Remote Condition Monitoring of Track Assets Using Revenue Vehicles

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Agenda

1. Monash IRT Overview
2. Introducing the Instrumented Revenue Vehicle
3. Examples of benefits
4. Further development

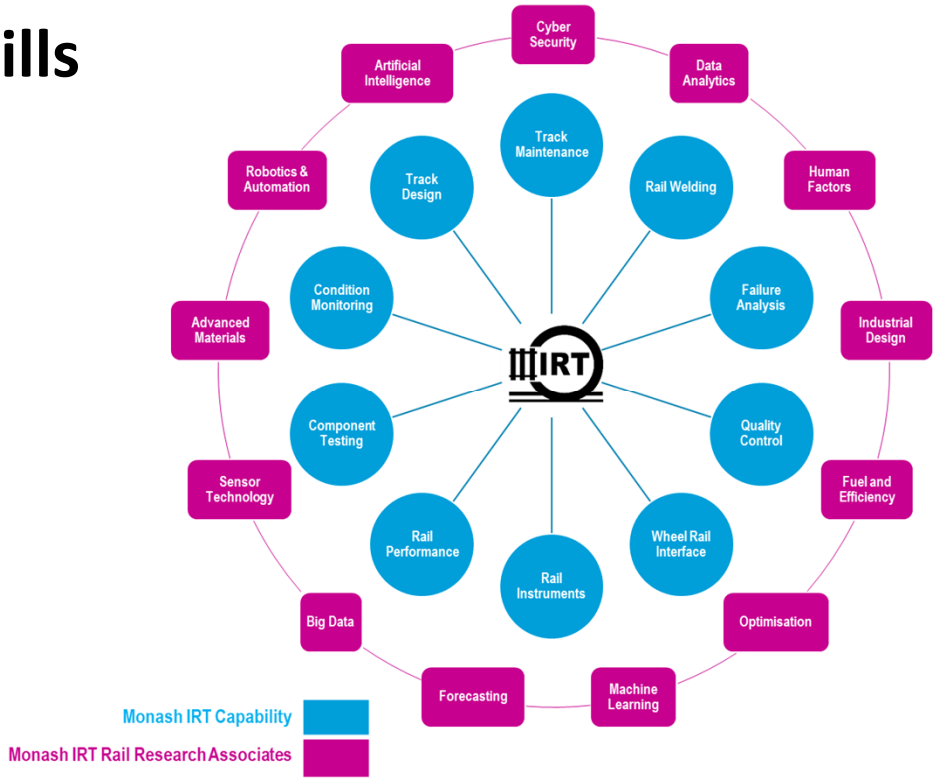
IRT Capabilities

- Materials Analysis and Physical Testing
- Condition Monitoring
- Data Analytics
- Wheel-Rail Interface
- Vehicle Dynamic Simulation
- Track Performance
- Welding Process Development
- Novel Technology Implementation

IRT Services over 160 Clients

Broader Academic Capabilities

- **Links to world class academic skills in:**
  - **Accident research**
  - **Human factors**
  - **AI and Machine Learning**
  - **Sustainable Materials**
  - **Industrial Design**
  - **Robotics and Automation**



Instrumented Revenue Vehicles

Instrumented Revenue Vehicles

- **Autonomous structural health condition monitoring system on revenue service rollingstock**
- **Over 100 instrumented vehicles have been installed by IRT**
- **Near real time reporting of the condition of the track and rolling stock performance**
- **Effectiveness of maintenance activities**

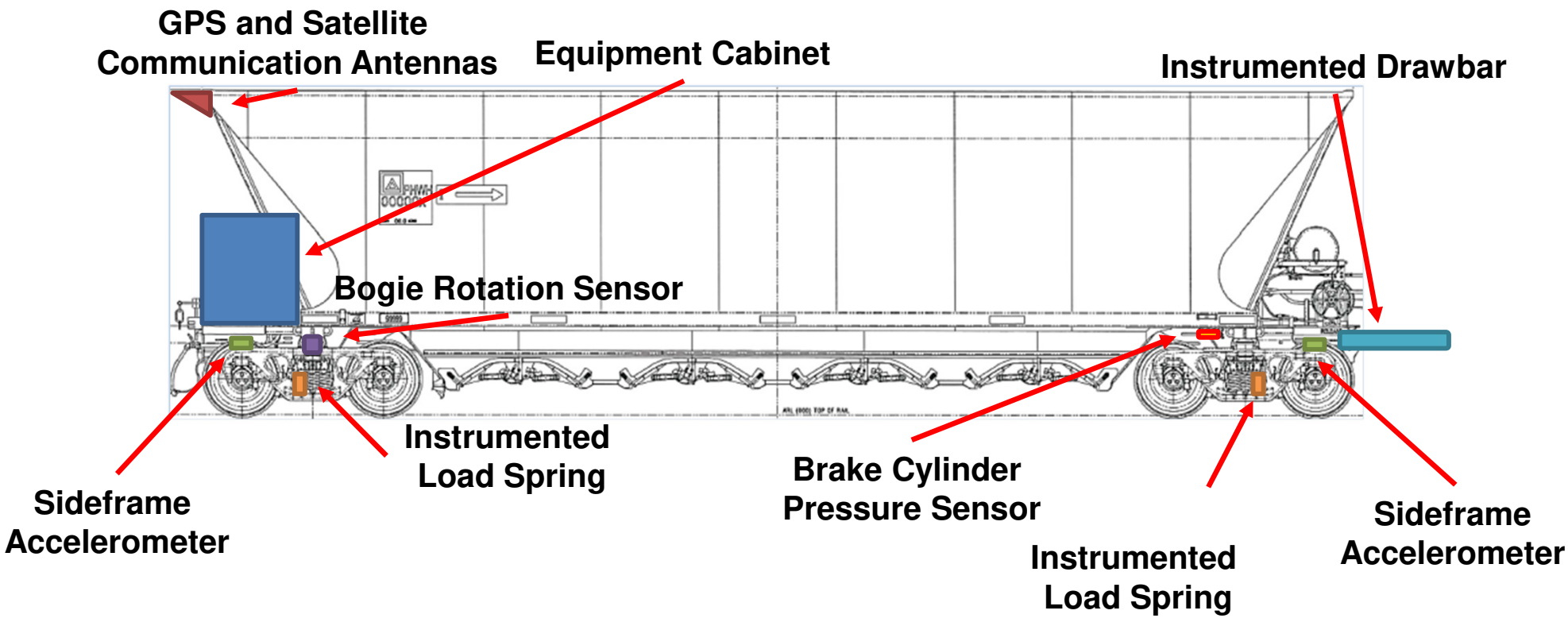
IRV System Examples





- Mature technology, since 2002
- Ruggedized integrated monitoring system
- Passenger and freight applications
- Local and self powered solutions

