

Presentation 3:

Cold Climate Testing: Why Arjeplog and Colmis in northern Sweden become a hub for the global automotive industry every winter
Per Gyllenberg and Benjamin Minshaw, Colmis

About the presenters

Per Gyllenberg



Deputy Manager @ Colmis

Worked in a variety of roles at the company until becoming the Deputy Manager (2018)

Bachelor Degree in Economics (BSc)

Benjamin Minshaw



Marketing Manager @ Colmis

Worked in a variety of roles at the company until becoming the Marketing Manager (2019)

Master in Business Administration (MBA)

COLMIS

Vehicle Dynamics Seminar 2023

AstaZero & Online - May 24th, 2023

66°03'06"N 18°01'12"E

COLMIS

The home of
Winter Testing.

Agenda

This is Colmis

Why Arjeplog

Why Colmis

Q&A Session

The image features a solid blue background with abstract white geometric shapes. A large, light blue circle is partially visible on the left side, with a vertical line extending upwards from its top. To the right, another smaller light blue circle is partially visible, also with a vertical line extending upwards from its top. The text "This is Colmis." is centered in a bold, white, sans-serif font.

This is Colmis.

An aerial photograph of a vast, frozen lake in winter. The ice is a pale, textured white. Several circular and oval tracks, likely for winter driving or racing, are visible on the ice. In the center and right, there are several islands and peninsulas covered in dense evergreen trees. The sky is a clear, pale blue. The overall scene is a stark, cold, and open landscape.

An open and independent
winter proving ground that serves
the global automotive industry.



Our story.



1985

First electric split-mu track.



1997

ISO certifications.



2009

Rajd & Safety.



2016

New Dynamic Area.

Colmis Proving Ground is established.



1987

SIMLOC Hotel



2007

Open Proving Ground.



2013

ColmisPlus & Driver Training.



2022

An aerial photograph of a water park, showing various pools and slides. The water is a deep blue color. In the center, there is a large, circular pool with a dark, swirling pattern. A small boat is visible on the water in the lower center. The text "Our purpose." is overlaid in white, centered horizontally and vertically.

Our purpose.

Everything you need,
in one place.
So that you can
focus on the testing.

A red tractor with a large water cannon attachment is shown in a field, spraying a massive amount of water. The sun is high in the sky, creating a bright, hazy atmosphere. The water is being sprayed in a wide, powerful stream that fills the right side of the frame. The tractor is positioned in the lower-left quadrant, and its shadow is cast on the ground. The background shows a flat, open landscape under a clear blue sky with some light clouds.

Our way.



Not a customer,
a partner.




A customised
cold test solution.

Your success is our
success.

A photograph of three construction workers walking in front of a blue building. They are wearing high-visibility yellow jackets with reflective stripes. The worker on the right is wearing a headset. The text "A team. Not a single player." is overlaid in white on the image.

A team.
Not a single player.

***Together we are
Colmis.***



”If you are looking for a reliable supplier Colmis is the one to choose.”

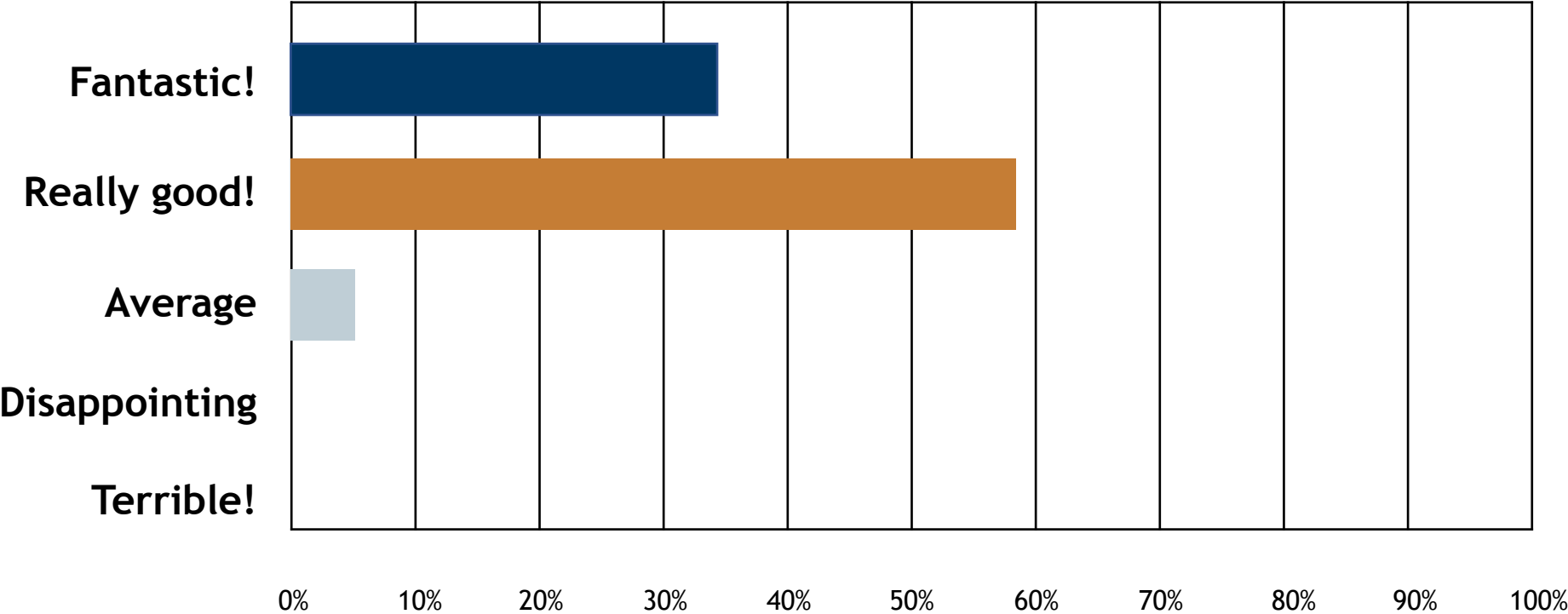
Contract customer -23

”Colmis has a relaxed atmosphere, they don’t panic, they’re friendly and professional. You can have a nice chat with them but you can also have a technical discussion and talk about some problems and they will solve it.”

Spot customer -22

Source: Independent Consultancy Audit

How would you rate your overall satisfaction with your stay at Colmis this season (comparing it to previous years, if applicable)?



Source: Customer Survey Season 2022/2023

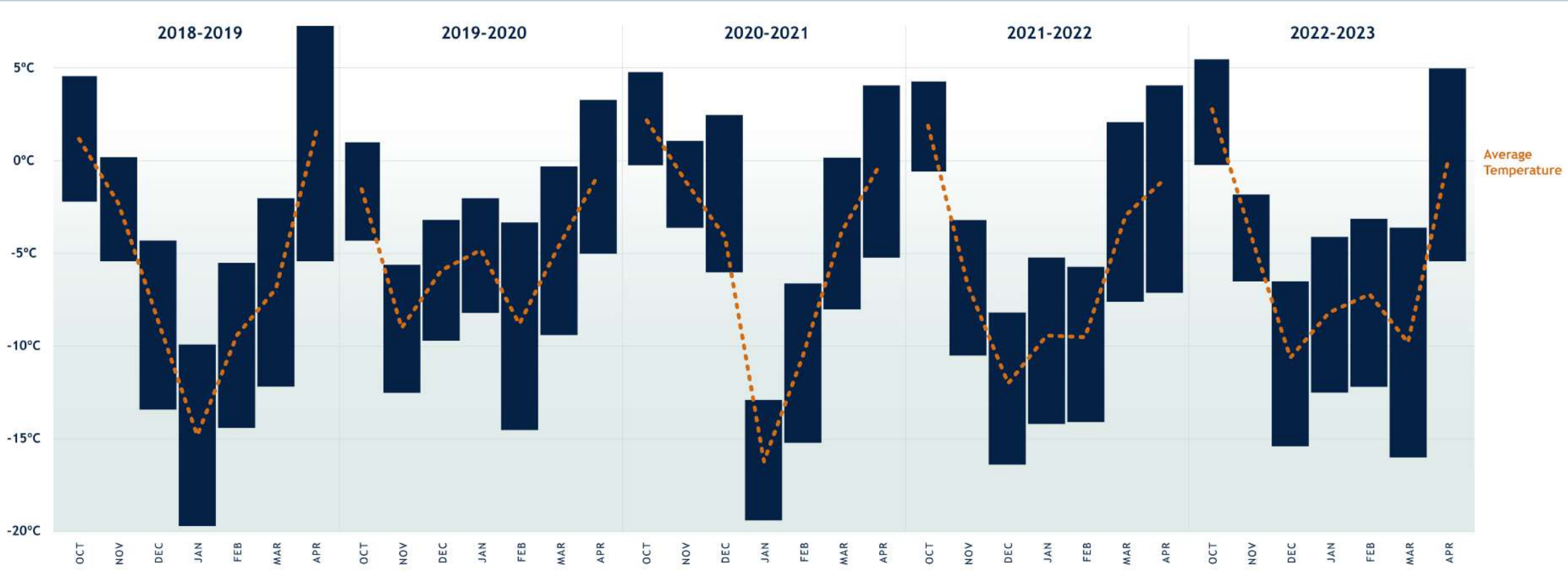


Why Arjeplog.

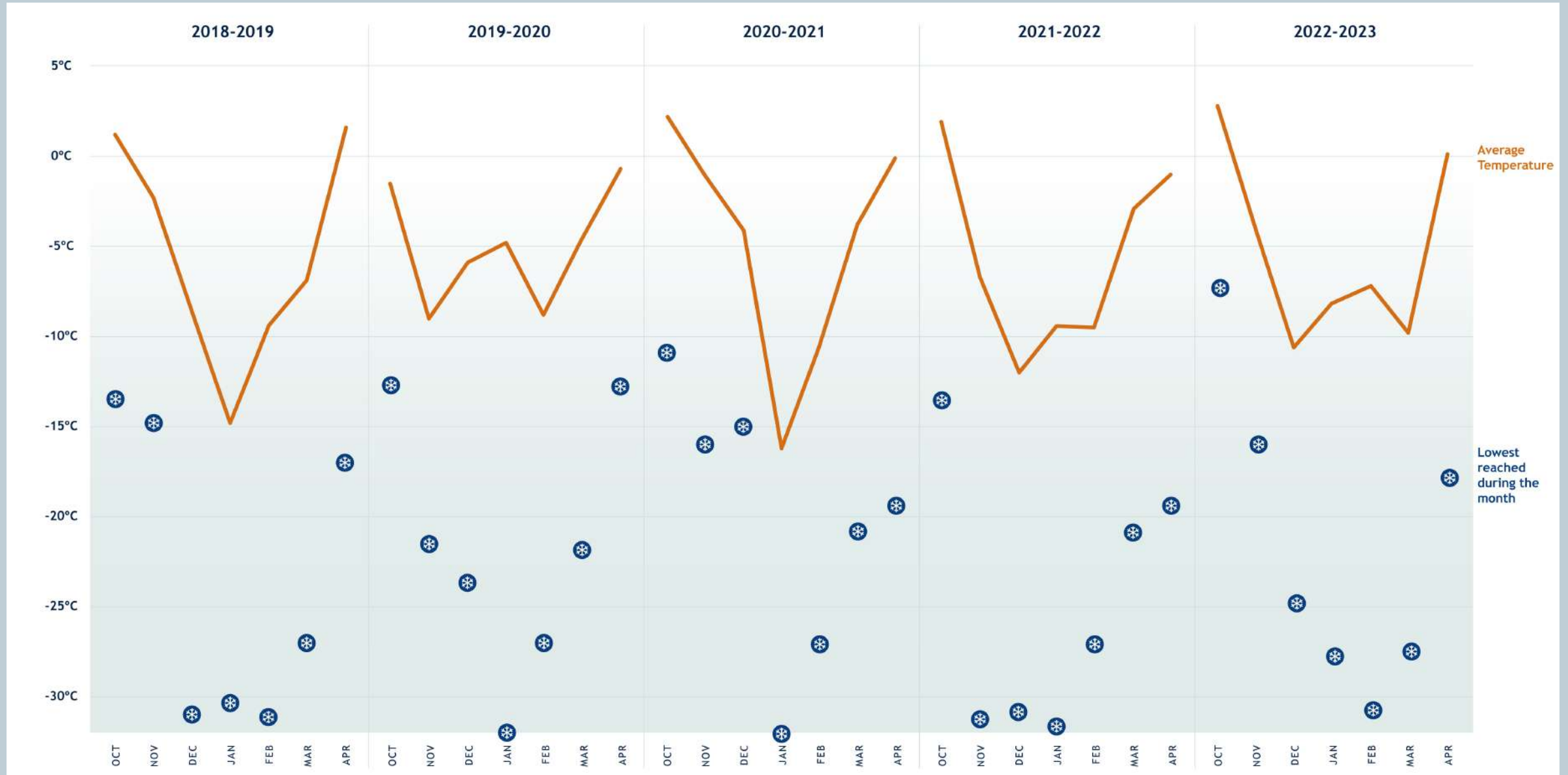


Location.

