SIEMENS
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Simulation and Validation of Derailment Experiments with Simpack

2016 SIMULIA European Multibody Simulation User Group Meeting

Agenda

- Motivation
- Test rig
- Simulation and Validation results
- Process and Tools
- Conclusions

Motivation

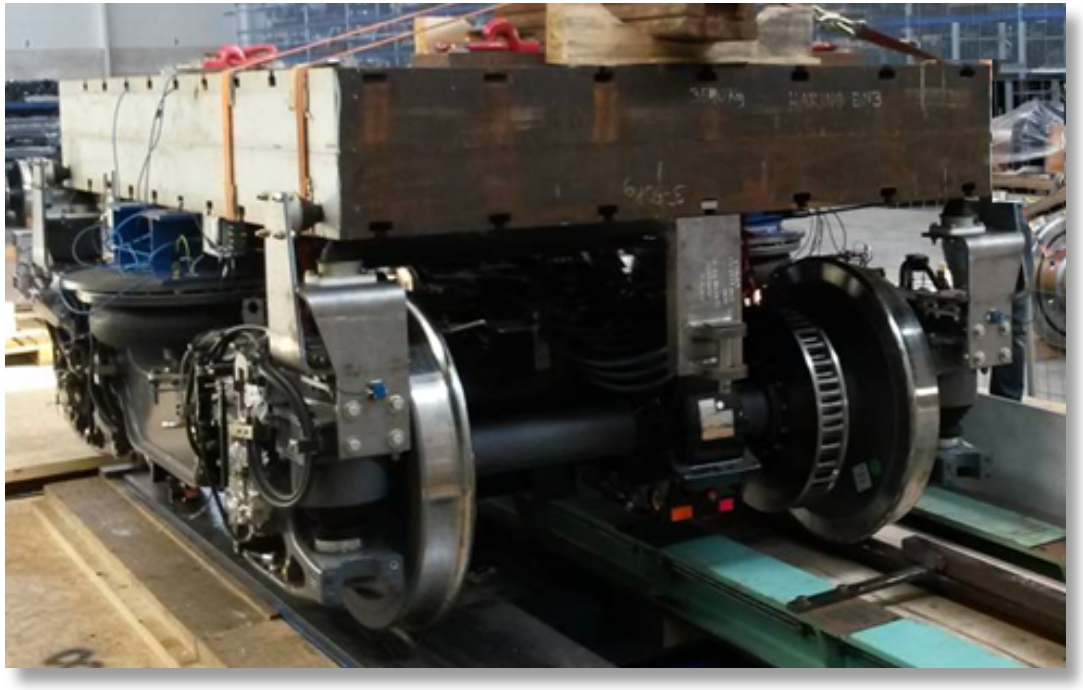
SIEMENS

The Siemens Mobility Division offers automated metros for driverless train operation.

- Derailment detection system because of safety reasons
- Implementation of algorithms need bogie specific parameters
- Parameters are determinded by real experiments with a bogie

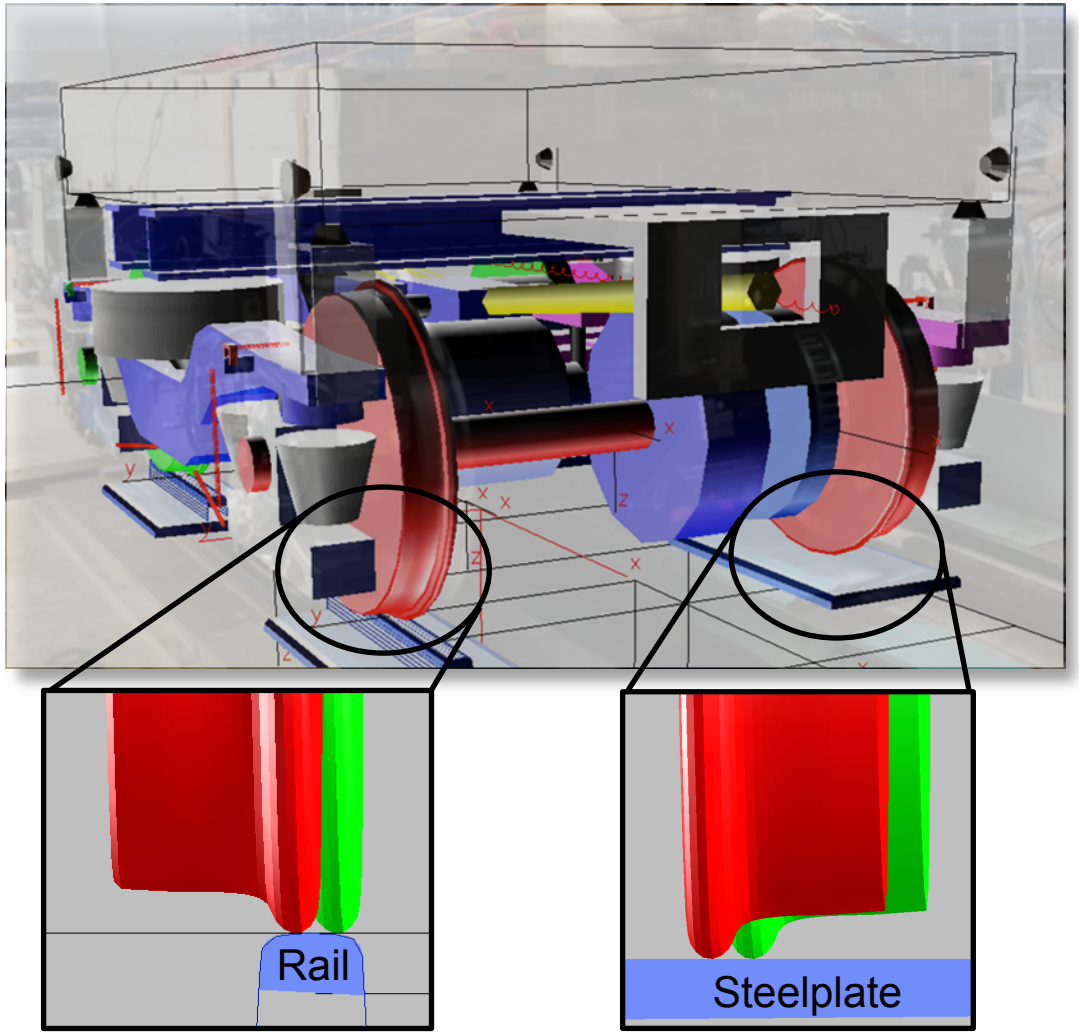
Is it possible to simulate the derailment experiments with Simpack on a virtual test rig?

