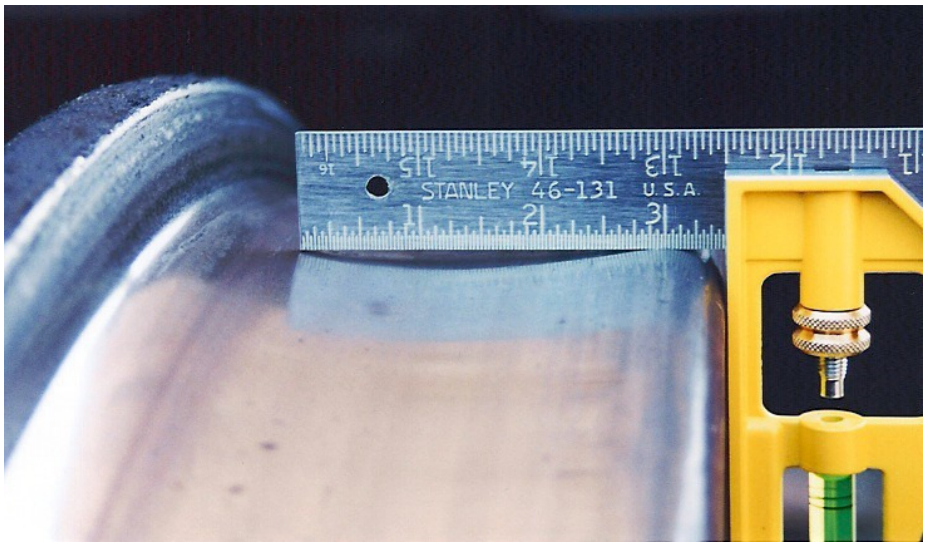
Charting the Relationship Between Asymmetric Wear and Hollow-worn Wheels



Ulrich Spangenberg

Vehicle/Track Interaction & Instrumentation

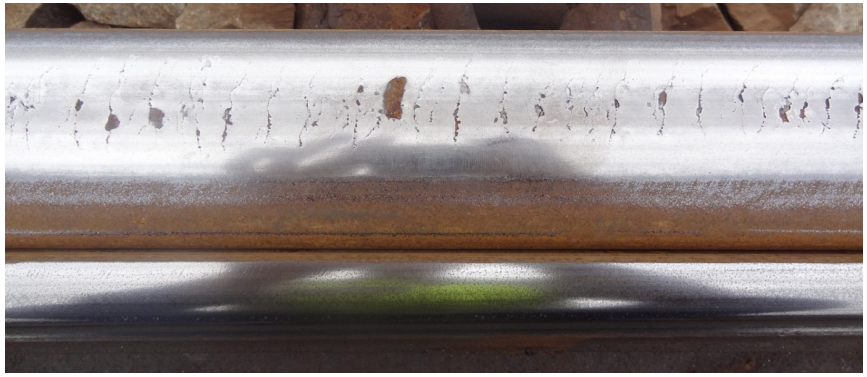
MxV Rail

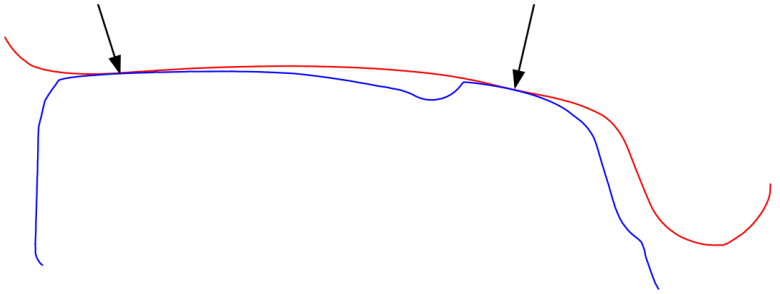
Overview of presentation

- Introduction and background
- Method
- Wheel wear value correlations
- Hollow wheel performance
- Asymmetric hollow wear causes
- Conclusion

