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Friction Management
Portec Rail / Kelsan Technologies

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ONE STEP AHEAD.

FM application and rainy weather

The influence of precipitation on trackside FM application in heavy haul environment

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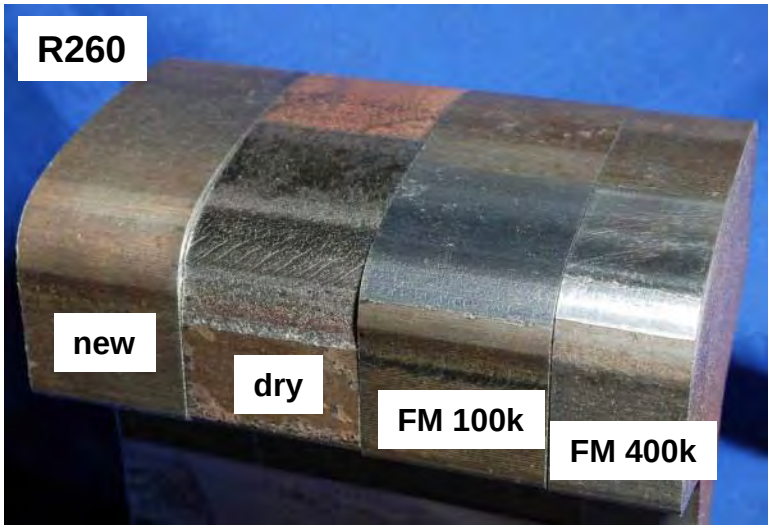
Overview

- Background
- Test environment
- Methodology
- Results
- Conclusions
- Outlook

Background (personal)

- voestalpine Schienen GmbH: rail producer from Austria / Europe
- Technical collaboration between voestalpine and Kelsan Technologies since 2004
- Topic: RCF and wear
- Secondment to Kelsan/Vancouver between Mar. 2010 and Nov. 2010



Background (technical)

- Rain provides noise reduction on transit systems
  - Some transit systems turn FM off while precipitation as no squealing noise is present
- Heavy Haul systems are quite different (loads, train lengths…)
  - What interaction between HH trains and precipitation?

Test site

- Data used from Western Class 1 Railroad subdivision (L/V site)
- 6 deg (300m) curve
- 1% steady ascending grade
- Superelevation posted for 35 mph (56kph)
- Unit 286k coal trains (loaded) westbound
- Power distribution (head-mid-tail): 2-1-0 and 2-1-1
- Aluminum hoppers, typical train length: 124 cars

Weather Data

- Weather station at nearby airport (CYVR and 71882)
- Data obtained through http://www.wunderground.com/
- Data available per day on an hourly basis (2007 – present)
- Different categories of precipitation – light rain, rain, heavy rain, light snow, snow
- Data on precipitation amount
- Distance between L/V site and weather stations: 3.1 miles (5 km)

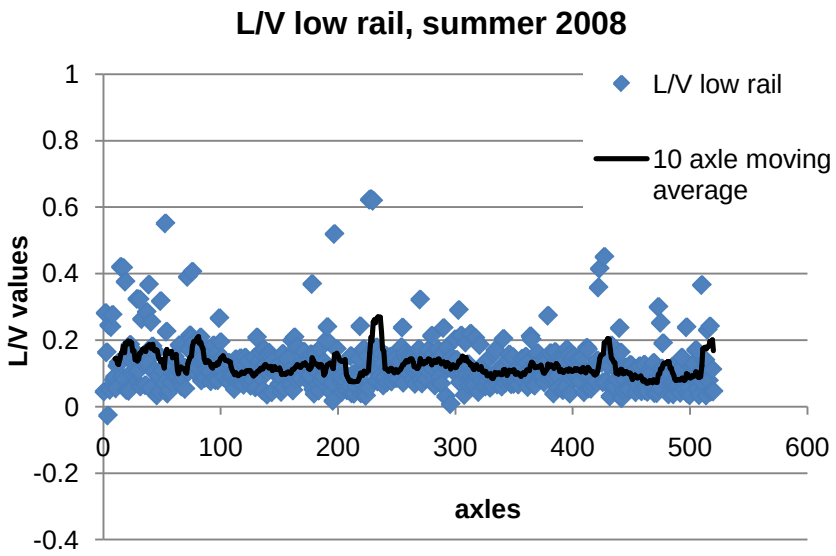
Overview – L/V and Weather stations

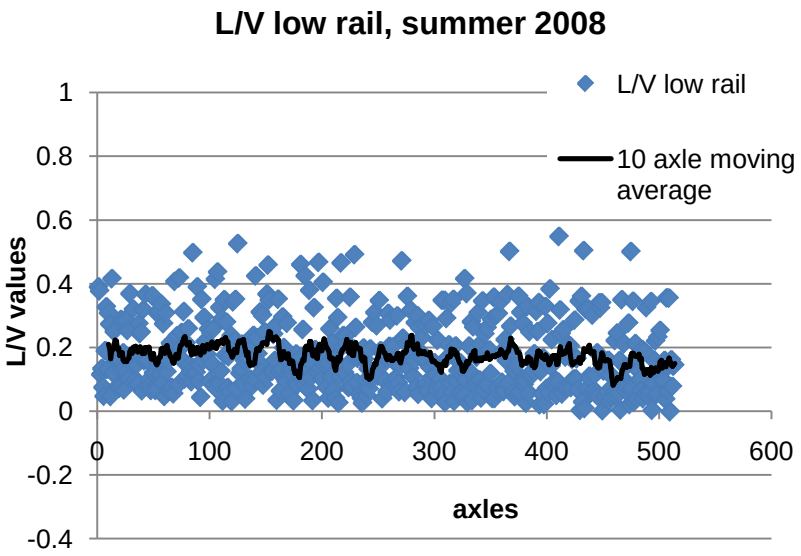
Methodology

- Focus on low rail L/V data – underbalanced train speed (15-20mph – 24-32 kph)
- Identifying days with definite rain conditions between 2007 and present date (rain or heavy rain and more than 0.2inch (0,5cm) daily precipitation)
- Time stamp at L/V site correlated with rain periods
- Only periods between May – September were examined (no snow!)
- Detailed analysis (2008):
  - September 5th – September 22nd: FM application was completely turned off
  - September 22nd – November 30th: FM application was turned on again
  - May – September 2009 and May-September 2010 for confirmation
  - Leading vs. trailing axles