IRV Sensor Examples



IRV Sensor Examples

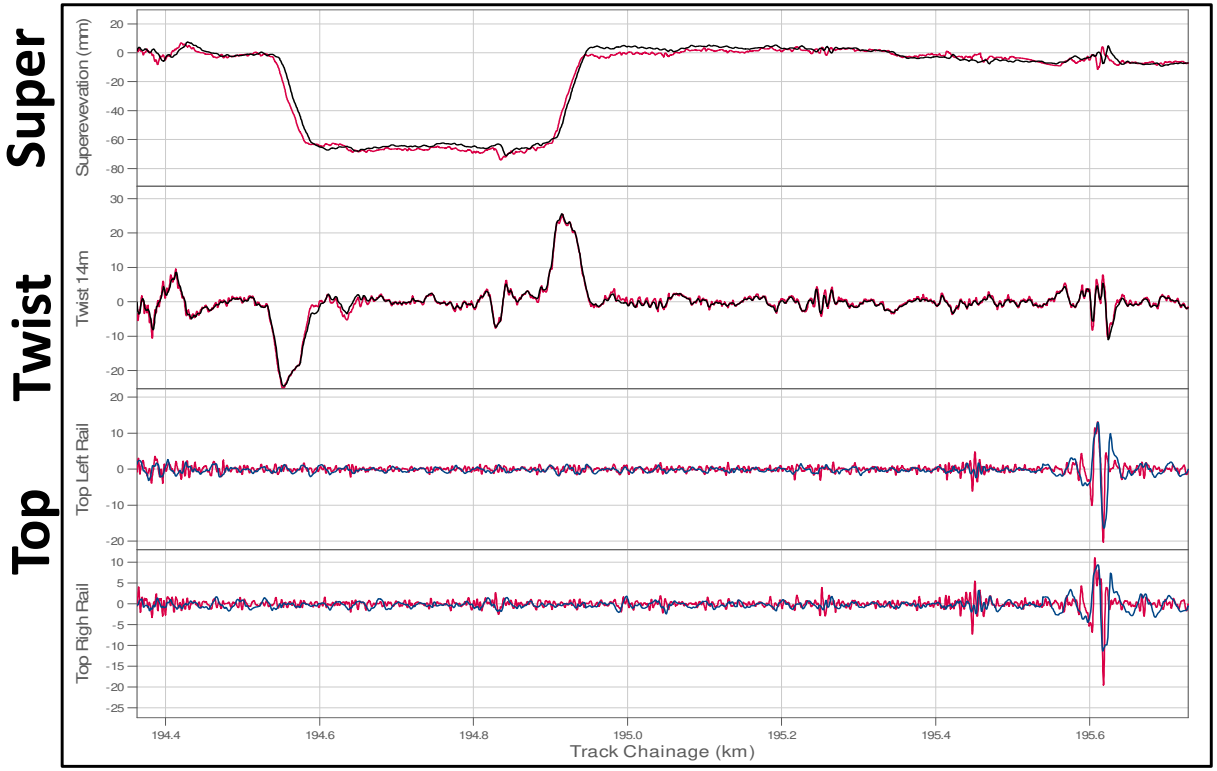
- Instrumented springs & triaxial accelerometers on axle box ends – track geometry
- Lateral accelerometer on bolster centre plate - hunting
- Steer sensors – track buckle indication
- Drawbar/coupler instrumentation – in-train forces during running and unloading

IRV System Benefits

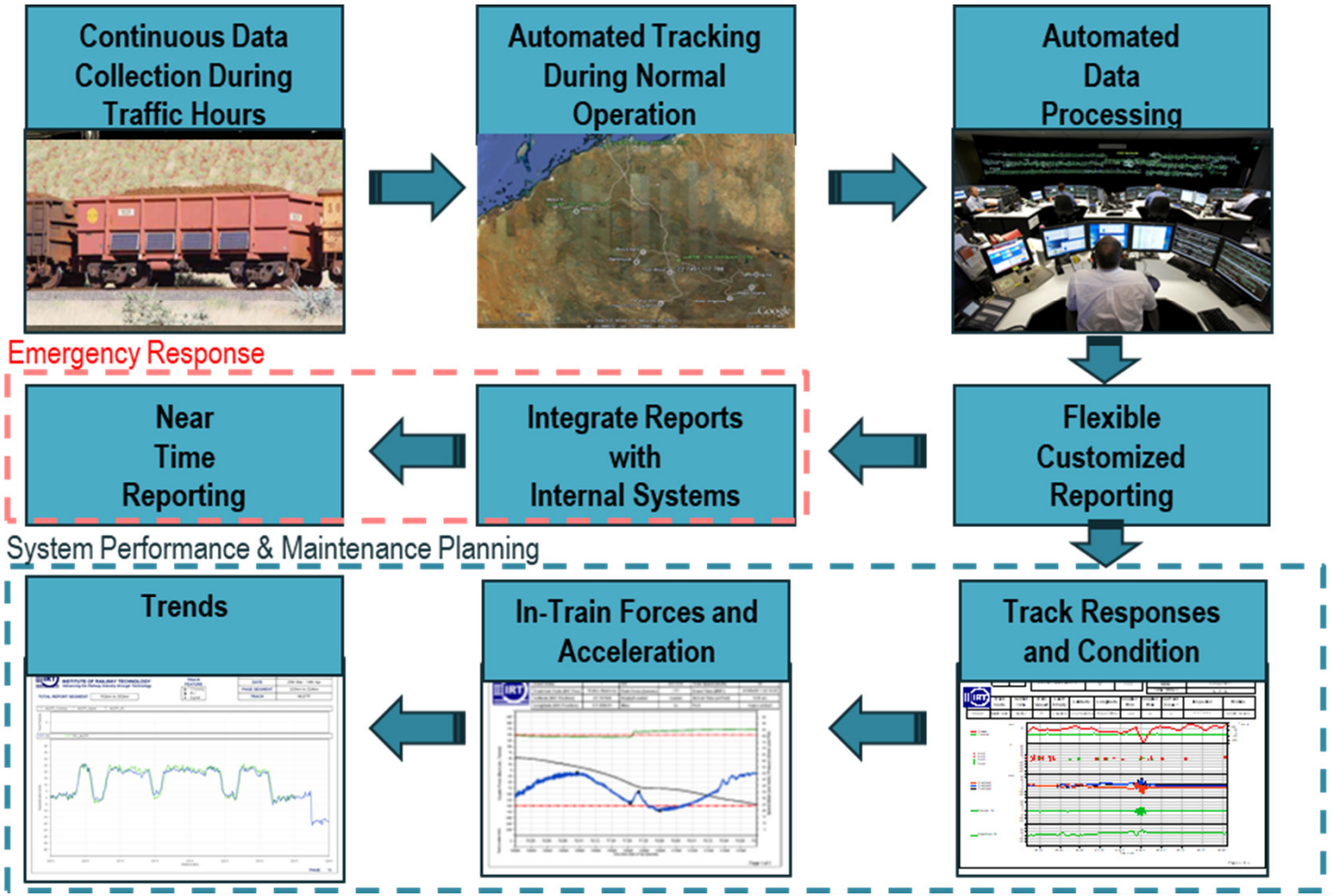
	IRV	Geometry Car
Rail Running Surface	✓	✓
GPS Position	✓	✓
Altitude	✓	✓
Vertical Alignment (Top / Surface)	✓	✓
Lateral Alignment	Bogie Steer	✓
Twist	✓	✓
Curvature	✓	✓
Measures under dominant vehicle loading	✓	
Vehicle Dynamic Response to Track	✓	
Vehicle Hunting	✓	
Vehicle In-Train Force	✓	
Doesn't requires separate path & operators	✓	
Track Measurement Interval	~20-150 per week	~1-3 months