Introduction and background

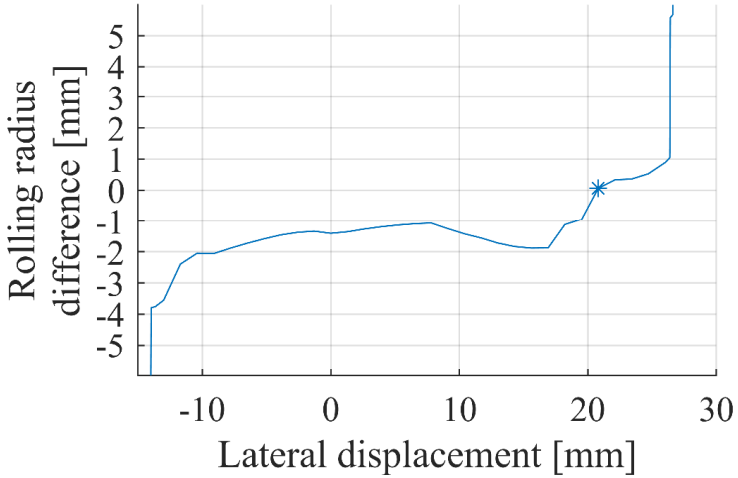
- **Hollow worn wheels are known for:**
  - **Wheel removal criteria**
    - **AAR Interchange Field Manual rules 41.A.1.ab and 41.A.2.b**
    - **5 mm and 4 mm to be changed out**
  - **Causing track damage**

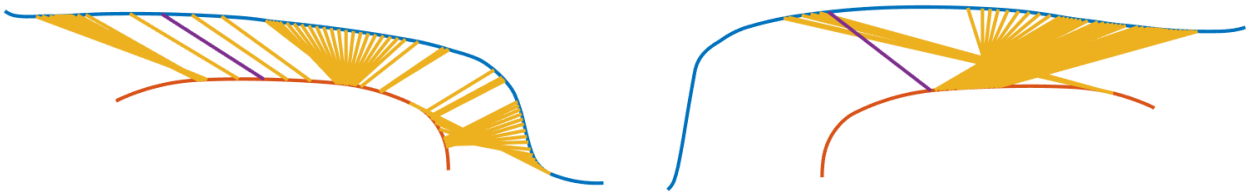




Introduction and background

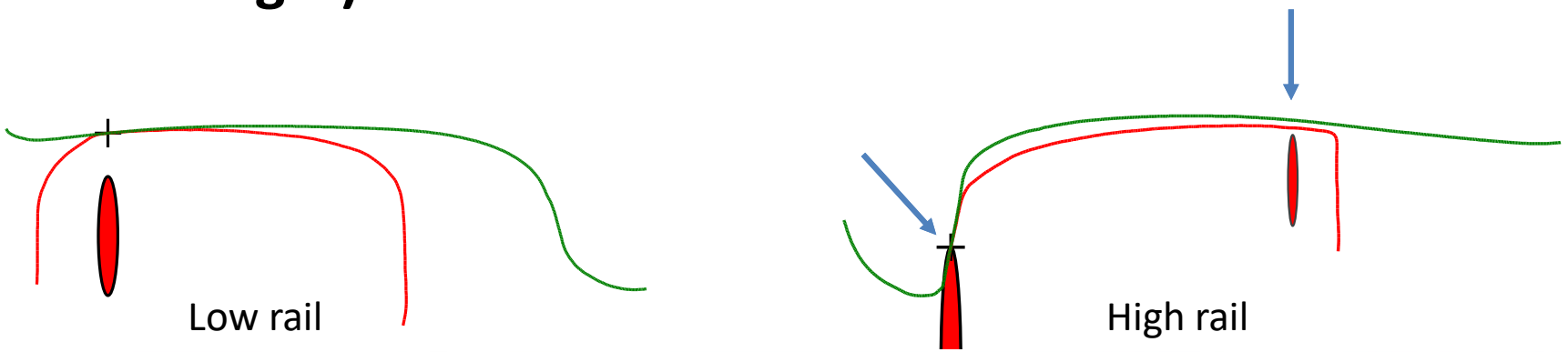
- **Hollow worn wheels are known for:**
  - **Increased rolling resistance**





