

Pantograph condition monitoring, and other techniques used to monitor Overhead Line Equipment on Network Rail's Wales & Western region



Jai Parhar BEng – Asset Engineer (OLE Mtce support)

Darrel Tiddy – IEng IET – Senior Asset Engineer (OLE Mtce support)

Agenda

- The pantograph and Overhead Line Equipment (OLE) interface
- Why is it important to monitor pantographs
- Early systems for monitoring pantographs (Panchex)
- How we used to do pantograph monitoring
- PanVue – System Overview
- Applicable Network Rail Standards
- PanVue Maintenance and System Support
- PanVue Lens Cleaning
- PanVue Case studies
- Thermal Imaging of OLE
- Conclusion
- Acknowledgements
- Q&A

The pantograph and OLE interface

- A balancing act.
- Numerous influences.
- Design vs construction.

If all goes well then it looks something like this...



Why is it important to monitor pantographs?

- Early detection that something is wrong with OLE infrastructure.
- Early detection that something is wrong with pantograph set-up.
- Provides a status on the overall carbon condition.
- Ultimately can reduce the likely hood of dewirement and other service affecting failures.



Missing pantograph upper assembly - 2024

Panchex – the fore runner to modern digital systems

1997 Electrification of Paddington – Heathrow Panchex (Delta Rail system) installed at Southall to measure pantograph up-lift. System went out of use during early 2000s. **Major incident December 2017.**



Panchex at Chadwell Heath (courtesy of PWI)

Great Western Mainline Electrification – EIS

July 2017 Platform 1 Paddington wired

May - Oct 2017 Stockley – Maidenhead

January 2018 Platform 2 Paddington wired

January 2018 to Didcot

October 2018 to Swindon

January 2019 to Bristol Parkway

January 2019 to Newbury

April 2019 to Chippenham

January 2020 to Cardiff

June 2020 through the Severn Tunnel

How we used to do pantograph monitoring (**mid 2000s – 2017**)

- Notified of pantograph issues by the TOCs
- Placing staff on overbridges and Paddington transfer deck with binoculars – often hours at a time
- Finding damage on the infrastructure – sometimes days or week after reports of damage
- Damage sometimes reported by track maintenance staff / members of the public.

TIME CONSUMING AND LEFT FOR CHANCE



PanVue System Overview

1. Westbourne Park x2
2. Heathrow x2 (not shown, owned by Heathrow Ltd)
3. Southcote x2
4. Didcot x4
5. Bristol x2



2/5 of these sites are undergoing soak testing with the remaining 3 in full operational use.

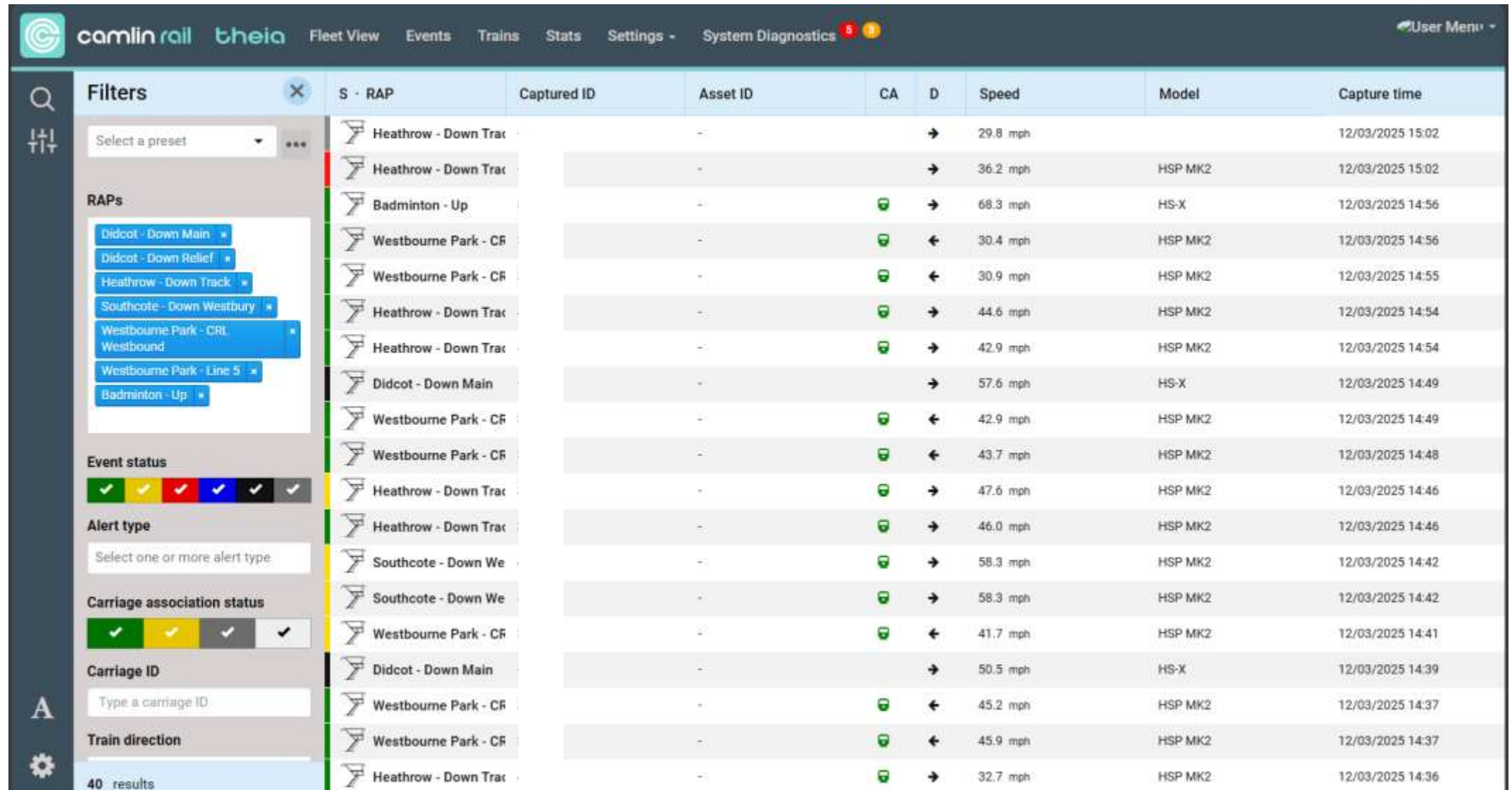
Other PanVue systems are currently being installed nationally.

PanVue System Overview



Heathrow Portal (tunnel mouth), Westbourne Park (overbridge) and Didcot (portal) installations

PanVue System Overview



The screenshot displays the PanVue System Overview interface. The top navigation bar includes 'camlin rail', 'theia', and several menu items: 'Fleet View', 'Events', 'Trains', 'Stats', 'Settings', and 'System Diagnostics' (with a red '5' and a yellow '1' badge). A 'User Menu' is visible in the top right corner.

On the left side, there is a sidebar with a search icon, a 'Filters' section with a 'Select a preset' dropdown, and several filter categories: 'RAPs' (with a list of RAPs like 'Didcot - Down Main', 'Heathrow - Down Track', etc.), 'Event status' (with color-coded checkboxes), 'Alert type' (with a 'Select one or more alert type' dropdown), 'Carriage association status' (with checkboxes), 'Carriage ID' (with a 'Type a carriage ID' input), and 'Train direction'.

The main table displays train movement data with the following columns: 'S - RAP', 'Captured ID', 'Asset ID', 'CA', 'D', 'Speed', 'Model', and 'Capture time'. The table shows 40 results, with the first few rows listing movements from Heathrow, Badminton, Westbourne Park, and Didcot.

S - RAP	Captured ID	Asset ID	CA	D	Speed	Model	Capture time
Heathrow - Down Track	-	-	-	→	29.8 mph	-	12/03/2025 15:02
Heathrow - Down Track	-	-	-	→	36.2 mph	HSP MK2	12/03/2025 15:02
Badminton - Up	-	-	🟢	→	68.3 mph	HS-X	12/03/2025 14:56
Westbourne Park - CF	-	-	🟢	←	30.4 mph	HSP MK2	12/03/2025 14:56
Westbourne Park - CF	-	-	🟢	←	30.9 mph	HSP MK2	12/03/2025 14:55
Heathrow - Down Track	-	-	🟢	→	44.6 mph	HSP MK2	12/03/2025 14:54
Heathrow - Down Track	-	-	🟢	→	42.9 mph	HSP MK2	12/03/2025 14:54
Didcot - Down Main	-	-	-	→	57.6 mph	HS-X	12/03/2025 14:49
Westbourne Park - CF	-	-	🟢	←	42.9 mph	HSP MK2	12/03/2025 14:49
Westbourne Park - CF	-	-	🟢	←	43.7 mph	HSP MK2	12/03/2025 14:48
Heathrow - Down Track	-	-	🟢	→	47.6 mph	HSP MK2	12/03/2025 14:46
Heathrow - Down Track	-	-	🟢	→	46.0 mph	HSP MK2	12/03/2025 14:46
Southcote - Down We	-	-	🟢	→	58.3 mph	HSP MK2	12/03/2025 14:42
Southcote - Down We	-	-	🟢	→	58.3 mph	HSP MK2	12/03/2025 14:42
Westbourne Park - CF	-	-	🟢	←	41.7 mph	HSP MK2	12/03/2025 14:41
Didcot - Down Main	-	-	-	→	50.5 mph	HS-X	12/03/2025 14:39
Westbourne Park - CF	-	-	🟢	←	45.2 mph	HSP MK2	12/03/2025 14:37
Westbourne Park - CF	-	-	🟢	←	45.9 mph	HSP MK2	12/03/2025 14:37
Heathrow - Down Track	-	-	🟢	→	32.7 mph	HSP MK2	12/03/2025 14:36

Measures: carbon wear, pantograph orientation, carbon chipping, uplift and horn orientation

