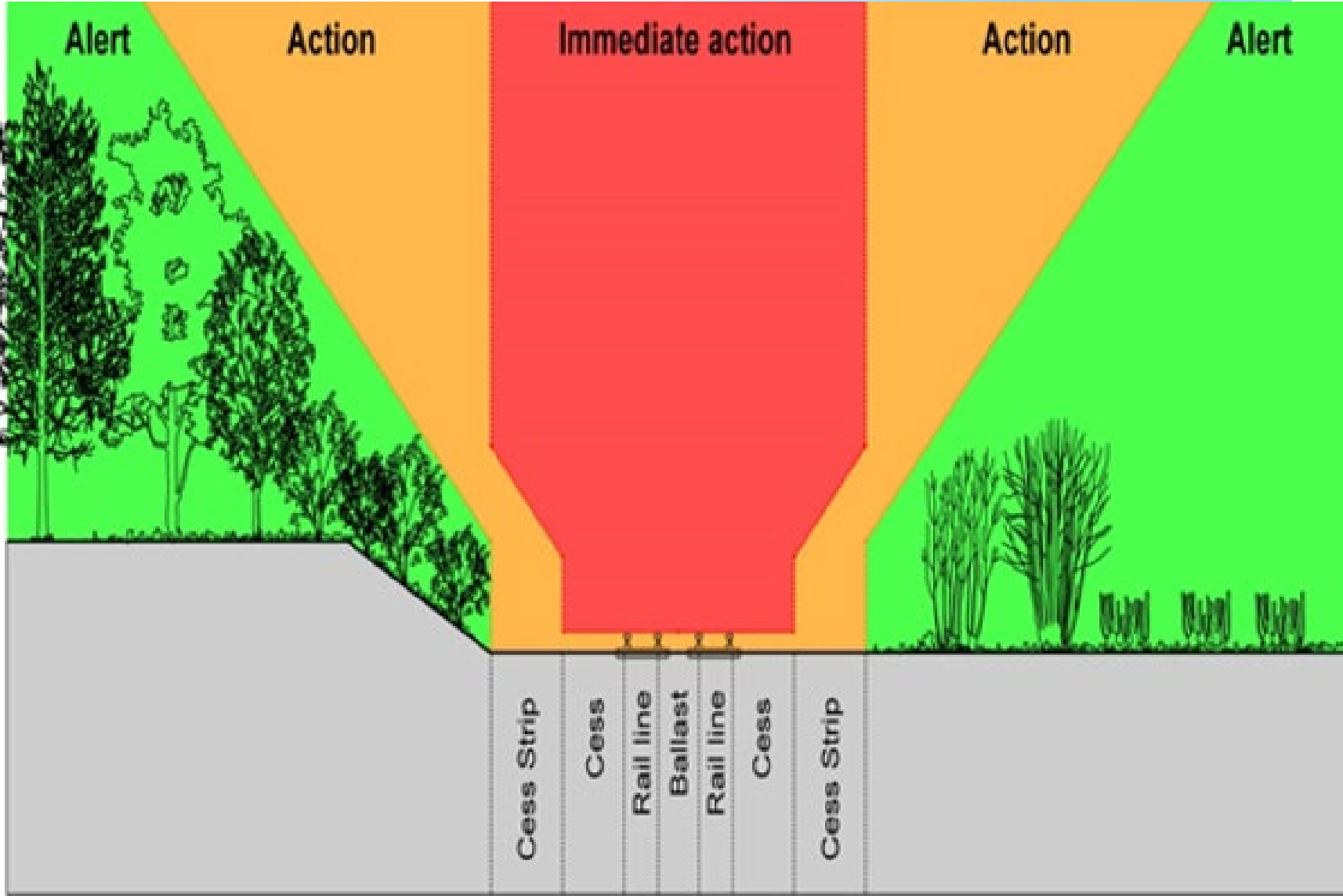


Figure 5 – Schematic representation of the vegetation structure when linespeed ≥ 60 mph; **red**, prohibited; **amber**, action where required; **green**, allowed.