Maximum temperature to Minimum temperature (average)



Average Temperature / Lowest reached Temperature during the month





Global Winter Testing Hub: OEMs & suppliers

Confidentiality: Scarcely populated

Area infrastructure: Network of public roads

Access: 1h from airport

Why Colmis?



Safety First.



Sustainability & Quality



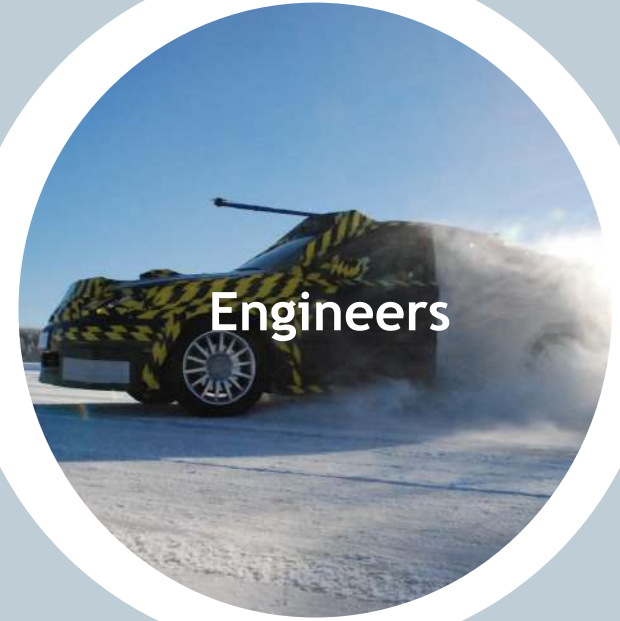
ColmisPlus Vehicle development support



Mechanics & technicians



Durability Drivers



Engineers

Also third party supply of materials & equipment for testing, project coordination, and much more...

A modern hotel room with a bed, a blue armchair, and a dark blue blanket. The room is well-lit and features a large bed with white linens and two brown textured pillows. A blue armchair is positioned in the foreground, and a dark blue blanket is draped over the side of the bed. The background shows a window with light-colored curtains and two bedside lamps.

SIMLOC

Accommodation

>90 hotel and apart-hotel rooms

Private house rentals, apartments, cabins.

Comfortable, flexible, nearby.

12 000 m²

Workshops & Office space

>90

Hotel rooms
+ rental of private
houses/apartments

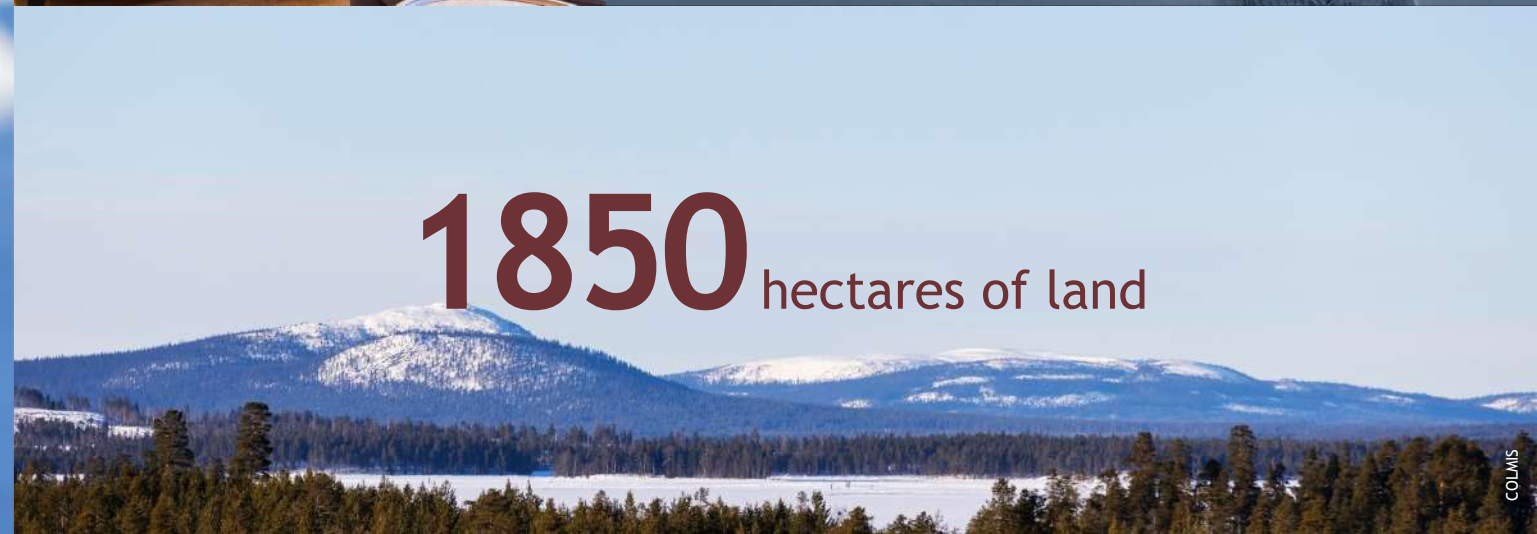
>50 land & lake-ice tracks

700 km of tracks



35

employees



1850 hectares of land



The Land Tracks

Some examples of many

Dynamic Area



Circle Track



Split-μ



Twisted Humps and Cobble Stone



Hill Tracks 10-20%



Forest Track





The Lake Tracks

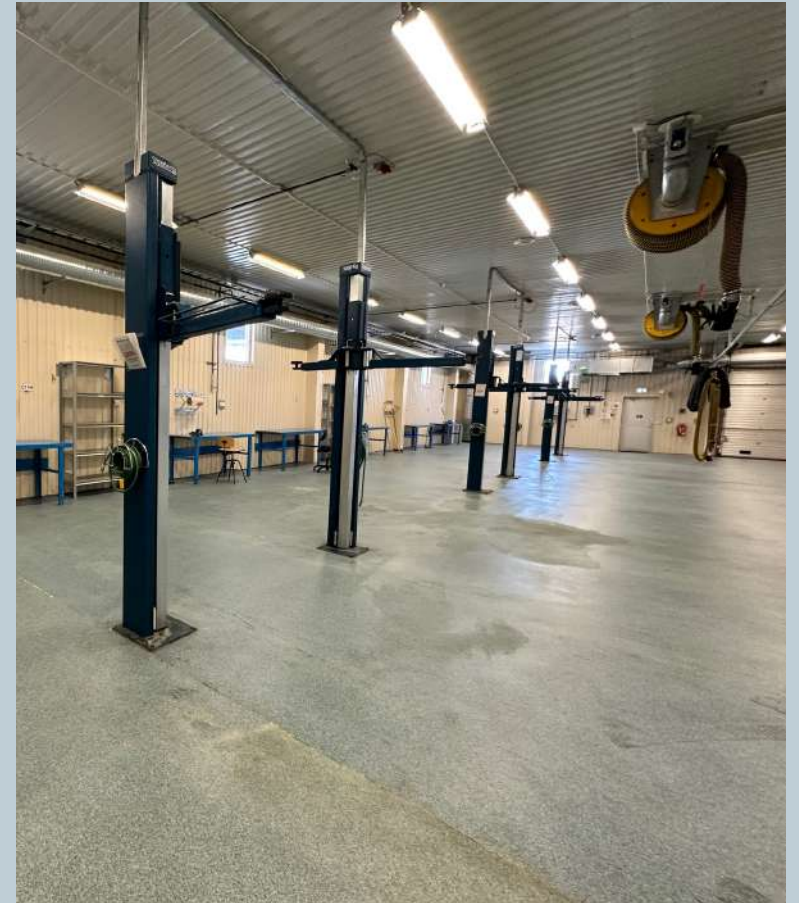
The Lake Tracks

Ice thickness (cm)	Maximum permissible gross weight (also applies to vehicle trailer) (tonnes)	Maximum permissible axle load (tons)	Minimum distance to another vehicle
20	2		
25	3		
30	4		
40	7	5	40
50	12	7	40
60	16	10	40
70	20	10	40
80	25	10	40
90	30	10	40



Still 84cm today!

The workshops and offices



EV Charging



2023-05-22



Infrastructure.

COLMIS

Cold Chambers.



An open proving ground.

Contract Customers

ADVICS **BorgWarner** **CEVT**
Haldex **STELLANTIS** **JTEKT**
株式会社ジェイテクト
AAM DRIVELINE SYSTEMS AB **GKN** GKN AUTOMOTIVE **HL Mando**

AVL **BOSCH** **DANA** **brebmo** **FEDERAL MOGUL** **Ferrari**
FEV **LOTUS** **Applus+ IDIADA** **MIRA** **HYUNDAI** **nexteer**
T-engineering **Perkins** **R3E** **SSANGYONG** **SCANIA**
NISSAN **thyssenkrupp** **Togg** **VOLTA TRUCKS** **VOLVO**

Spot Customers

What comes next?



ADAS & Autonomous Driving

More EVs (+ Hybrids) & Hydrogen

New Mobility Trends

Facing Climate Change

Stay updated.

Follow us @ColmisAB



Questions?



*A warm welcome.
To a cold place.
For a safer road ahead.*

COLMIS

per@colmis.com

benjamin@colmis.com

PHONE: +46(0)730789288



Presentation 4:
AstaZero tracks
Håkan Andersson, Astazero

Presentation 5:
***Suspension design as part of complete vehicle
development***

Yansong Huang, VCC and Chalmers

Presentation 6:

***Tyre rolling resistance at various operational
conditions and limitations in current tyre
labelling***

Jukka Hyttinen, Scania and KTH

Presentation 7:

