

VIRTUAL VEHICLE Research Center

## ICRI – Damage Modelling

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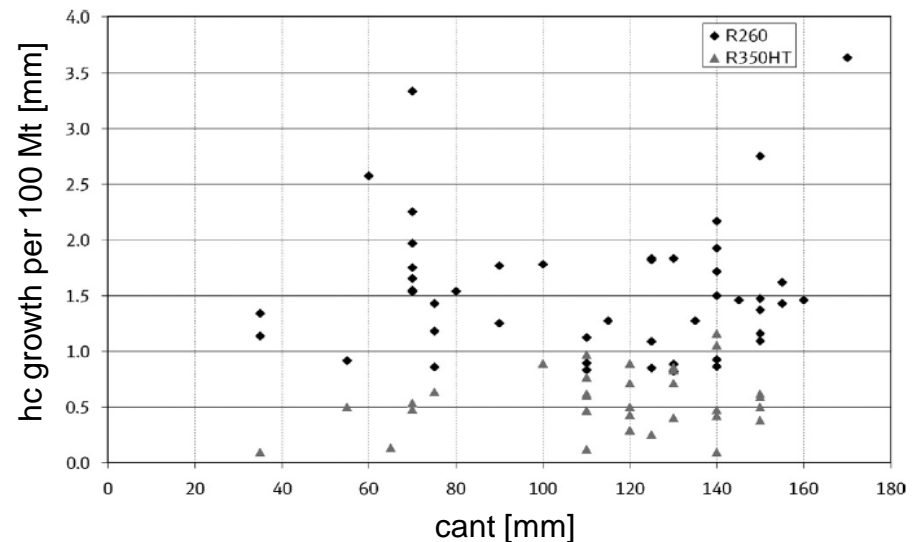
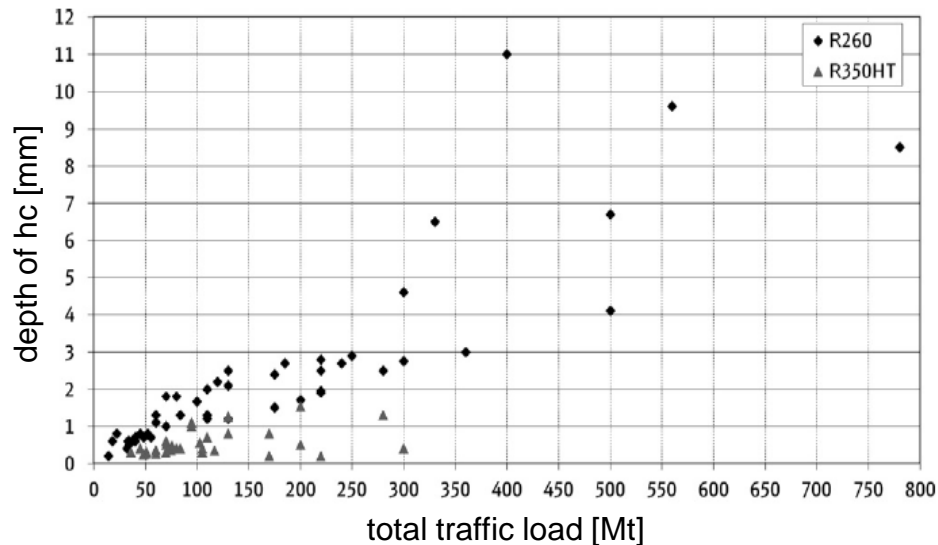
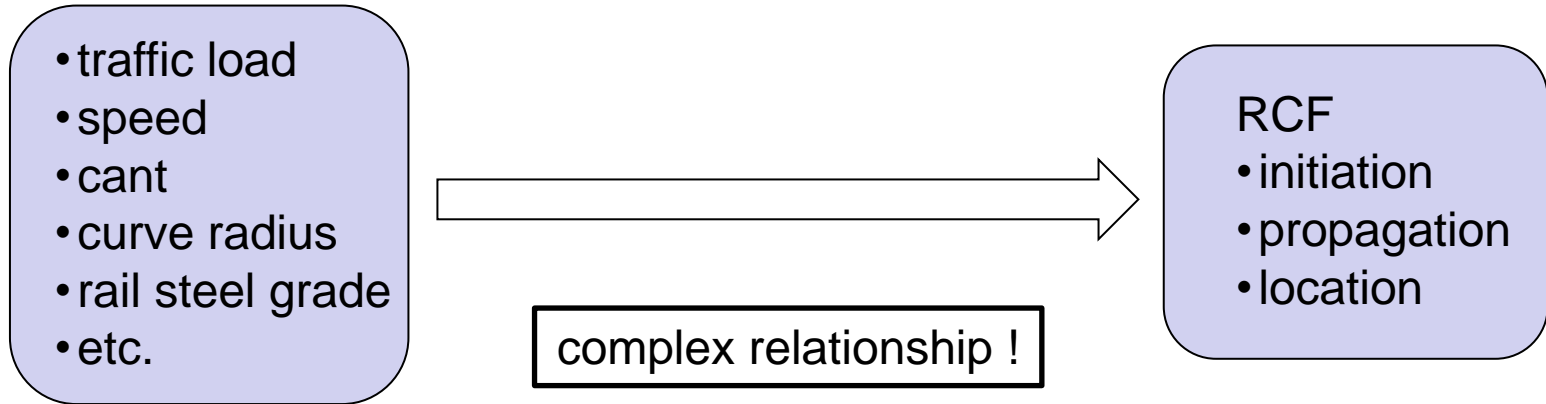
Adam Bevan  
Institute of Railway Research