Test Rig



- One single bogie with an equivalent mass
- Equipped with an extensive measuring system
  - Accelerations at each suspension level
  - Relative distances in primary suspension
  - Speed
  - Angle of attack

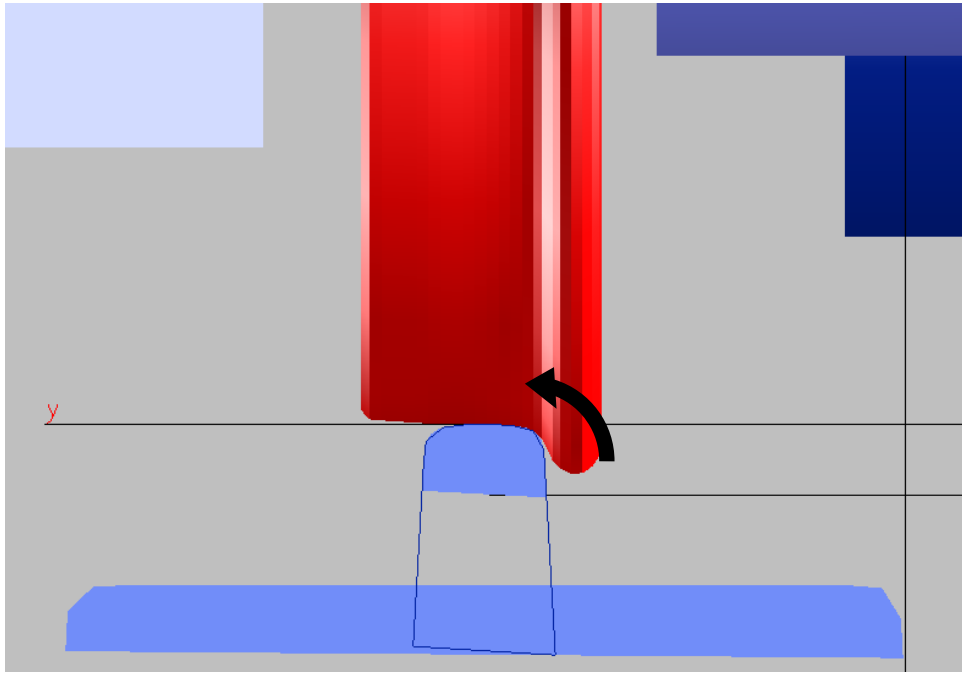
Test Rig – Modelling in Simpack



- Steelplate on left side
- Additional bushing elements
- Lift lock
- Emergency Spring with friction
- Torsional stiffness of bogie frame