Tyres and the purposes of models

Edo Drenth and Niklas Fröjd, Volvo Trucks

V O L V O

PURPOSE DRIVEN TYRE MODEL FIDELITY

Keeping the Connection

Volvo Autonomous Solutions

Volvo | Niklas Fröjd / Edo Drenth | Internal

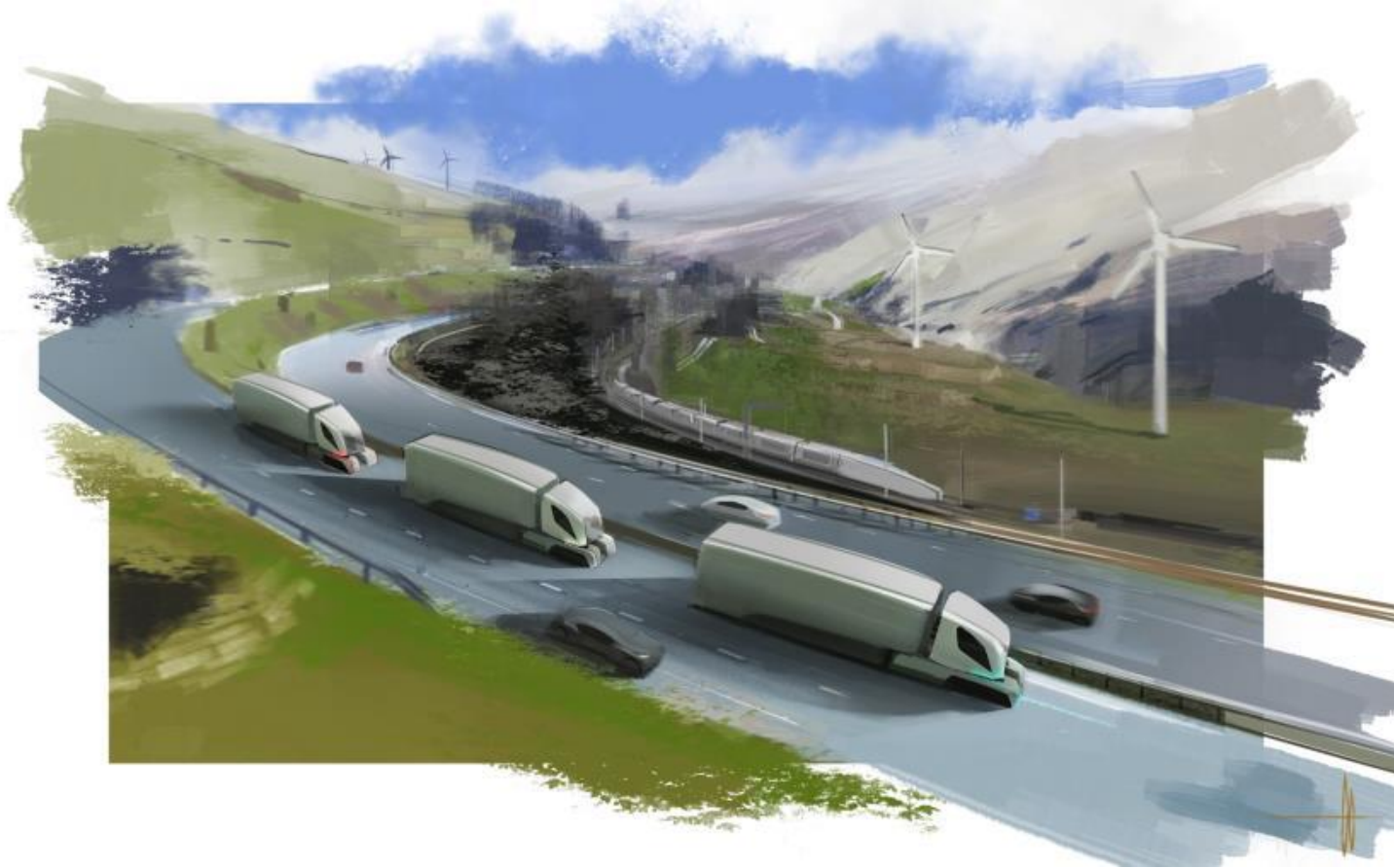
2023-05-23

Volvo Group

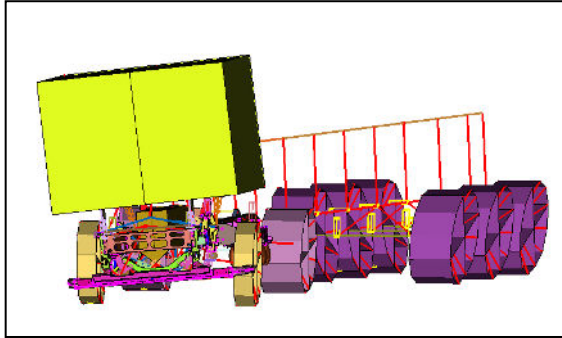


EMPLOY 100.000 PEOPLE,
PRODUCTION IN 18 COUNTRIES
SELLS ON 190 MARKETS.

Group Trucks Technology



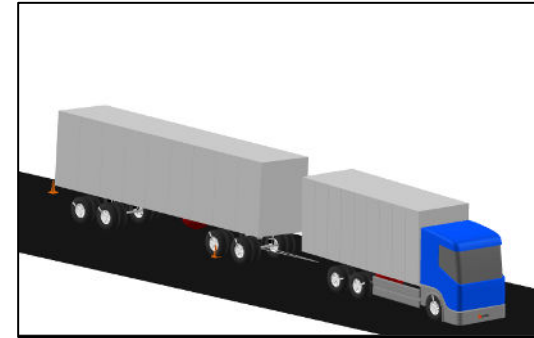
FEM



Semi-detailed 2-track (VTM)



Modelica



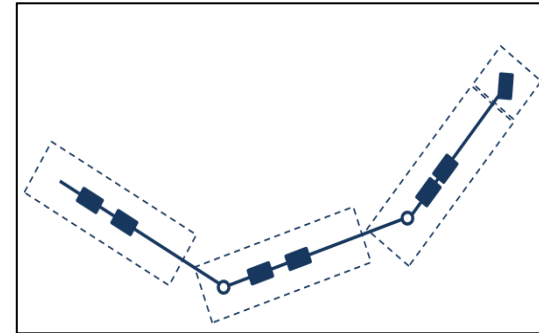
MBS



ASM for HIL/SIL/MIL verification



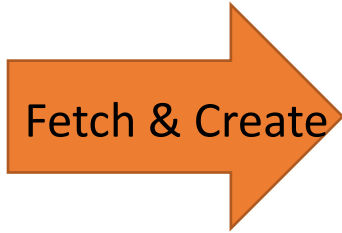
Single-track models for on-line for control design



Model data



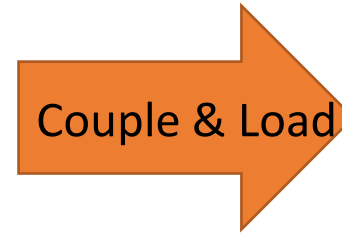
PDM



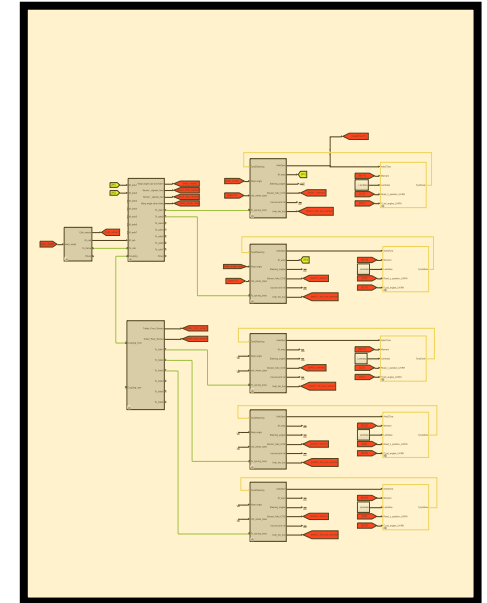
Fetch & Create

```

C:\vtm_development\VTM16b\Parameter Template Files\Init3_Tractor3_Template.m
EDITOR PUBLISH VIEW
+ Find Files
Open Save Compare Go To EDIT Breakpoints Run Run and Advance Run Section Run and Time
New
FILE NAVIGATE BREAKPOINTS RUN
20 %% Basics
21
22 % Short description, reference to spec
23 vtm.dsc(1)='3-axle tractor with single front axle';
24
25 % Number of axles [-]
26 vtm.na(1)=3;
27
28 % Vehicle type (rigid or tractor)
29 vtm.type(1)='tractor';
30
31 % Number of front axles [-]
32 vtm.nfa(1)=1;
33
34 % Type of axle 1=driven 0=nondriven
35 vtm.axletype(1,1:vtm.na(1))=[0 1 1];
36
37 % Type of rear axle steering 1=steered 0=non steered
38 vtm.susprear_steertype(1,1:(vtm.na(1)-vtm.nfa(1)))=[0 0];
39
40 % Axle positions r.t. first axle [m]
41 vtm.ll(1,1:vtm.na(1))=[0 -3.4 -4.77];
42
43 % Coupling positions r.t. first axle [m]
44 vtm.lc(1,1:2)=[0 -3.75];
45
46 % Coupling height r.t. ground [m]
47 vtm.hc0(1,1:2)=[0 1.13];
48
49 % Unladen tractor axle group loads [kg]
50 vtm.fale=[5767.97];
51 vtm.rale=[4151.25];
52
53 %% Axles, wheels and tyres
54
55 % Axle mass [kg]
56 vtm.maxle(1,1:vtm.na(1))=[750 1300 1300];
57
58 % Track width [m]
59 vtm.w(1,1:vtm.na(1))=[2.09 1.85 1.85];
60
  
```

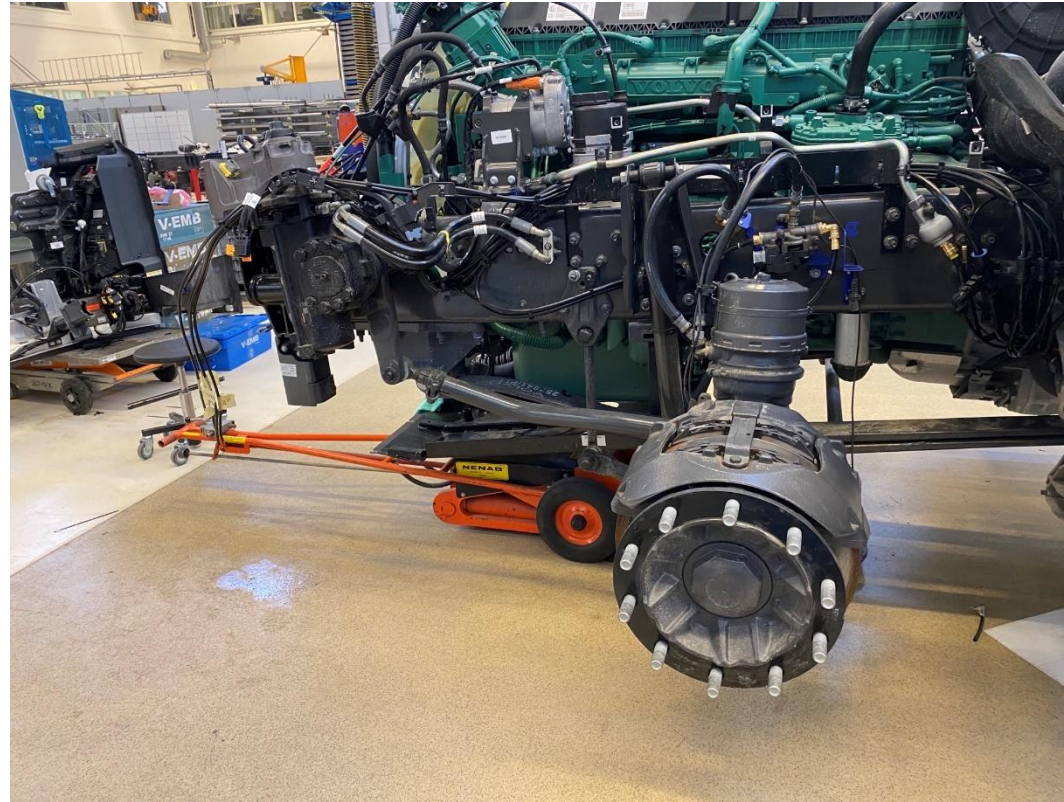


Couple & Load



Executable model

The suspension and steering



The truck frame



The swap-body superstructure



V O L V O

The tipper



V O L V O

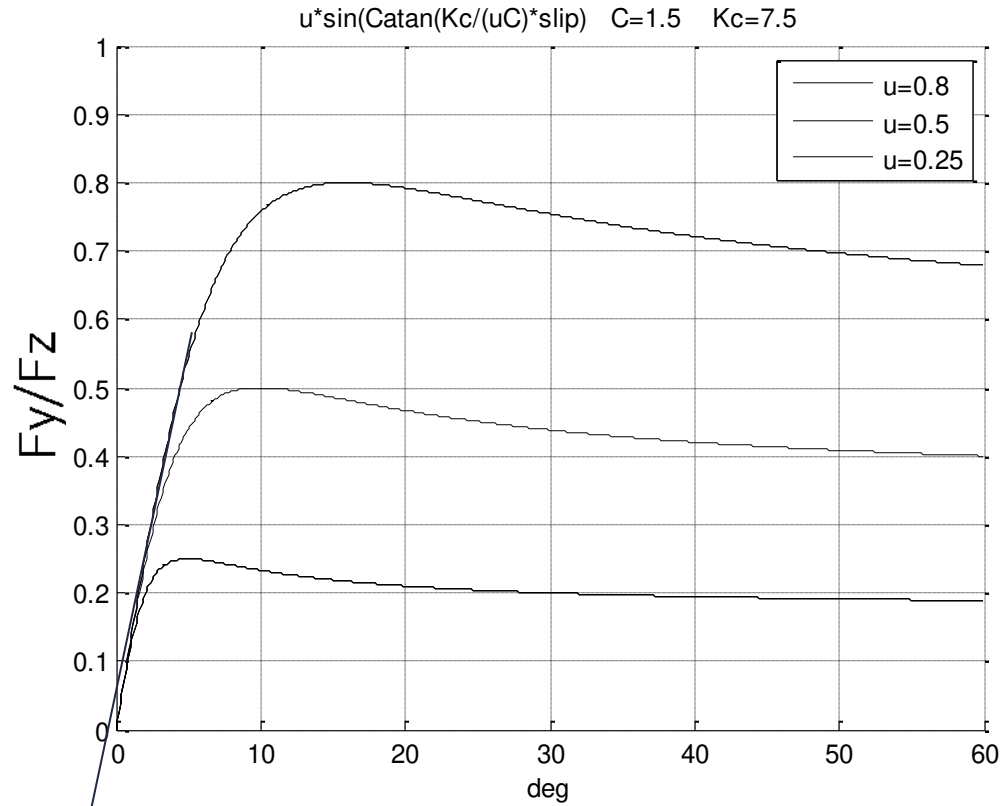
Timber



Tyres



2. Useful non-linear tyre model for two-track modeling



$$K_c = K_{c0} \left(1 + k \frac{F_z - F_{z0}}{F_{z0}} \right)$$

$$F_y = \mu \times F_z \times \sin \left(C \times \text{atan} \left(\frac{K_c}{\mu C} \alpha \right) \right)$$