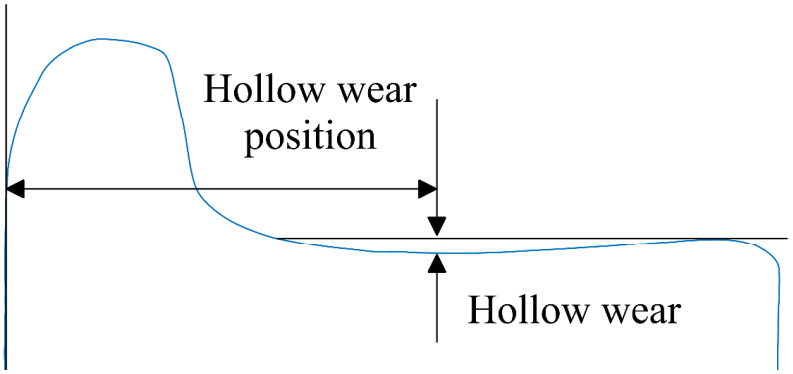
Introduction and background

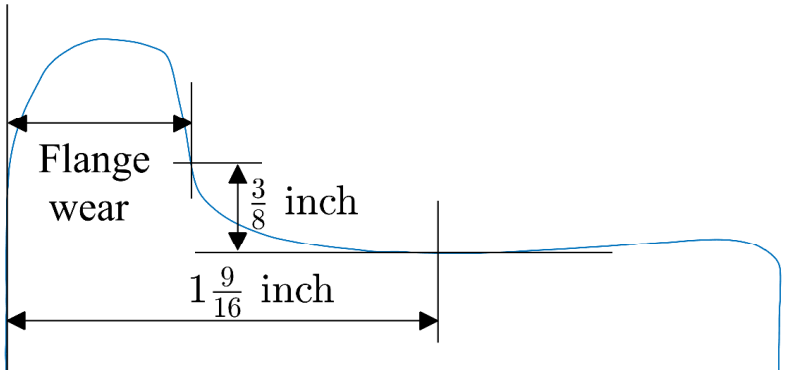
- **Hollow worn wheels are known for:**
  - **Increased truck-side lateral to vertical (L/V) ratios**
  - **Decreased resistance to rail roll-over (WRI 2018, Rosenberger)**



Introduction and background

- **Objective/aim:**
  - **Study the formation of hollow worn wheels and asymmetry to reduce asymmetry**



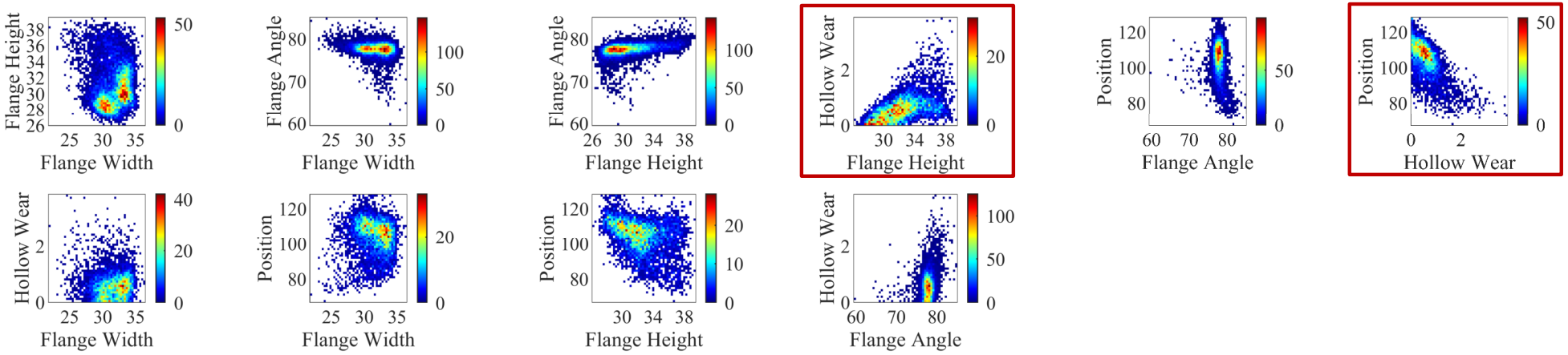


Method

- **Wayside measurement system data:**
  - **Wheel profile detector system (320k and ~4 million)**
  - **Matched with Umler® entries**
  - **Truck geometry detector**
  - **Hunting detector**
  - **Manufacturing records of diameters and trucks**