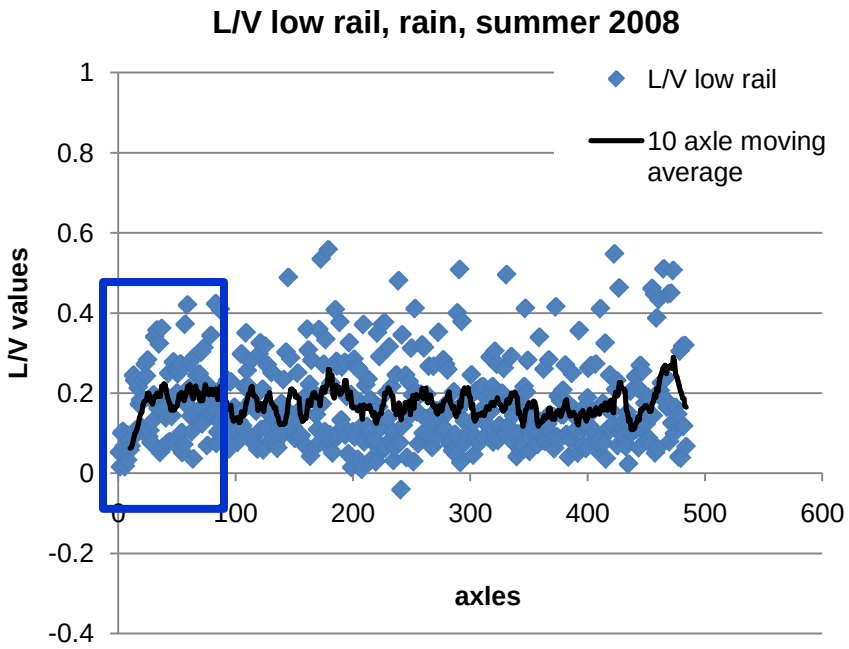
General analysis – no rain

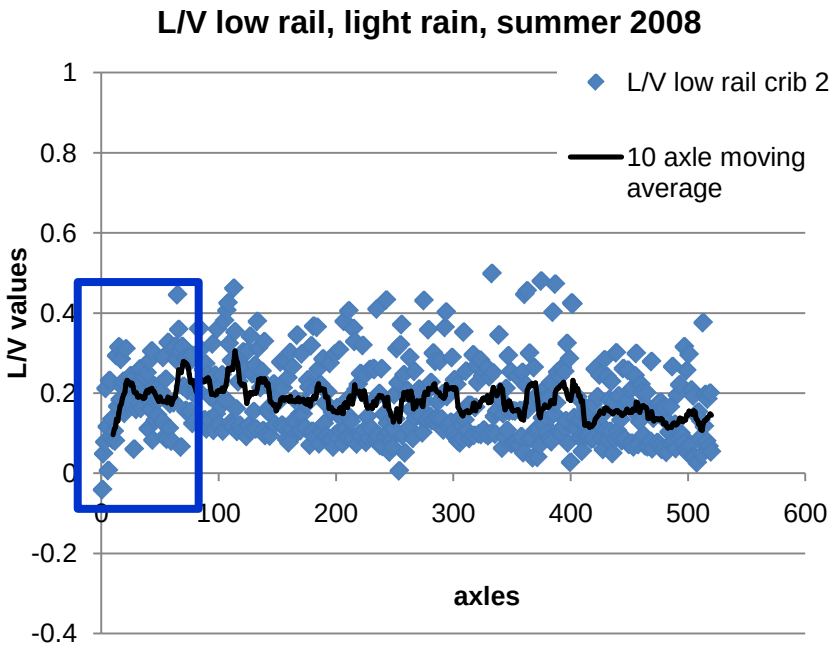
- All low rail axles used
- 10 axle moving average trend analysis included





General analysis: rain

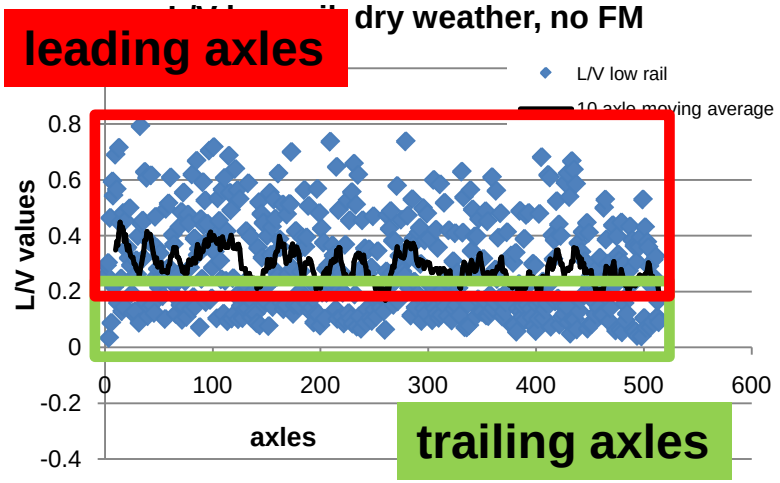


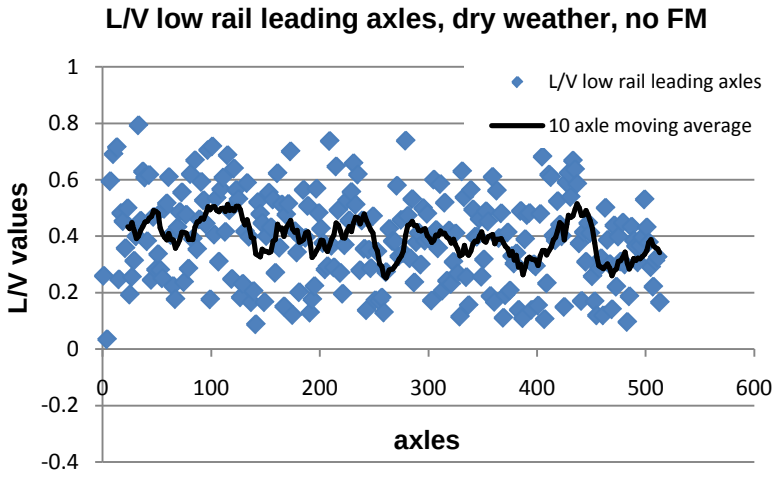


- Rain: starting at low L/V values – increase during the first 50 axles
- Similar results for 2009

Detailed analysis: No FM, dry weather

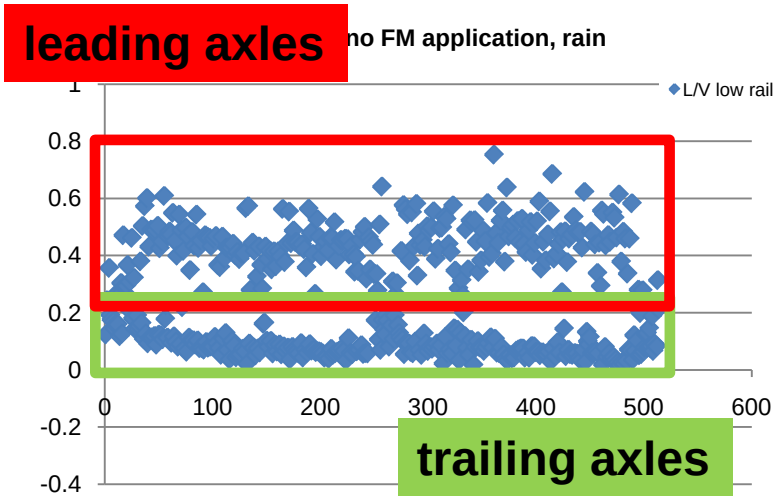
- September 5th - September 22nd: no FM application
- Dry weather conditions
- L/V low rail: all axles and leading axles only
- Dry results: large data scatter, high L/V values