Vision

V.A.S. portable application software can be entirely **verified** virtually and solely **validated** in the vehicle

SIL



Component
HIL

System
HIL



Mission

Develop reusable and portable vehicle simulation models for all stages of the virtual verification of software applications



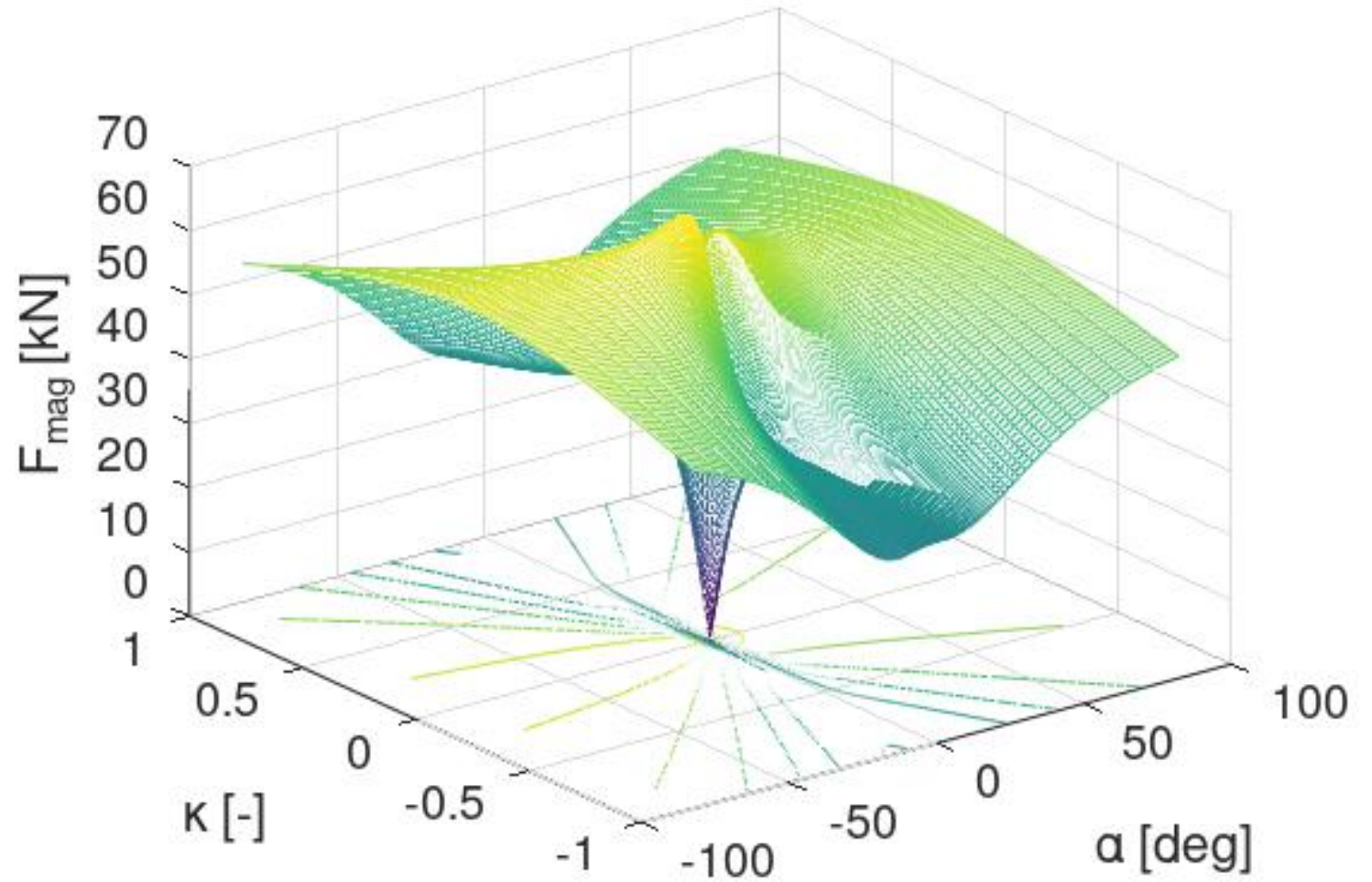
Starting point

445/65 R22.5

Pacejka 2002 – combined slip

Extrapolated parameters from truck
tyre parameter sets

The TA15 will be on “rails”

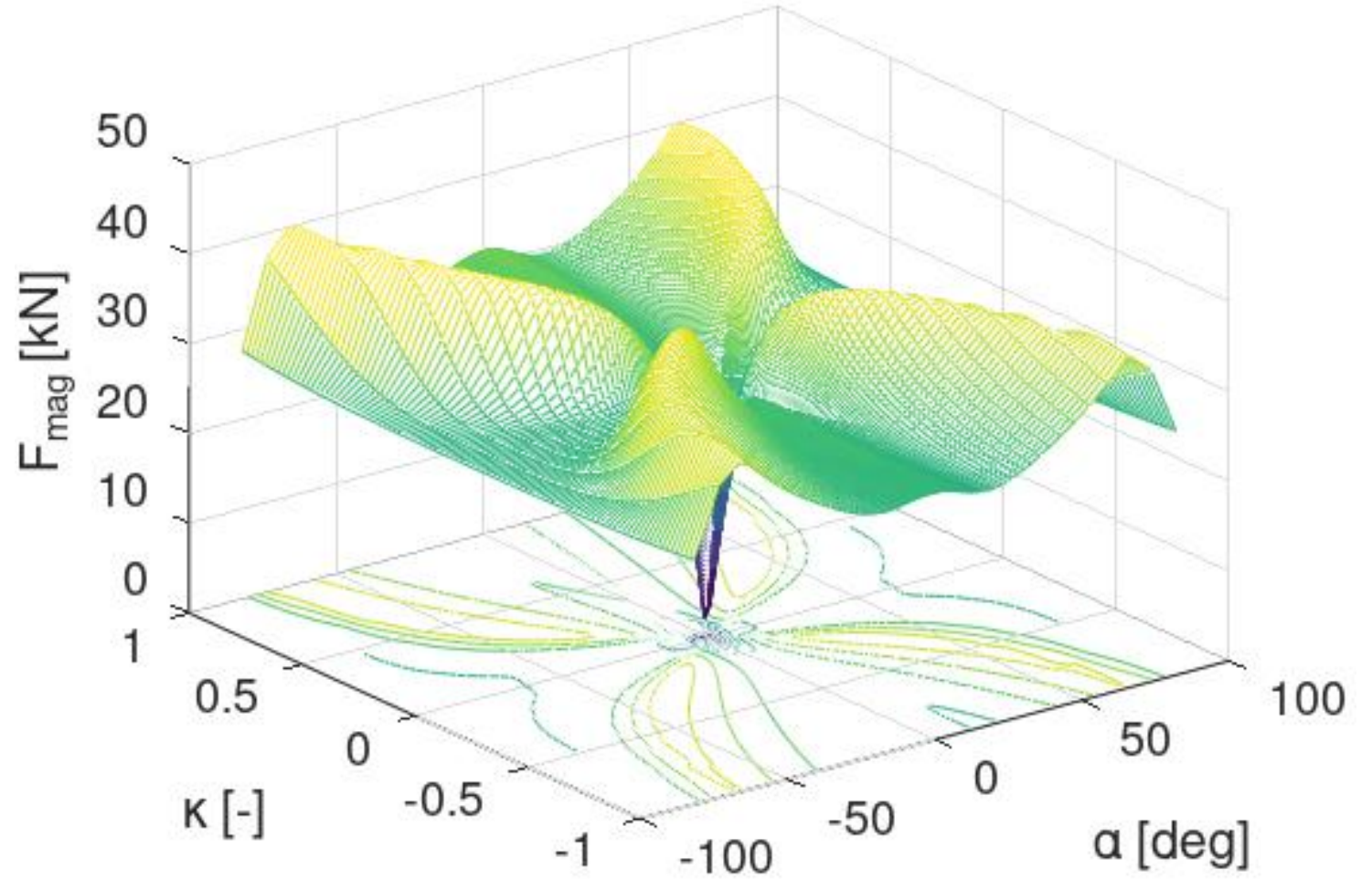


Measured and fitted

Truck tyre

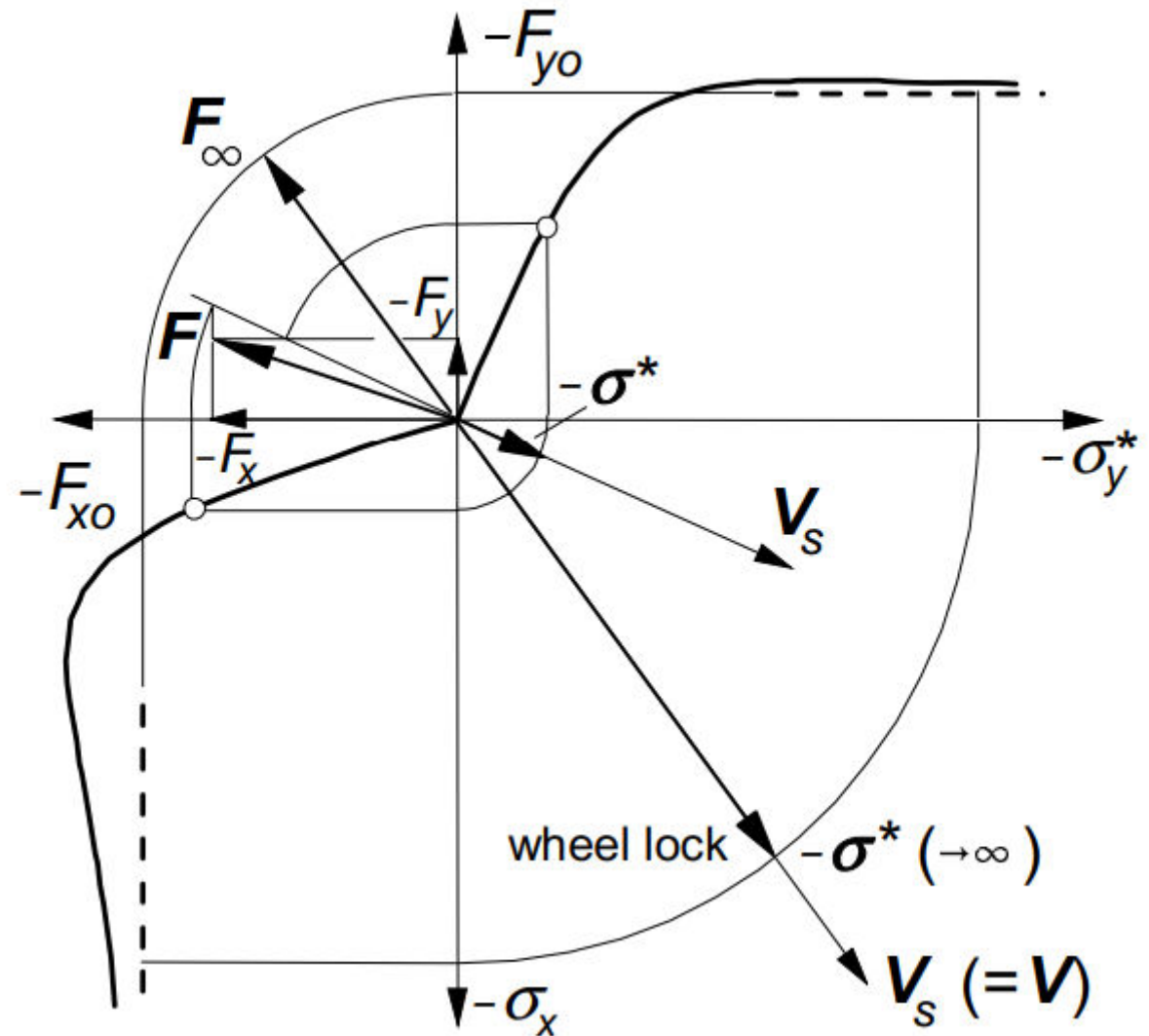
Pacejka 2002 – combined slip

Overfitted within available data?