PanVue System Overview

Westbourne Park  

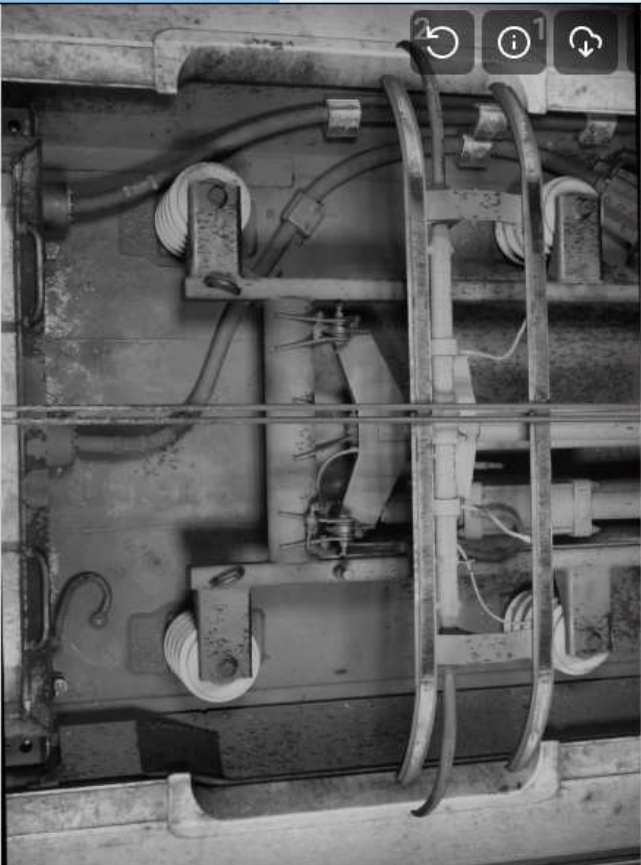
MODEL HSP MK2  **ASSET ID** 

TRAIN ID **SPEED** ← 47.7 mph

UPLIFT  -23.33 mm **CAPTURED** 12 Mar 2025 15:10:50

EVENT TAGS
Select a tag

CAMERA PIC **DISPARITY MAP**



Strip 2  **Strip 1**    



STRIP 2

5	4	3	2	1
35 mm	34 mm	33 mm	34 mm	35 mm

31mm
28mm

Applicable Network Rail standards

Old standards some of which not relevant to monitoring equipment!

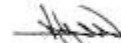
Ref	NR/SPEL/PG1072
Issue	2
Date	April 2006

Business Process Document

Trackside pantograph monitoring equipment

Endorsement & Authorisation

Endorsed by:



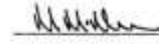
K. Lyford, Head of Electrification & Plant Engineering

Authorised by:



A. McNaughton, Chief Engineer

Accepted for issue by:



M. McManus, National Standards Manager

This document is the property of Network Rail. It shall not be reproduced in whole or part nor disclosed to a third party without the written permission of the Standard Owner.
© Copyright 2006 Network Rail
Uncontrolled copy once printed from its electronic source.
Published & issued by: Network Rail 40 Milton Street, London E11Y 3EE

Ref	NR/SPEL/PG1073
Issue	2
Date	April 2006

Business Process Document

The siting of pantograph monitoring equipment

Endorsement & Authorisation

Endorsed by:



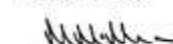
K. Lyford, Head of Electrification & Plant Engineering

Authorised by:



A. McNaughton, Chief Engineer

Accepted for issue by:



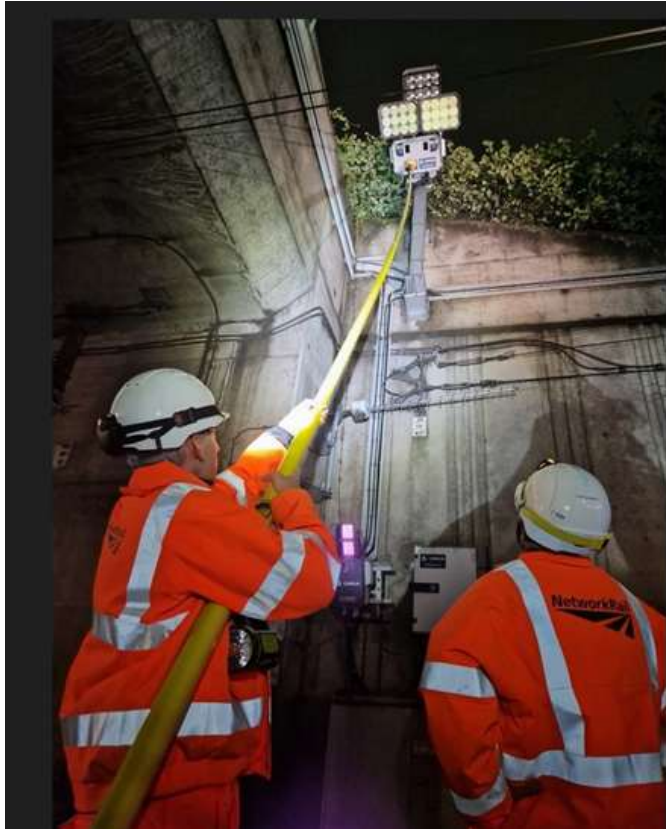
M. McManus, National Standards Manager

This document is the property of Network Rail. It shall not be reproduced in whole or part nor disclosed to a third party without the written permission of the Standard Owner.
© Copyright 2006 Network Rail
Uncontrolled copy once printed from its electronic source.
Published & issued by: Network Rail 40 Milton Street, London E11Y 3EE

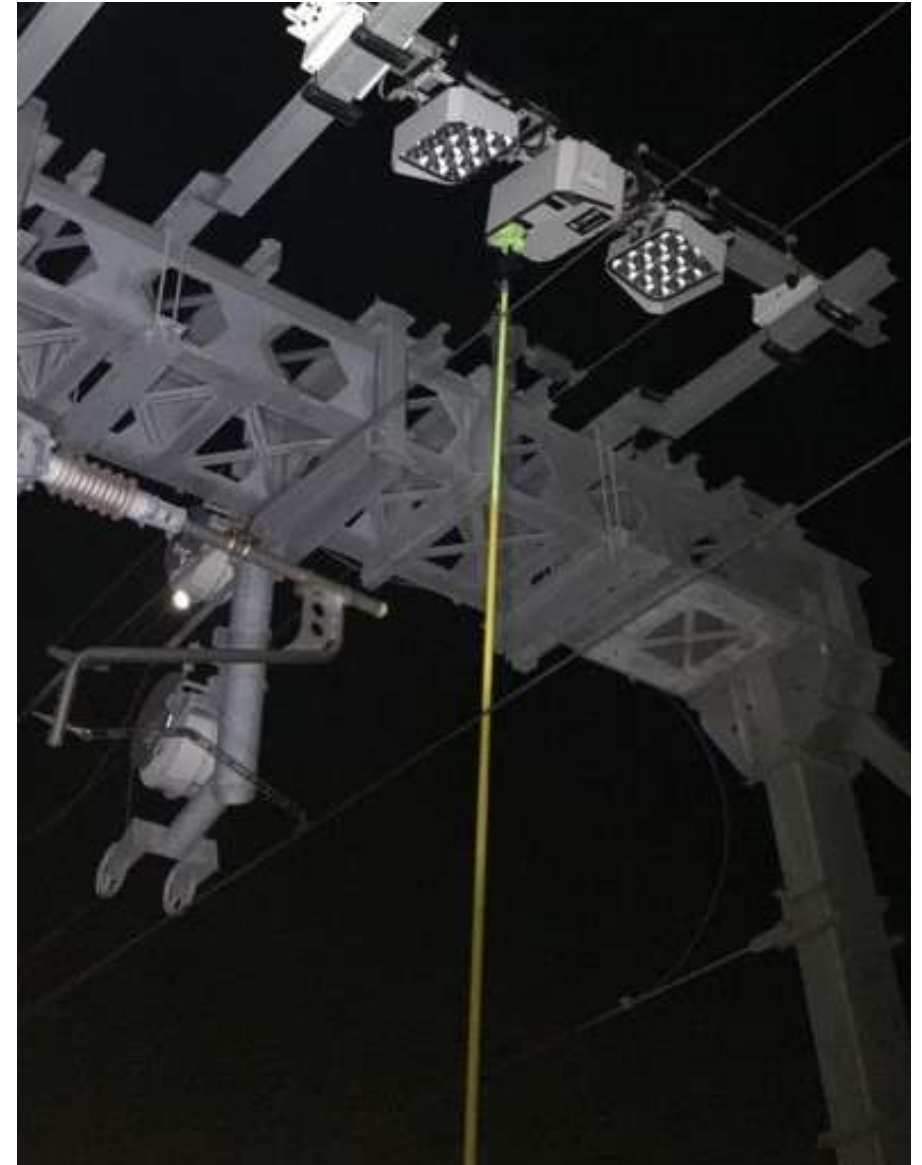
PanVue Maintenance and System Support

Service Level Agreement (SLA) in place

- 4 weekly meetings and 24/7 support contract
- Two yearly high-level inspection and maintenance required
- Low-level lens cleaning as and when required