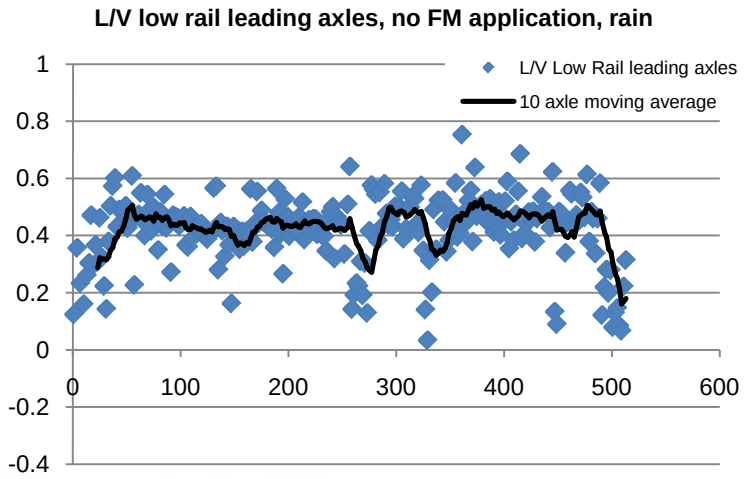




Detailed analysis: No FM, rain

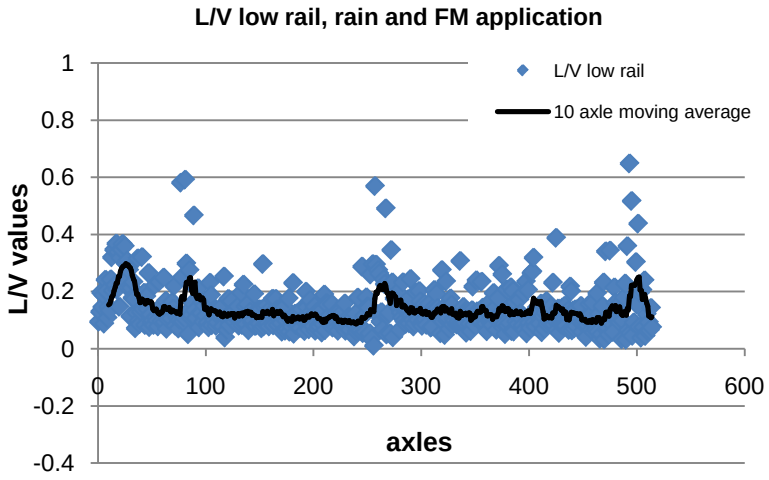
- September 5th - September 22nd: no FM application
- Rain conditions
- L/V low rail: all axles and leading axles only
- Rain results:
  - First 50-80 axles increase from low L/V values
  - Separation of leading and trailing axles

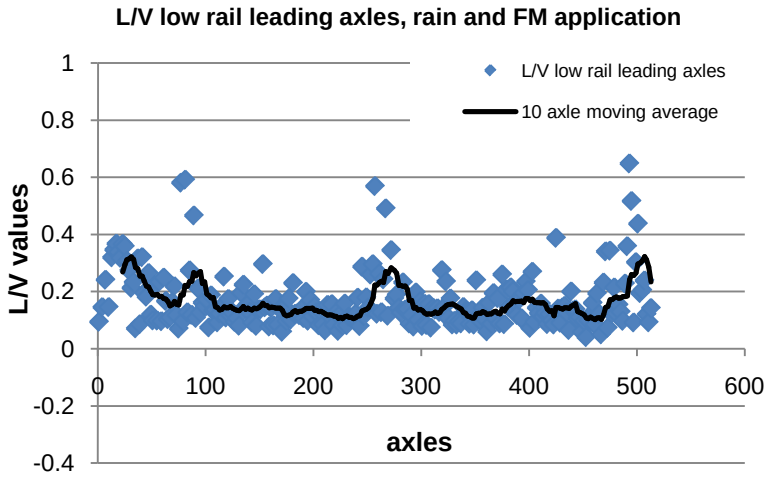




Detailed analysis: FM application, Rain

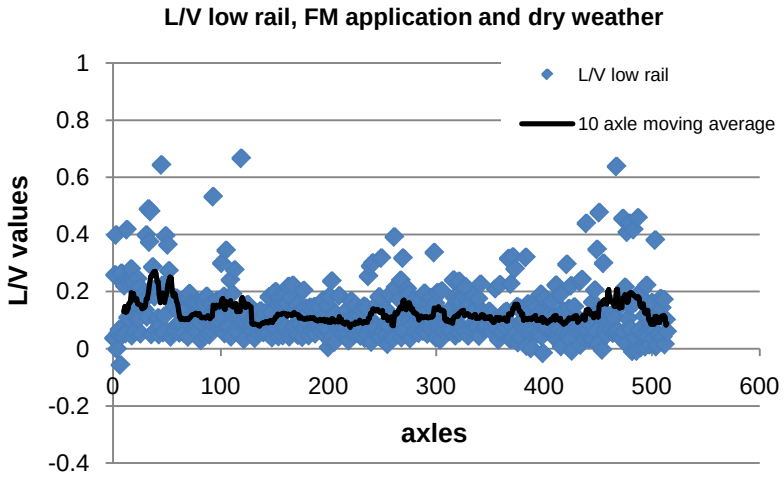
- After September 22nd : FM application
- Rain conditions
- L/V low rail: all axles and leading axles only
- FM application and rain results:
  - First 50 axles increase from low L/V values to Maximum
  - decrease to nominal values between axles 50-100

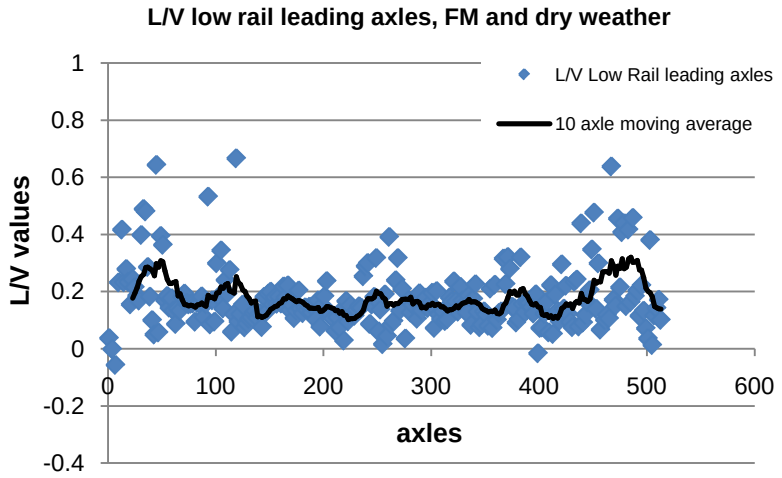




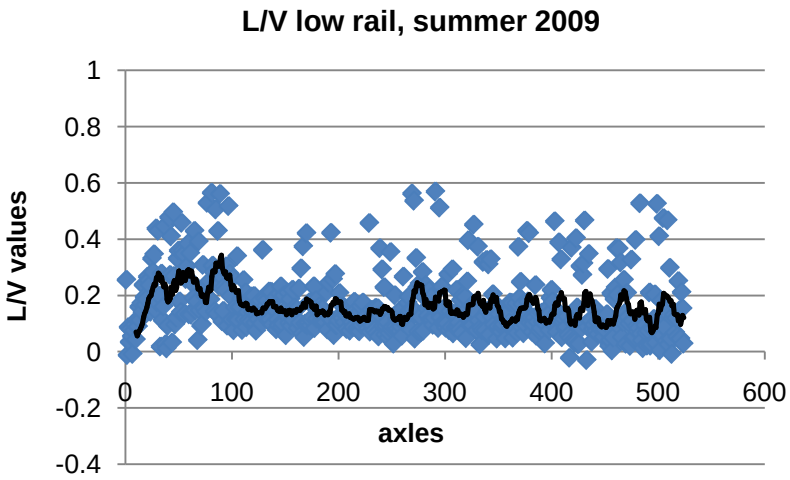
Detailed analysis: FM application, dry weather

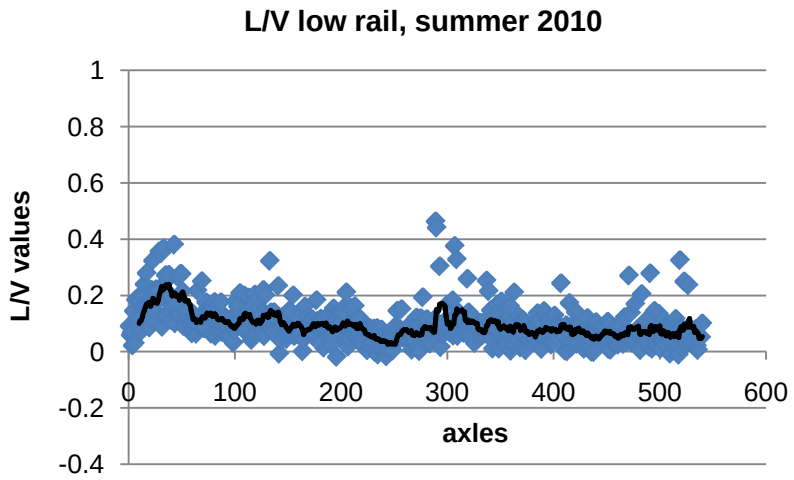
- After September 22nd 2008: FM application
- Dry weather conditions
- L/V low rail: all axles and leading axles only
- FM application and dry weather results:
  - Some data scatter during the first 50 axles