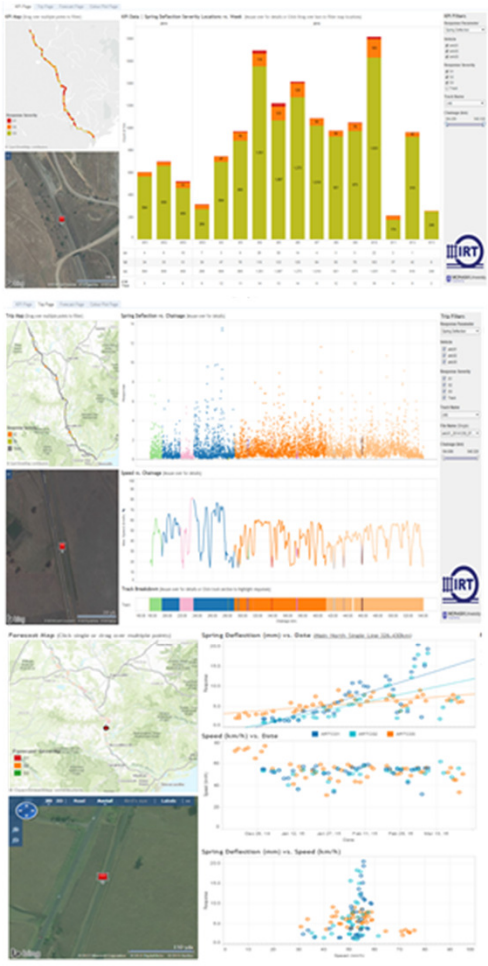
Repeatability and Accuracy

- Geometry car data (red line) and IRV data (black line) shows close correlation
- From actual vehicles, at operating speed, multiple times per day



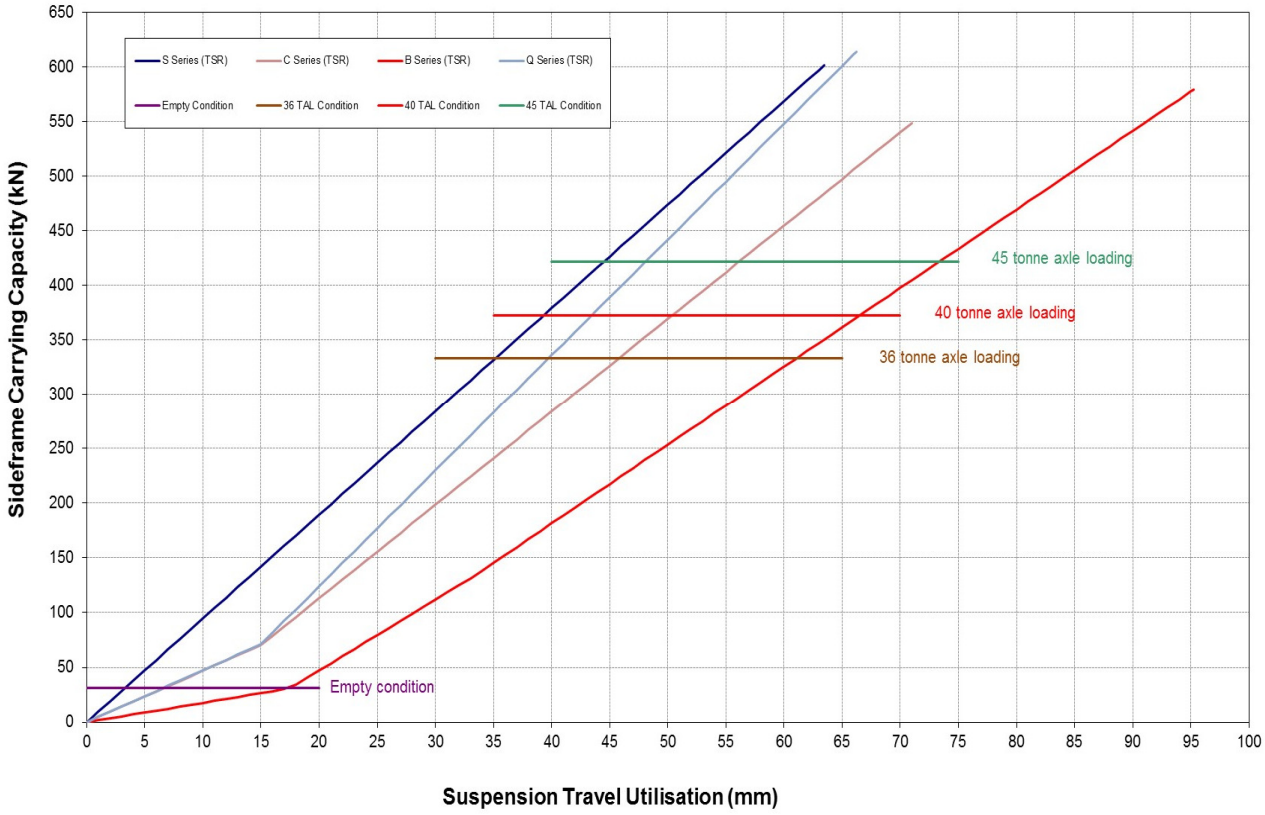
How is it Delivered?