What do we have?

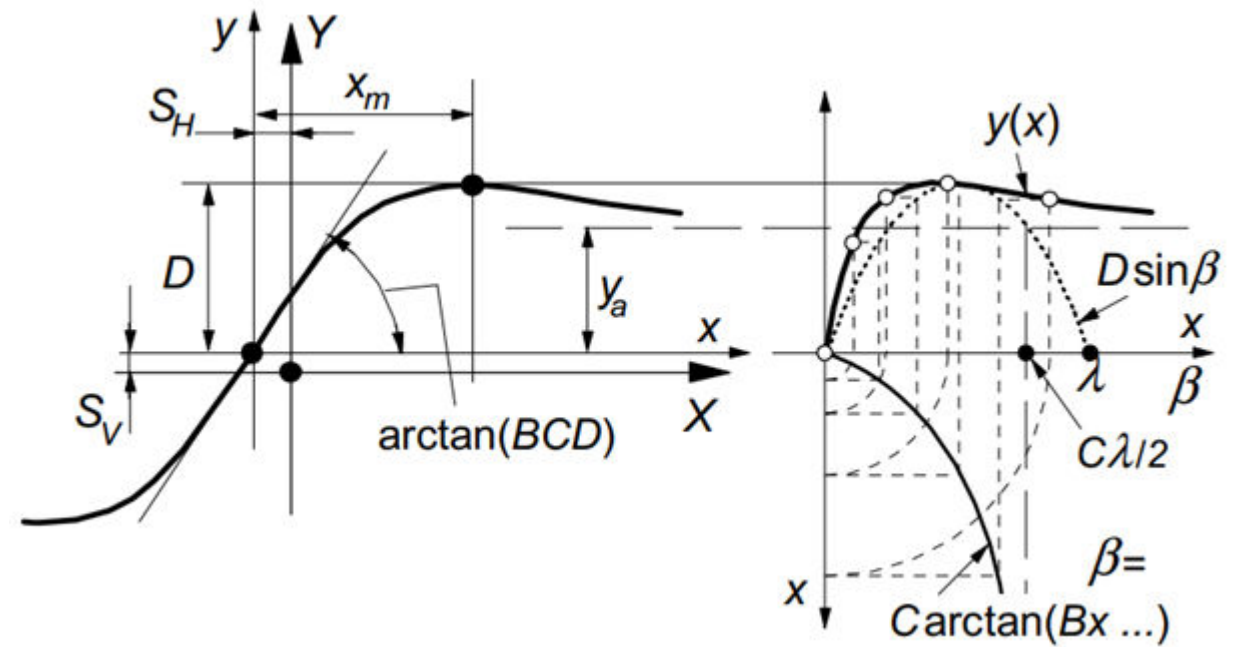
- Basic notion of uniaxial slip characteristics
 - Magic Formula
- Similarity methods
 - Theoretical slips
- Longitudinal slip stiffness
- Cornering stiffness
- Peak friction characteristics
 - Declining with load
 - Asymptotic?
- Identical asymptote for friction?



Source: Tyre and Vehicle Dynamics, Hans B Pacejka

Reverse Engineering

- Use existing parameter sets (backward compatible)
- Remove all shift functions
 - Symmetric tyre characteristics
- Utilise Magic Formula 2002 main parameter interrelationships
 - B, C, D and E
 - Forthcoming ISO standard
- **Heavy commercial vehicles and buses – Vehicle dynamics simulation and validation – Tyre model for lateral estimation of heavy vehicle combinations operated at dry paved road surface**



Source: Tyre and Vehicle Dynamics, Hans B Pacejka

VAS22 tyre model features

- 21 parameters
- PAC02 backward compatible
 - The remaining parameters have identical meaning
 - Can read a full set of PAC02 parameters
 - Will throw DTCs for non-plausible parameter values
- Robustness
 - All characteristics are asymptotically sound beyond validity range

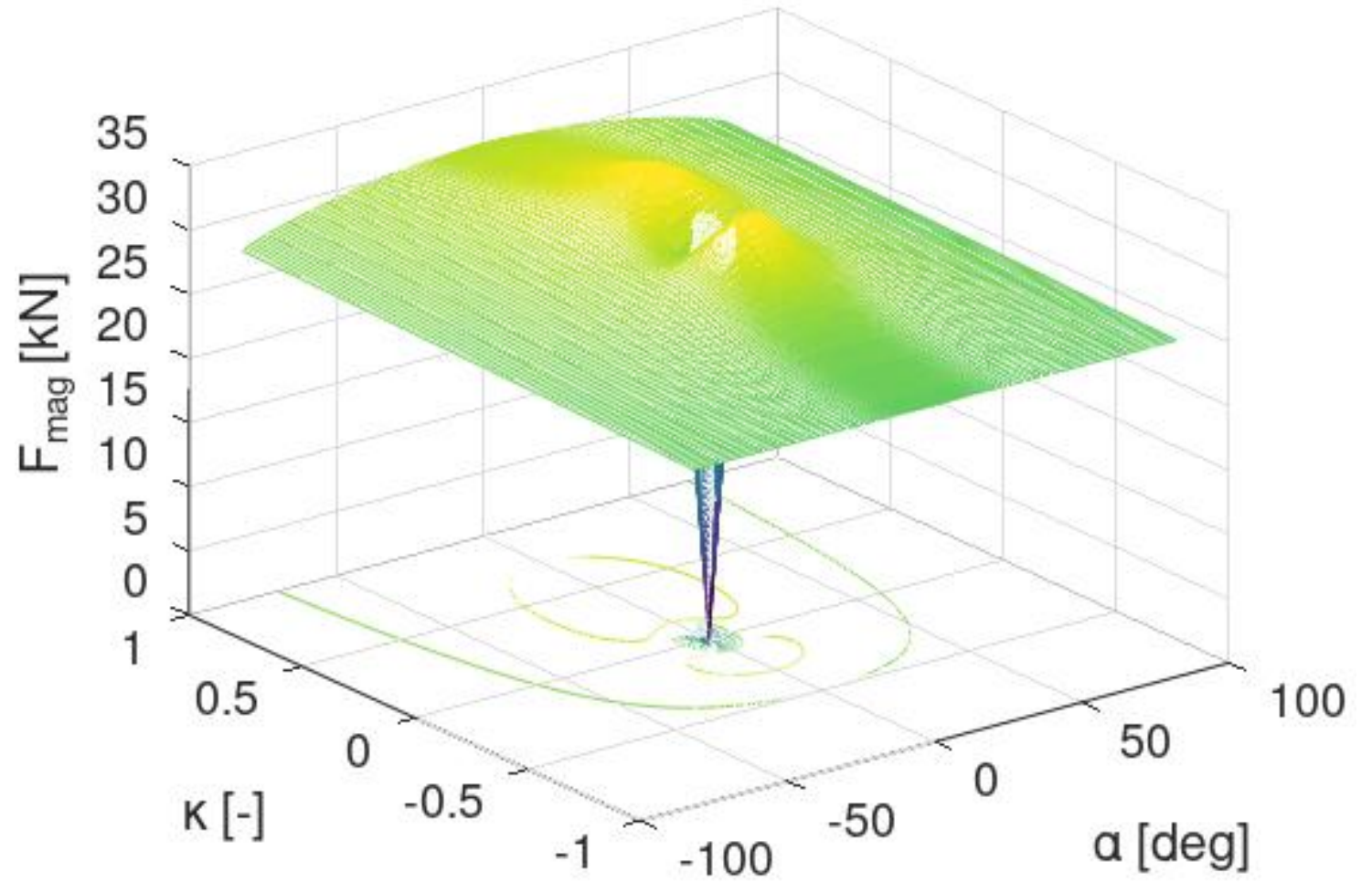
kappaPeak	:	<input type="text" value="-0.15"/>
PCX1	:	<input type="text" value="1.45"/>
PDX1	:	<input type="text" value="0.85"/>
PDX2	:	<input type="text" value="-0.05"/>
PDX3	:	<input type="text" value="0"/>
PKX1	:	<input type="text" value="8.0"/>
PKX2	:	<input type="text" value="7.0"/>
PKX3	:	<input type="text" value="-0.3"/>
Pure slip lateral		
alphaPeak	:	<input type="text" value="17.1887338539"/> deg
PCY1	:	<input type="text" value="1.3"/>
PDY1	:	<input type="text" value="0.75"/>
PDY2	:	<input type="text" value="-0.05"/>
PDY3	:	<input type="text" value="0.2"/>
PKY1	:	<input type="text" value="-13.0"/>
PKY2	:	<input type="text" value="1.8"/>
PKY3	:	<input type="text" value="0.2"/>
Pure slip aligning torque		
QCZ1	:	<input type="text" value="1.2"/>
QDZ1	:	<input type="text" value="0.1"/>
QDZ2	:	<input type="text" value="-0.003"/>
QDZ3	:	<input type="text" value="0.0"/>
QDZ4	:	<input type="text" value="0.0"/>

Results

445/65 R22.5

VAS22 – combined slip

Minimum set of parameters

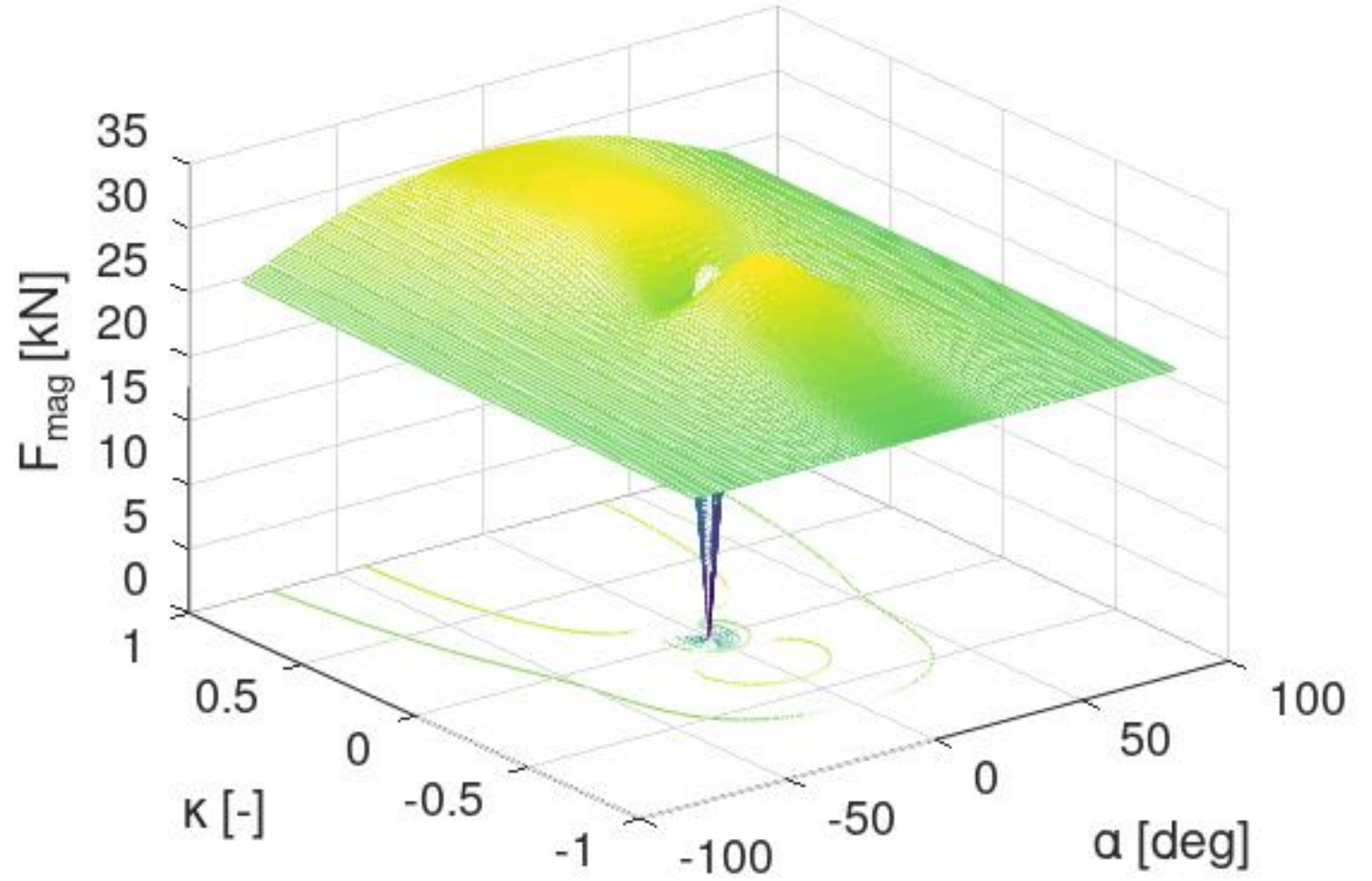


Results

385/55 R22.5

VAS22 – combined slip

Minimum set of parameters



Tyre model fidelity

Perhaps vice versa

The tyre model at hand
represents
a possible outcome of a real tyre

V O L V O

Presentation 8a:
Vehicle Engineering MSc programme,
Mikael Nybacka, KTH

Presentation 8b:
Mobility engineering MSc programme,
Dag Bergsjö, Chalmers

MASTER'S PROGRAMME

MOBILITY ENGINEERING

MCS, 120 CR, 2 YEARS



CHALMERS
UNIVERSITY OF TECHNOLOGY

DEVELOP TOMORROW'S MOBILITY SYSTEMS!