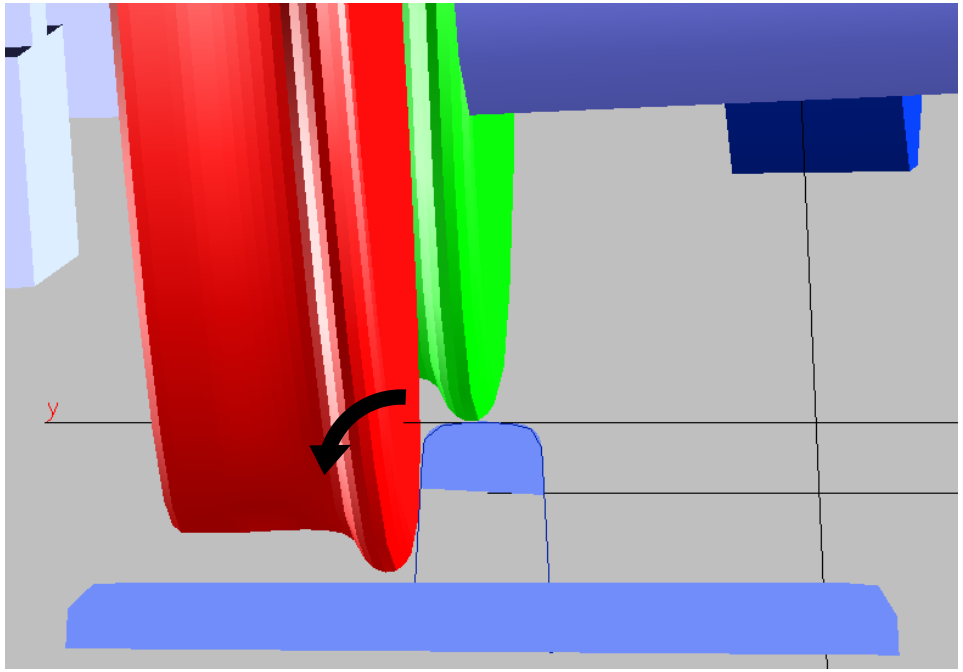
Focus of this Work

Derailment safety – design of bogie
Ensure that wheel climb does not happen



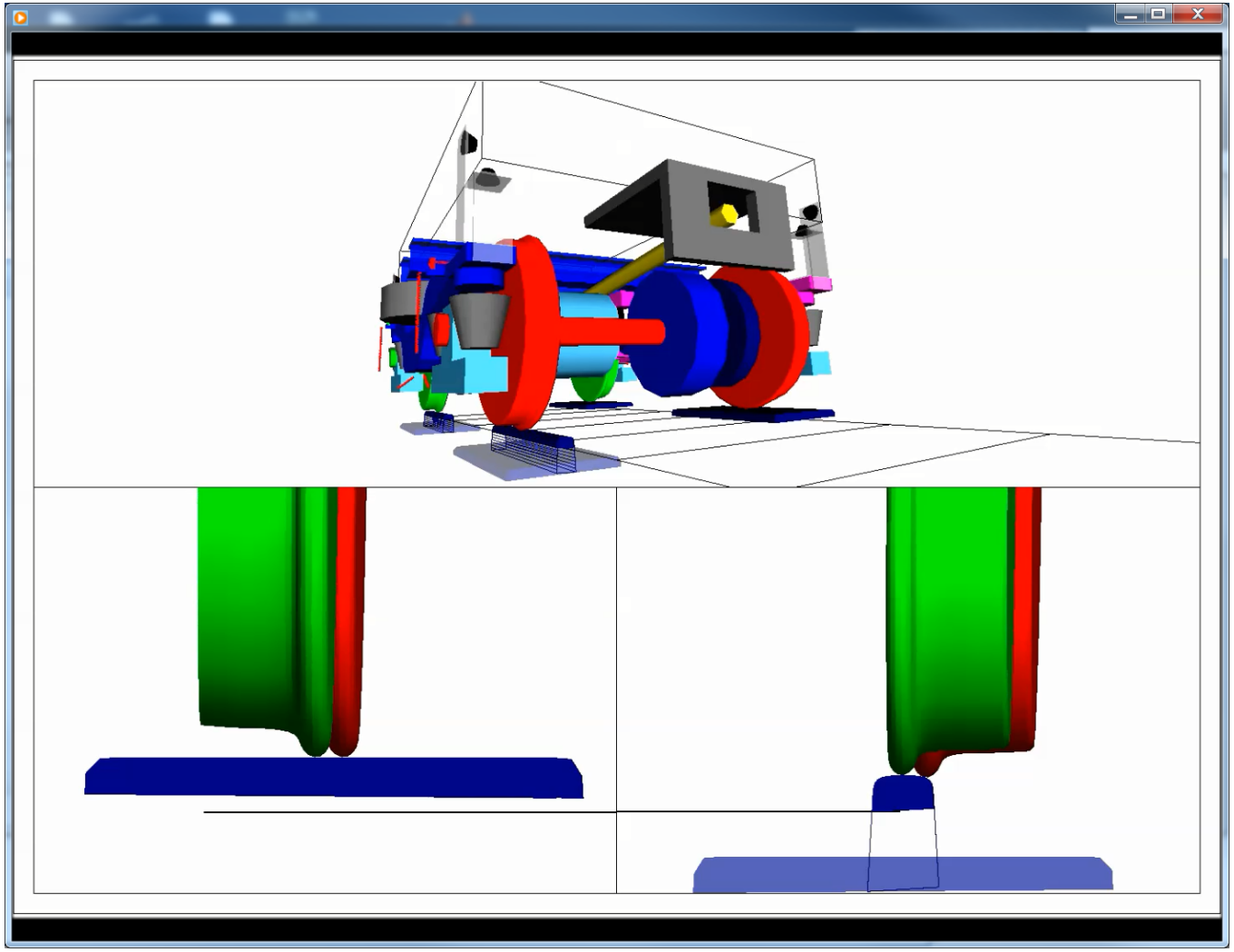
Not Focus of this work

Process of derailment itself, by derailing over the wheel flange to the outer side