Since 2018



Go do your thing



Vegetation at Salisbury



Go do your thing

Pictures: Rail Accident Investigation Branch



1966



Go do your thing



Autumn Mitigations-Seasonal Fleet



Go do your thing

Photos: Network Rail



RHTT Disadvantages

- Dedicated train – very expensive (£65million nationally each autumn)
- Lost treatment due to clashes with engineering possessions
- Lost treatment due to equipment failures
- Most routes only get treated once/day, six days per week
- Route restrictions limit use of modern locos.
- MPVs are obsolete – need a replacement strategy for the end of CP7 – multi million pound procurement

Autumn Mitigations – TGAs and Manual Treatment



Photos: Network Rail

Go do your thing



Northern Mitigations

From This.....



To This



Go do your thing



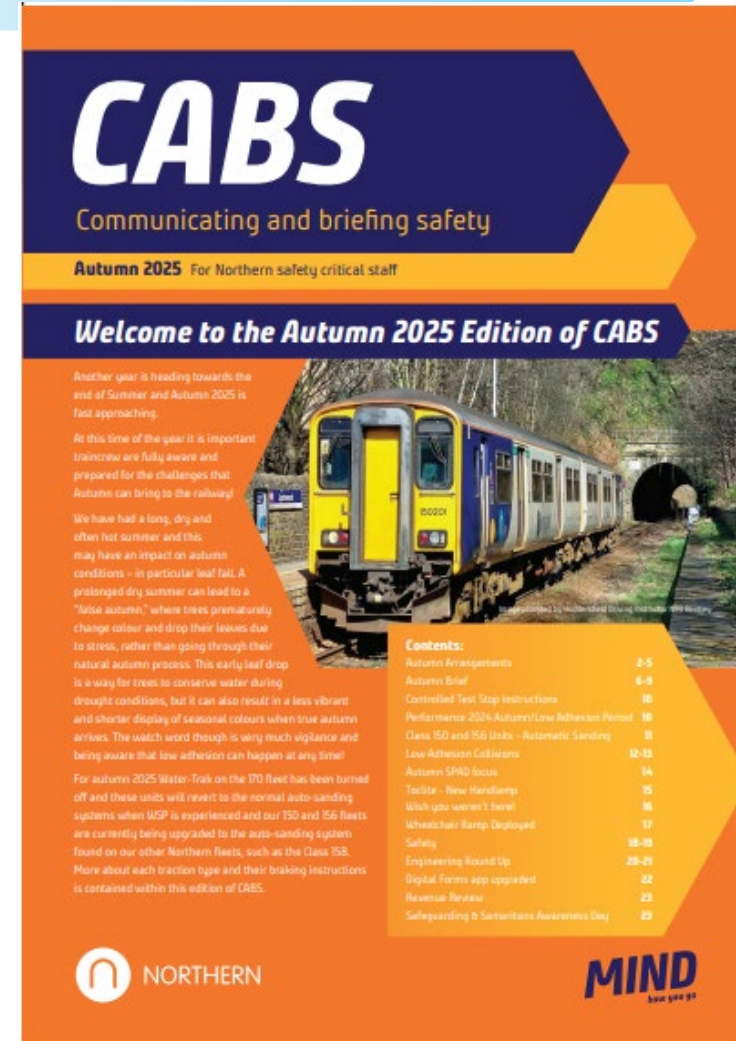
Northern Mitigations

- Wheelslide Prevention Systems retrofitted to all Class 15x fleets (apart from seven Class 155s)
- Data from CAF Fleet can be observed in real time through the Leadmind Portal (Similar system being rolled out for legacy fleets)
- Double Variable Rate Sanders fitted to the Class 323 fleet for Autumn 2024
- Water-Trak fitted to the Class 170 fleet
- Wheel lathes installed at all Northern Traincare Centres (apart from Heaton)

Northern Drivers

- Drive to the conditions
- Brake earlier than at other times of the year
- Use the correct braking instructions for the type of train
- Carry out regular “Running Brake Tests”
- If in doubt place the brake into Emergency
- All newly qualified drivers to undertake a face-to-face briefing prior to 1st October
- Northern to install new driver simulators that will give some experience of driving in low adhesion conditions

Go do your thing



Whiteboards

- Whiteboards are installed at all driver depots and are used by drivers to inform others about areas of concern.
- If conditions are worse than expected for the time of year, conditions are said to be “Reportable” and signaller should be informed.