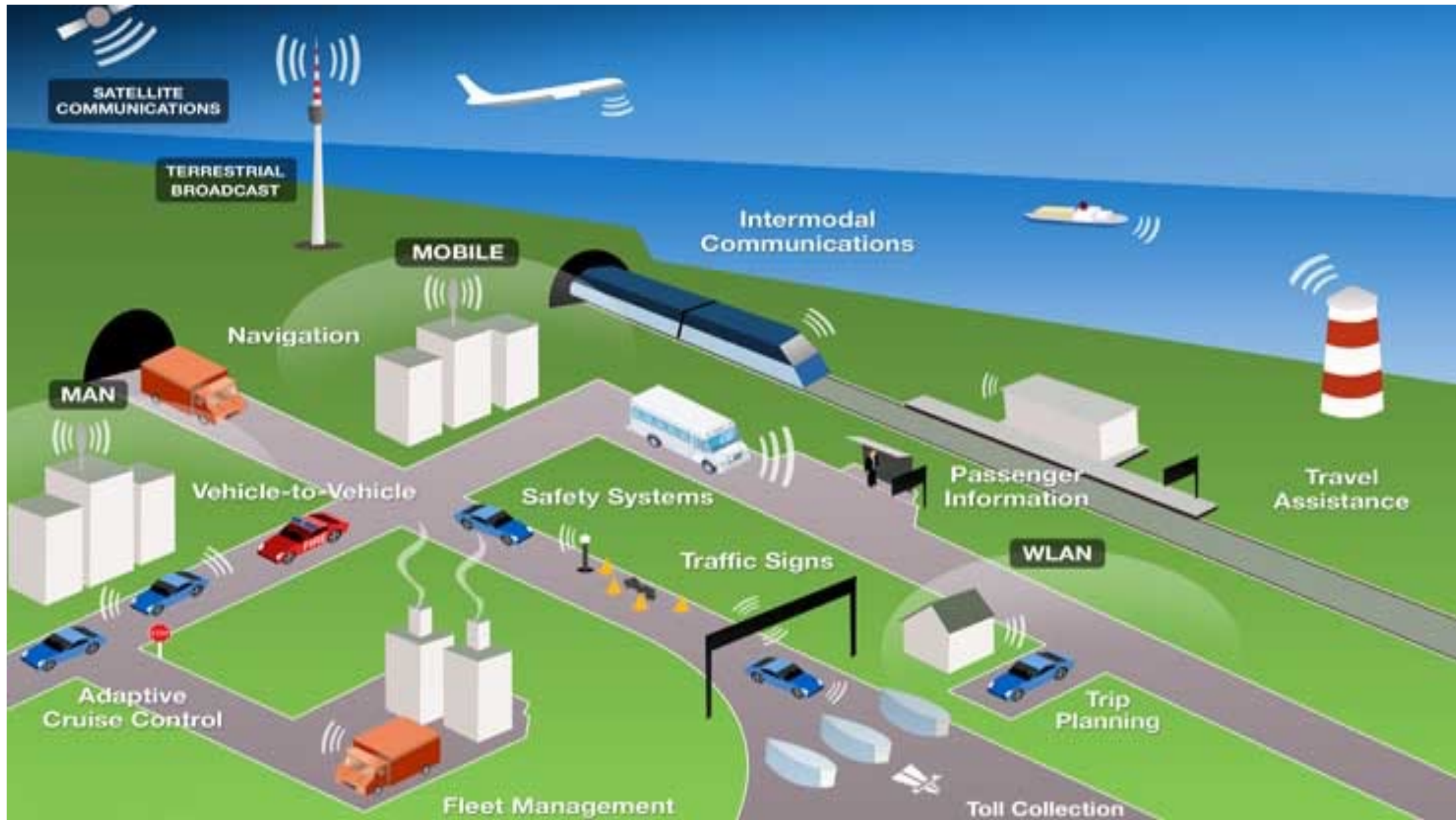
Program integrating
aerospace, automotive
engineering, marine
technology and railway
technology



Dag Bergsjö

dagb@chalmers.se

Program Director MPMOB



Aim of MP



Train students:

- To develop safe, sustainable, high-performance mobility solutions.
- To understand features, design requirements and challenges of the present and future mobility solutions.
- To gain a holistic knowledge of mobility solutions and the ability to apply them for different transportation needs and environments.

MPMOB: programme in a nutshell



Broad knowledge on mobility

- Mechatronics for mobility
- Propulsion for mobility
- Connected fleets and automated data collection
- Systems engineering

In-depth knowledge in one of these profiles

- Aerospace engineering
 - Fluids
 - Structural
 - Artificial intelligence
- Automotive engineering
 - Active and passive safety
 - Powertrain and propulsion systems
 - Vehicle engineering and aerodynamics
- Marine technology and naval architecture
 - Structures
 - Fluid
 - Systems engineering
- Railway technology
 - Railway mechanics
 - Structural deterioration
 - Asset management

MPMOB: facilities for education



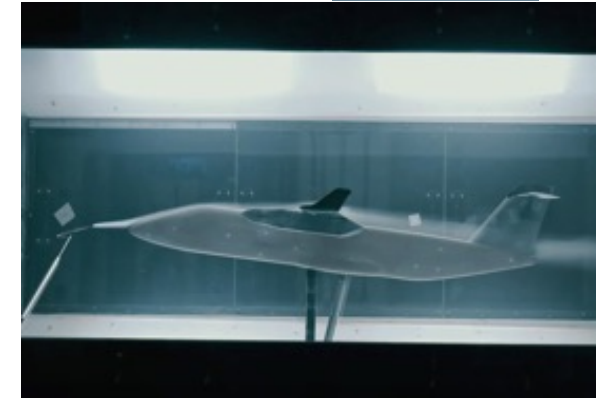
Hybrid powertrain lab



Driving simulator



Brake rig for rail



Low-speed wind tunnel



Resource for vehicle research
(REVERE)



Maritime simulator



Low-pressure compressor rig

MPMOB: study plan



Year 1				Year 2			
LP1	LP2	LP3	LP4	LP1	LP2	LP3	LP4
Systems and mechatronics for mobility engineering (EEN130)	Elective / Compulsory elective	Elective / Compulsory elective	Connected fleets in data-driven engineering (MMS210)	Elective / Compulsory elective	Elective / Compulsory elective	Master thesis	
Introduction to propulsion and energy systems for transport (MMS195)	Elective / Compulsory elective	Elective / Compulsory elective	Elective / Compulsory elective	Elective / Compulsory elective	Elective / Compulsory elective		

- Compulsory courses for 52.5 ECTS
- Compulsory elective courses for 37.5 ECTS (to be chosen among 32 different courses)
- Elective courses for 30 ECTS (to be chosen from 12 different Master programmes)

MPMOB: project work



- Project in aerospace (Aerospace engineering)
- Automotive engineering project (Automotive engineering)
- Marine design project (Marine technology)
- Project in railway technology (Railway technology)
- Chalmers formula students (Automotive engineering)

MPMOB: industrial connections



- Abetong
- Autoliv
- Alstom
- Consulting companies (Alten, Altran, ÅFRY, Atkins)
- China Euro Vehicle Technology (CEVT)
- GKN Aerospace
- Green Cargo
- Heart Aerospace
- Lucchini
- SAAB
- SSPA
- Stena Line
- SJ
- SweMaint
- Trafikverket
- Volvo Group
- Volvo Cars
- Wabtec



Lunch Seminars (Fall 2023)

SAS & Heart aerospace (spring 2023)



MPMOB: research-based education



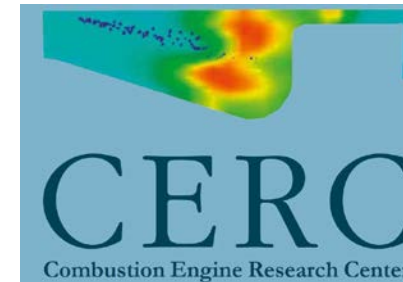
<http://www.charmec.chalmers.se/>



<https://emobilitycentre.se/>



<https://lighthouse.nu/>



<https://www.chalmers.se/en/centres/cerc/Pages/default.aspx>

TechForH2 - Hydrogen Centre

<https://www.chalmers.se/en/departments/m2/news/Pages/TechForH2---for-a-sustainable-hydrogen-economy-of-tomorrow.aspx>



VEHICLE AND TRAFFIC SAFETY CENTRE AT CHALMERS

<https://www.saferresearch.com/>

MPMOB: international opportunities

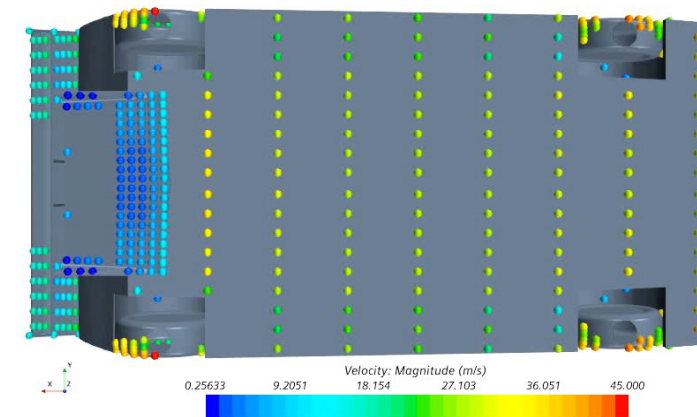
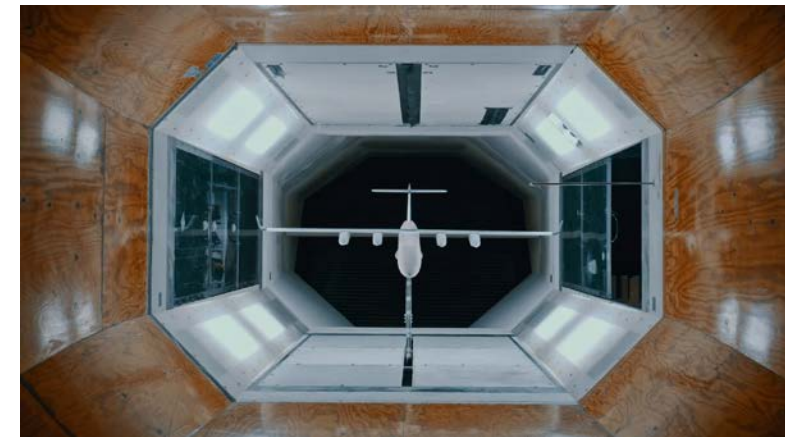


- Double degree with University of Stuttgart (automotive engineering)
- Nordic Master in Maritime engineering, within Nordic Five Tech (marine technology)
- Erasmus exchanges (<https://cth.moveon4.de/publisher/1/eng#>)