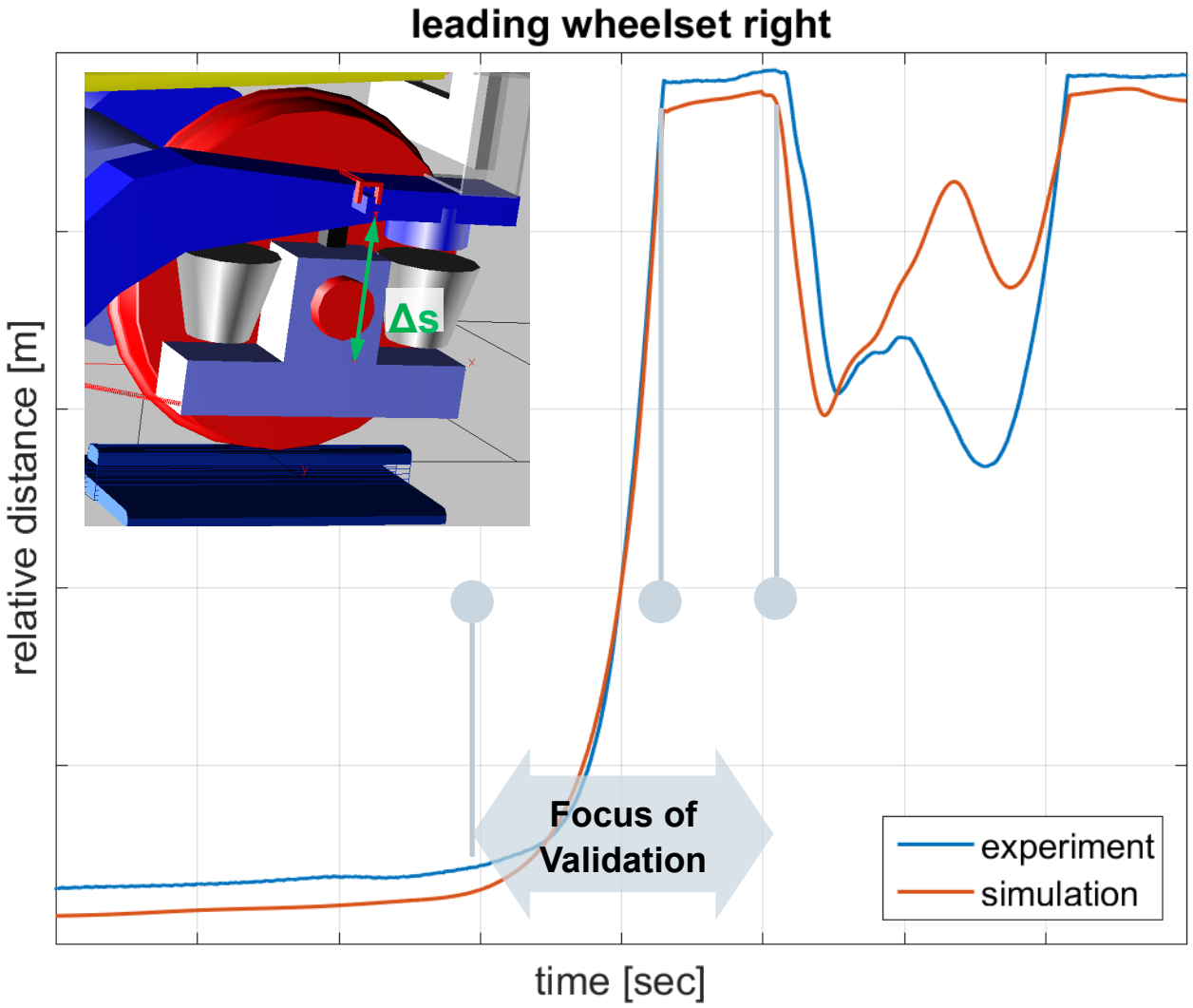


Focus of this work

Animation

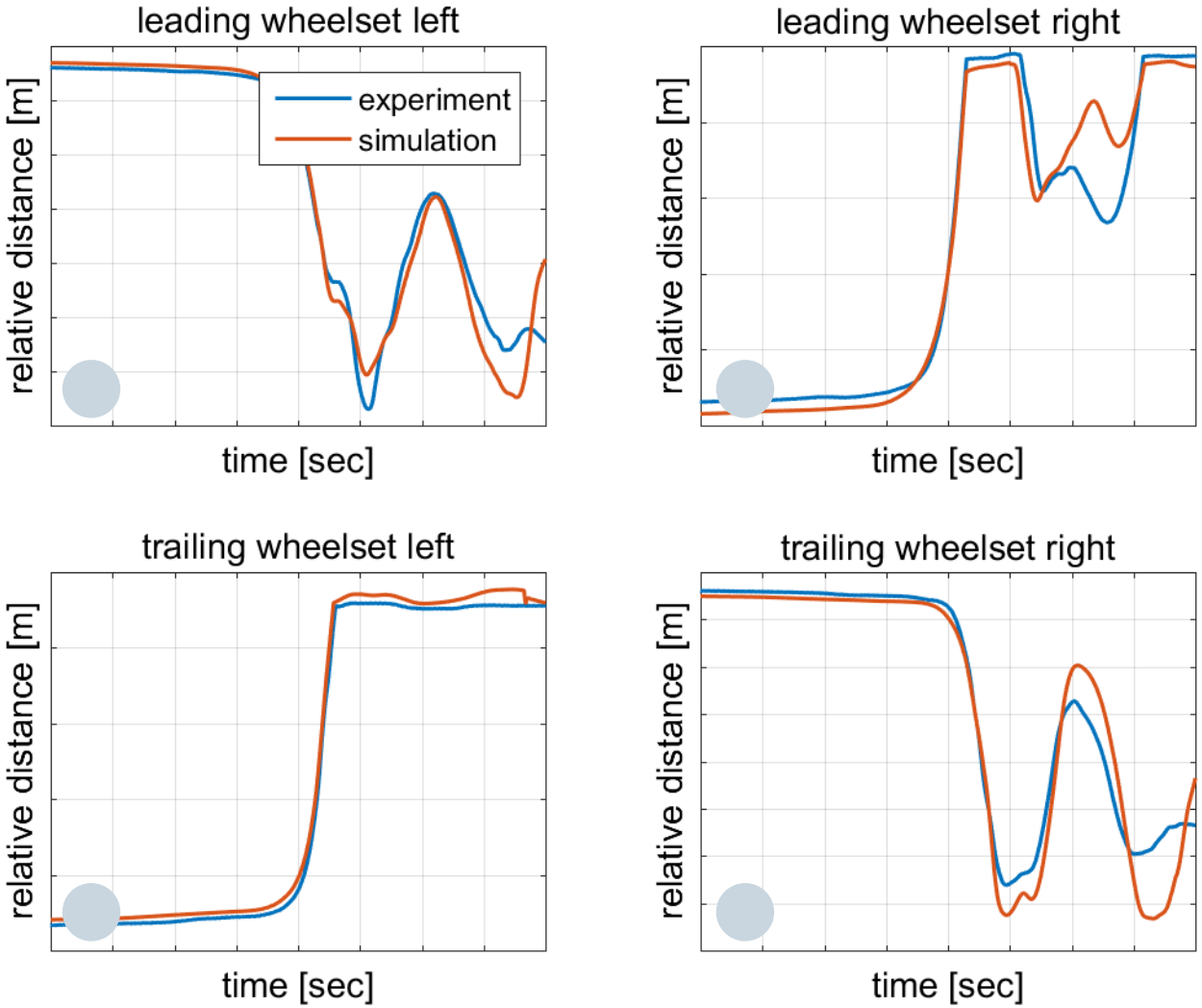


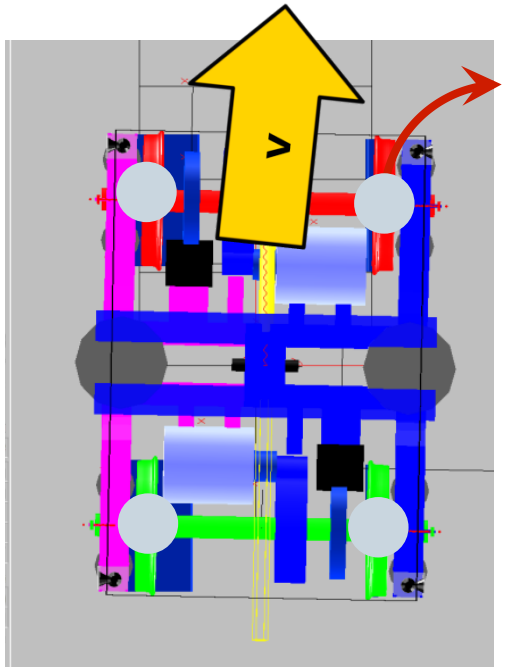
Validation – relative distance in primary suspension of derailing wheel



- Wheelset starts to slip down rail