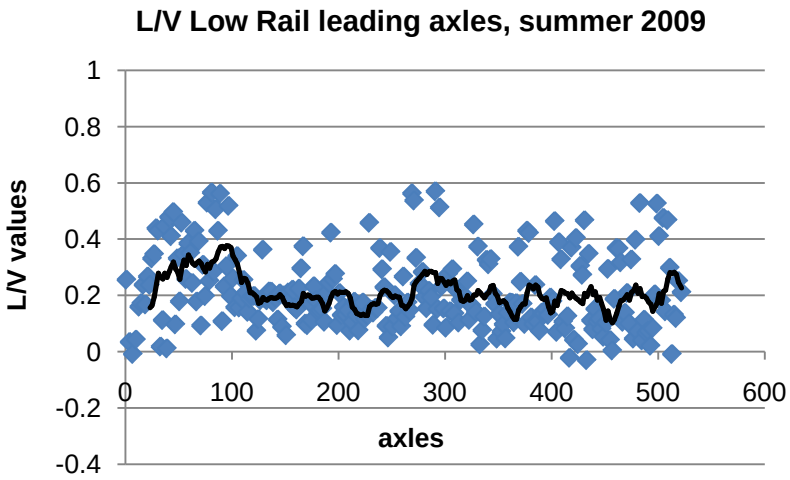


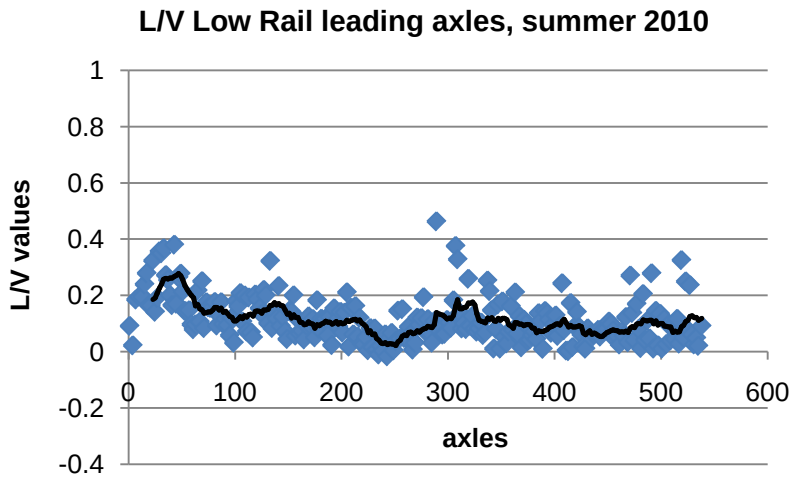


Confirmation
rain and FM application: summer 2009 and 2010

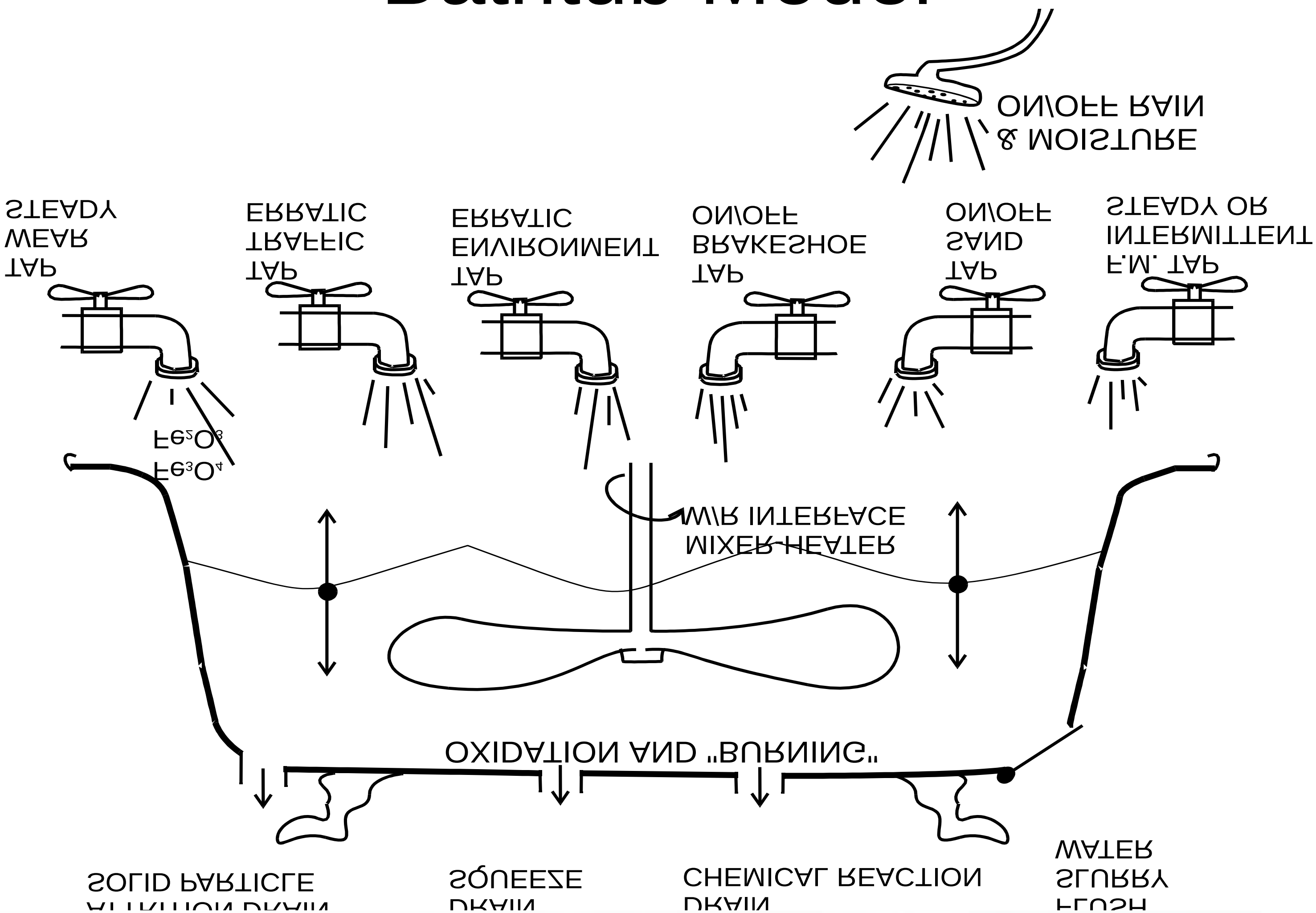




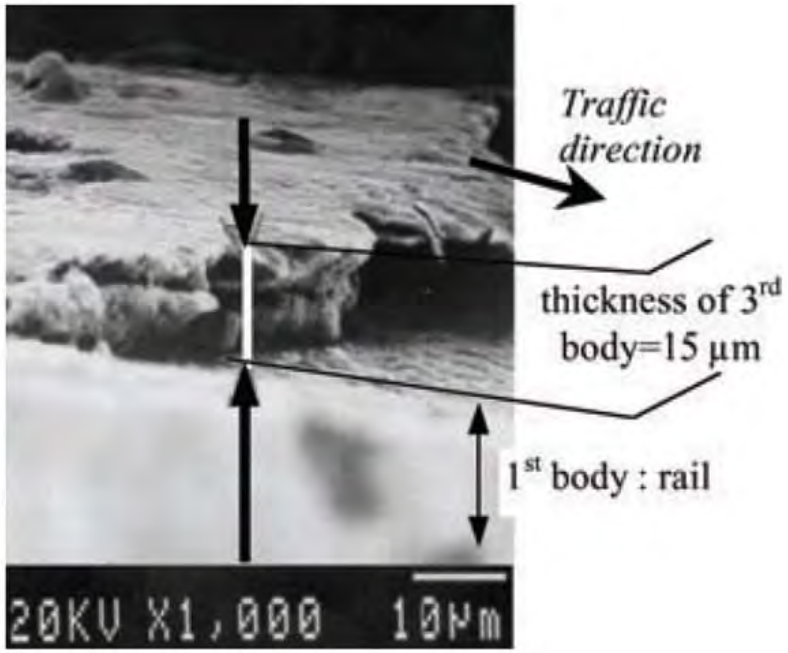




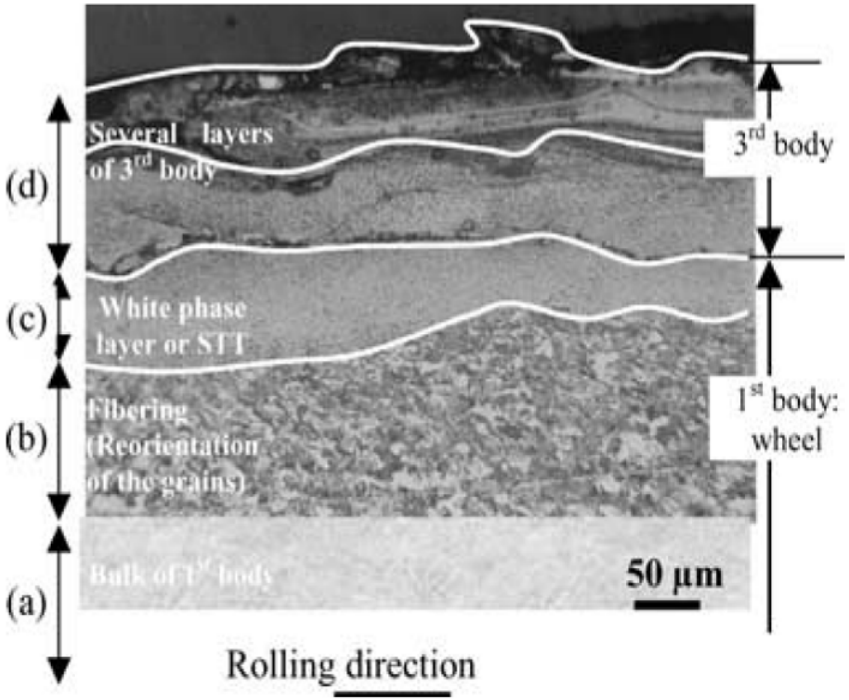
Wheel Rail Inteface – Top of Rail: Bathtub Model