LEAF FALL BOARD			
DATE	TIME	LINE OF ROUTE	EXPECTED / REPORTABLE
18/10/25	17.15	APPROACHING PARK NORTH UP DIRECTION SLIDE. 195	EXP.
SUN 19/10/25	12:18	- ASKAM UP MAIN PLATFORM	EXP.
	12:22	- SMALL SLIDE 10 MPH (195123) - PARK NORTH CROSSING UP MAIN.	EXP.
SUN 19/10/25	12:06	- WILKINSON / SLIDE / UP MAIN / BETWEEN BOX + PLATFORM	EXP.
	12:13	- CARL / SLIDE / UP MAIN / ON APPROACH + PLATFORM	EXP. 195#
	12:21	- GRANGE / SLIDE / UP MAIN / BATHING POOL → PLATFORM	EXP.
	12:35	- SILVERDALE / SLIDE / UP MAIN / LOW SPEED SLIDE (5 MPH) COMING TO A STOP	REPORTABLE.
SAT 18/10/25	20.15	DOWN @ RAVENGLASS WHEELSLIDE TROUBLE TAKING POWER Emergency Brake App. due to slipping	EXP. 195.
TUE 21/10/25	06:01	ASKAM DOWN APPROACH SLIDE / AWAY SLIP	EXP 156
	08:09	BOOTH UP AWAY SLIP	EXP 156
	08:17	SILECROFT UP AWAY SLIP	EXP 156
21/10/25	07.01	ASKAM DOWN - SLIDE / SLIP	195. EXP.
	07.15	GREEN ROAD DOWN - SLIP	
	08.06	RAVENGLASS UP - SLIP	
	09.15	BOOTH UP SLIDE + SLIP ASKAM UP - STRUGGLE OUT OF PLATFORM	
22/10/25	21:06	SILECROFT / UM / SLIP LEAVING / 156	EXP.

Reportable (ROLA)

- When a driver experiences “Reportable” they should contact the signaller and complete a form with them.
- This will generate a visit by a Network Rail Mobile Operations Manager who will inspect the track and carry out manual cleaning as required.

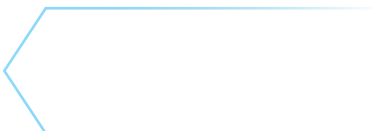


T (Track)
I (Is)
G (Good)
E (Expected)
R (Reportable)

Levels of rail adhesion
There are three levels of rail adhesion conditions:

Level	Definition
Good	Rail adhesion conditions are good.
Expected	Rail adhesion is no worse than would be expected for the location and environmental conditions.
Reportable	Rail adhesion is worse than would be expected for the location and environmental conditions.

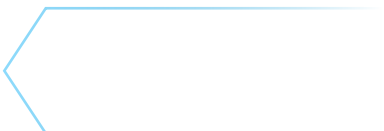
Sanders



- Sanders are now fitted to all UK trains
- Deposit sand at a fixed rate of 2kg/minute
- “Open system” no indication that the pipes are blocked
- Northern CAF fleet found to be dropping insufficient sand in Autumn 2023. High proportion of station overruns with CI331
- Subsequent investigation found oil contamination and blocked bleeder valves
- £400k rectification programme completed in Sept 2024