ICRI Workshop London  
01-02-2017

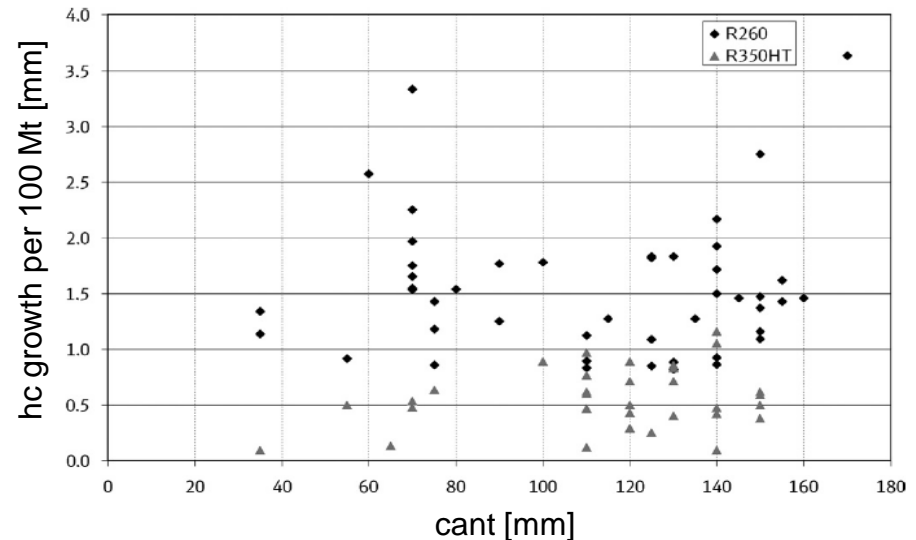
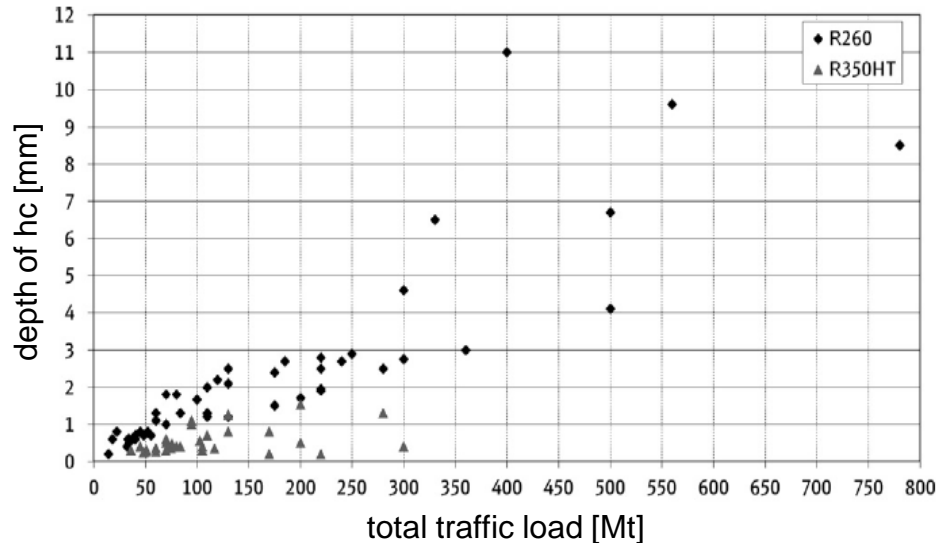
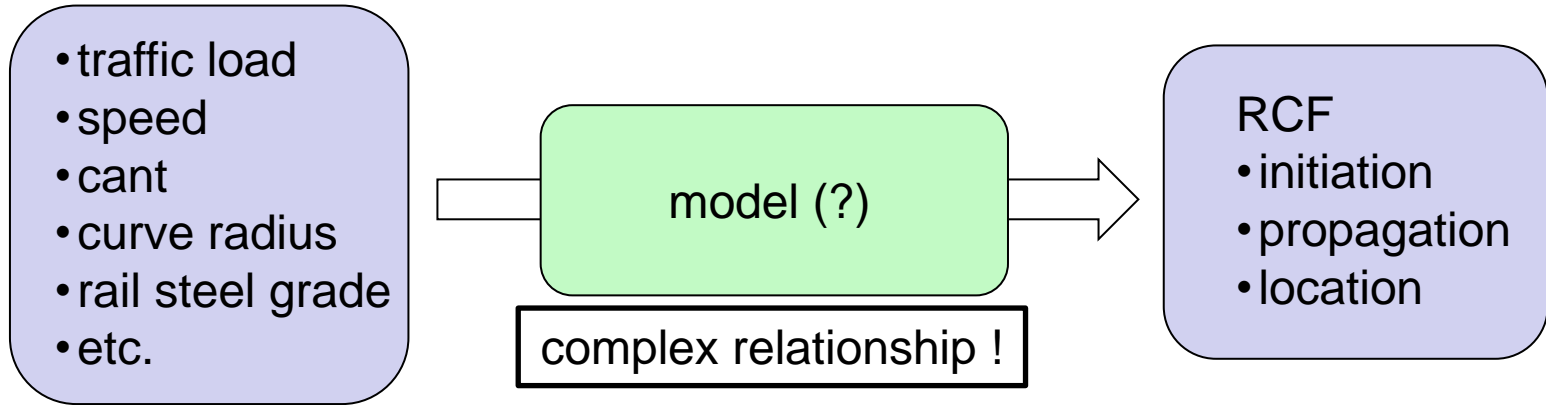