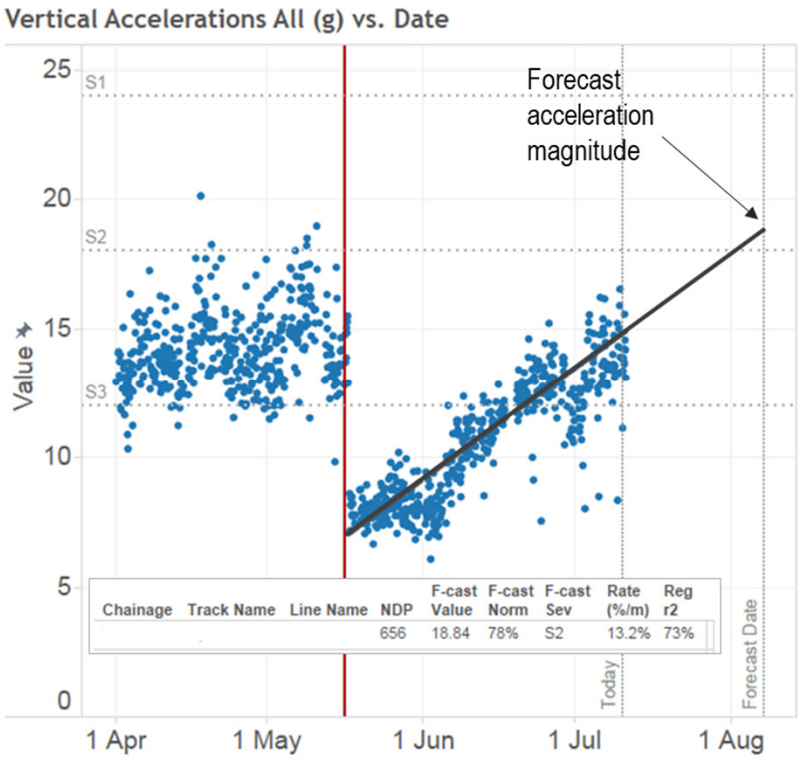


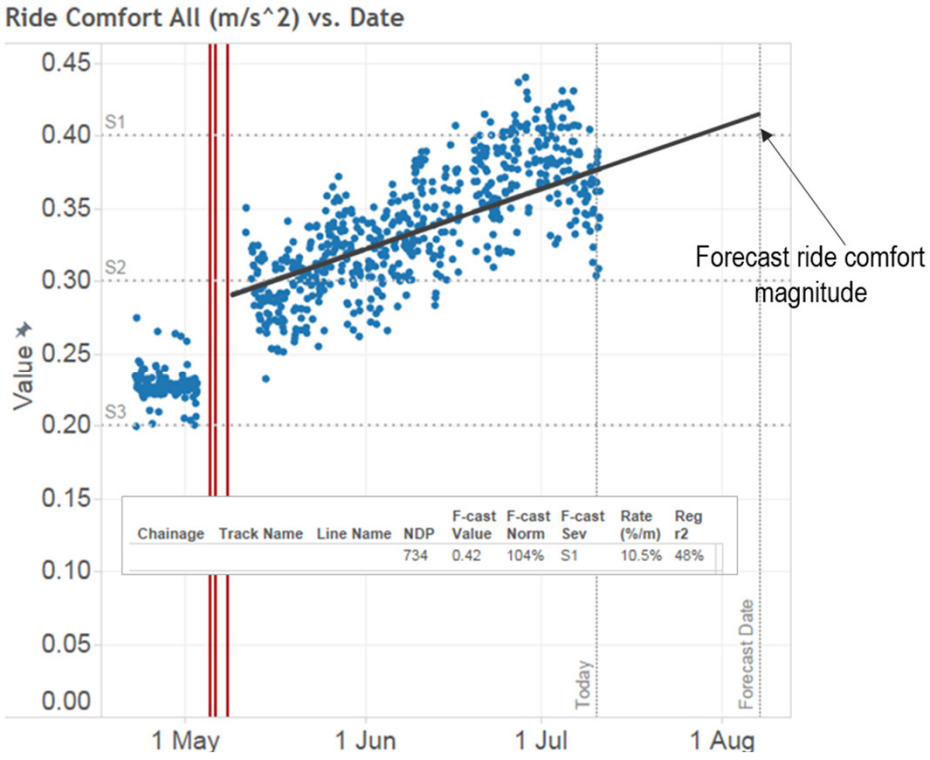
IRV Vehicle Reactions

- Wagon types react different to loading conditions
- Critical events tailored to vehicle response
- Spring binding or wheel lift event risk