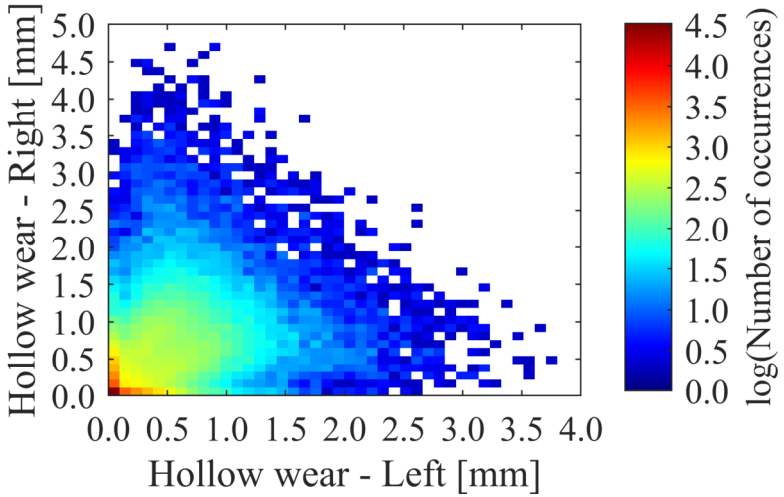
Wheel wear value correlations

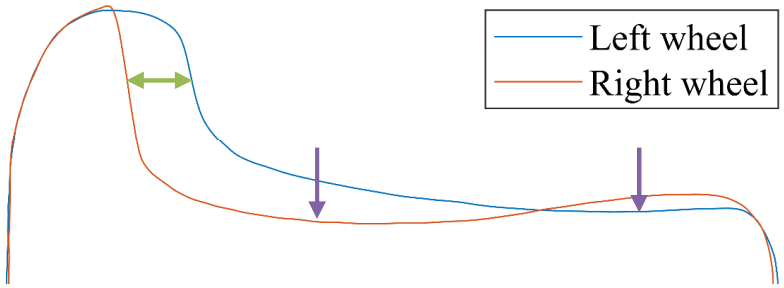
- **Comparisons of typical wheel wear values**
  - **All values in millimeter or degrees**



Wheel wear value correlations

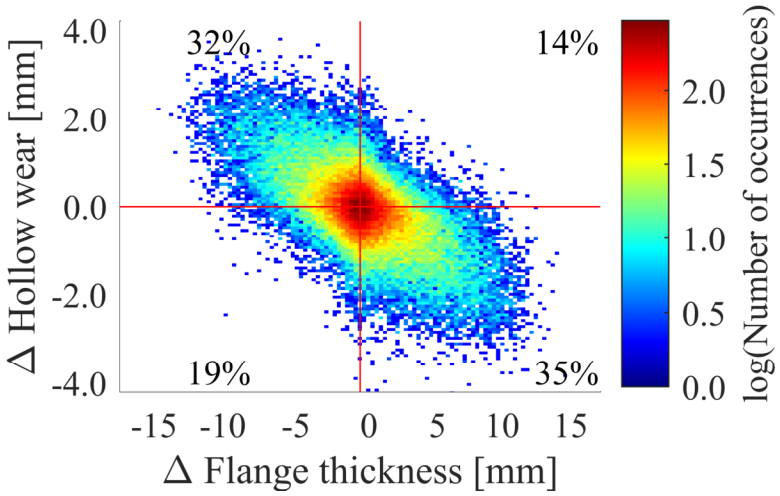
- **Left vs right**
  - **Symmetric to around 0.5 mm**
  - **Severe hollow worn wheel with ΔFlange thickness and ΔPosition**
  - **Note Δ means right minus left**

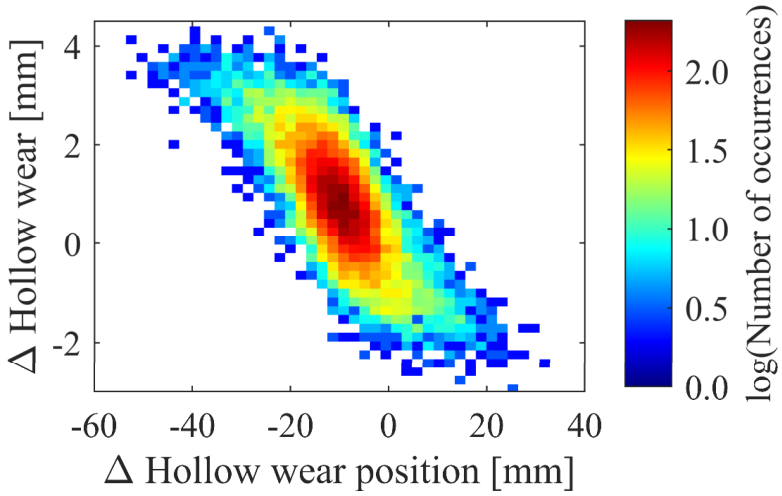




Wheel wear value correlations

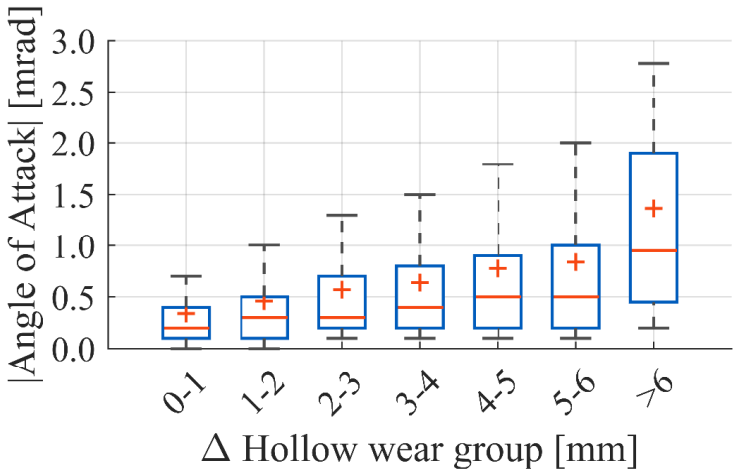
- **ΔHollow wear versus other Δparameters**