MPMOB: job opportunities



- Design of parts and systems (e.g., yacht designer, powertrain integration engineer)
- Simulation engineer (e.g., crash simulation engineer, vehicle dynamics CAE engineer)
- Asset management (e.g., asset management railway engineer, maintenance engineer)
- Technical sales engineer
- Project manager
- Research & development (e.g., railway technical specialist, traffic safety research specialist)
- Academia (e.g., PhD student)
- Other (e.g., offshore engineer)





CHALMERS
UNIVERSITY OF TECHNOLOGY

Poster 1:

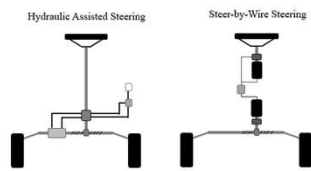
Quantify and mimic the feedback through the steering wheel at some driving conditions

Aron Dalemo, Polestar & Chalmers

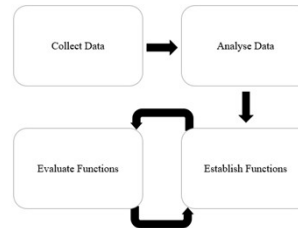
Master Thesis Micro Presentation

Aron Dalemo

Background & Aim

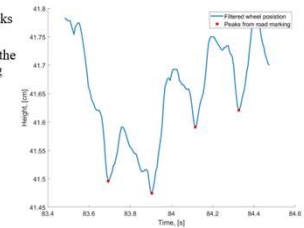


Method



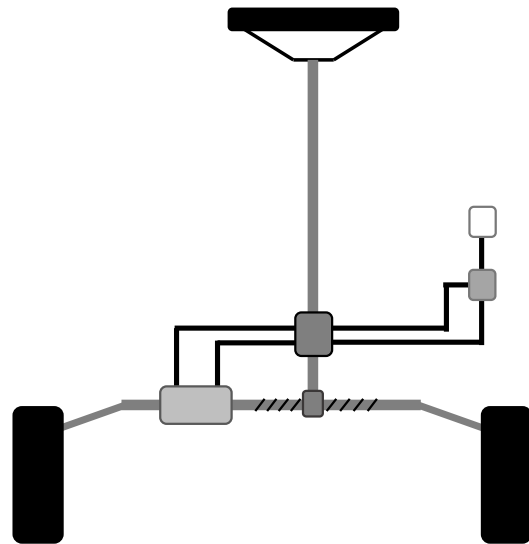
Result

- The general idea is to look at peaks and their placements
- Largest challenge is to not catch the same phenomena in other driving situations
- Shows potential