- Lift stop takes effect
- Wheel hits ground

Validation – relative distance in primary suspension in each wheel



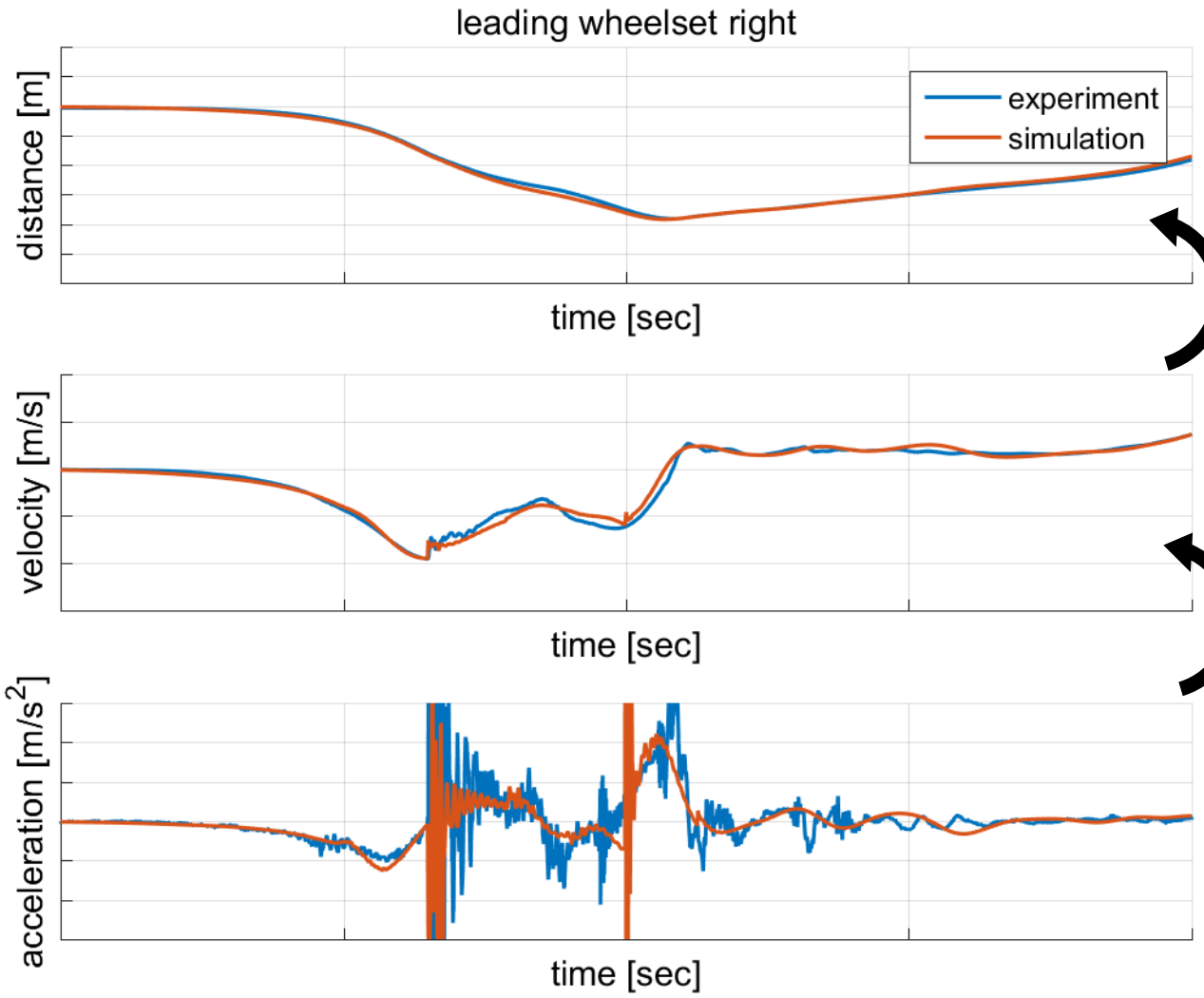


Validation – acceleration at axlebox

- Wheelset starts to slip down rail
- Lift stop takes effect
- Wheelset hits ground