*COMET K2 Competence Center* - Initiated by the Federal Ministry of Transport, Innovation & Technology (BMVIT) and the Federal Ministry of Economics & Labour (BMWFI). Funded by FFG, Land Steiermark and Steirische Wirtschaftsförderung (SFG)

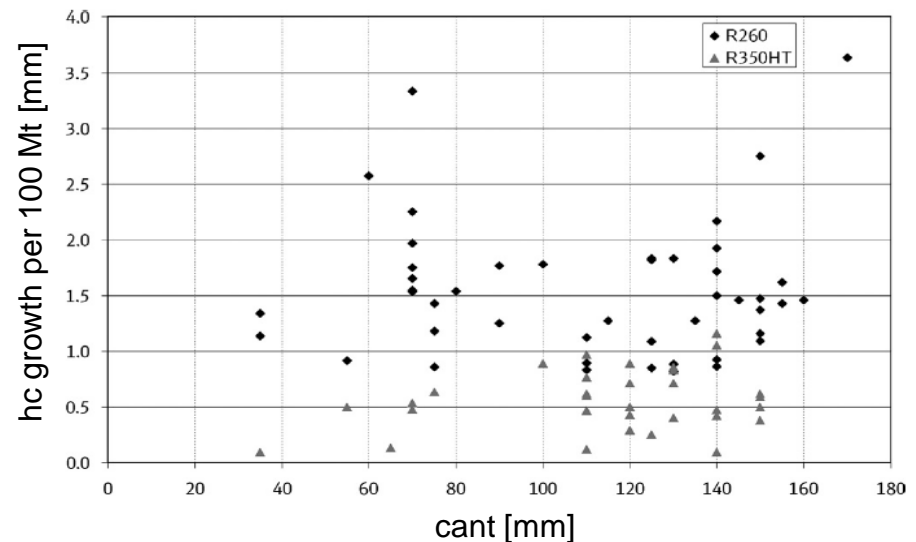
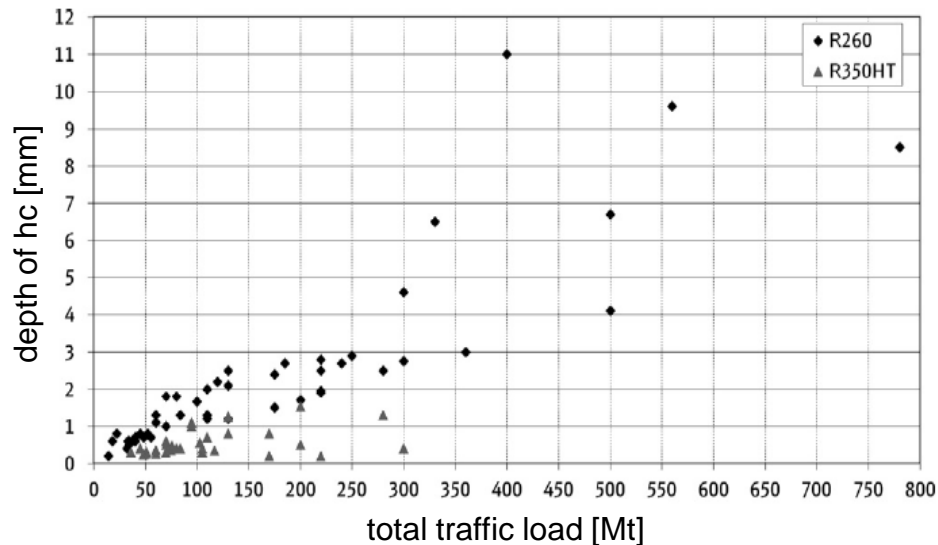
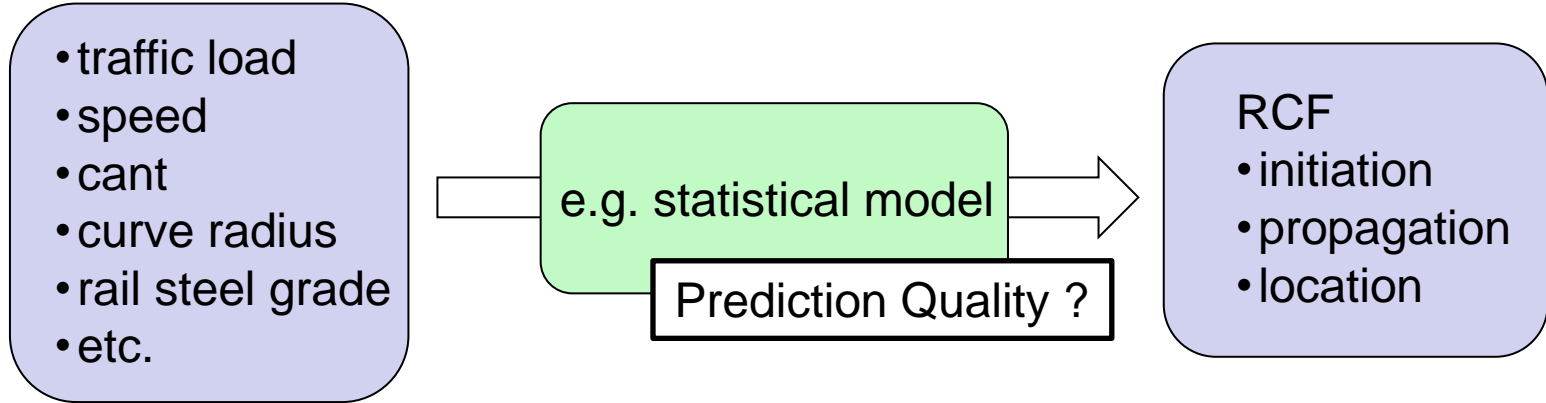
- **Making reference cases available**
  - for development, calibration and validation of **damage models**
  - including information for specific sections of track
    - line routing: curve radius, cant, etc.
    - rail steel grade
    - field observations: wheel-rail profiles, friction conditions, rail surface photographs, crack measurement data, crack growth rate, metallographic sections of rails, etc.
  - including Vehicle-Track Interaction data
    - traffic load, speed, cant deficiency, lubrication, etc.
    - vehicle data: wheelbase, masses, spring stiffnesses, etc.
    - MBD vehicle models: Simpack, Vampire, etc.
    - MBD simulation results:
      - contact patch shape and size, creepages, normal loads etc.
- **Discussion of damage assessment methodologies**
  - overview and comparison
- **Discussion of new model requirements**
  - influence of fluids, Friction Modifiers, residual stresses, etc. on the development of RCF
  - open points?