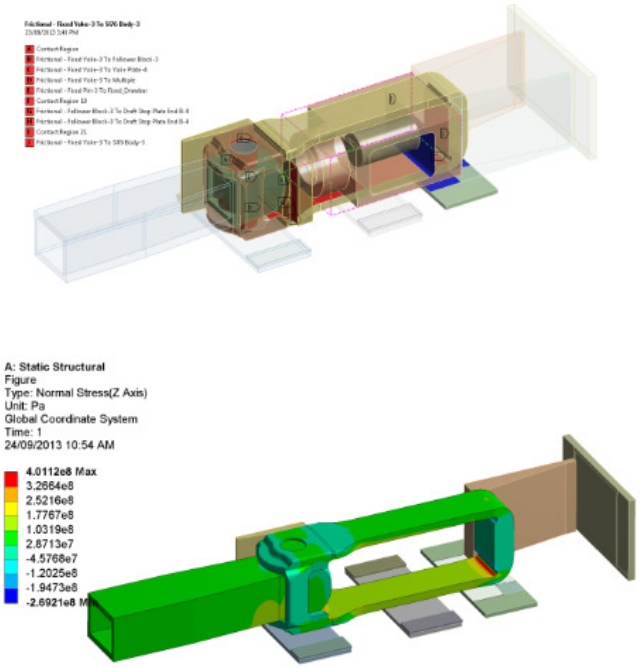


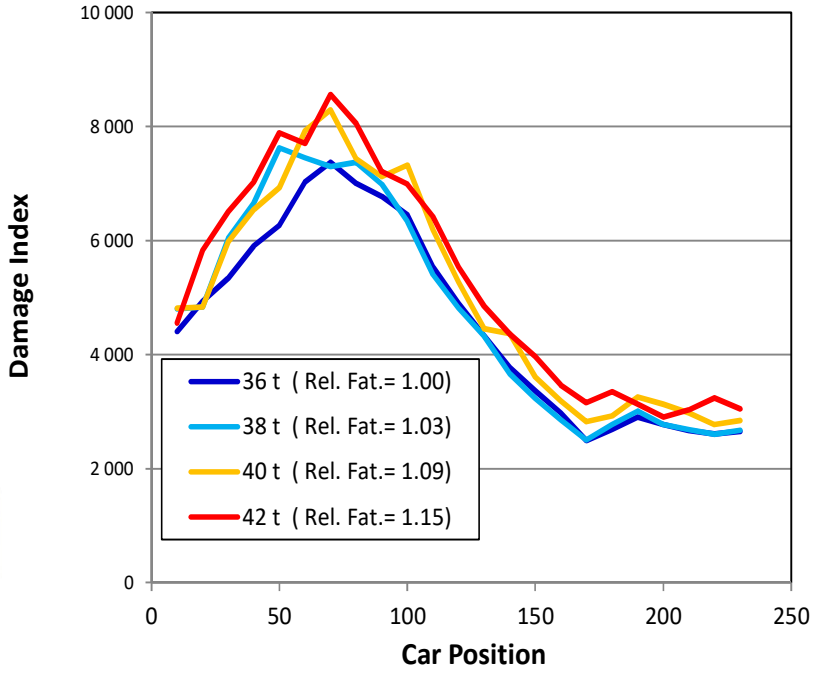
Forecasting of Maintenance





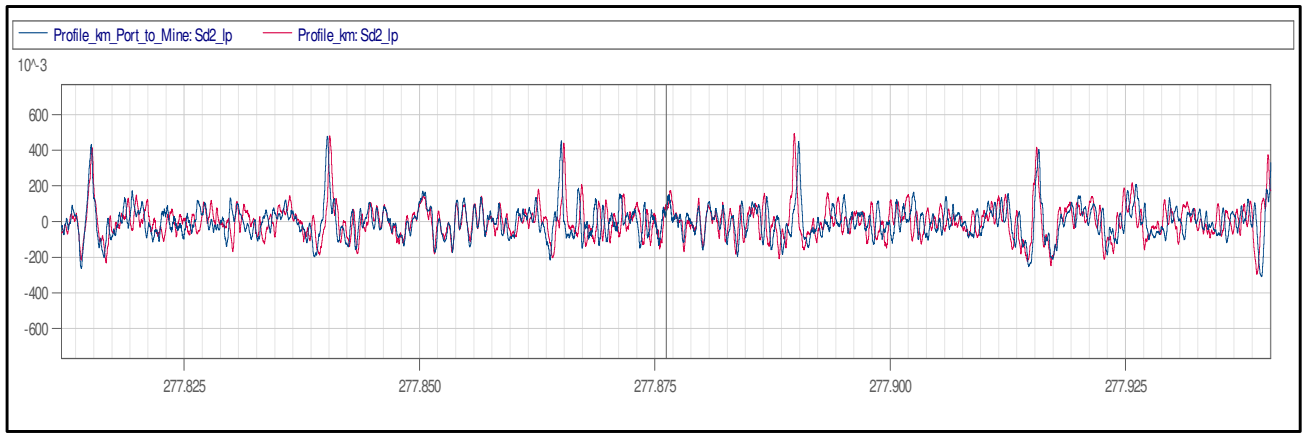
In-train Forces





Instrumentation ⇨ Dynamic Model ⇨ Prediction of maximum Fatigue Damage

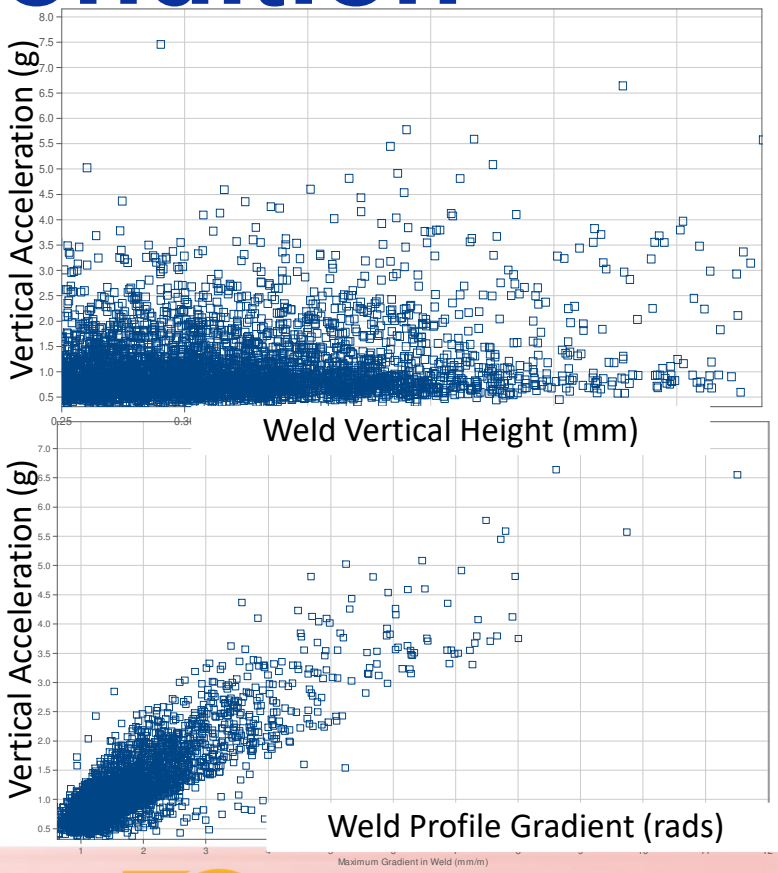
Example – Weld Condition



- **Rail longitudinal profiles sampled to 5mm increments along the track**
- **Running surface information can be extracted**
- **Dipped and peaked welds can be identified as well as vehicle dynamics due to weld condition**

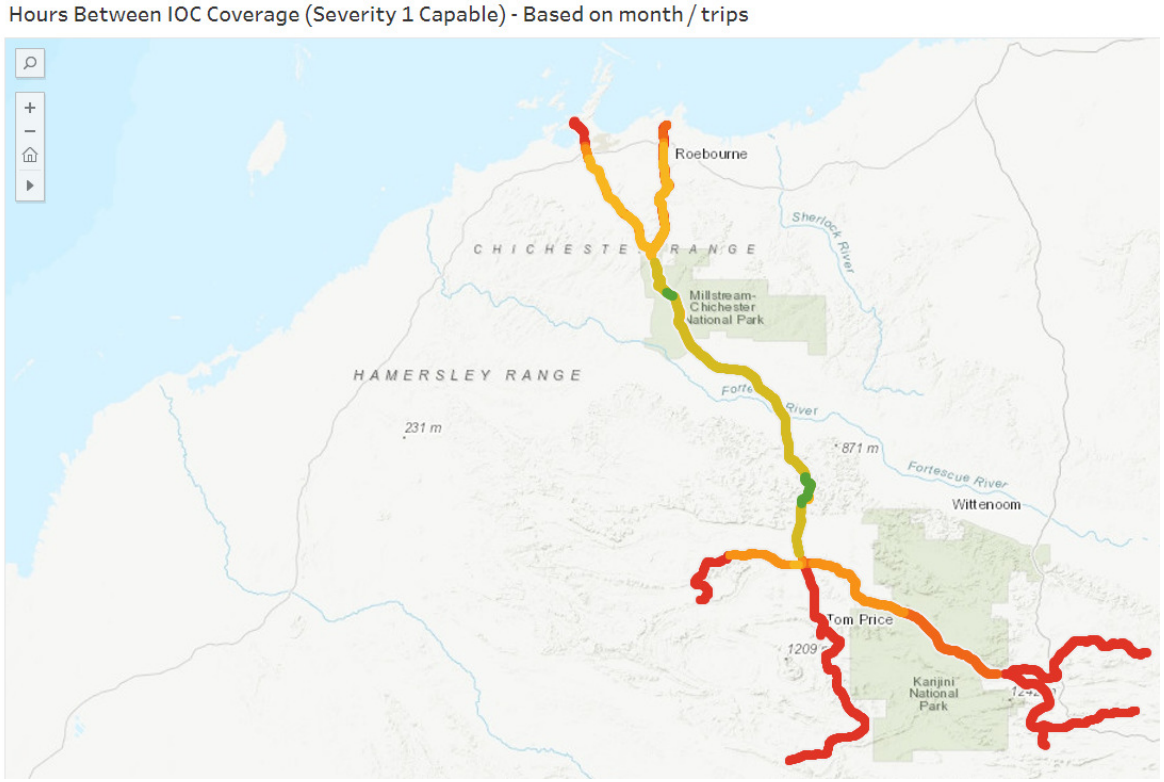
Example – Weld Condition

- View system wide weld profile data
- Convert results to system of choice (e.g. dip angle)
- Assess actual vehicle response to defects to produce standards relevant to safe operations



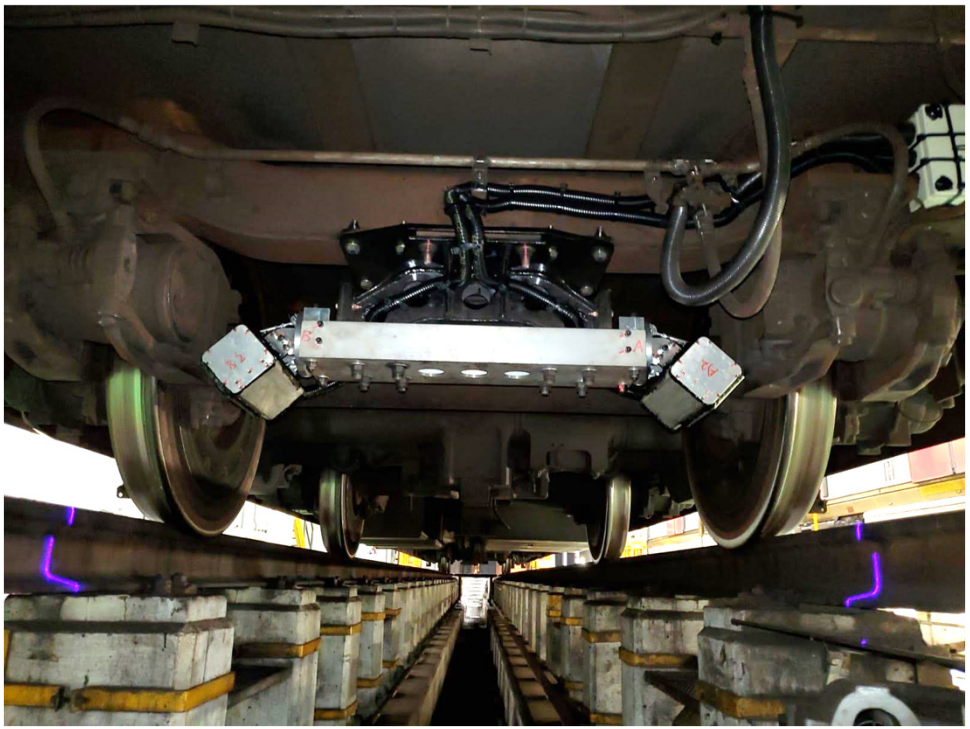
Network Coverage

- **Time between IRV measurements**
- **Used to highlight to operations where IRVs need to be included in rakes**