Interpretation of accelerations difficult

Validation – acceleration at axlebox

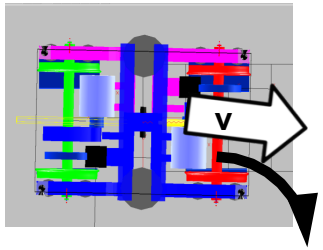


$$s = \int v(t) \cdot dt$$

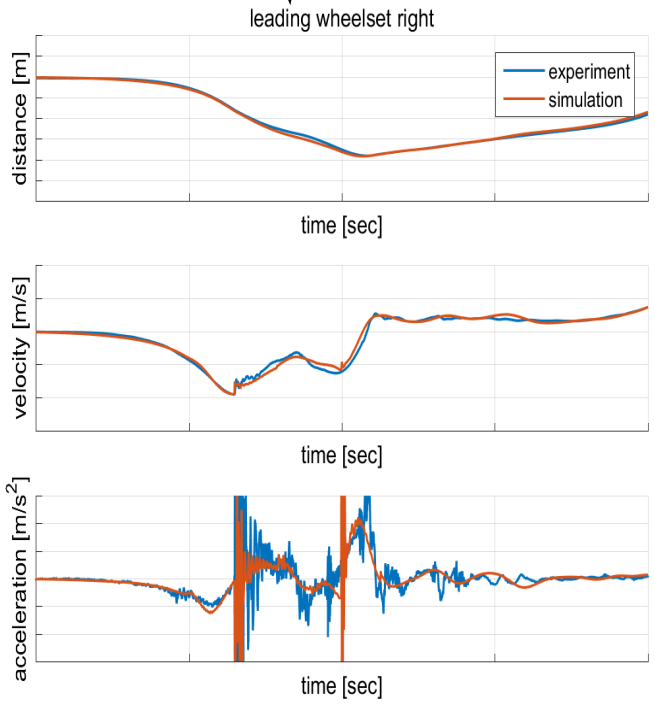
$$v = \int a(t) \cdot dt$$

Scenarios of validation

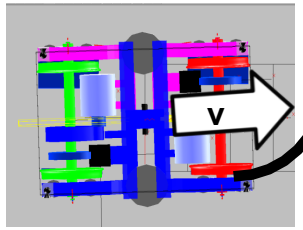
Derailment to outer side



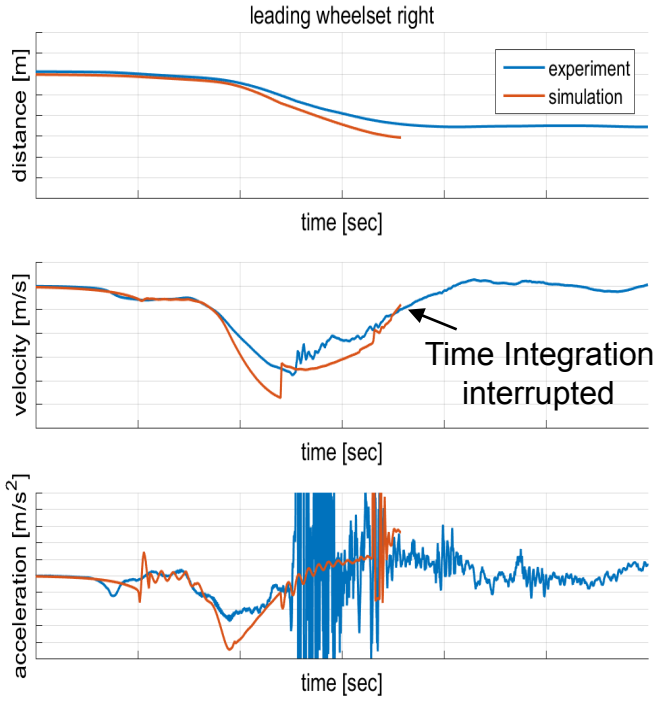
qualitatively and quantitatively good



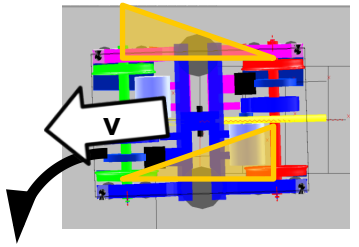
Derailment to inner side



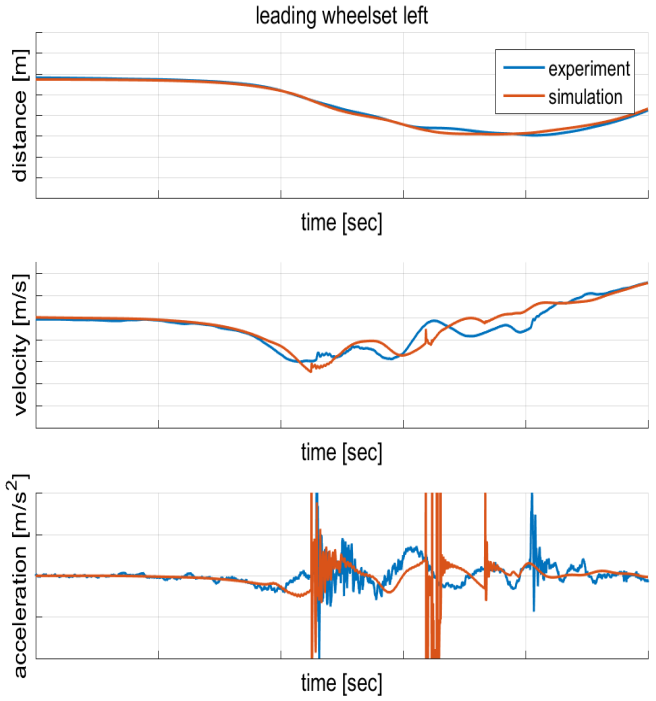
qualitatively good
quantitatively okay
Δ~25%