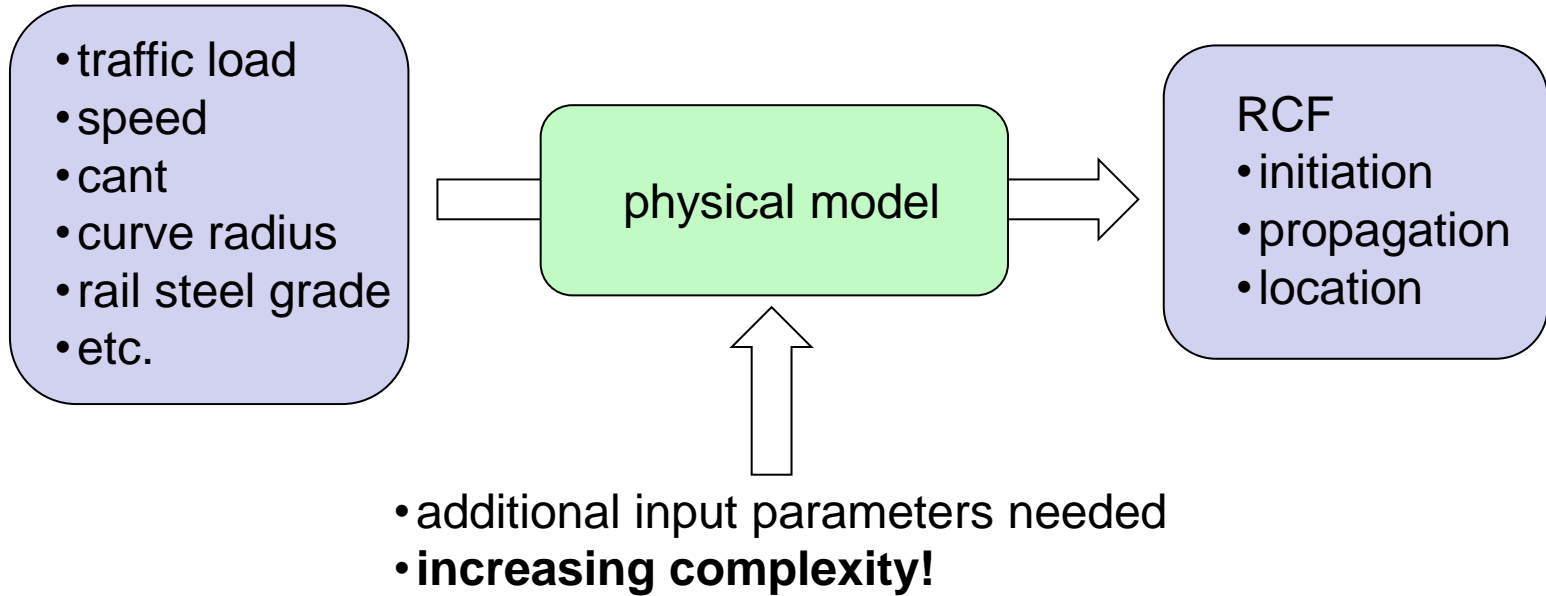
R. Heyder, M. Brehmer, Empirical studies of head check propagation on the DB network, Wear 314 (2014), 36-43.