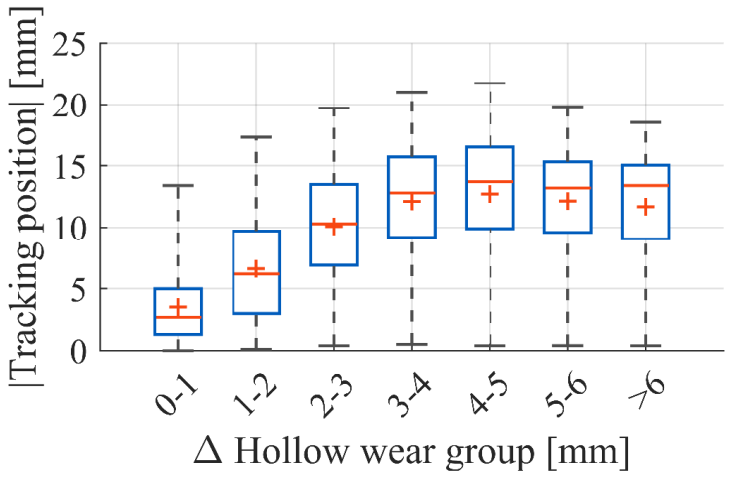
Hollow wheel performance

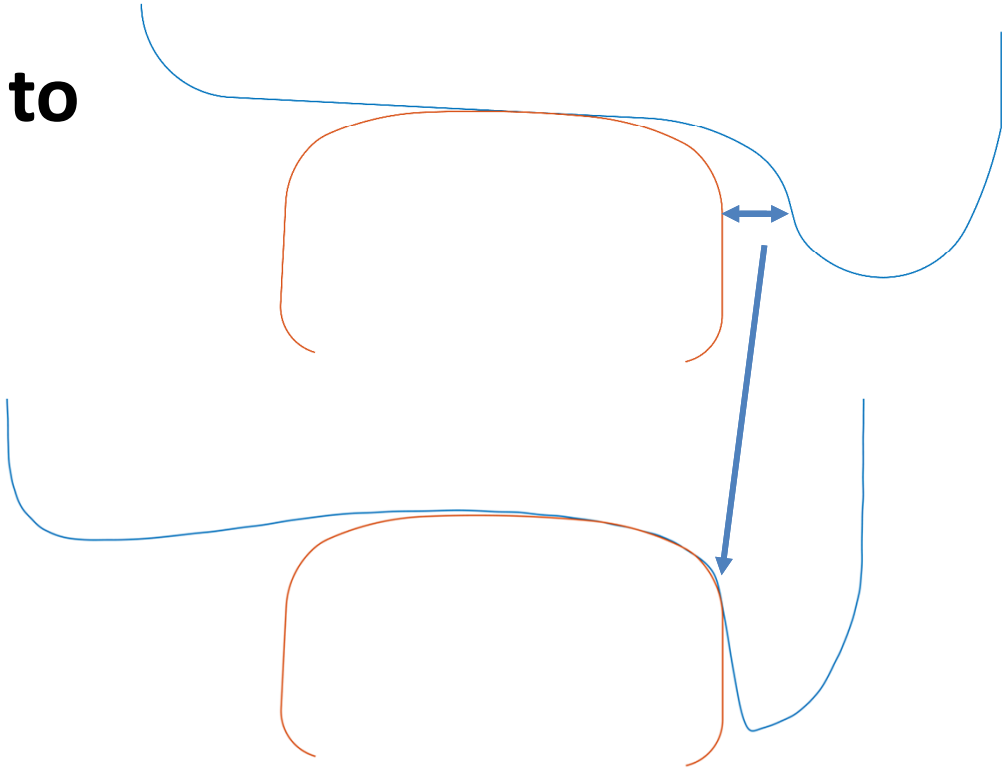
- **Angle of attack**
  - **Equivalent to steering around a curve of 0.5° (~3500 m)**