Lens cleaning at Heathrow Portal - July 2024

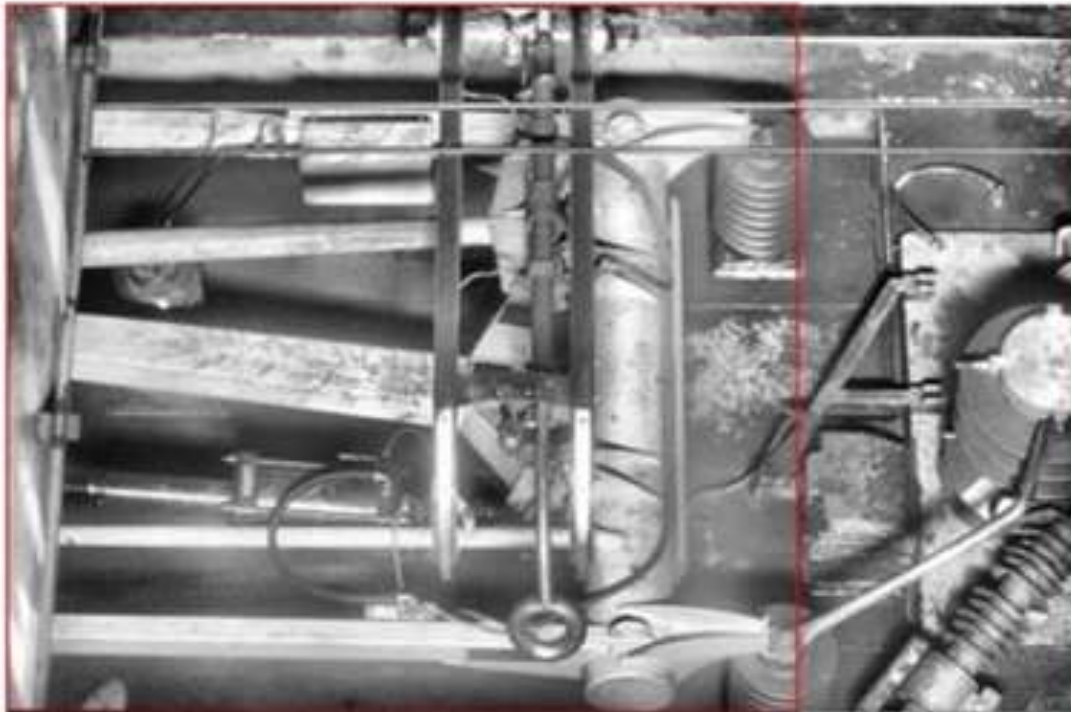


Lens cleaning at Bristol Parkway - July 2024

PanVue Lens cleaning

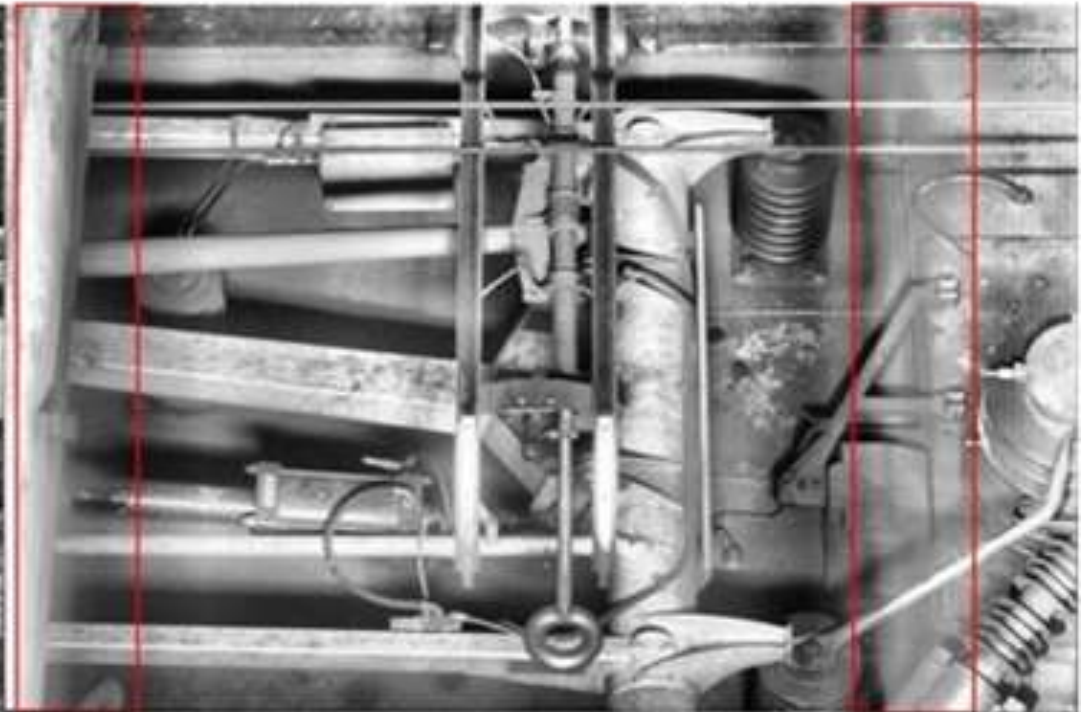
Before Cleaning

With a lot of "haze" in the image



After Cleaning

With less "haze" in the image specifically in the centre
With some remaining on the edges of the camera



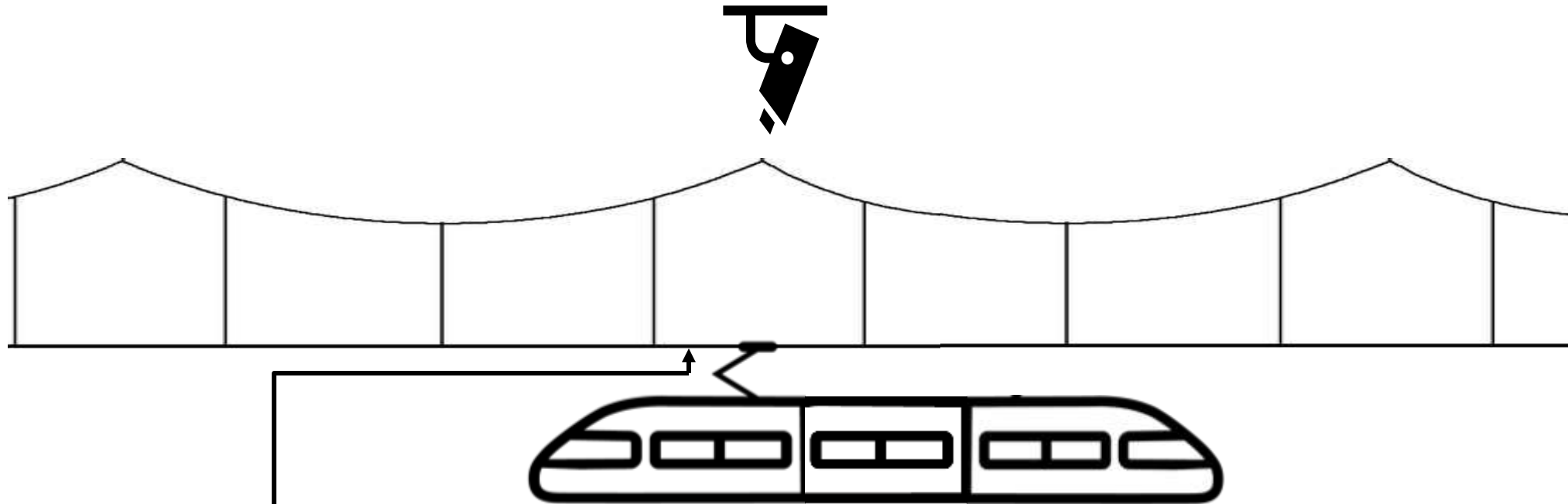
A stylized blue graphic of a railway track, consisting of two horizontal lines with vertical cross-ticks, positioned on the left side of the slide.

PanVue Case Studies

A stylized blue graphic of a railway track, consisting of two horizontal lines with vertical cross-ticks, positioned on the right side of the slide.

Case Study 1

PanVue uplift measurement is different!



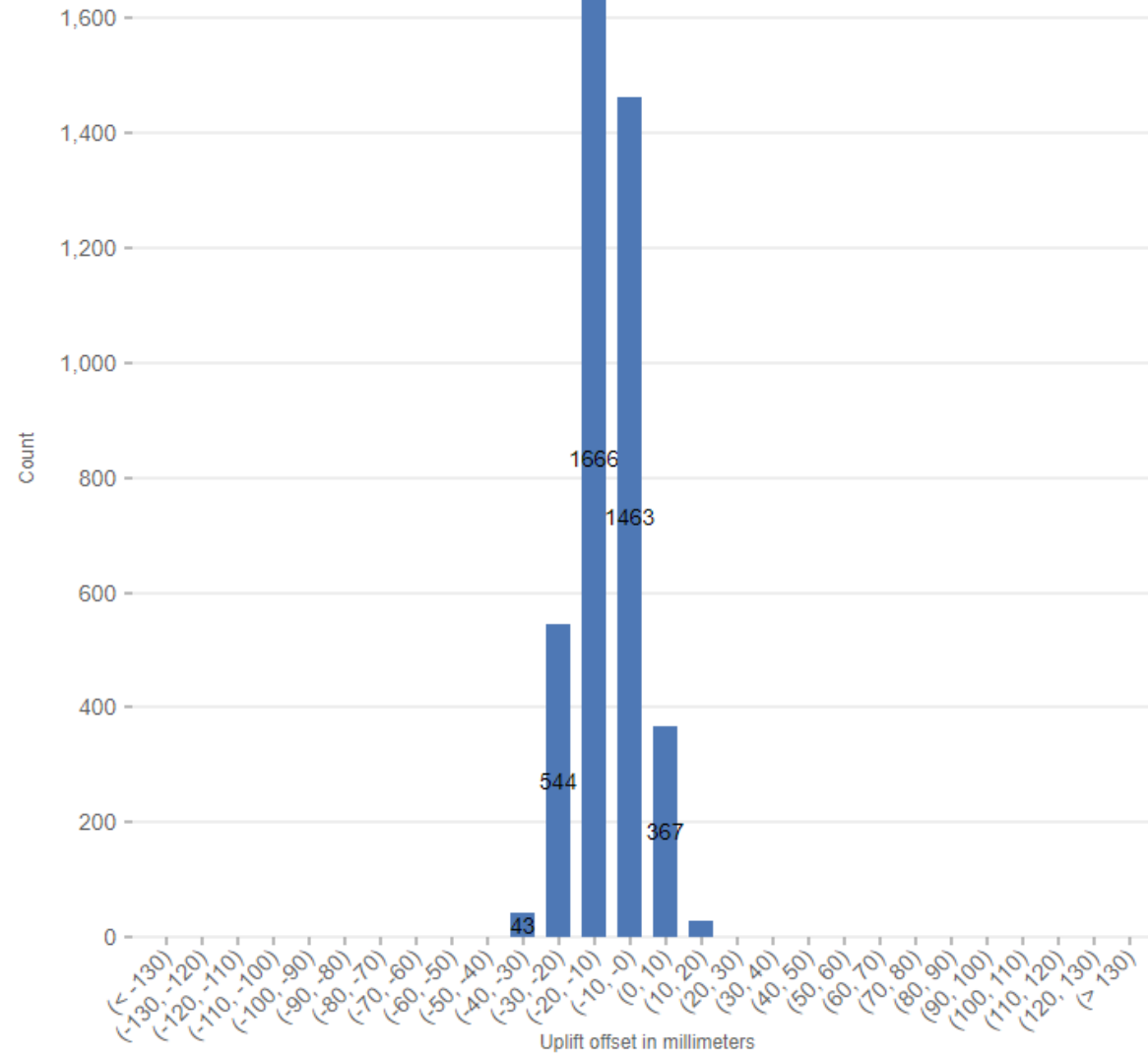
Positive uplift = contact wire higher than reference point