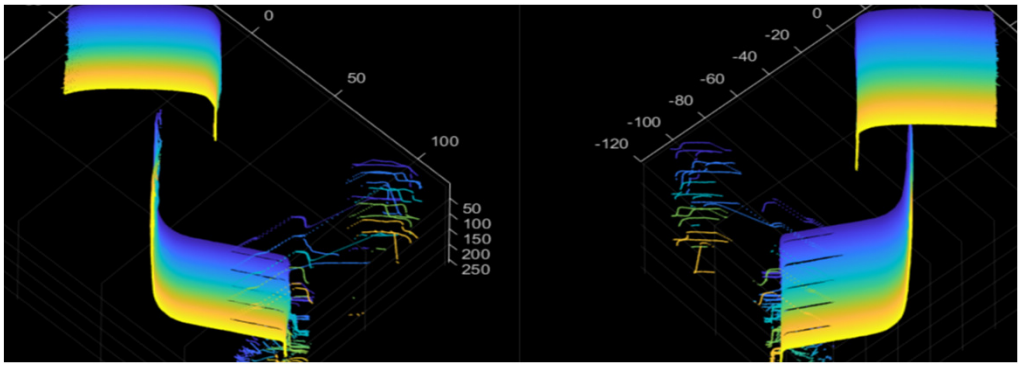
Dynamic Track Gauge Measurement

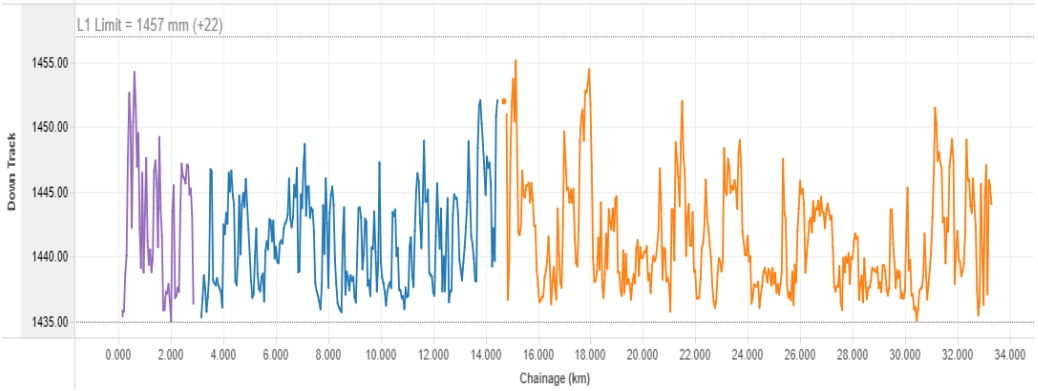
- **Installed as part of the IRV system in a revenue car**
- **Continuously measures gauge during normal traffic hours**
- **Satisfies EN 13848-1:2003+A1:2008 "Railway applications – Track Geometry Quality"**



Dynamic Track Gauge

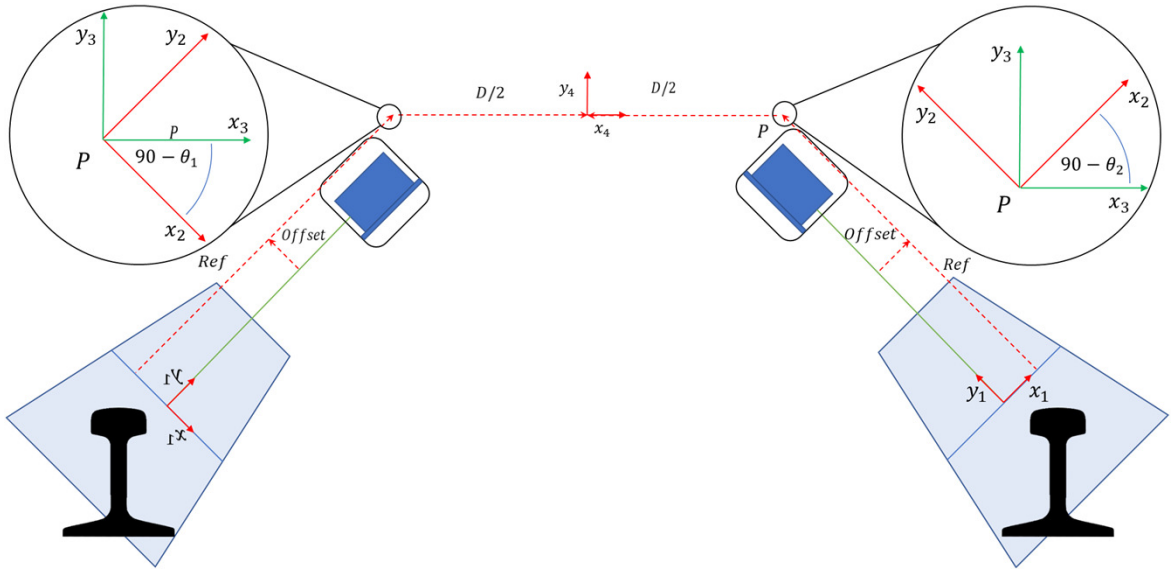
- Twin lasers used to calculate gauge
- Reported down to 1m when required
- Revenue vehicle loading so representative of any dynamic movement under revenue axle load
- Standard operation in MTR



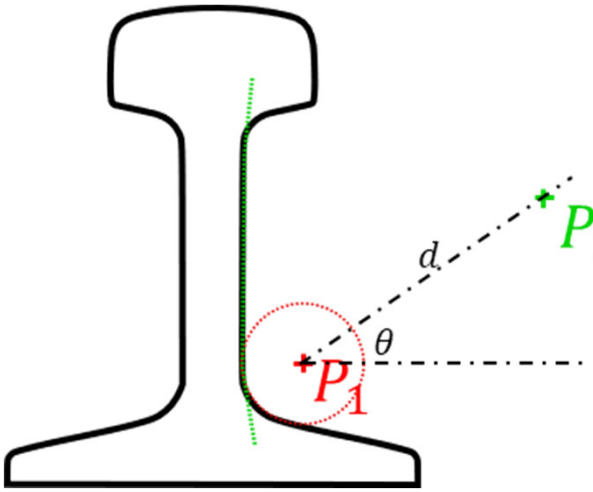


Expansion to Rail Wear

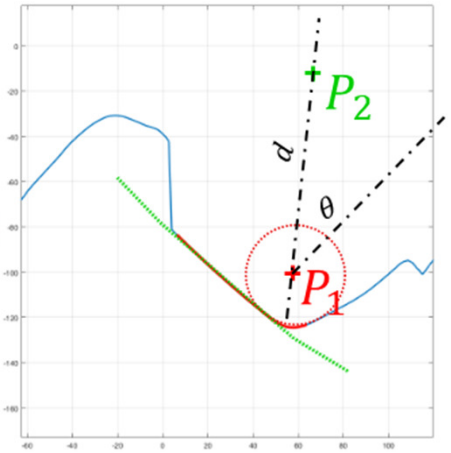
- **Complex calculations to convert rail frame of references into measurement frame**