Hollow wheel performance

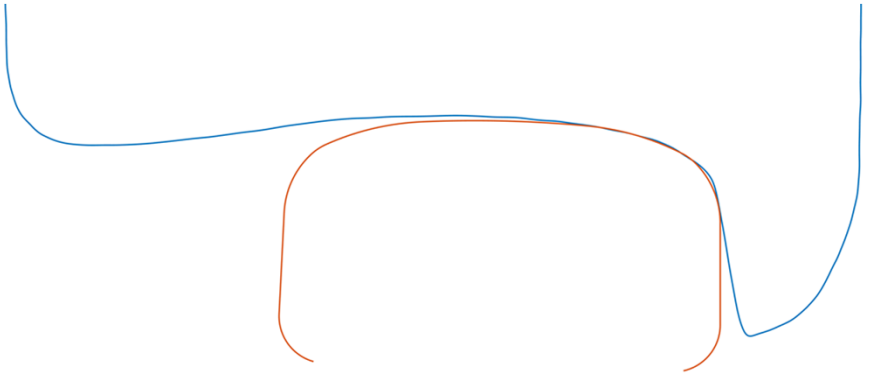
- **Tracking position relative to center of track**





Hollow wheel performance

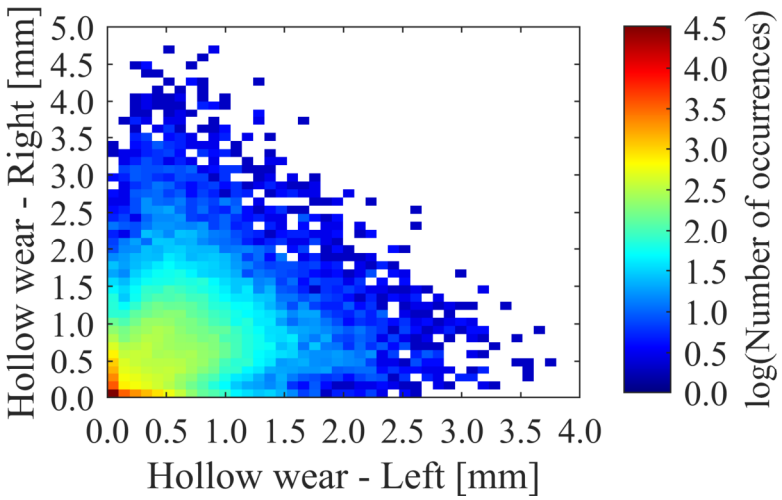
- **Hunting performance**
  - λ_{eq} Equivalent conicity
  - R_w Transverse radius of the wheel
  - R_r Transverse radius of the rail
  - α Contact angle