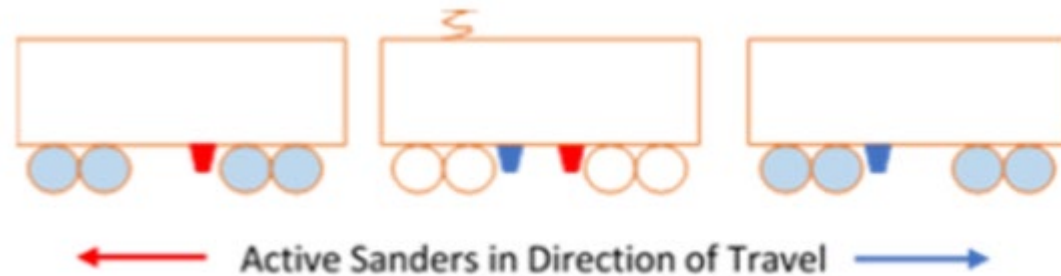
Innovation Projects



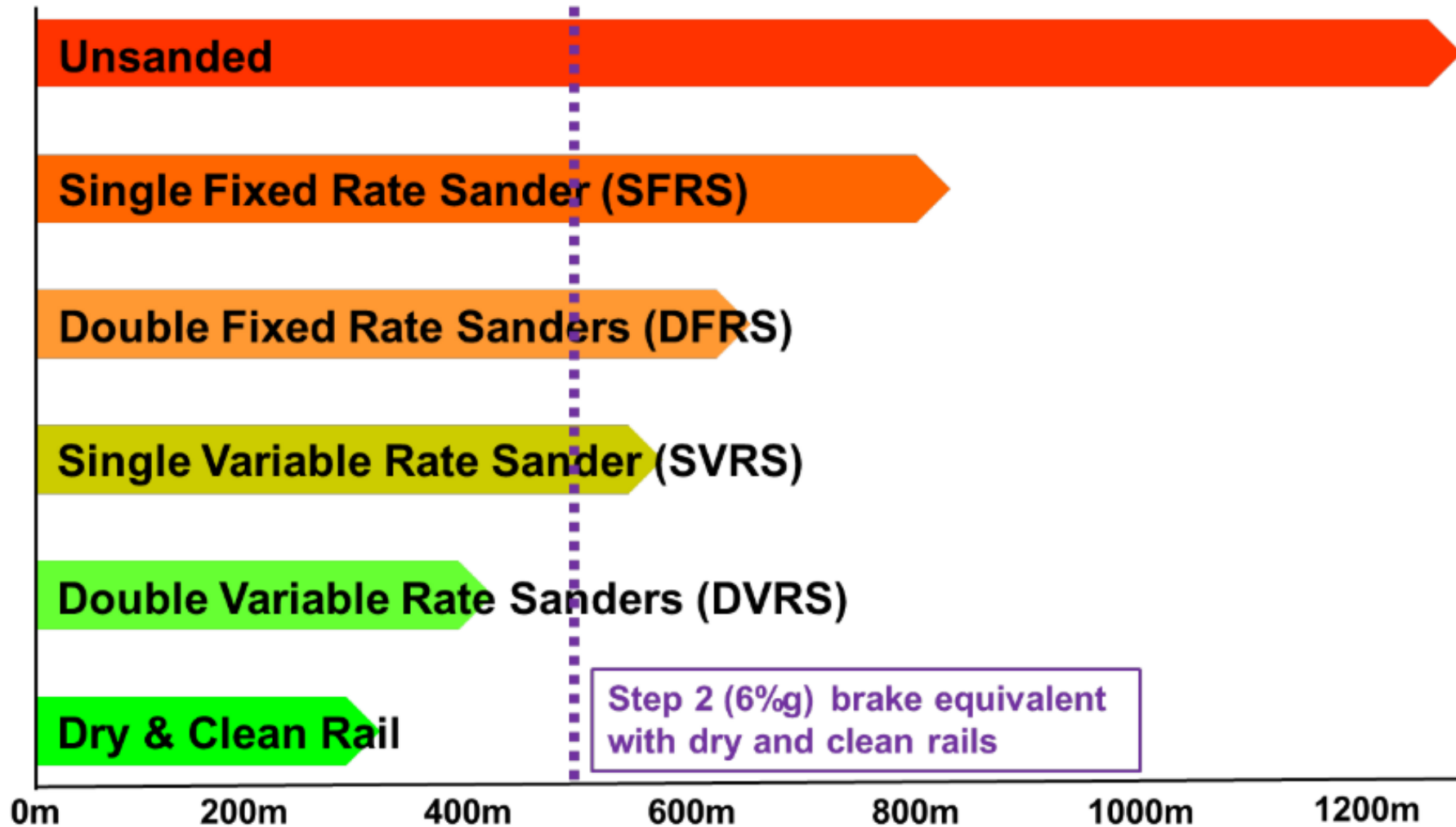
- Funding from Network Rail's Performance Innovation Fund 
- Double Variable Rate Sanders
- Water-Trak
- Cryogenic Railhead Cleaning

Double Variable Rate Sanders

- First trials carried out by the RSSB in 2017
- Class 323 chosen because it was easier (and cheaper) to install
- Drops sand at between 2 and 4 kg/min ahead of the 3rd and 7th axles
- Benefit of sand spread along the train