Negative uplift = contact wire lower than reference point

Case Study 1

Uplift distribution

Last 90 days



Example of expected uplift distribution

Case Study 1

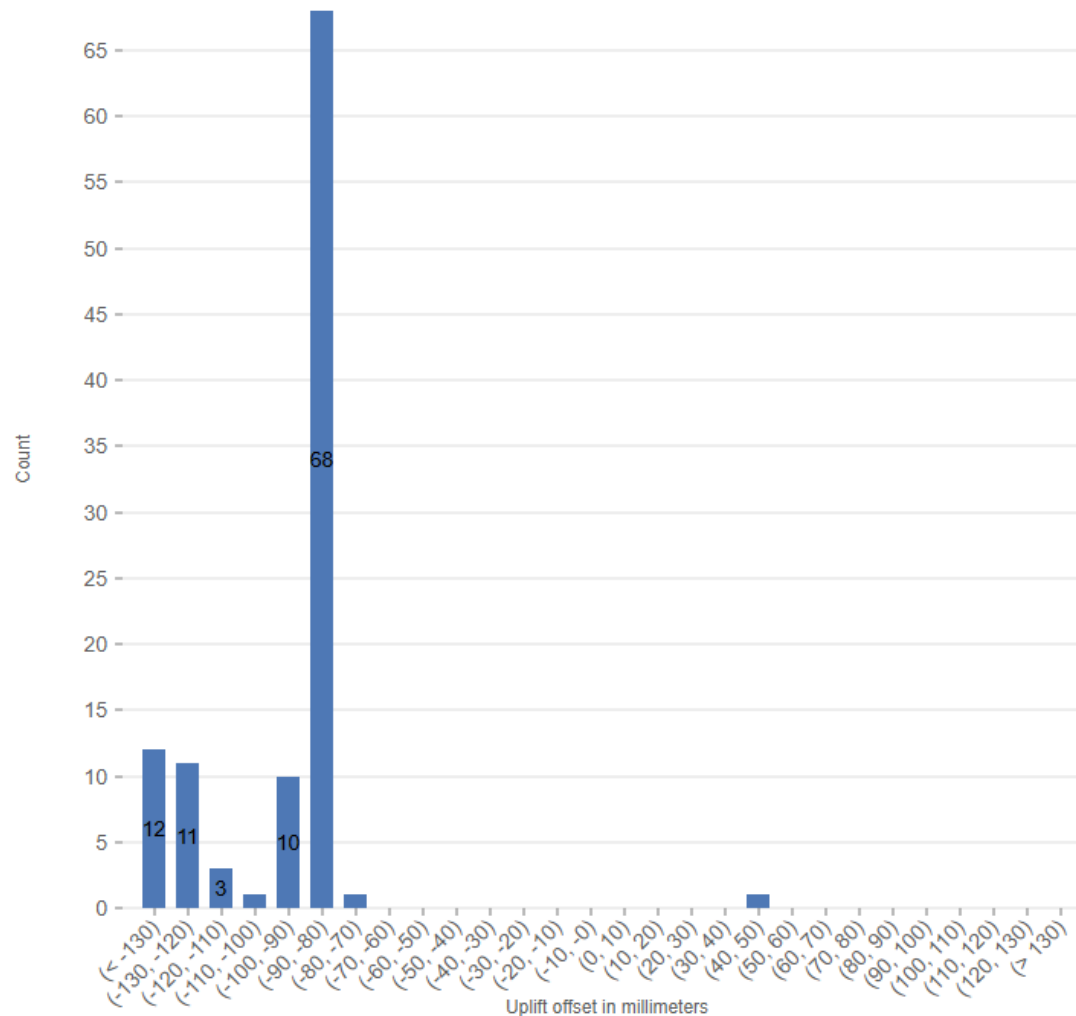
What's different about
the OLE in the
Heathrow tunnels?