$$\lambda_{eq} = \frac{R_w}{R_w - R_r} \sin \alpha$$

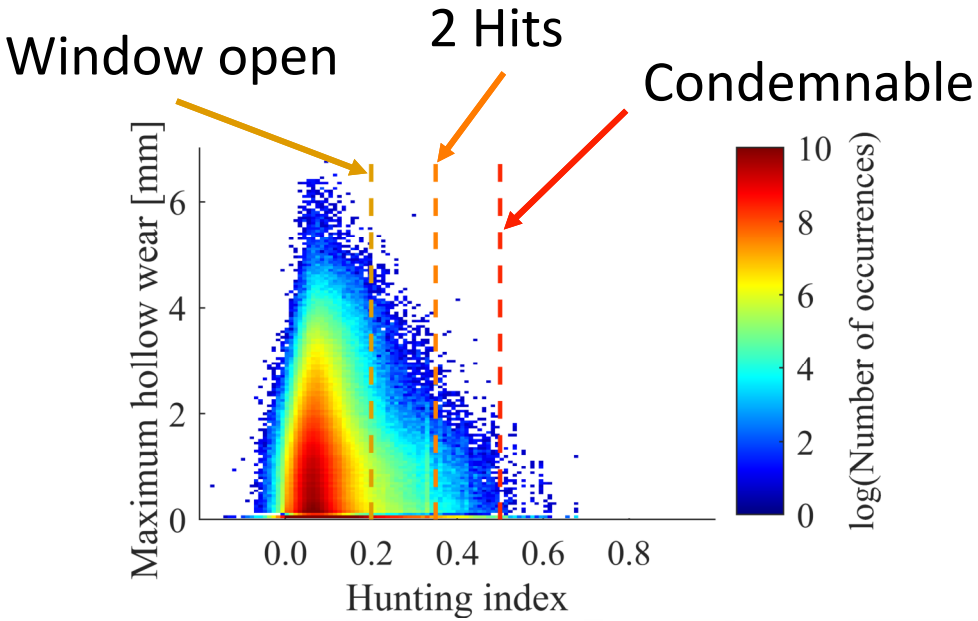
Hollow wheel performance

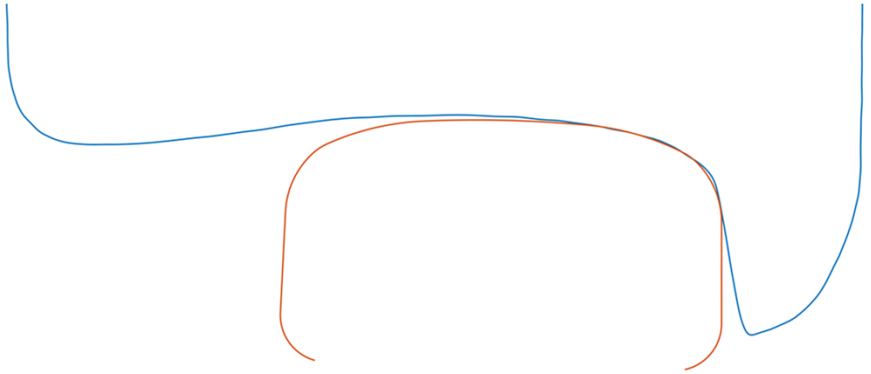
- **Hunting performance**
  - **Hunting index reported per axle**
  - **Maximum hunting index within 3 months of hollow measurement**
  - **High values of hollow wear linked to asymmetry**



Hollow wheel performance

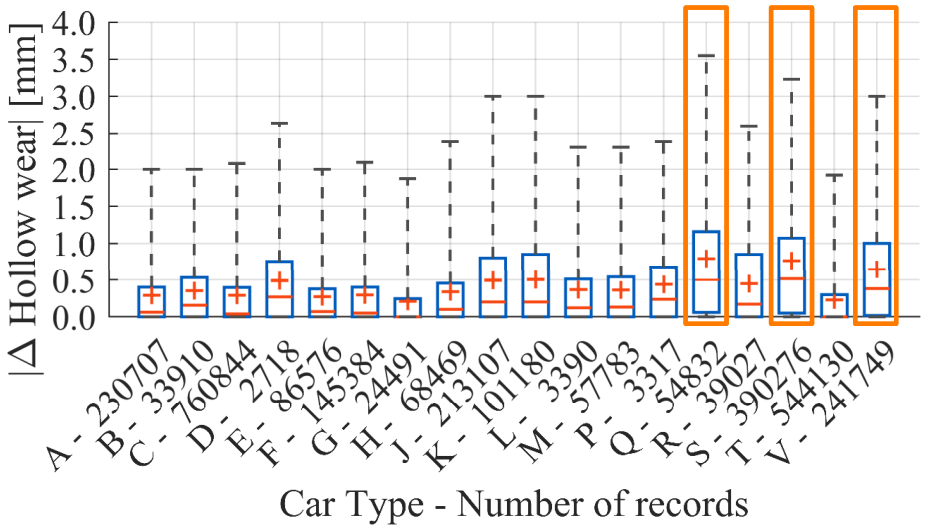
- **Hunting performance**





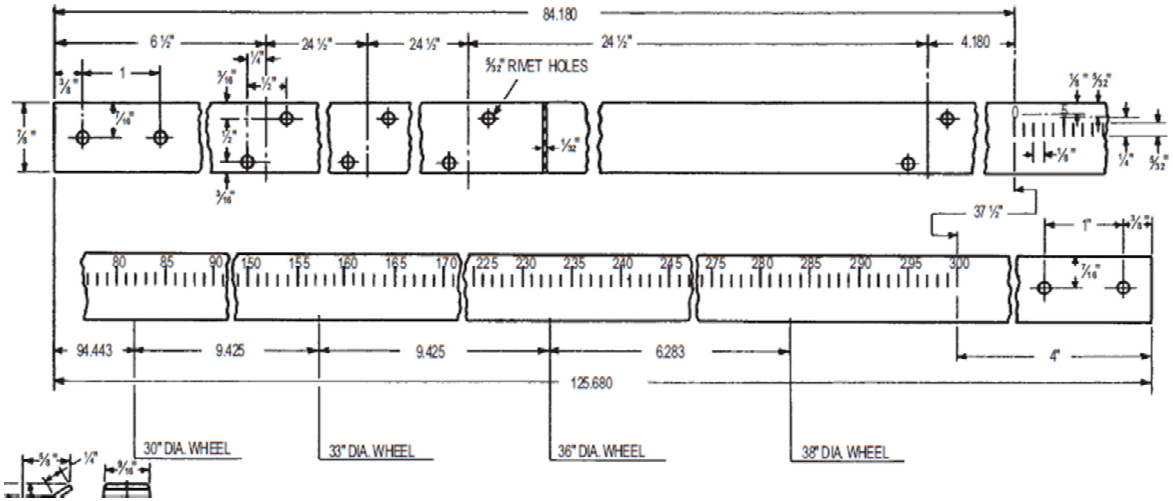
Asymmetric hollow wear causes

- **More prevalent on intermodal and vehicular flat car types (Umler® Q, S and V)**
  - **Vehicles associated with higher speeds and long travel distances**
  - **Mainly on small diameter wheels**