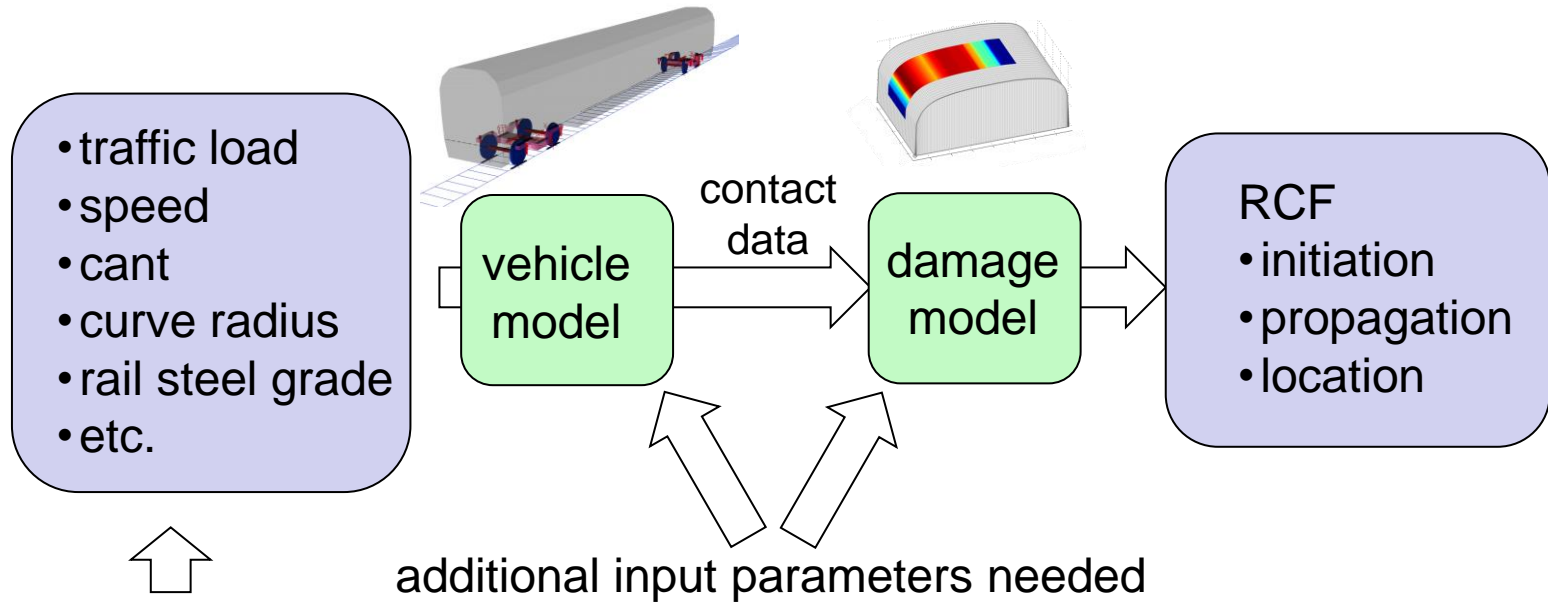


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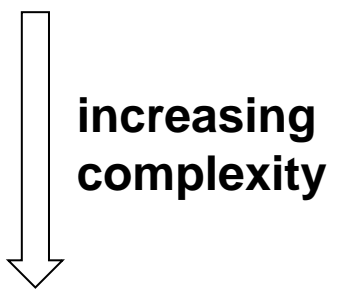


variation of input data (?)  
 → e.g. stochastic approach

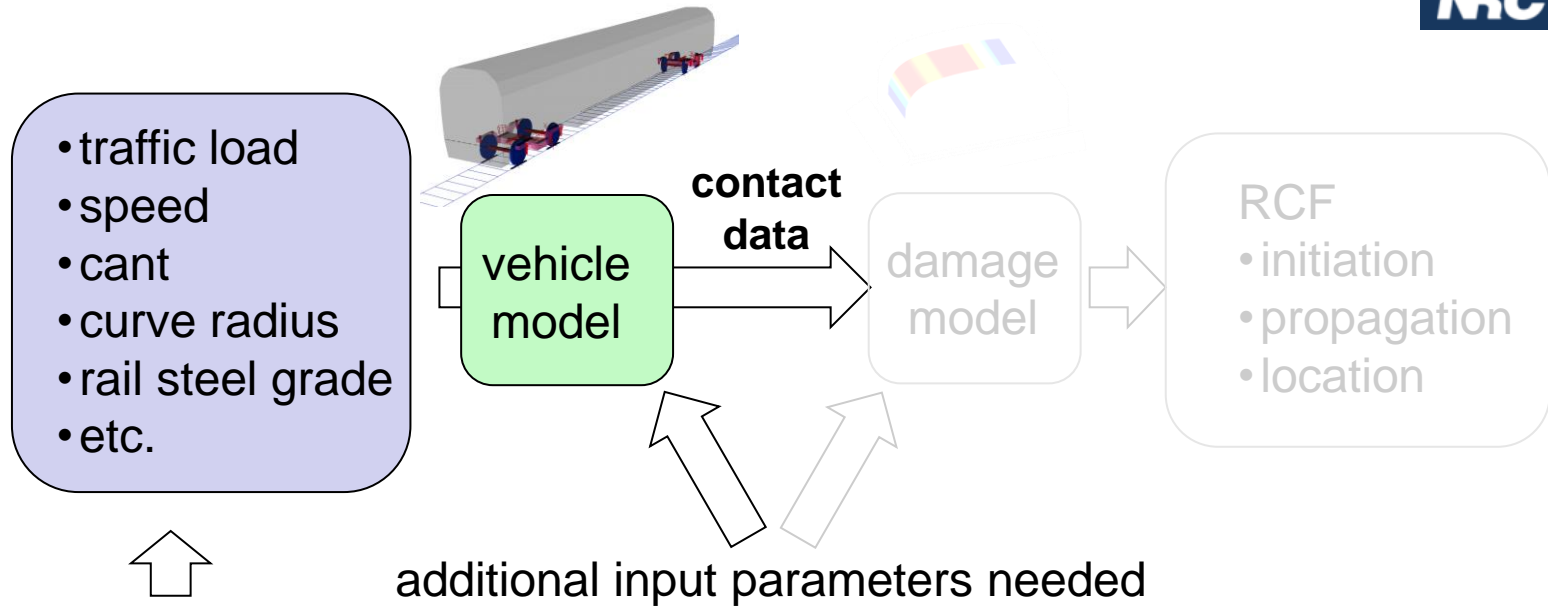
- vehicle data
- wheel-rail profiles, etc.
- rail material parameter
- etc.