Case Study 1

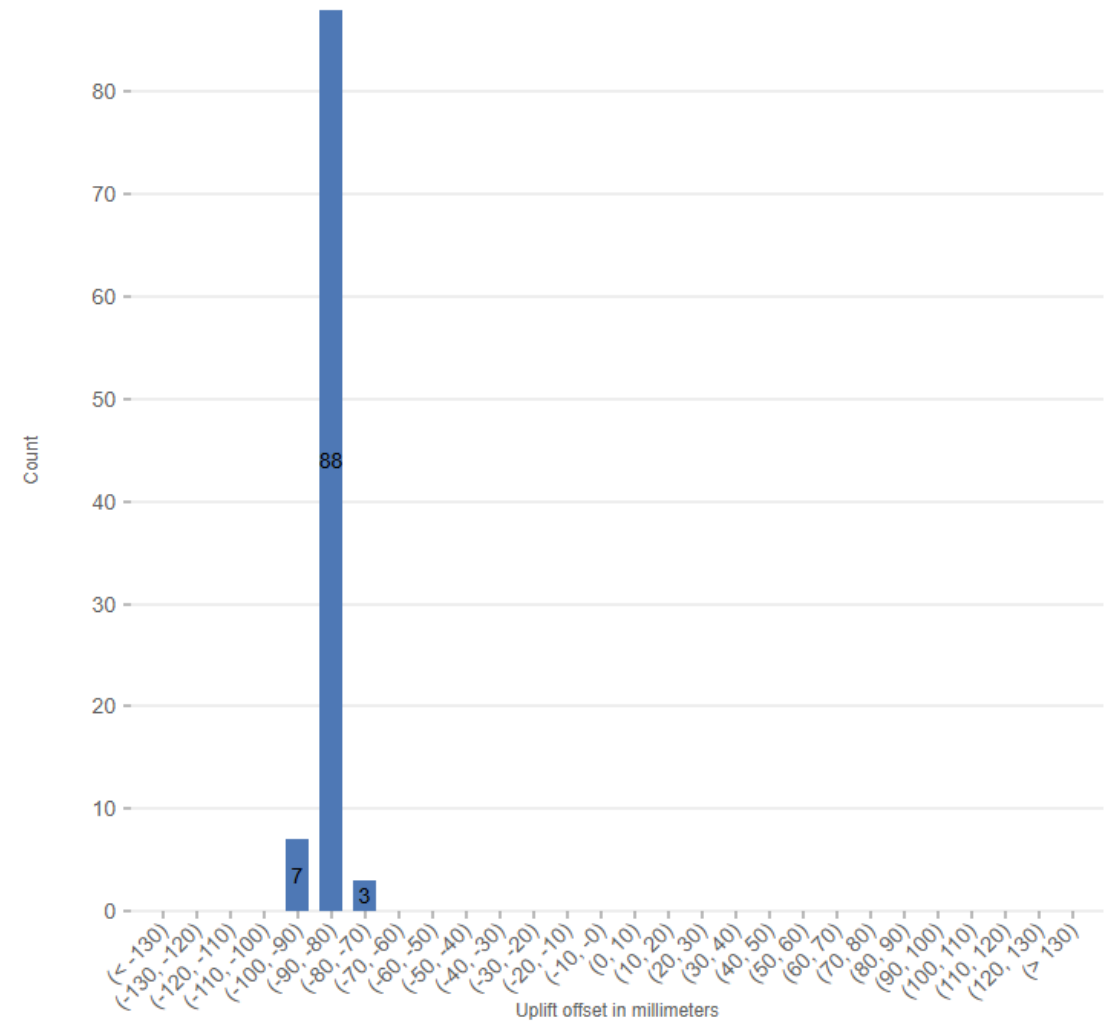
Uplift distribution

9/1/2024 → 1/22/2025



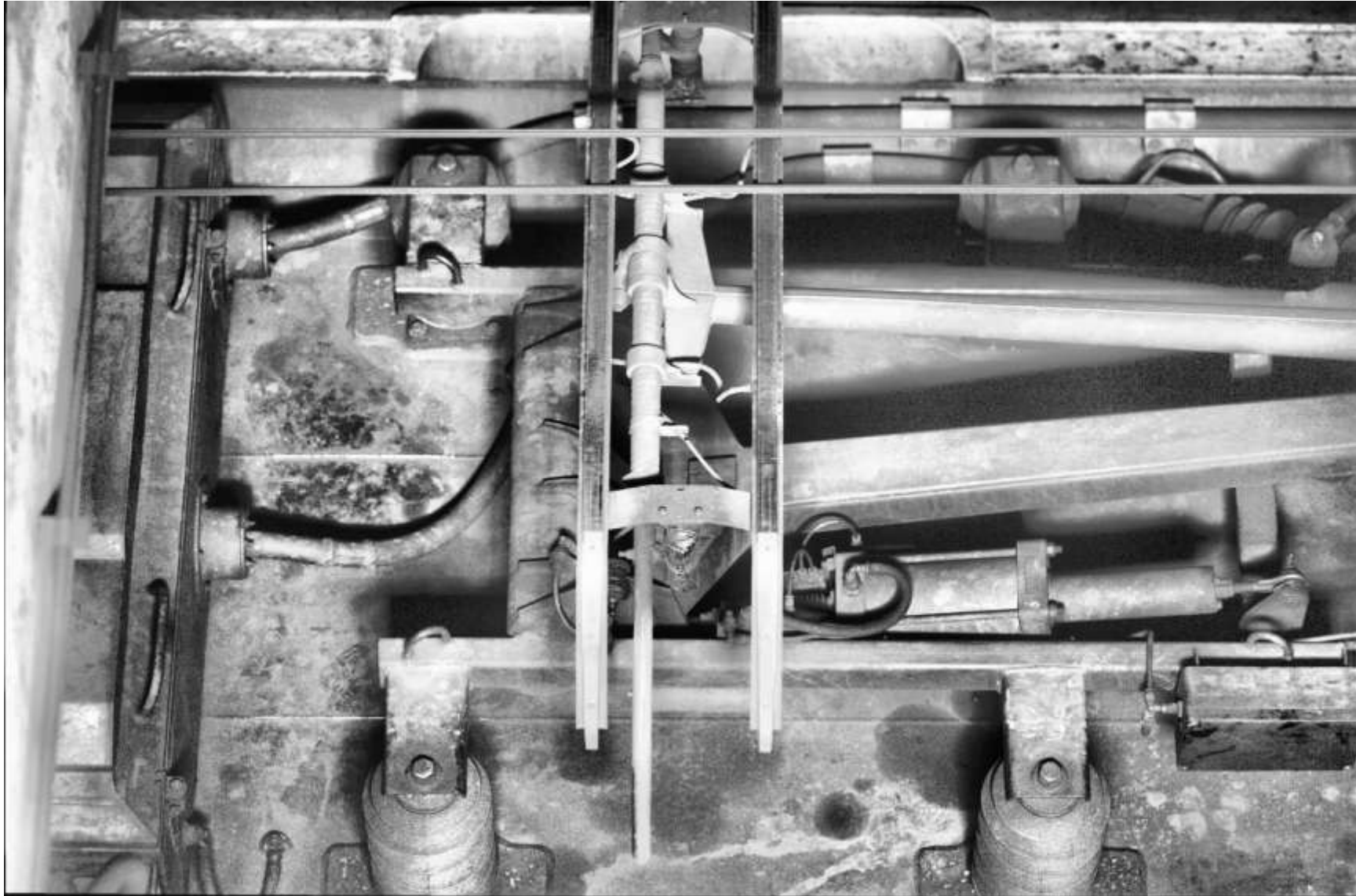
Uplift distribution

9/1/2024 → 1/22/2025



The same train with 2 **very** different uplift distributions across both pantographs

Case Study 1



Just how fine the margins
are

Case Study 1

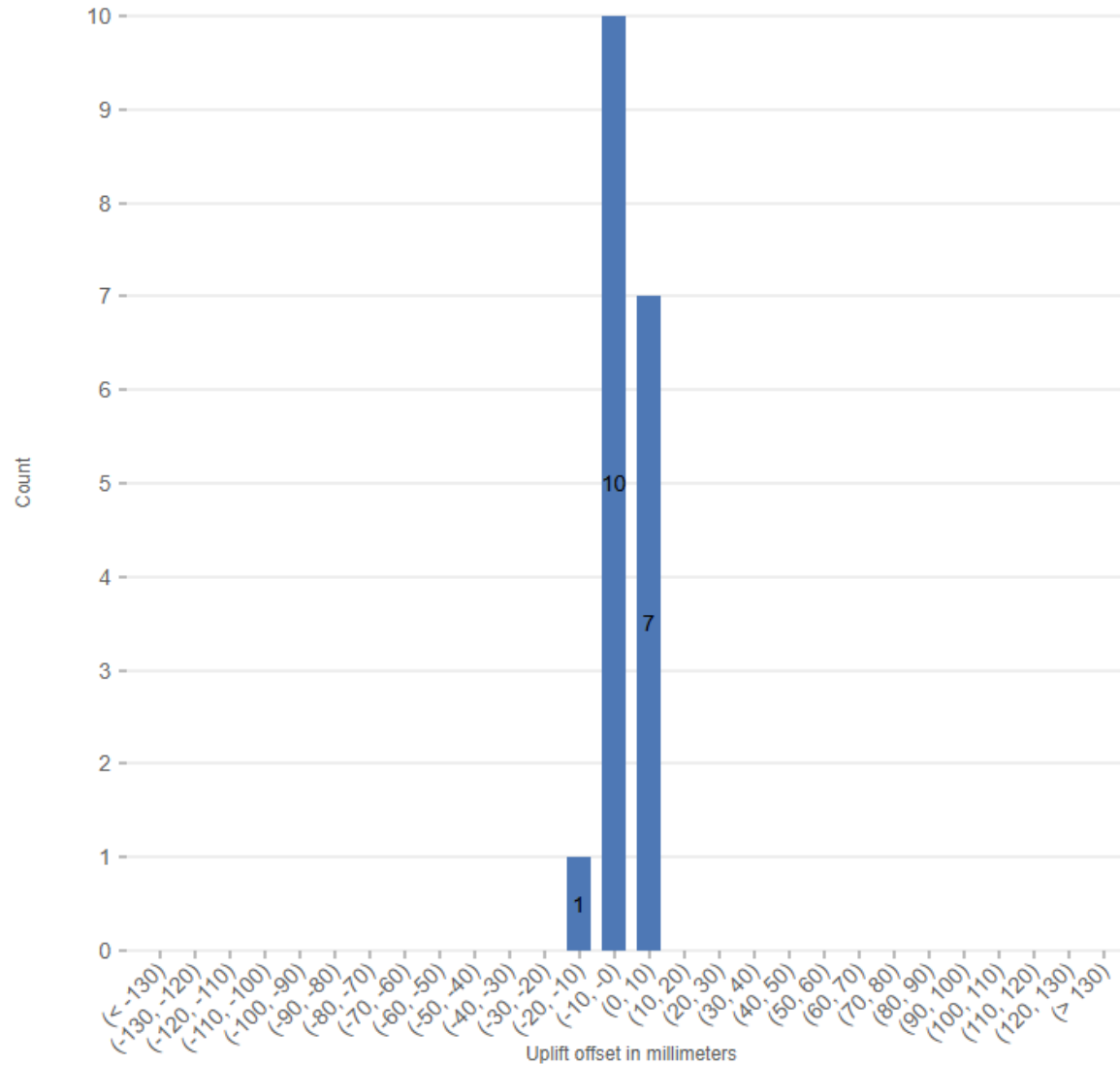


Example of the OLE inside Heathrow tunnels

Case Study 1

Uplift distribution

2/24/2025 → 3/11/2025

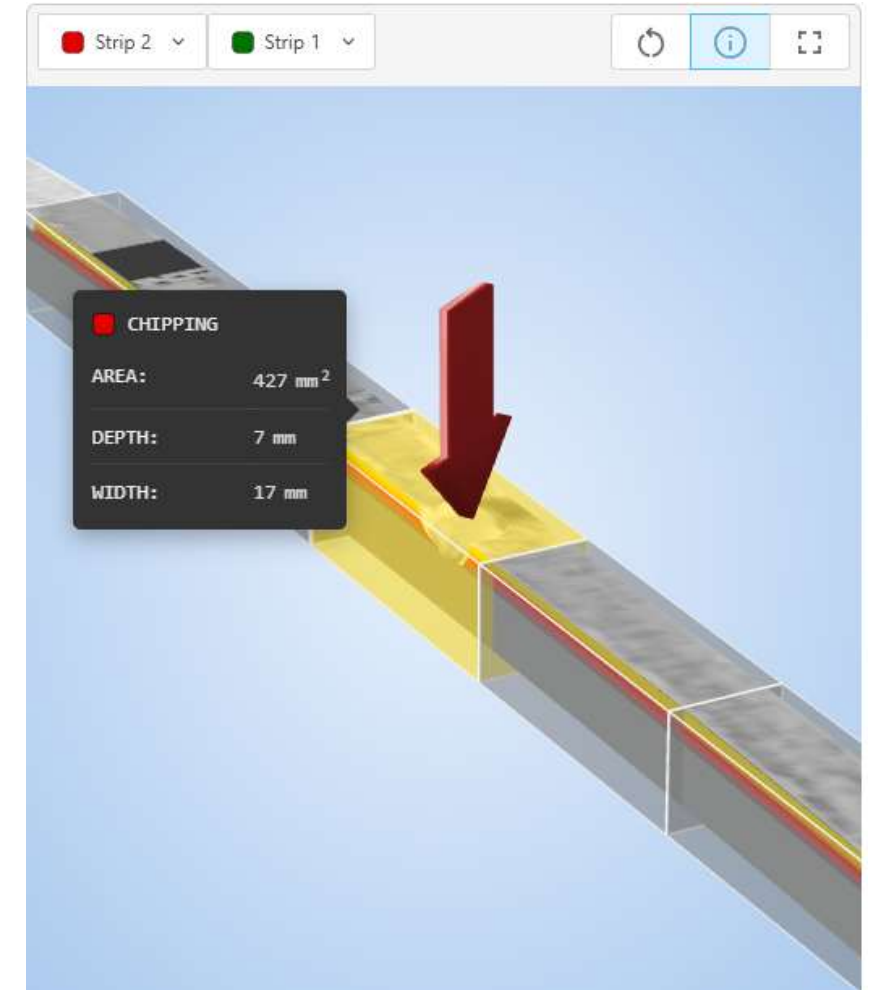
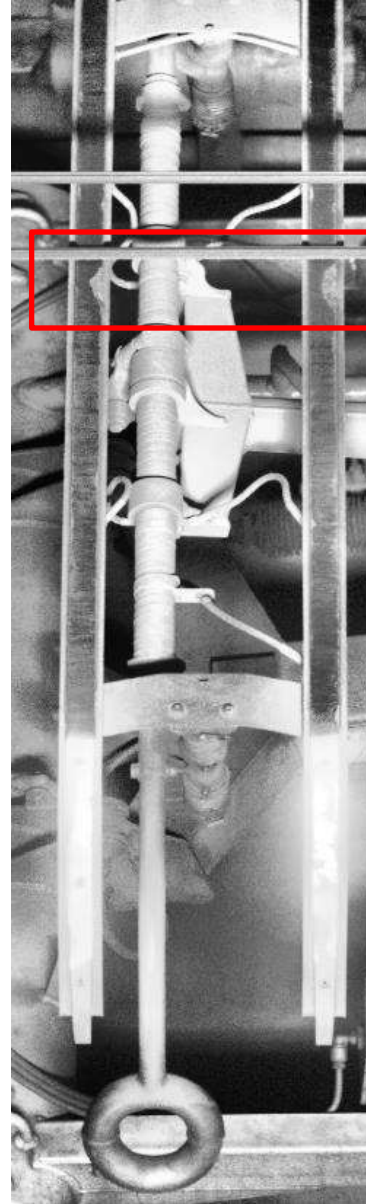
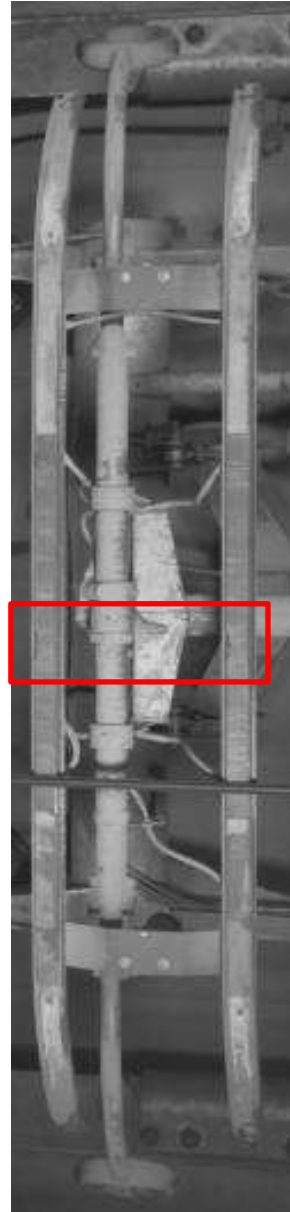
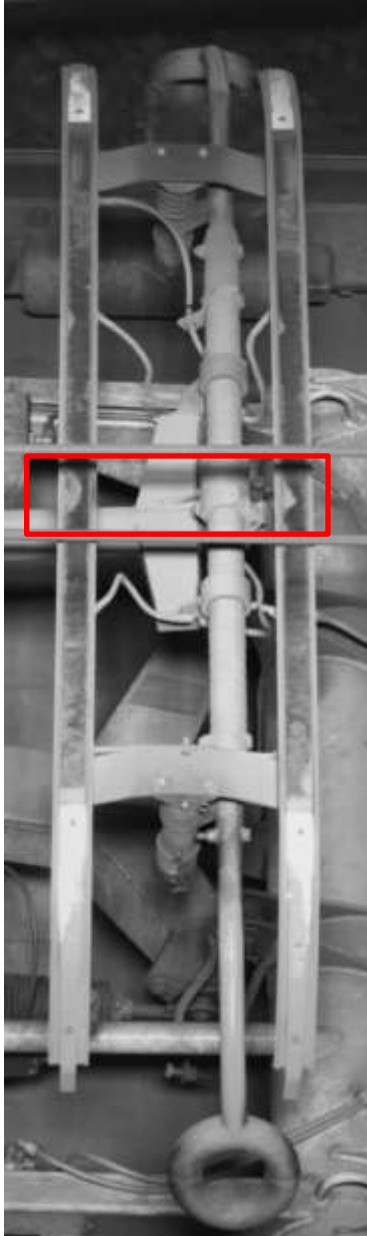