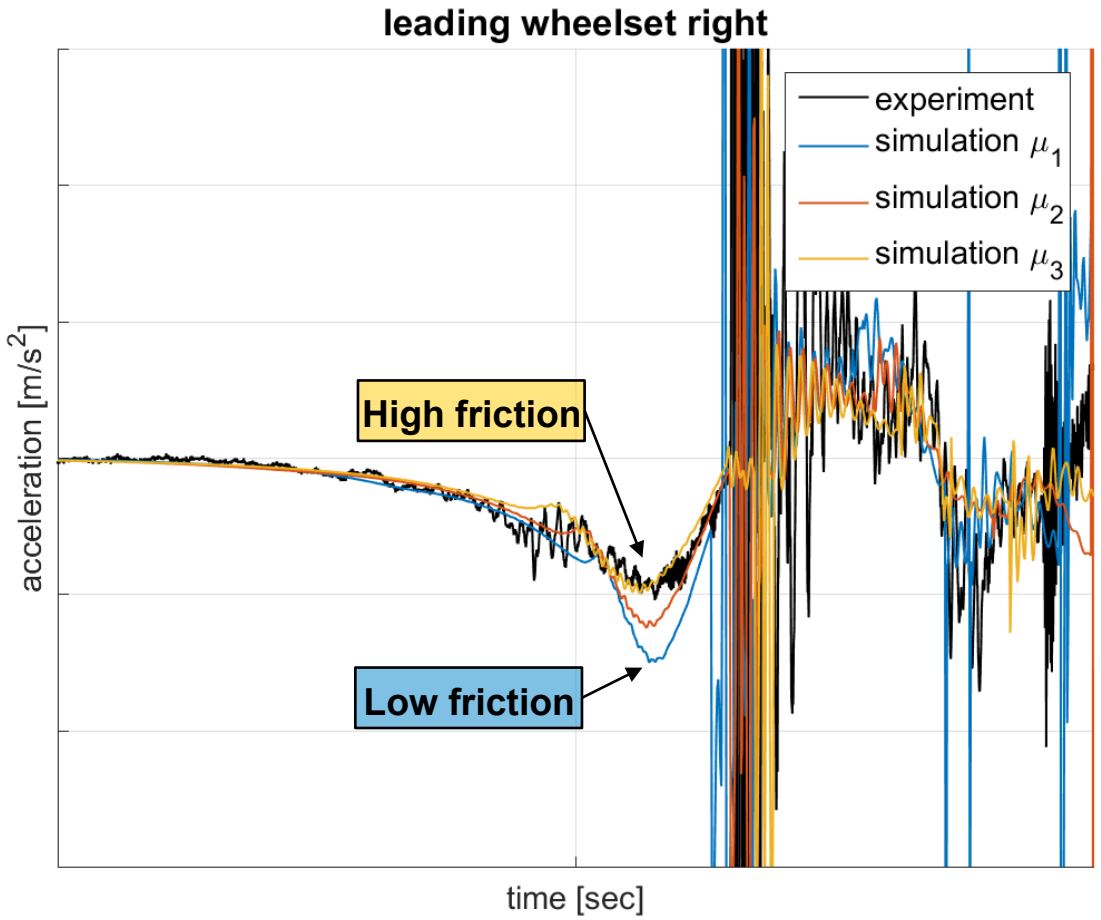
Derailment to outer side with twist



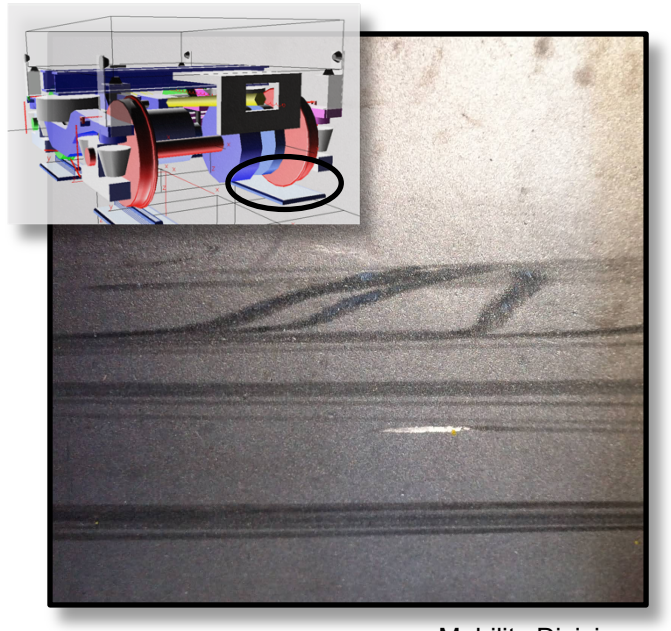
qualitatively okay
quantitatively good



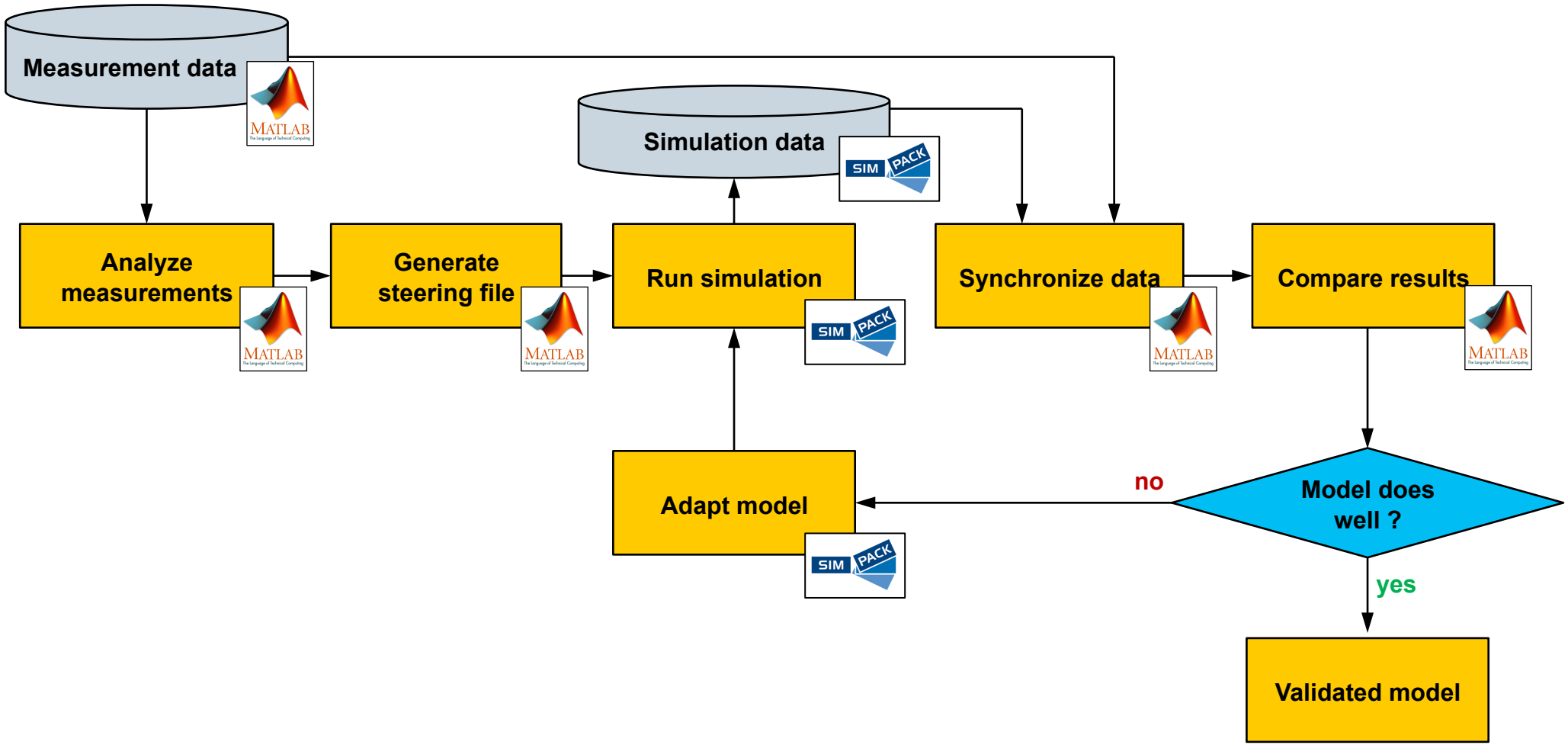
Uncertainty of Friction



- Friction has high influence on results
- Differences in results
  - friction?
  - incorrect modelling of force element?
- Rust on rail
- Traces on steelplate (plastification cannot be modelled)
- Further investigations have to be done

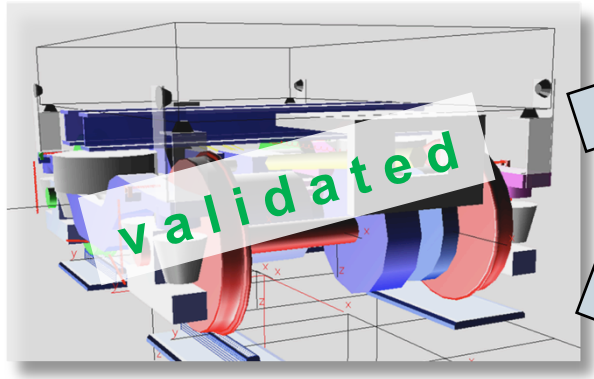


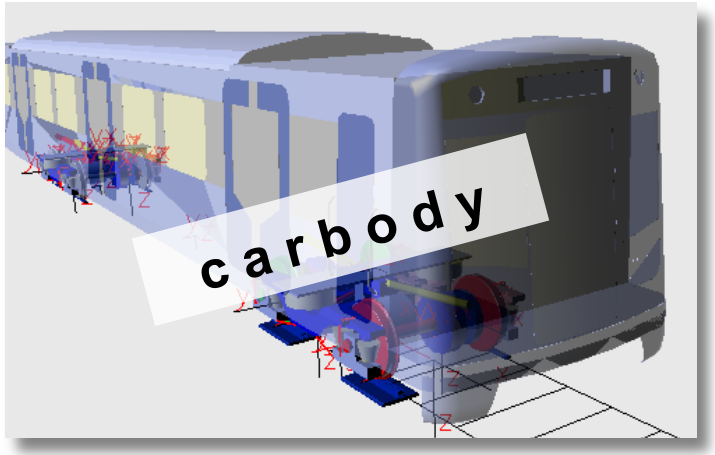
Process and Tools