Third Body Layer – Micron Scale



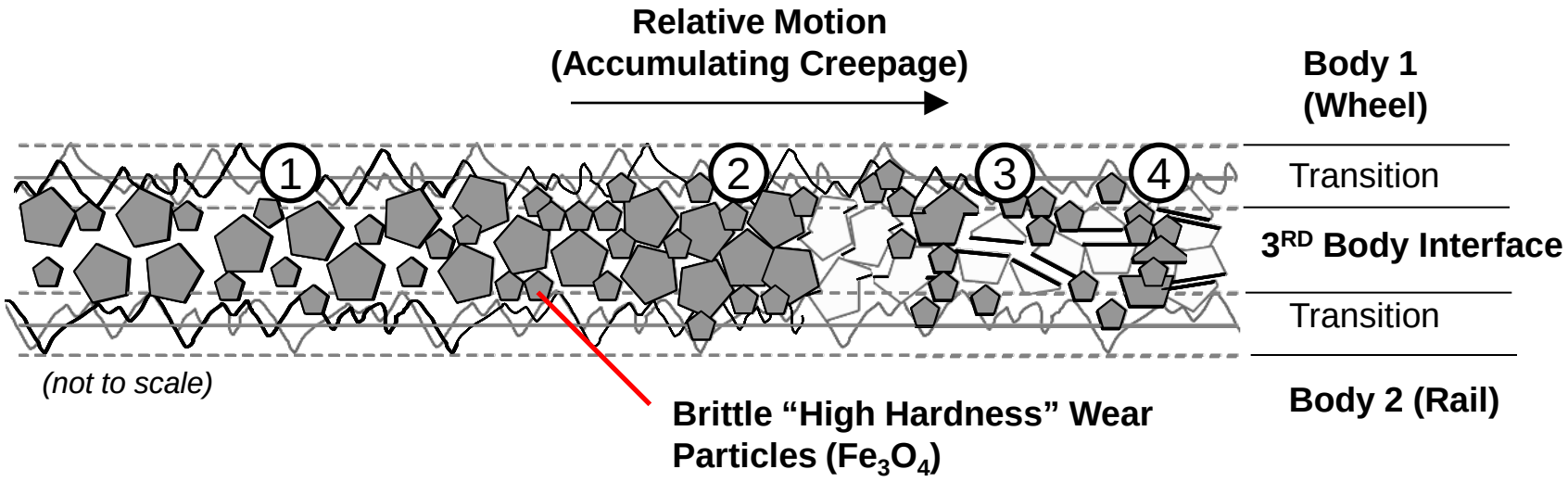
Rail



Wheel

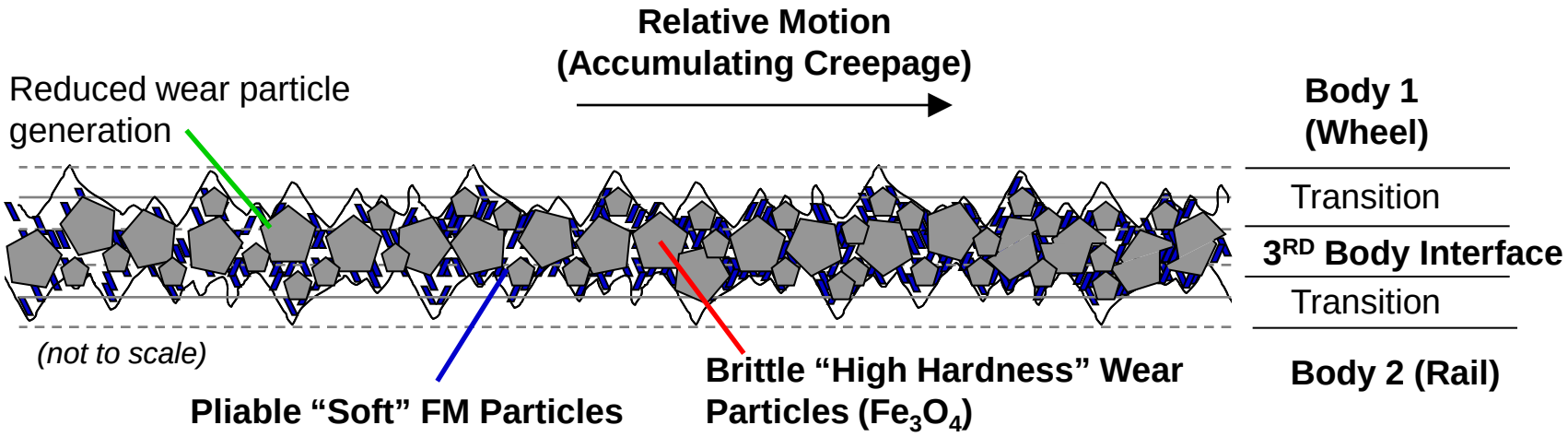
Y.Berthier, S. Decartes, M.Busquet et al. (2004). The Role and Effects of the third body in the wheel rail interaction. *Fatigue Fract. Eng. Mater Struct. 27, 423-436*