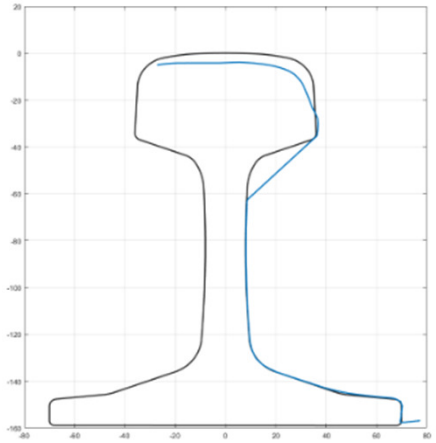
Profile Alignment



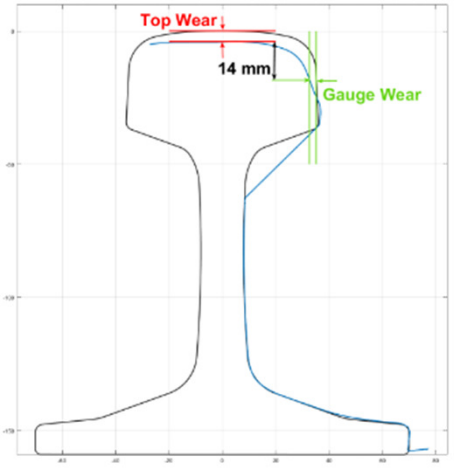
Template theory



Web locating

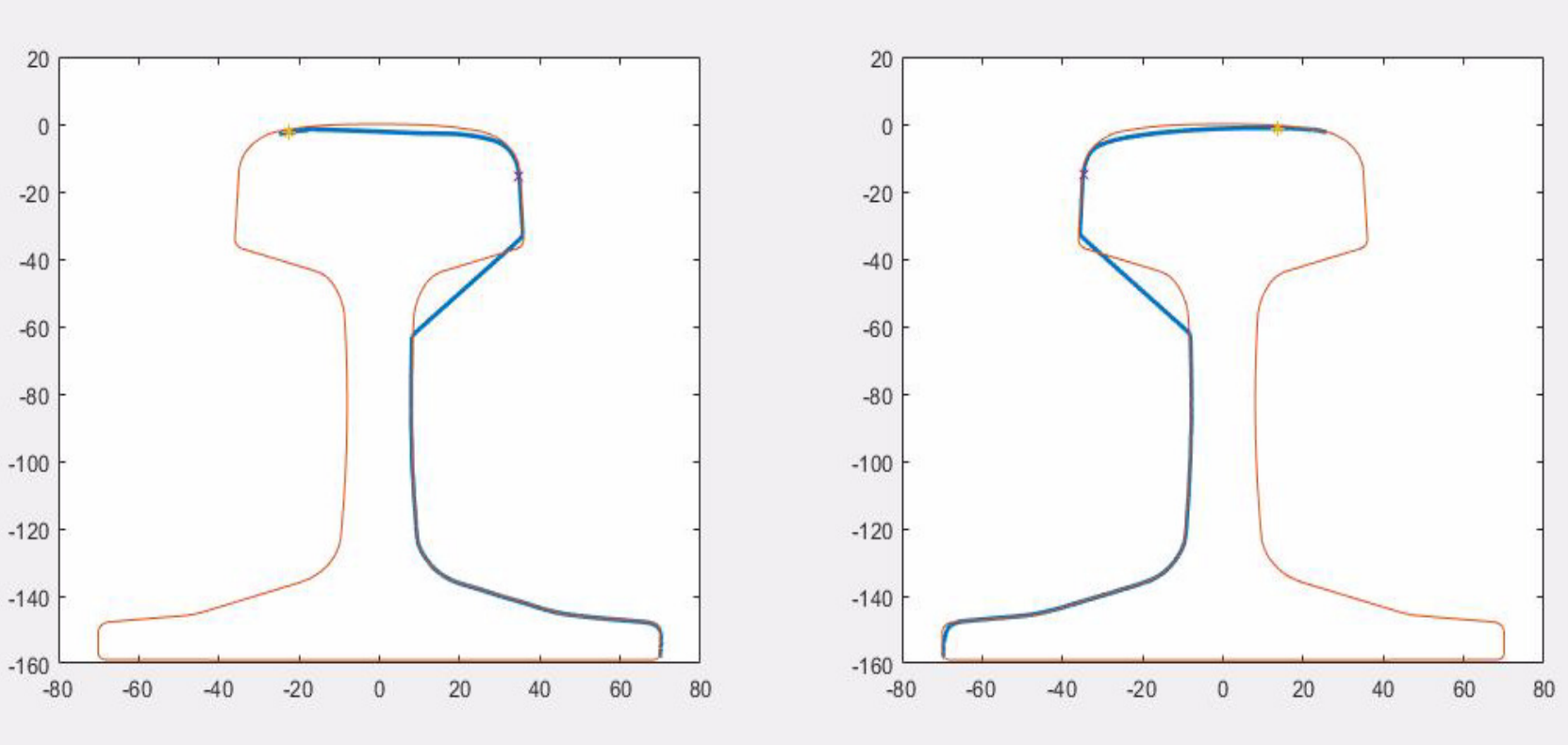


Template alignment

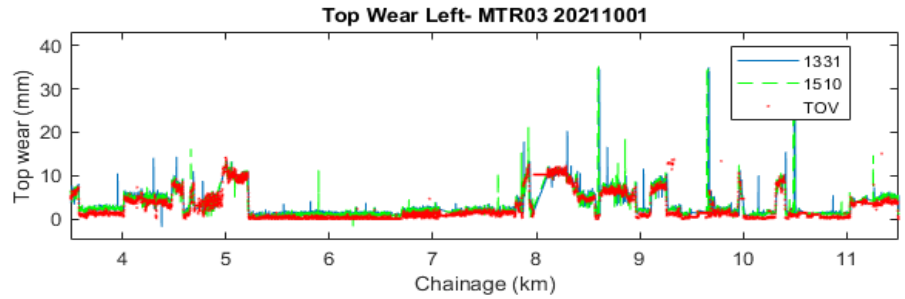


Wear Calculation

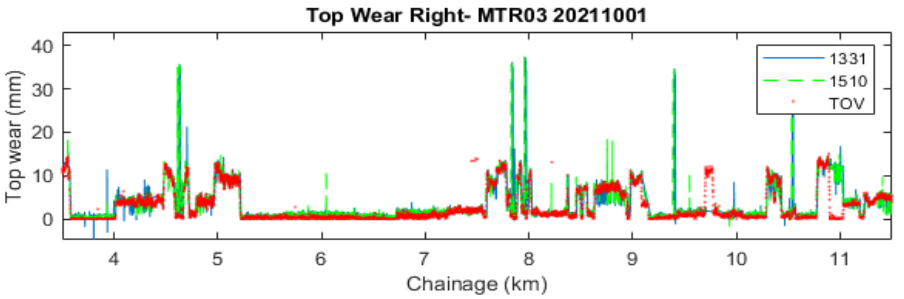
Calculation of wear done onboard

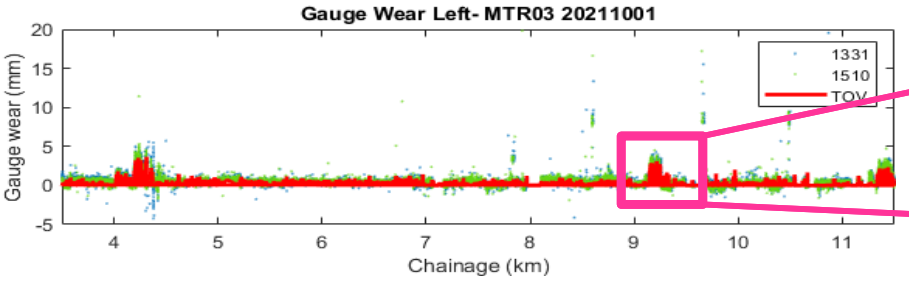


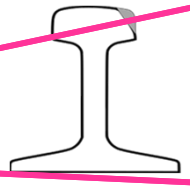
Validation against Track Geometry Car



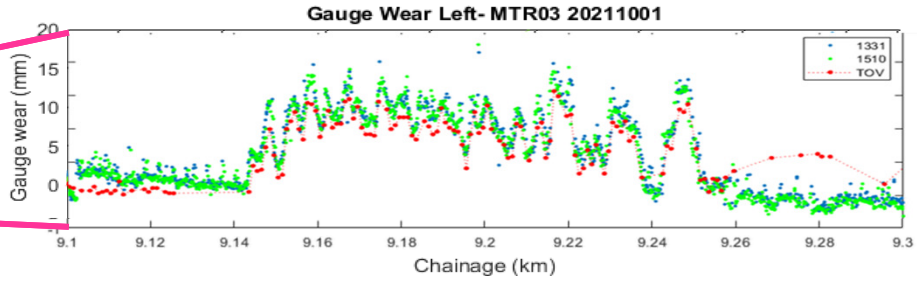
Vert





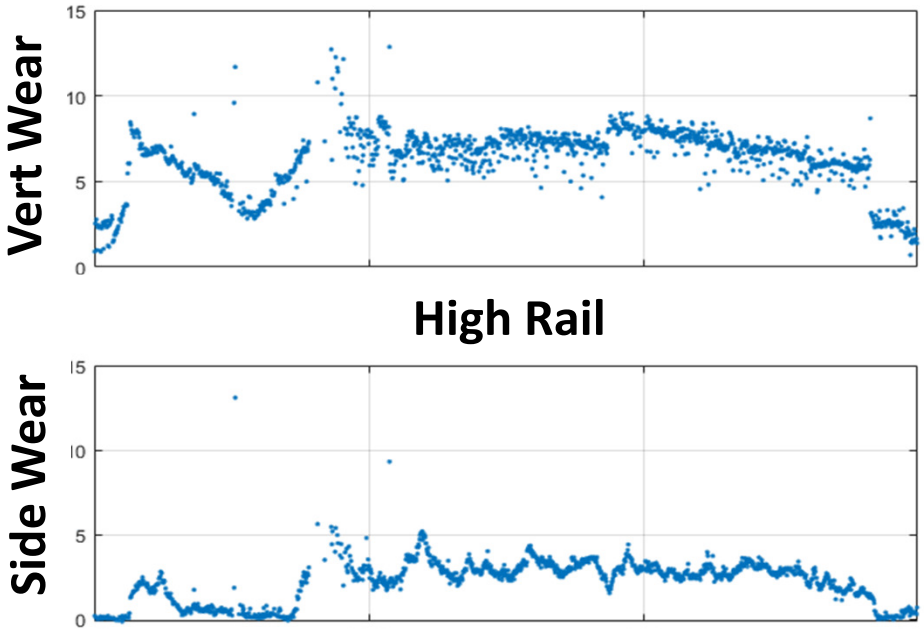


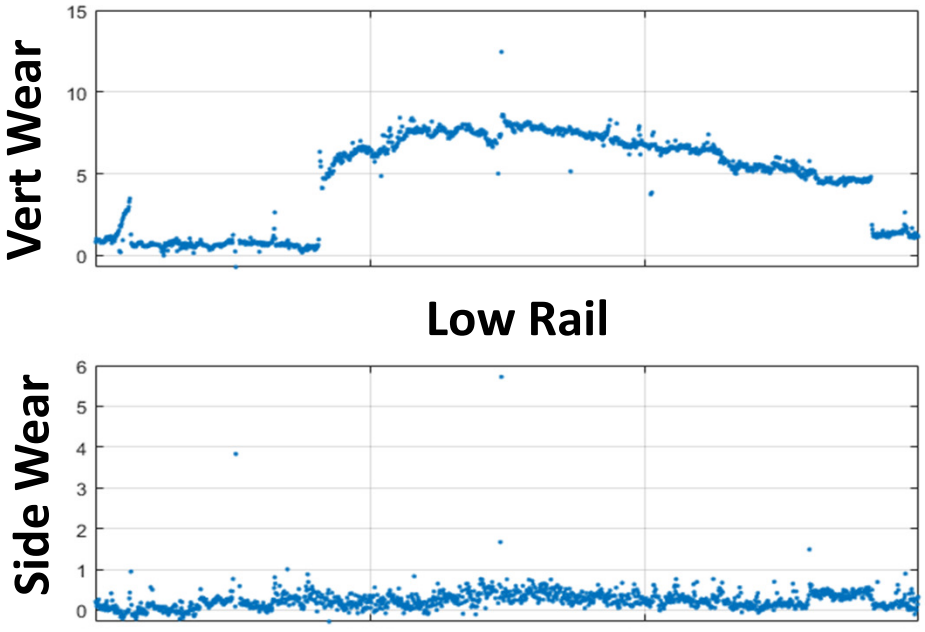
Side



- **Good correlation to geometry car and able to drill down into 1m data**

Validation





- Example measurements through a curve
- Vertical wear similar for low and high, side wear much lower on low rail

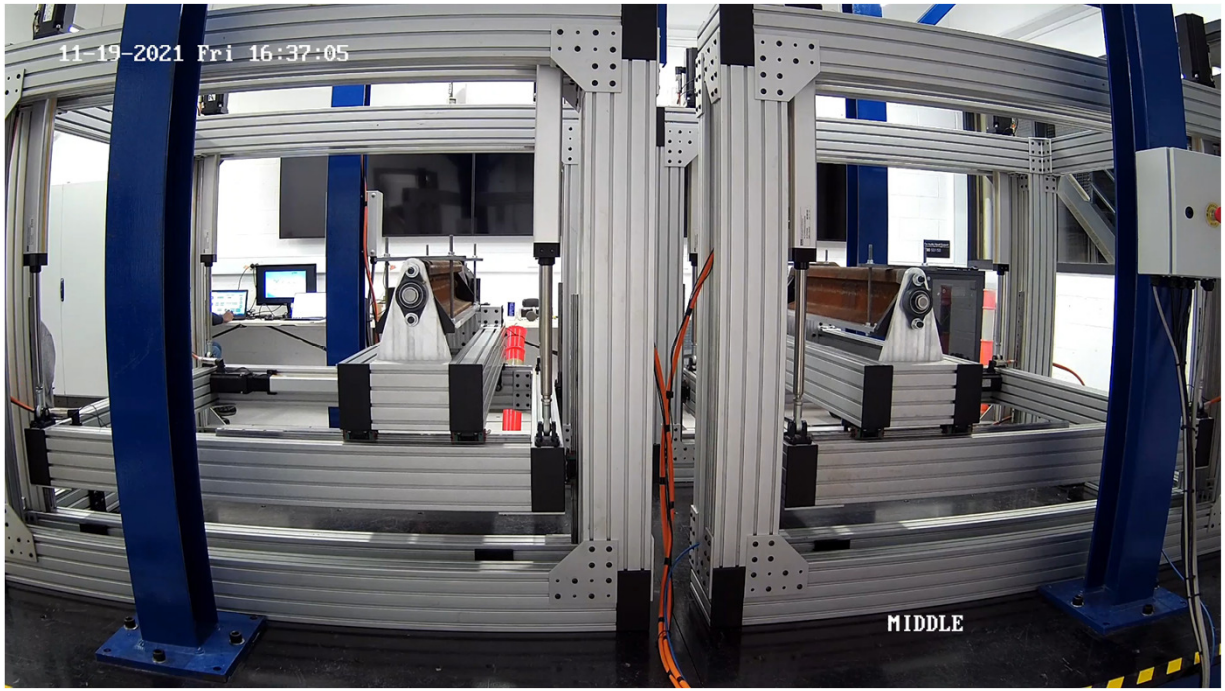
Continued Development

Axle Power Generation

- Current systems powered by solar and batteries
  - Reduced output during poor weather or orientation
- Axle generation system in use for six months, generates 350W at 80km/h
- Fail safe nylon bearing adaptor interface

Continued Development

- **Bespoke rig at Monash for further developing the systems**
- **Can simulate measured real track gauge, cant and inclination defects and test capabilities of IRV**



Summary

Instrumented Revenue Vehicles

- **Lower cost, rugged, revenue vehicle monitoring**
- **Provides near real-time track, vehicle and component performance**
- **Forecasting of maintenance and improvement of standards**
- **Growing capabilities of track gauge, rail wear and power generation**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