Double Variable Rate Sanders



Go do your thing



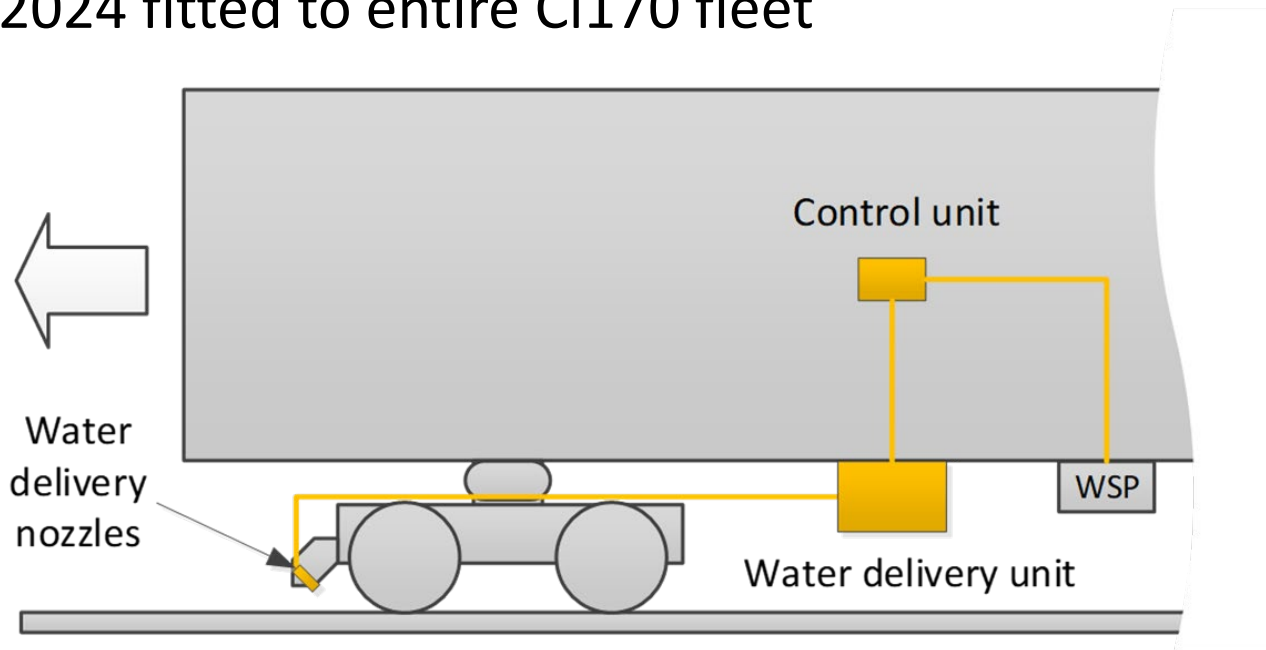
Double Variable Rate Sanders

- All Northern Class 323s are now fitted and operating with DVRS
- No safety of the line incidents with Class 323s in 2024 or 2025
- Evaluation process carried out post season to assess any performance benefit
- It may take 2-3 seasons to build driver confidence
- South Western Railway – Single Variable Rate Sanders on CI158/159
- Future roll out requires a business case – currently expensive and potentially overcomplex
- Fitment to future new build fleet more viable



Water-Trak Autumn trials with Northern

- Prototype systems fitted at either end of a Northern Class 319 service train (319368) in October 2020.
- 2024 fitted to entire CI170 fleet