- Examples:
- T-Gamma based approach
  - Ekberg indices
  - VIF-RCF
  - FEA

increasing complexity



# ICRI Damage Modelling – Example



variation of input data (?)  
→ e.g. stochastic approach

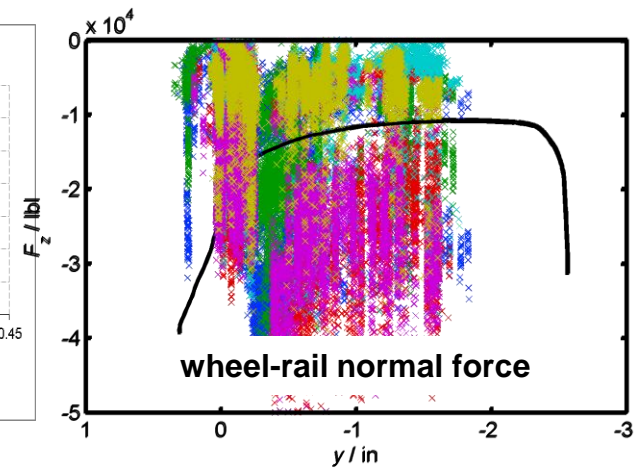
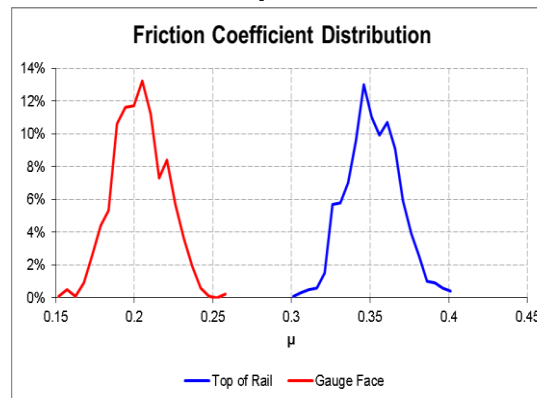
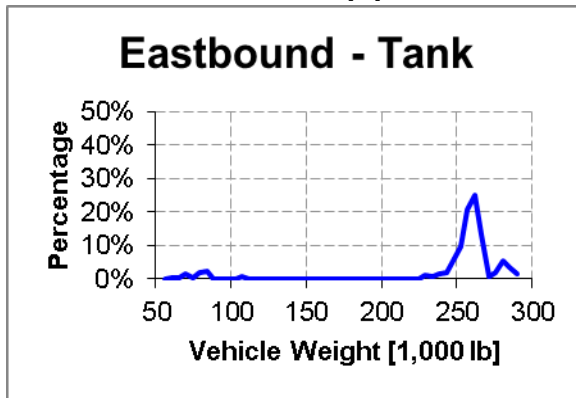
- vehicle data
- wheel rail profiles
- rail material parameter
- etc.

**ICRI data package**

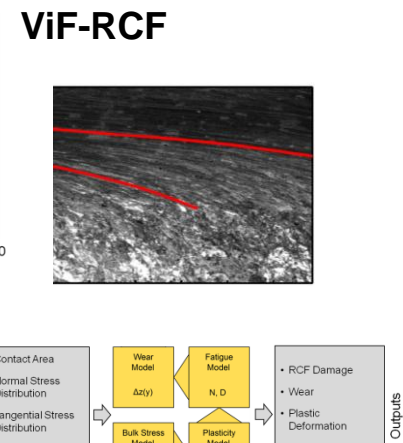
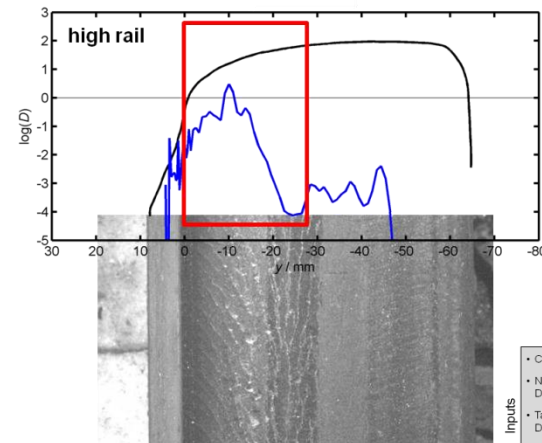
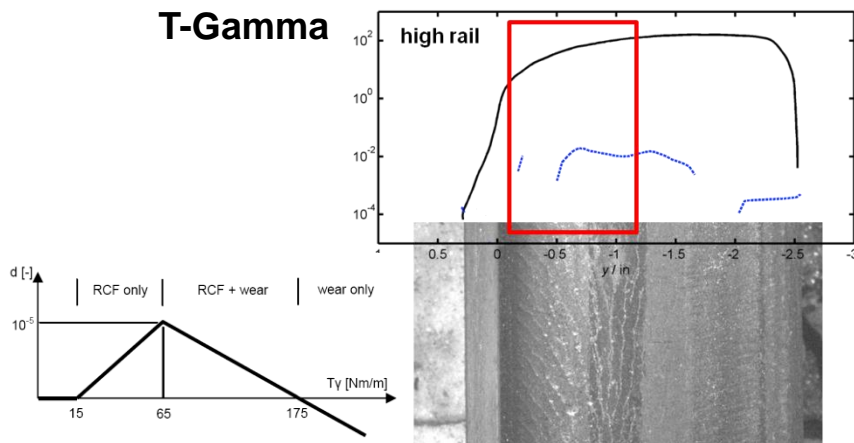