“Dry” Wheel / Rail Interface



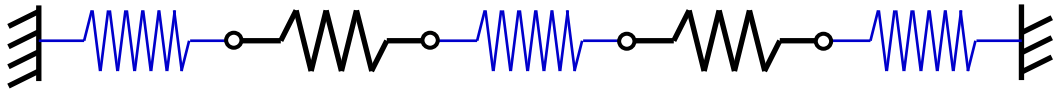
- Relative Wheel/Rail Motion (Creepage) Accommodated by: Rolling(1) – Elasticity(2) – Breaking(3) – Void Collapse(4)

“FM Treated” Wheel / Rail Interface



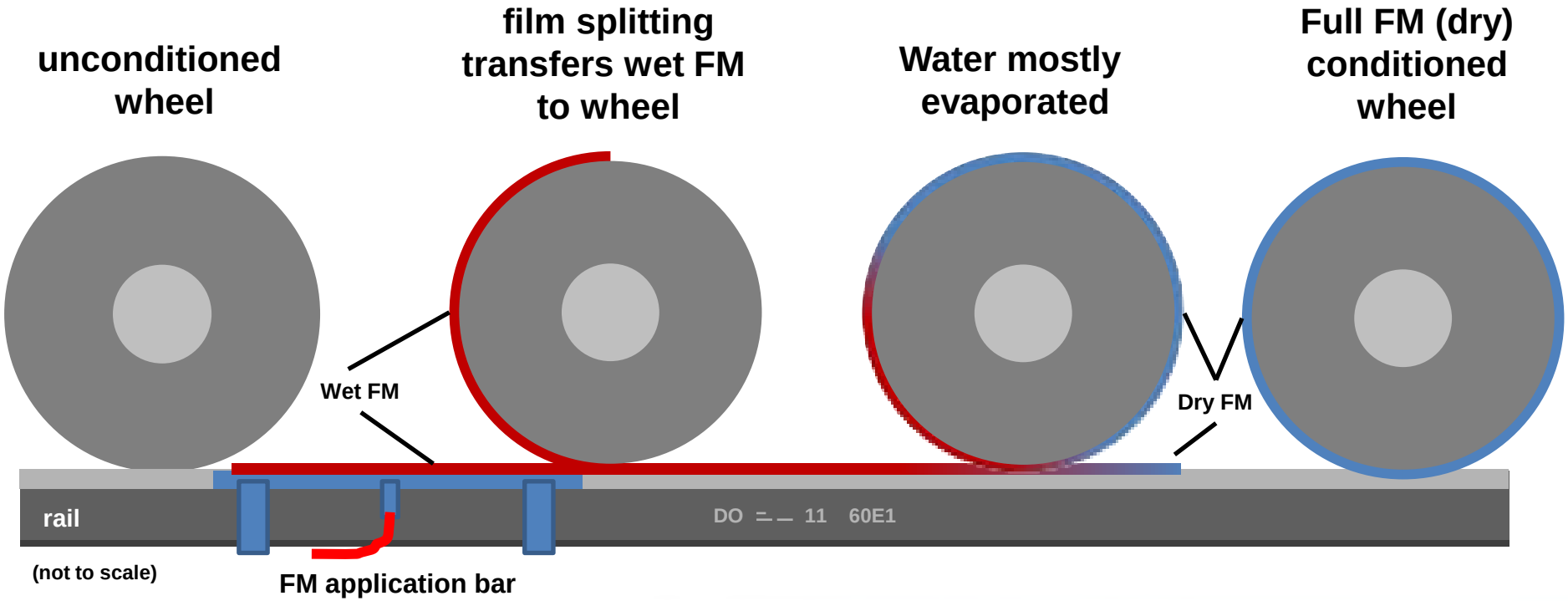
KELTRACK® creates a *composite* deformation mechanism

Pliable FM particles provide an elastic shear displacement accommodation mechanism that negates/arrests brittle particle breaking and void collapse



Film splitting mechanism

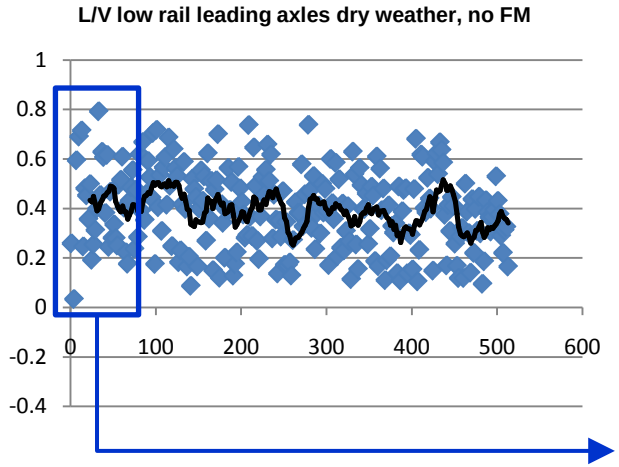
- Transfer of liquid FM from rail to wheel and vice-versa
- At and shortly after the FM application bars

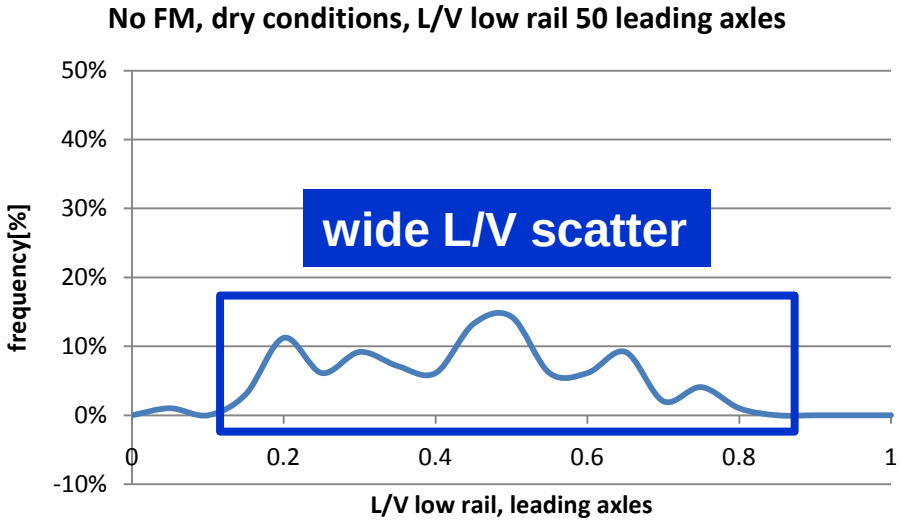


Film splitting

Explanation – no FM application, dry weather

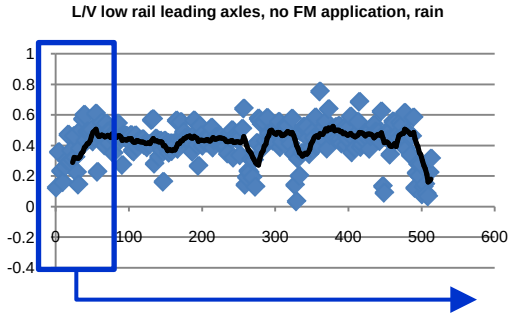
- No FM, dry weather:
  - Baseline condition, high scatter due to mixture of dry bathtub components (oxides, wear, break shoe debris, environment)