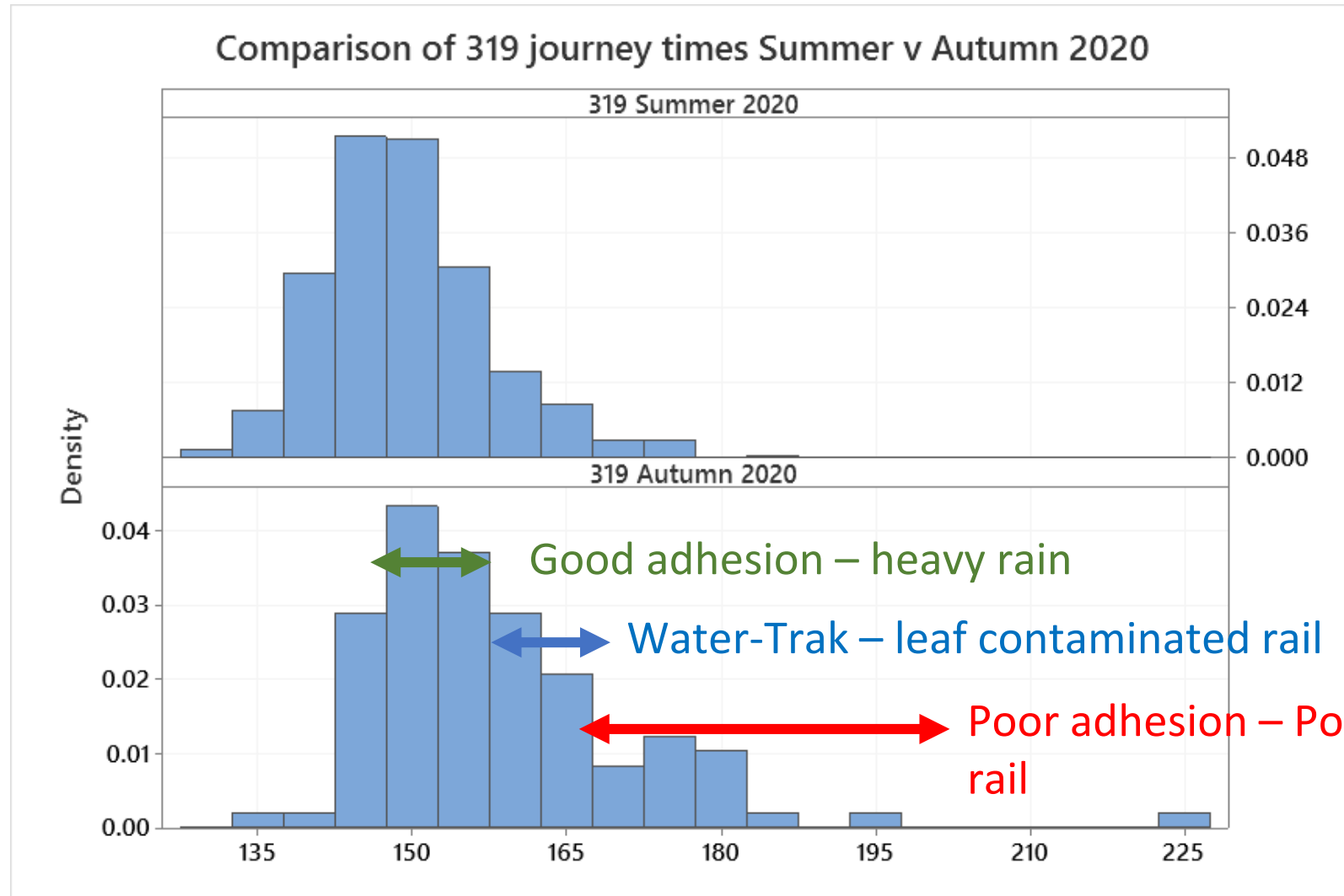
Pressure: 7 Bar

Flow rate: 3 Litre/min = 1 to 4 ml/metre



Pictures: Water-Trak

Operational benefits

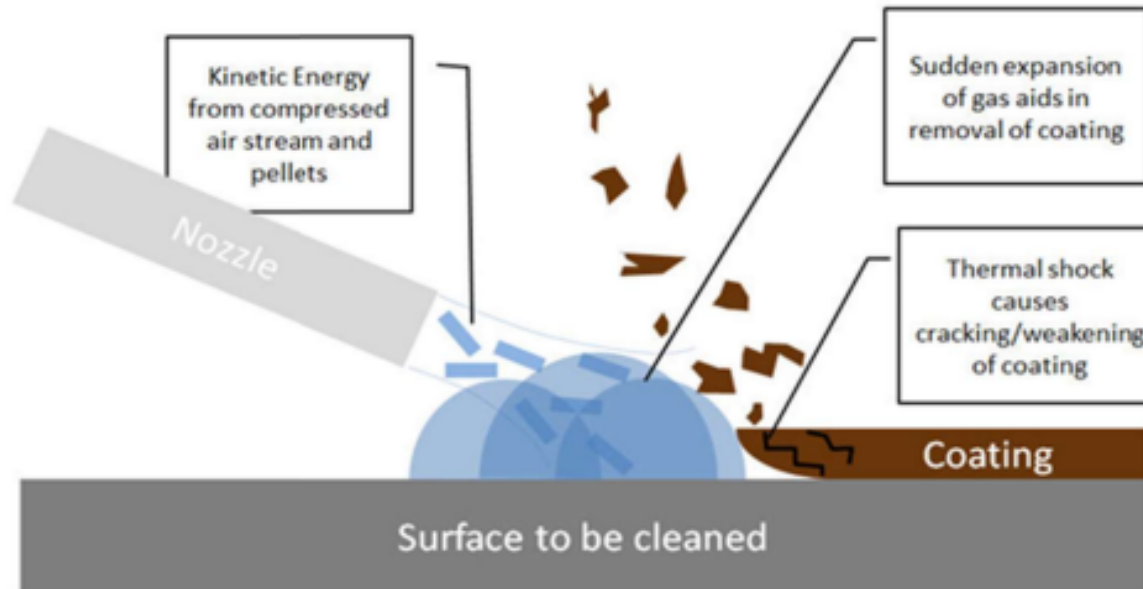


Analysis of actual Class 319 Garswood to Bryn journey times

- Average autumn delay of 8.4 seconds
- Journey time variation doubled
- Class 331 data is similar

Autumn trial results

Our Technology

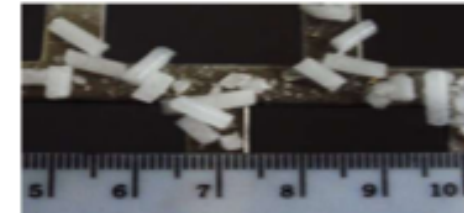


Dry-Ice Pellets:

- Food grade
- No chemicals
- No residue
- By-product
- Cheap
- Readily available
- Low usage

General Benefits:

- Can be applied off a variety of platforms
- Small space envelope
- Effective cleaning proven
- No impact on other track infrastructure



Cryogrip

To **improve** railway network **performance** and **safety** through step change in rail head cleaning



Before

After



Our Products



AI friction rail head
assessment tool for
“Smart” cleaning

Passenger
train



RHTT -
light rail or
mainline



RRV



Dry-ice Pellet
Generation System
– for use on RHTT
or in depot