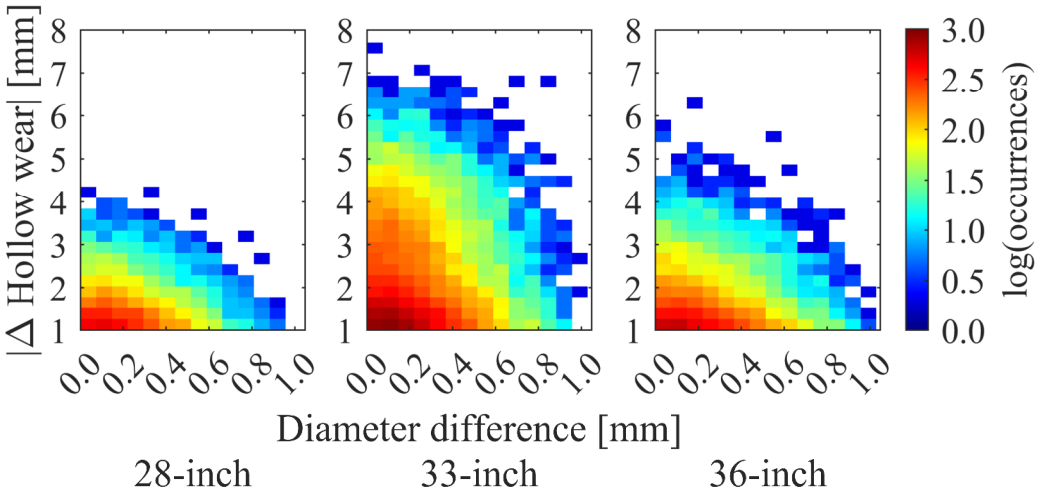
Asymmetric hollow wear causes

- **Influence of initial diameter difference**
  - **New wheel diameters matched within 1 tape size**
  - **1/8 inch increments**
  - **Up to 1 mm diameter difference**



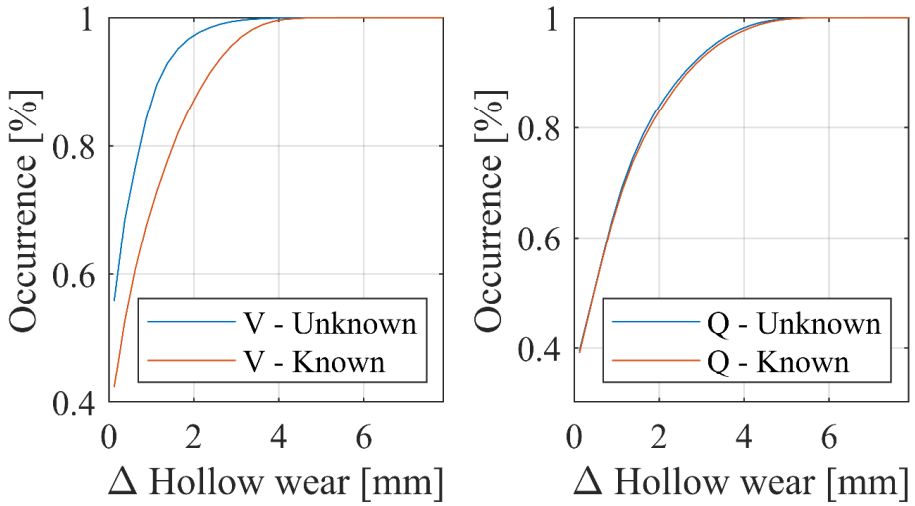
Asymmetric hollow wear causes

- **Influence of initial diameter difference**
  - **Asymmetry not driven by initial diameter difference**



Asymmetric hollow wear causes

- **Influence of truck type**



Conclusion

- Hollow wear is typical
- Root cause(s) of asymmetric hollow wear remain unknown
  - It is not caused by initial diameter difference
  - Could be related to truck type
  - More prevalent on intermodal and vehicular flat cars

Conclusion

- **Asymmetric hollow wear results in:**
  - **Similar angles of attack**
  - **Lateral offset of the wheelset relative to the center of track**
- **Hunting not directly related to hollow wear**

Questions?

Thank you for your attention.