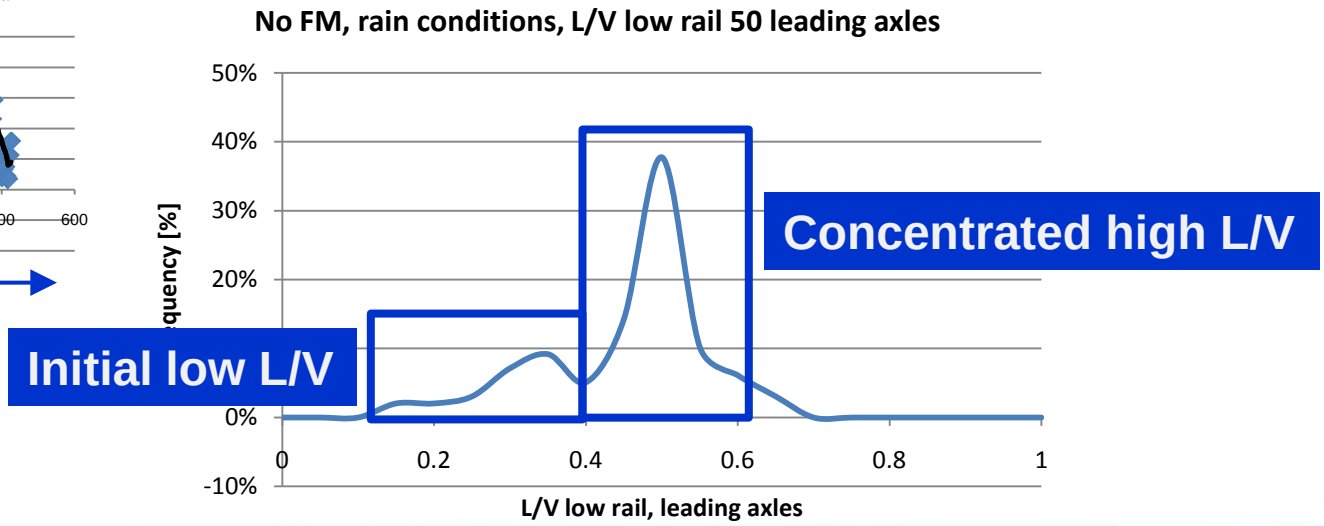




Explanation – no FM application, rain

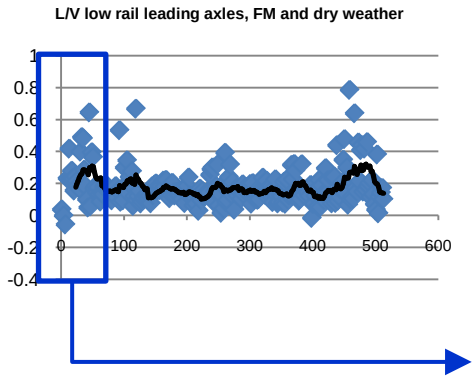
- No FM and rain:
  - Wet surface provides initial low friction conditions
  - Rain favors the formation of high friction iron oxides
  - Rain removes some other components on TOR
  - Water will evaporate and high friction oxides will remain resulting in the observed separation of leading and trailing axles

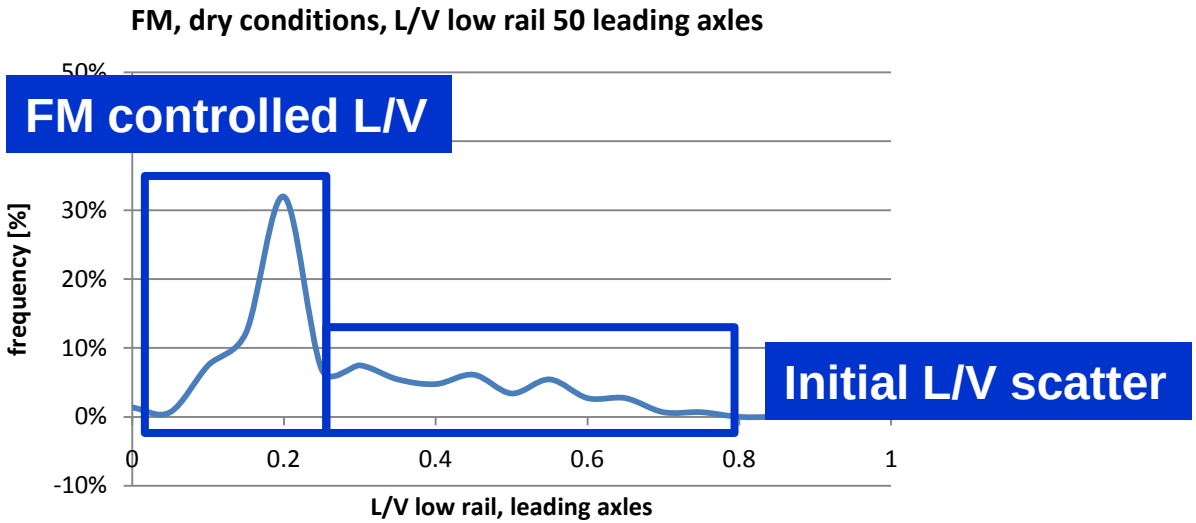




Explanation – FM application and dry weather

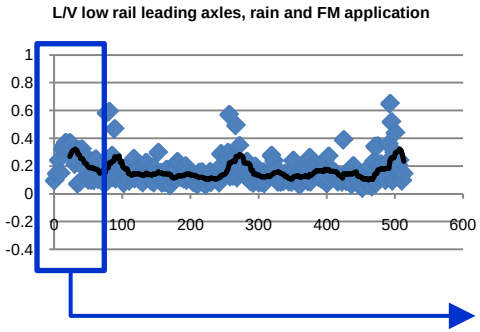
- FM and dry weather:
  - Film splitting mechanism conditions the wheels of a train