Uplift distribution after complete pantograph assembly change

Case Study 2

Filters	S - RAP	Captured ID	Asset ID	CA	D	Speed	Model	Capture time
Select a preset	Heathrow - Up Track	-	-	✓	→	47.4 mph	HSP MK2	20/01/2025 18:49
	Heathrow - Up Track	-	-	✓	→	48.1 mph	HSP MK2	20/01/2025 18:49
RAPs	Heathrow - Down Track	-	-	✓	→	31.4 mph	HSP MK2	20/01/2025 18:38
Select one or more RAP	Heathrow - Up Track	-	-	✓	→	48.6 mph	HSP MK2	20/01/2025 16:19
Event status	Heathrow - Down Track	-	-	✓	→	45.9 mph	HSP MK2	20/01/2025 16:05
Alert type	Heathrow - Down Track	-	-	✓	→	47.0 mph	HSP MK2	20/01/2025 14:24
Chipping Alert	Heathrow - Up Track	-	-	✓	→	44.2 mph	HSP MK2	20/01/2025 11:49
Carriage association status	Heathrow - Up Track	-	-	✓	→	50.0 mph	HSP MK2	20/01/2025 09:19
Carriage ID	Heathrow - Up Track	-	-	✓	→	49.5 mph	HSP MK2	20/01/2025 08:04
423	Heathrow - Up Track	-	-	✓	→	49.3 mph	HSP MK2	20/01/2025 06:19
Train direction	Heathrow - Up Track	-	-	✓	→	47.0 mph	HSP MK2	20/01/2025 05:49
Select train direction	Heathrow - Up Track	-	-	✓	→	44.6 mph	HSP MK2	19/01/2025 21:19
Event Tags	Heathrow - Down Track	-	-	✓	→	45.2 mph	HSP MK2	19/01/2025 19:37
Select event tags	Heathrow - Up Track	-	-	✓	→	46.2 mph	HSP MK2	19/01/2025 18:50
Model	Heathrow - Down Track	-	-	✓	→	45.8 mph	HSP MK2	19/01/2025 17:37
Select a pantograph	Heathrow - Up Track	-	-	✓	→	42.3 mph	HSP MK2	19/01/2025 17:35
354 results	Heathrow - Down Track	-	-	✓	→	48.2 mph	HSP MK2	19/01/2025 15:07
	Heathrow - Down Track	-	-	✓	→	36.2 mph	HSP MK2	19/01/2025 12:35
	Heathrow - Up Track	-	-	✓	→	48.2 mph	HSP MK2	19/01/2025 10:34
	Heathrow - Down Track	-	-	✓	→	41.9 mph	HSP MK2	19/01/2025 10:05