## NRC - ICRI data package

- stochastic approach → variation of input data



## Investigations carried out at Virtual Vehicle

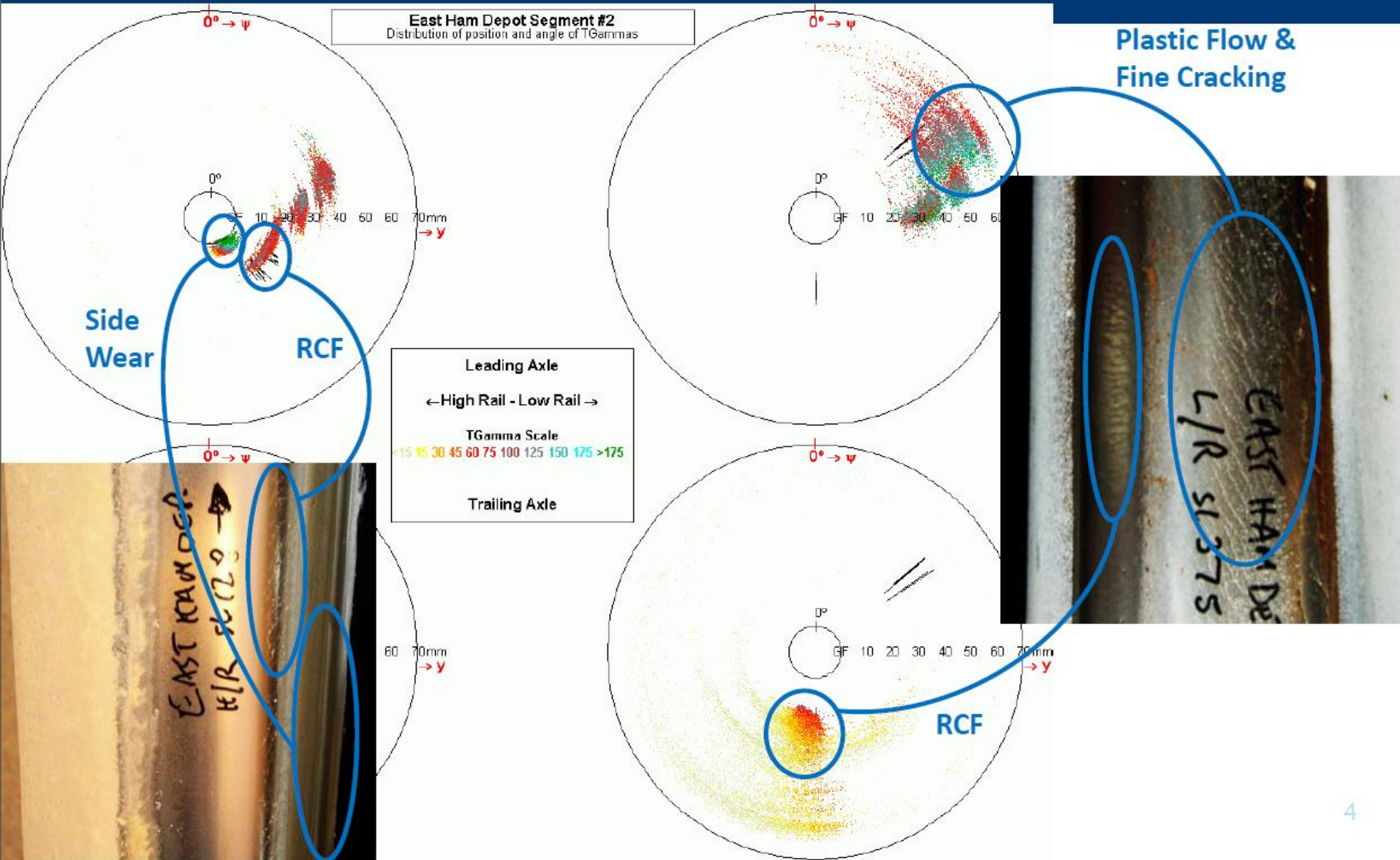


Results presented at ICRI workshop in Vancouver

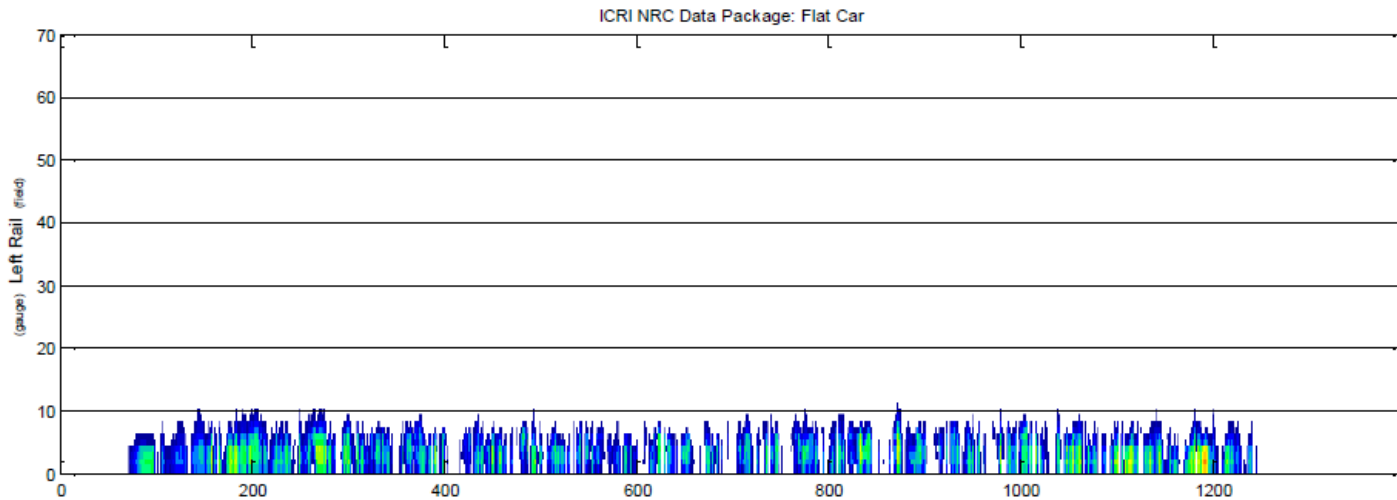
# Current Areas of Development

- Damage classification based on direction/magnitude of wheel-rail forces
- Contact patch energy  $\approx$  damage relationship in lubricated conditions
- Damage functions for alternative rail materials
  - Characterising performance of different material
    - Site data, full scale and twin disc testing
- Plastic flow / low rail damage
- Wear mapping based on vehicle dynamics simulation outputs