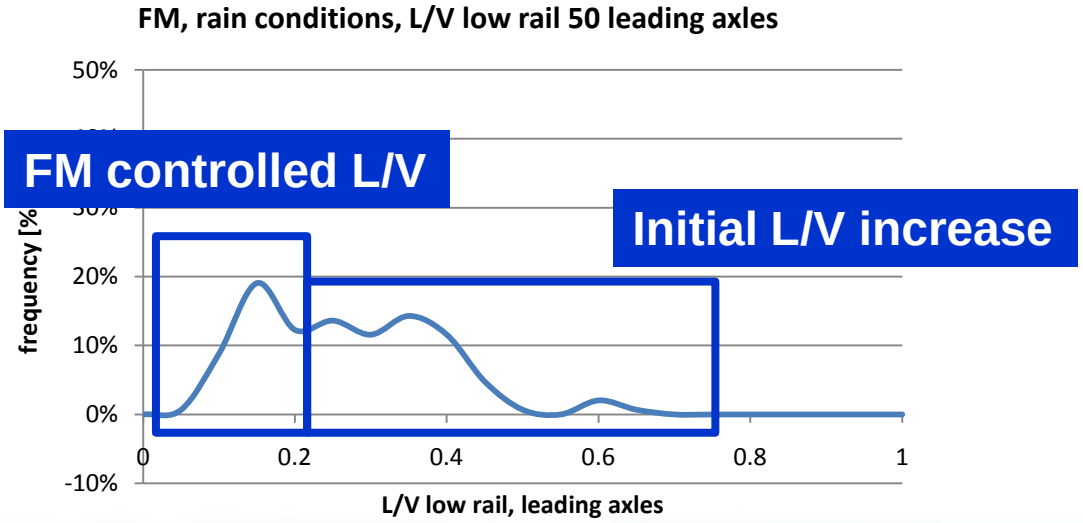




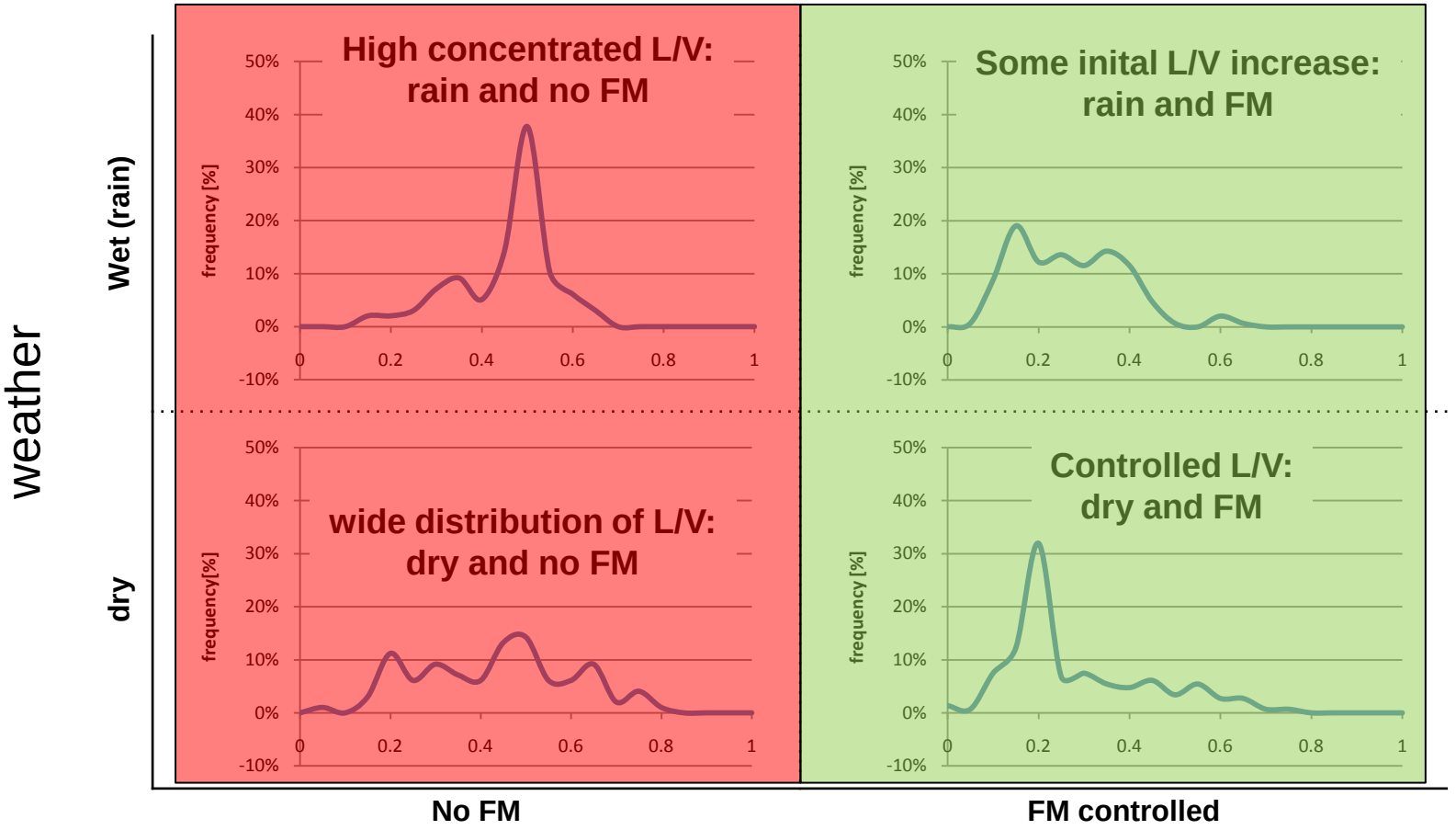
Explanation – FM application and rain

- FM and rain:
  - Wet surface provides initial low friction conditions
  - Rain favors the formation of high friction iron oxides
  - With every passing wheel the surfaces dry up (first 50 axles) and L/V increases
  - After these first axles the wheels stay dry and conditioned.
  - After these first axles the rail is dry again and FM application is effective again (film splitting mechanism).



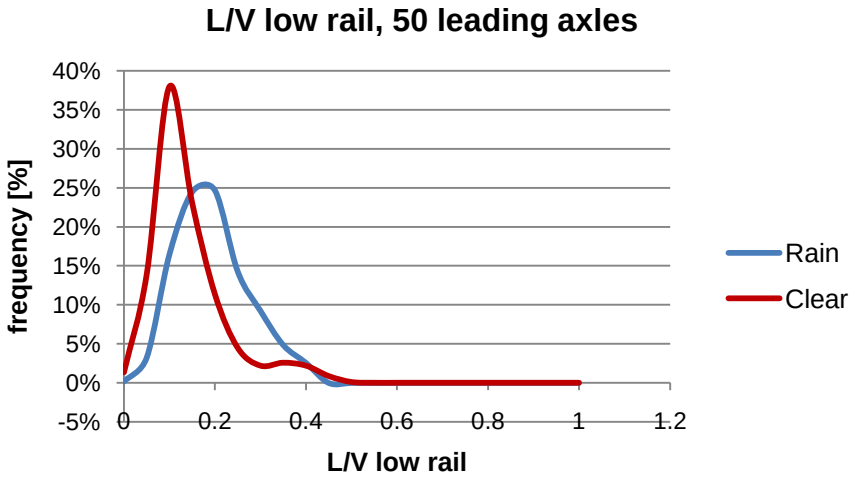


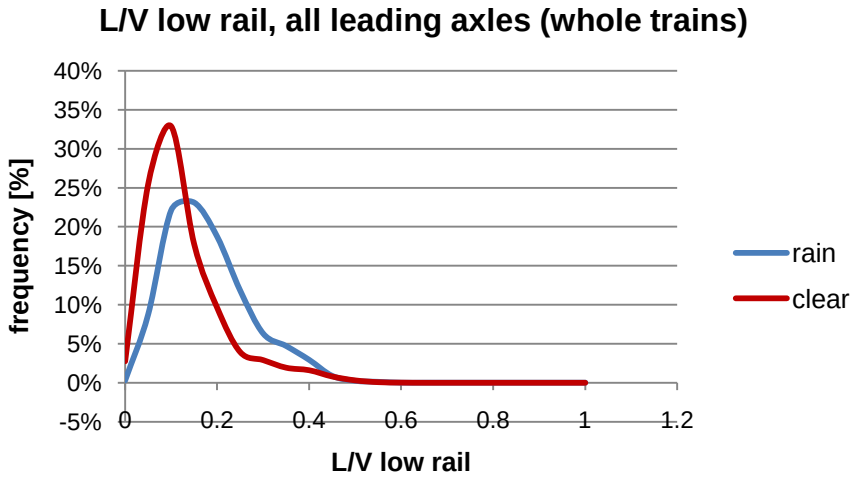
Summary analysis
first 50 leading axles (Sep. – Nov 2008)



Verification 2010

- 21 trains between April and Spetmber 2010 for rain and clear conditions
- Analysis for 50 leading axles only and whole train/all leading axles





Conclusion

- Rain influences directly the first 50-100 axles of a train
- Only the first few axles stay wet – the rest of the train „sees“ no rain
- Absence of FM and rain:
  - Initial L/V increase
  - Concentrated high L/V values due to high friction oxides on TOR
- Presence of FM and rain:
  - Initial L/V increase
  - Decrease to FM controlled L/V for the rest of the train
- Verification of the proposed mechanism necessary.

Outlook

- Investigation on the influence of snow in next winter
- Laboratory Experiments on the influence of a wet rail surface on the film splitting capability of a wet FM (in progress)
- Abstract submitted to IHHA 2011 (and accepted)

Thank you for your attention