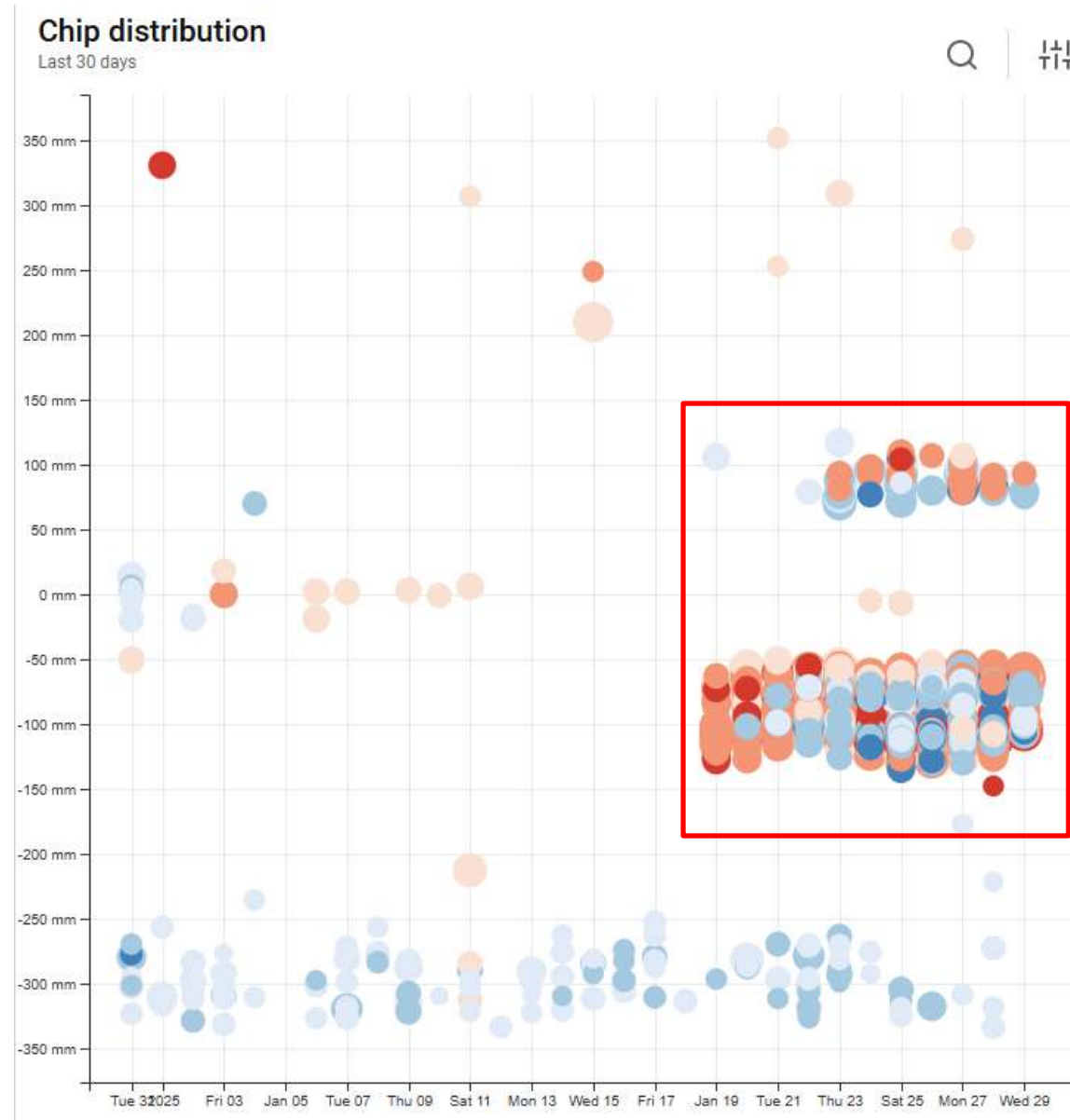
Case Study 2



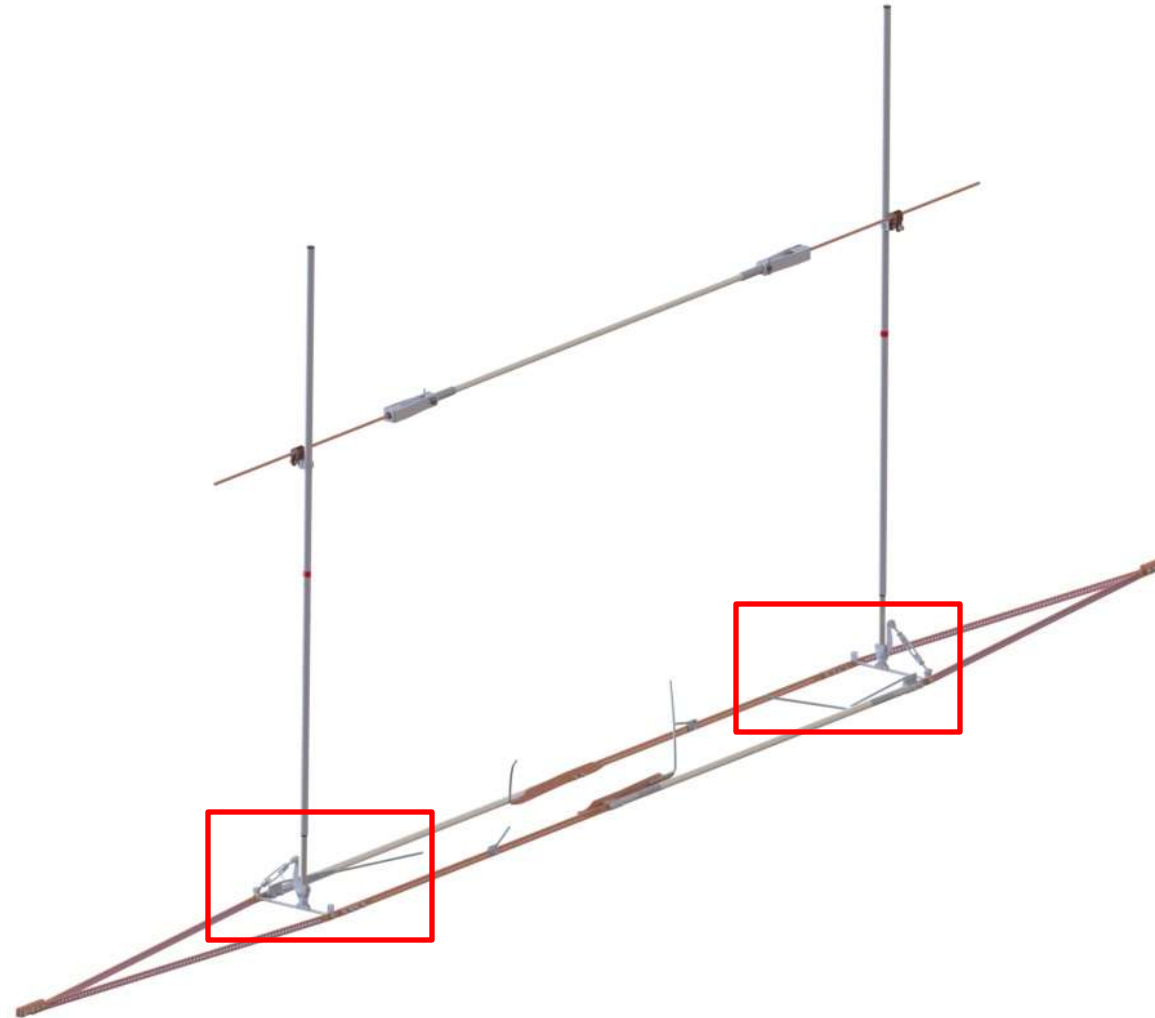
Same chipping pattern on only one specific unit type...