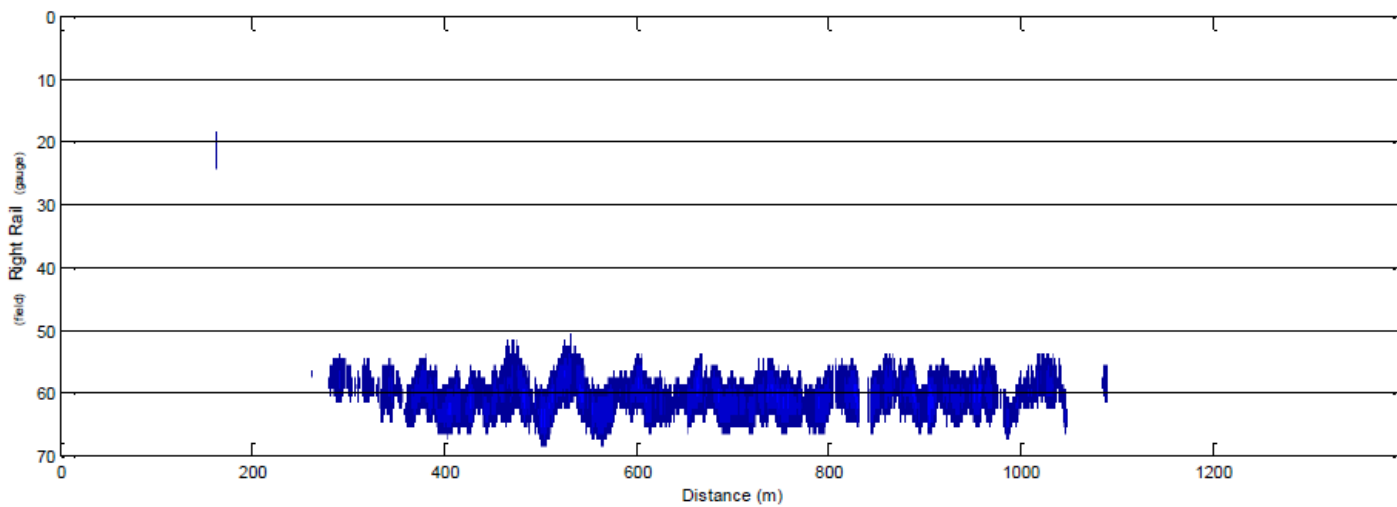
# Damage Classification



# Results for Flat Car Type



Direction of travel →



- **are there other data in a similar quality available**
  - for other operating conditions
  - for other rail steel grades
  - including metallographic sections of rail samples, etc.

→ **CSX railroad data currently collected/generated**
- **application of other damage models**
  - FEA
  - Ekberg indices
  - etc.
- **new model requirements**
  - impact of Friction Modifiers
  - influence of fluids
  - influence of residual stresses
  - ...
  - **Prediction of White Etching Layers / Studs / Squats !**

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