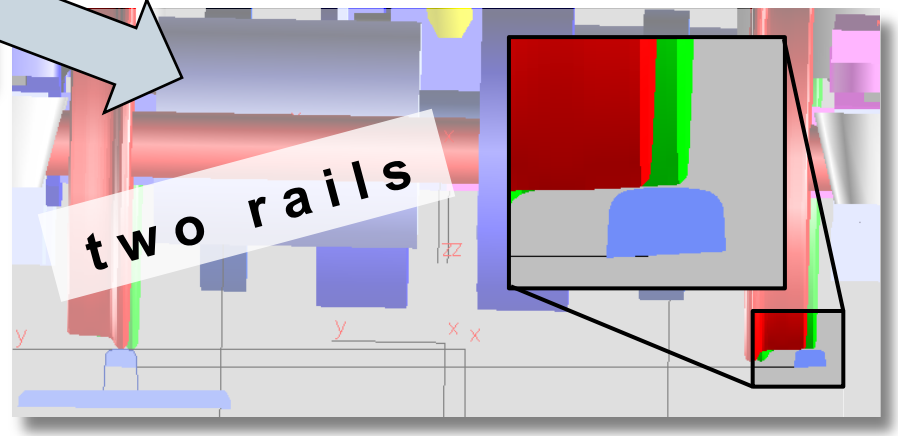


Conclusions and Future Work

- Validated model allows better understanding of the derailment process
- Validated model can be used as a starting point for more complex models
- Extended DoEs with different parameters







Real tests with another bogie

- With even more streamed signals
- Friction modifier
- Kalkers Contact in Simpack9

Contact

Bernhard Girstmair

Vehicle Dynamics and Analytics

Eggenberger Straße 31
8020 Graz, Österreich

Mobil: +43 (664) 6151032

E-Mail:
bernhard.girstmair@siemens.com

siemens.com