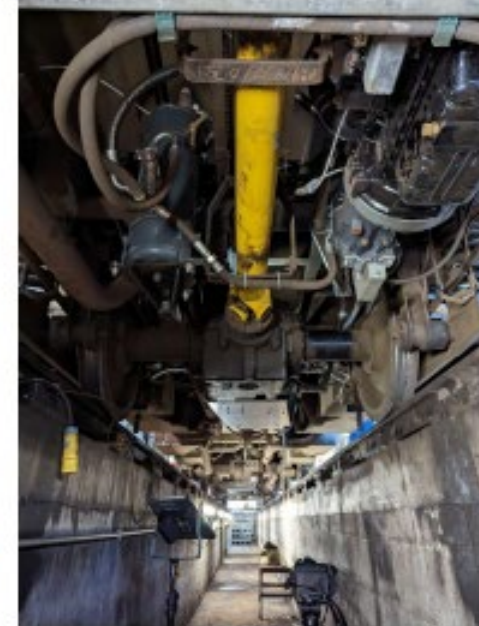
Passenger Train

- In-saloon system developed for use on Class 153 and Class 155 Northern trains
- Trials carried out in 2021 and 2022 on freight line near Monk Bretton – black leaf layer even in March!
- Network trials run in 2022 at Holbeck Depot to Kirkgate



Next Steps

- Bought Class 142 trains to develop cleaning demonstrators
- Designed underslung cleaning system



Go do your thing



The Future

- Compliant linesides won't completely solve the problem as there are 3rd party trees adjacent to the boundary. But it will provide a significant improvement and reduce the impact of fallen trees across track in storm events.
- Autumn Agnostic Trains fitted with DVRS/Water-Trak
- We will still need railhead cleaning, but could it be delivered on service trains
- Magnetic Train brakes? Widely fitted on UK trams and continental railways. Would be very difficult to retrofit but an opportunity for new train fleets.

THANK YOU. ANY QUESTIONS?



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