Case Study 2

Carbon centre point

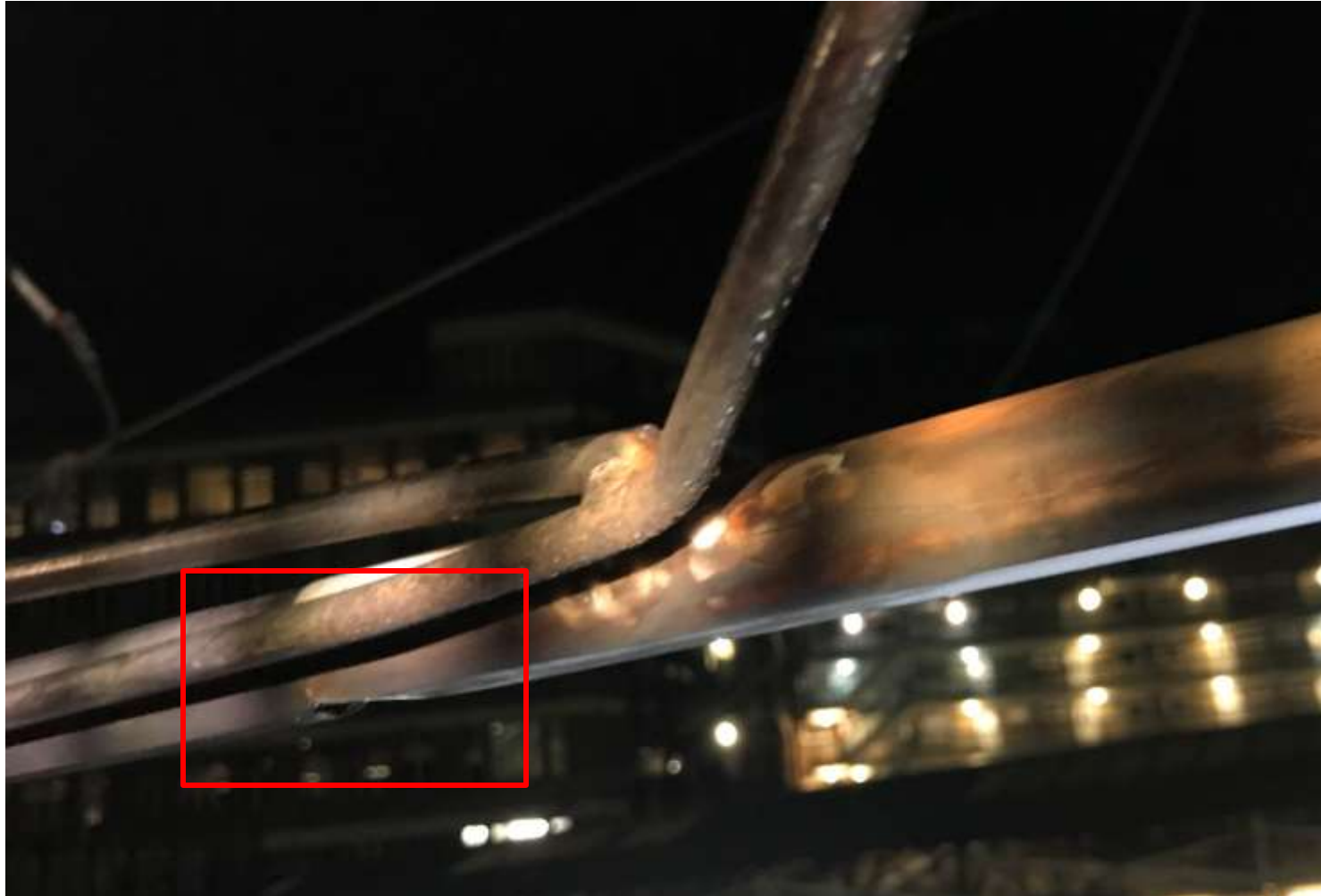


Case Study 2



Arthur Flury HI 25 Section Insulator

Case Study 2



Damaged section insulator found by maintenance team

PanVue - Ice

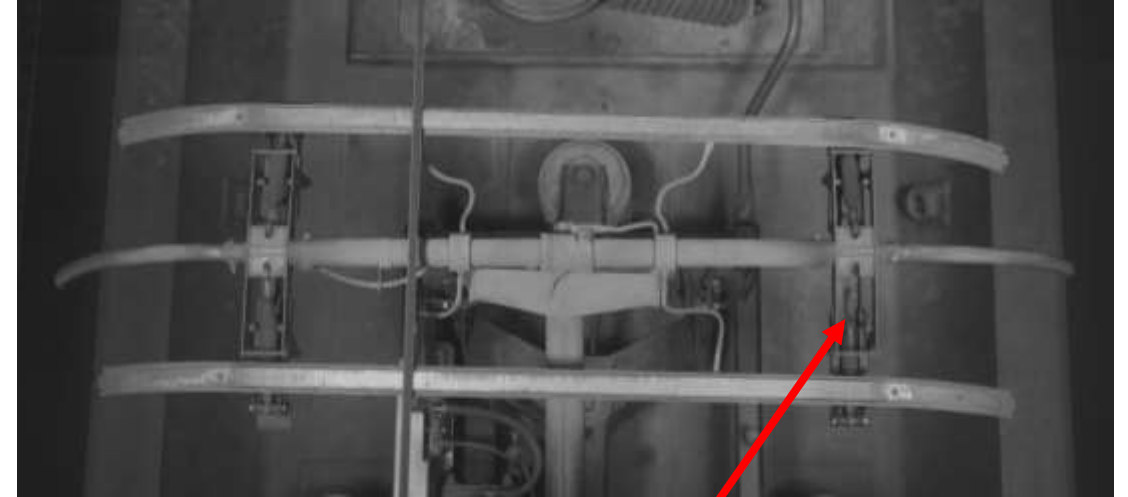


PanVue image - Didcot 2024



Ice damaged pantograph - 2023

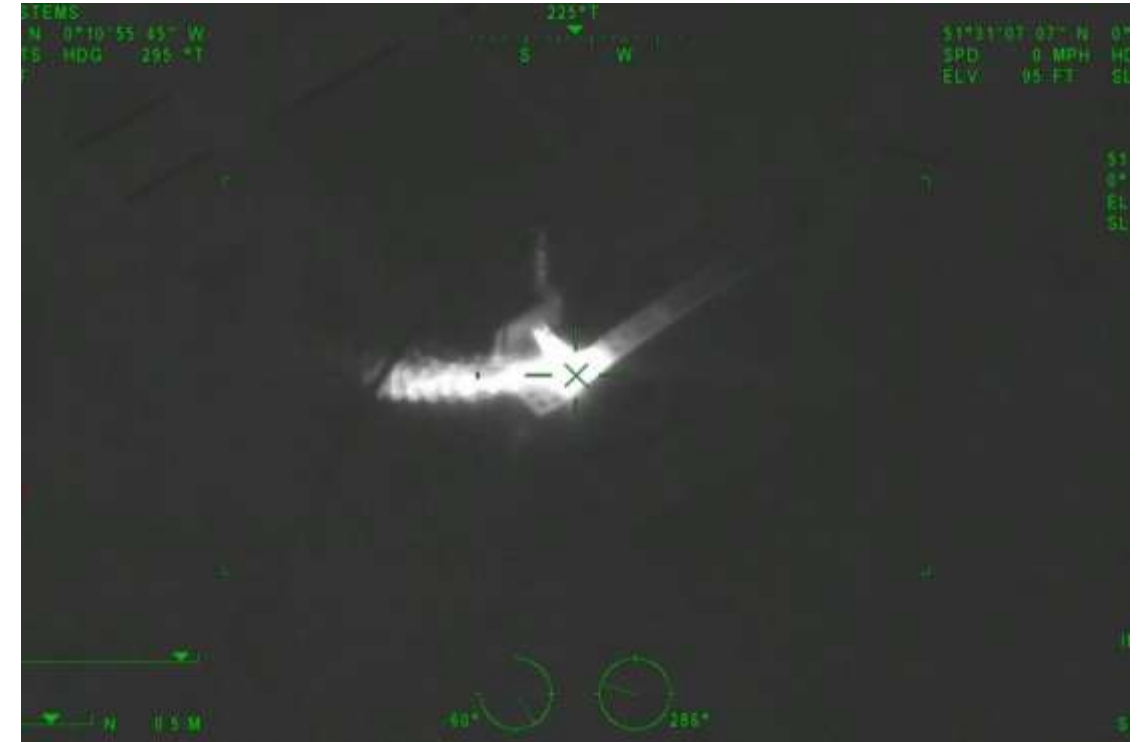
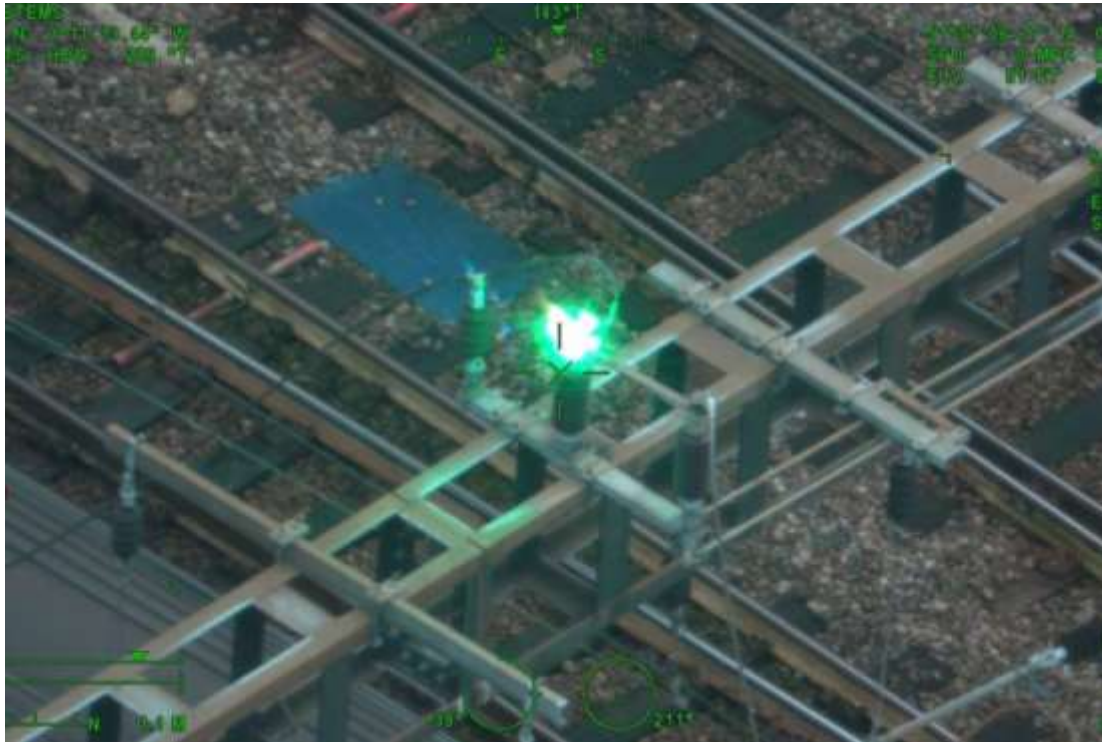
PanVue – orientation issues



Thermal Imaging of OLE



Thermal imaging



How we've historically done it

Thermal imaging



Examples of earth wire failures

Thermal imaging



How do you monitor a moving fault?

Thermal imaging



The image displays the AivR software interface, which is used for thermal imaging and data analysis. The main window shows a thermal image of railway tracks, with a purple overlay indicating a thermal hotspot. The interface includes a top menu bar with options like 'Close', 'Advanced Sighting', 'Quick Sighting', 'Annotate', 'Measure', and 'Zoom'. On the left side, there is a sidebar with icons for 'Network Rail', 'TTB', and a gear icon. Below the main image, there is a 'Sessions' tab with a list of sessions, each showing a session ID, location, time, and status. The right side of the interface features a 'VIEWING' panel with detailed information about the selected session, including route position, speed, bearing, altitude, time, date, weather station data, and detections. The bottom of the interface has a navigation bar with icons for 'Sessions', 'Issues', 'Shortcuts', 'Content Feed', and 'Favourites'.

Thermal imaging



Thermal imaging



Thermal imaging – examples of issues found



Thermal imaging – examples of issues found

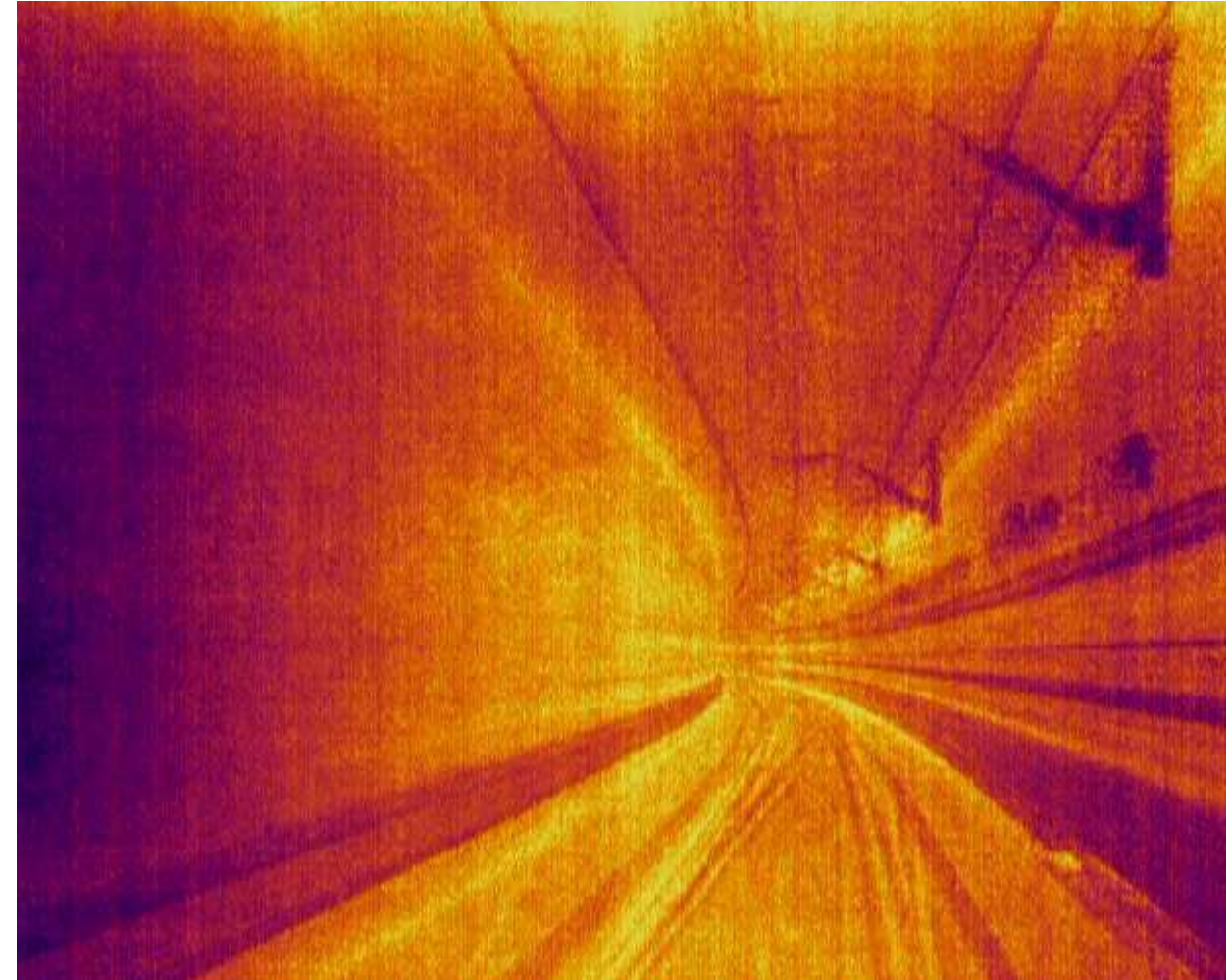


Thermal imaging – examples of issues found



Thermal Imaging – Use Cases

- Entry into service testing
- Finding install issues
- Thermal performance of OLE in tunnels
- Thermal performance on OLE under different load conditions
- Actively manage known thermal risks
- Extreme weather monitoring



Heathrow Tunnels Thermal Image

Modern OLE monitoring, a bright future

Uptake on other regions following Wales & Western implementation of PanVue.

Data and information driven railway, with track and train working together ready for Great British Railways.

Saved 3+ dewirements.

Asset health of both pantographs and OLE.

PanVue global uptake since W&W install: Netherlands, Italy, America, Kazakhstan, Australia and Hong Kong.



Acknowledgements

- Hayley Poulter and Stuart Hitch - Network Rail
- Andy Slade - Network Rail
- Joshua Ong – Network Rail
- Network Rail E&P Maintenance Teams
- Network Rail Design Delivery (NRDD)
- Southern Rail System Alliance (SRSA)
- Connor McIlmurray and Paul Fleming - Camlin Rail
- Andy Bowdidge - GWR
- David Payne and David Pearce - MTR Elizabeth Line
- Mike English – Hitachi Rail
- One Big Circle
- Atkins Realis (early development of PanVue)