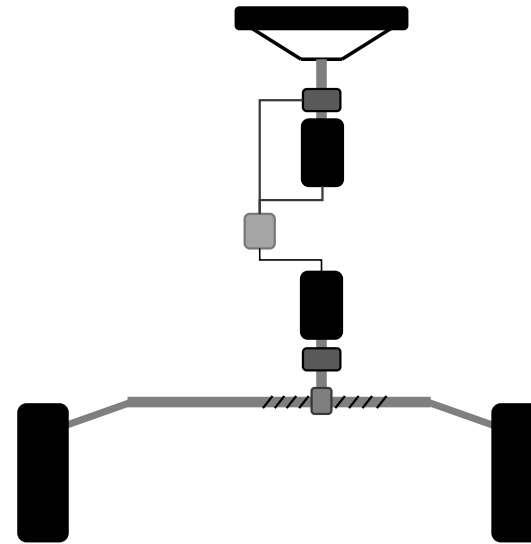


Background & Aim

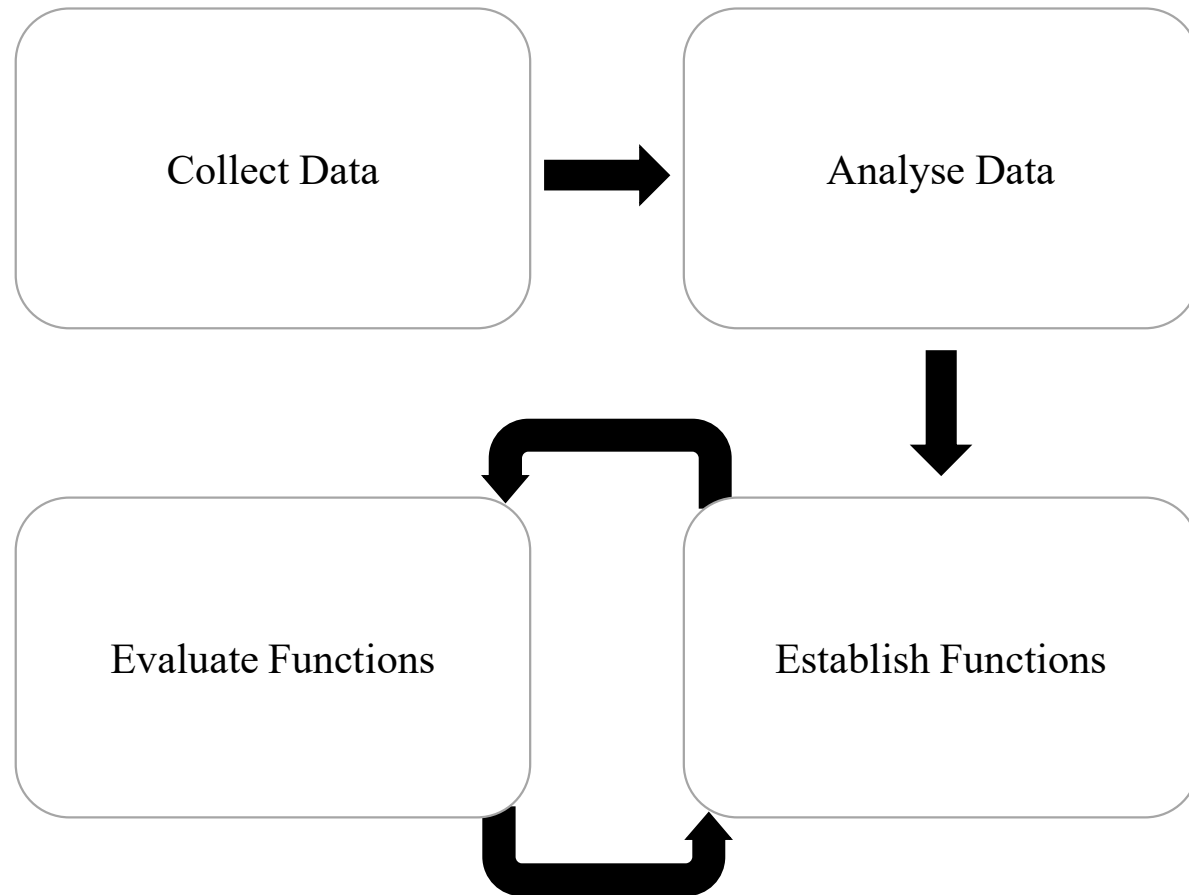
Hydraulic Assisted Steering



Steer-by-Wire Steering



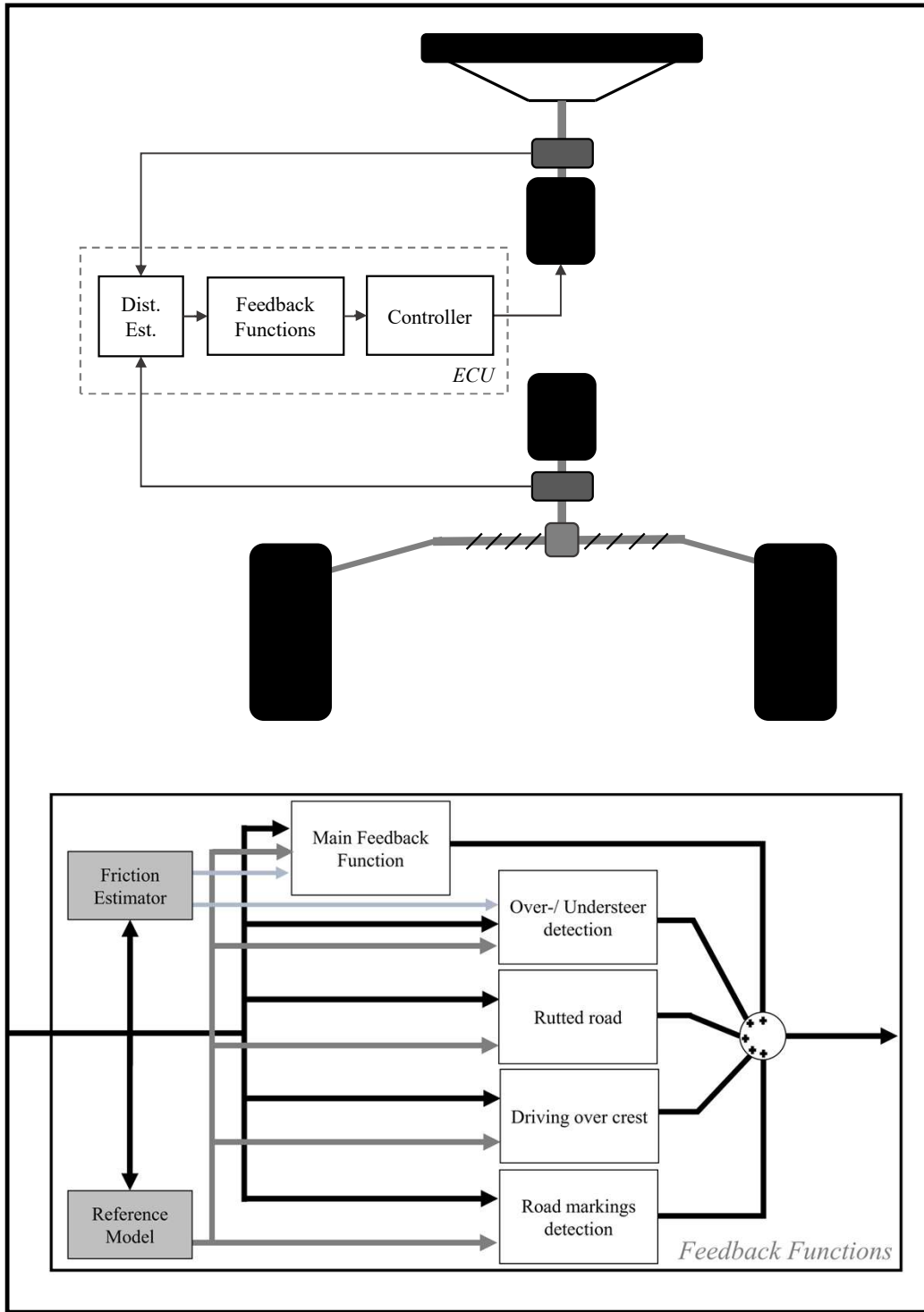
Method



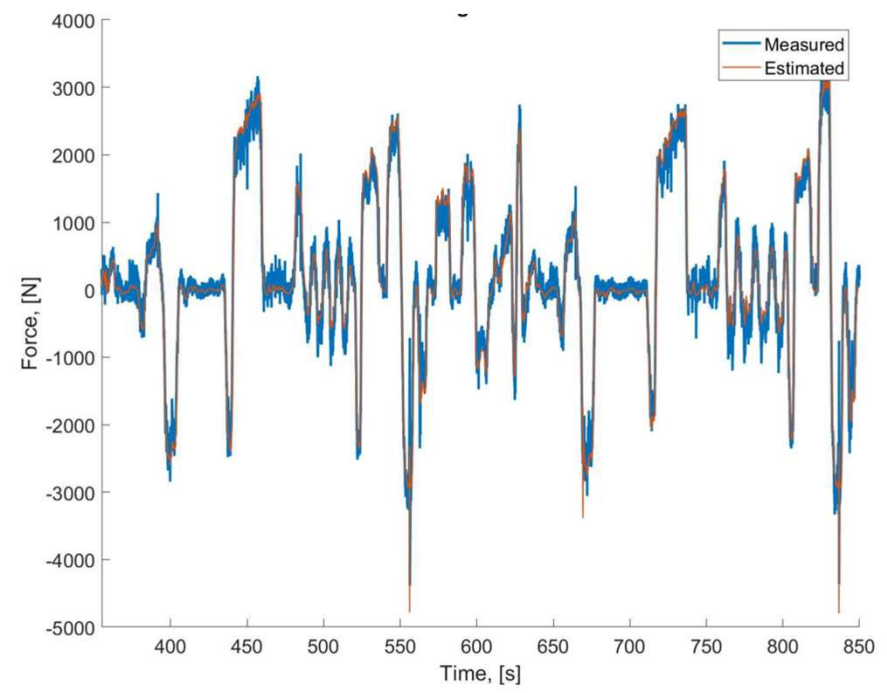
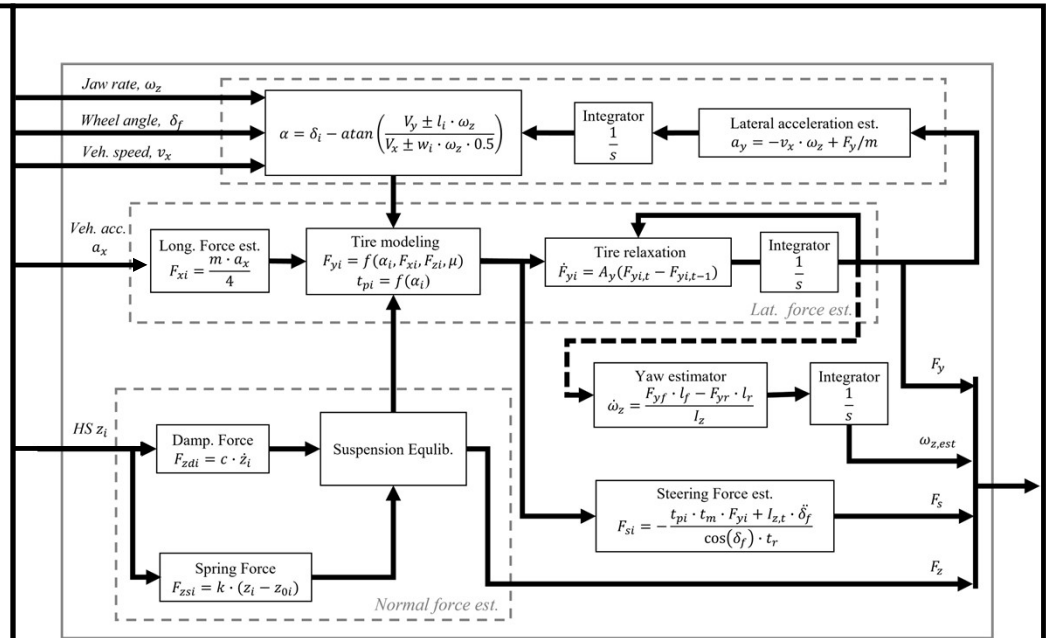
Quantify and mimic the feedback through
the steering wheel during some driving condition

Aron Dalemo

Model



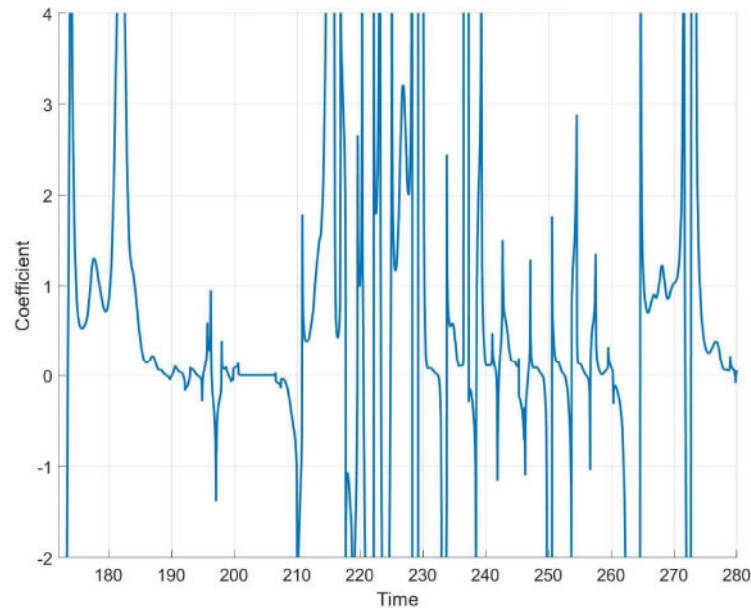
Reference model



Different scenarios

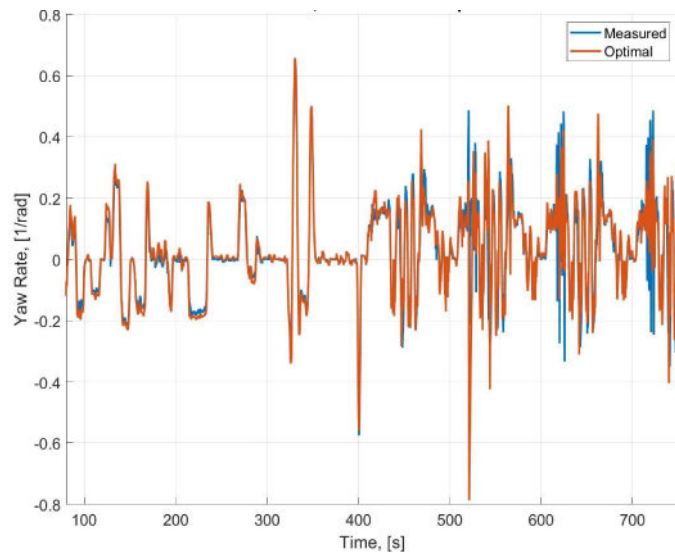
Low friction

Estimate current friction based on self-aligning torque. Only gives reasonable values when steady state. This could be due to longitudinal dynamics



Axle saturation

Adds torque to help the driver in scenarios with a saturated axle

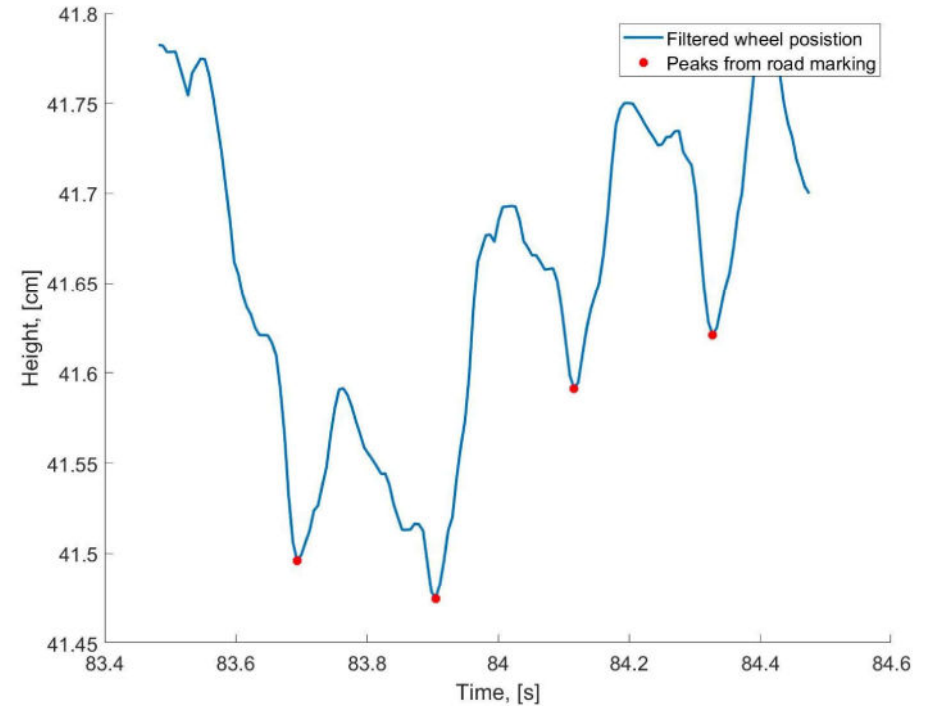


Dashed road markings

The general idea is to look at peaks and their placements.

The largest challenge is to not catch the same phenomena in other driving situations

Shows potential



Driving over crest while turning

Is incorporated in the reference model and main transfer function with height sensors

Rutted roads

The rutted part can be sensed in the tie rods and also in the height sensors.

Not possible to sense in time, more than one wheel has to pass and then it is too late

Poster 2:

***Using torque vectoring to improve steering
predictability while minimizing energy use in
Heavy electric vehicles***

Jonas Persson and Jonathan Åkesson, Volvo
Trucks & Chalmers

V O L V O

ON TORQUE VECTORING TO IMPROVE STEERING PREDICTABILITY WHILE MINIMISING POWER LOSS IN HEAVY ELECTRIC VEHICLES USING MODEL PREDICTIVE CONTROL

Volvo Trucks

Master's Thesis | Jonas Persson and Jonathan Åkesson | Chalmers University of Technology

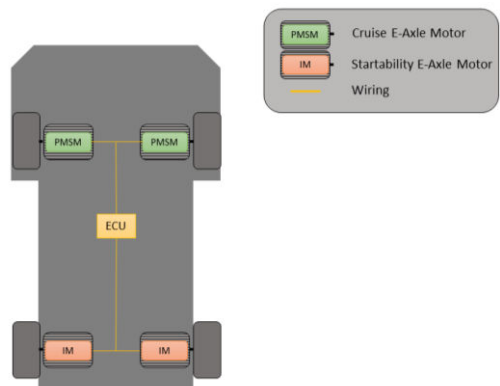
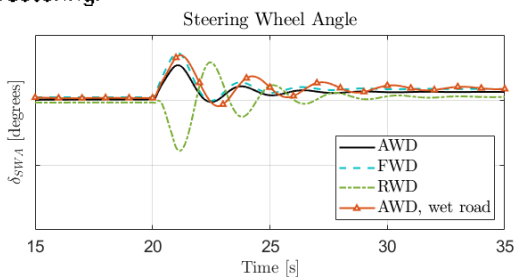
2023-05-22

1

V O L V O

Background

- Varying distribution of propulsion between e-axes will change the handling characteristics, which can make the vehicle unpredictable to steer.
- Separate motors on left and right side allows for micromanaging of lateral dynamics through torque vectoring.



Volvo Trucks

Master's Thesis | Jonas Persson and Jonathan Åkesson | Chalmers University of Technology

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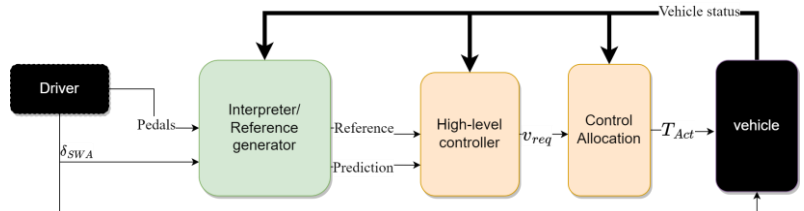
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1

V O L V O

Our Solution

- MPC based approach to generate a global force request to the control allocator
- Control allocator distributing global force to actuator level
- Interpretation of driver's input to generate references
- Rate of change for steering wheel angle and yaw rate
- Yaw rate controller based on bicycle model



Volvo Trucks
Department: ac no. Document name/ issue. Classification

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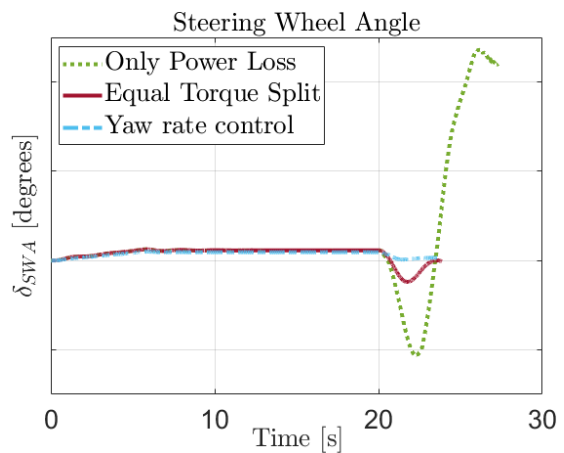
3

V O L V O

Predictable steering behaviour with Torque Vectoring

Steering wheel angle for emergency braking during cornering. Yaw rate controller aids in lateral stability, resulting in:

- less lateral sway,
- shorter braking distance
- and a more manageable manoeuvre for the driver.



Volvo Trucks
Department: ac no. Document name/ issue. Classification

2022-05-22 4

4

ON TORQUE VECTORING TO IMPROVE STEERING PREDICTABILITY WHILE MINIMISING POWER LOSS IN HEAVY ELECTRIC VEHICLES USING MODEL PREDICTIVE CONTROL



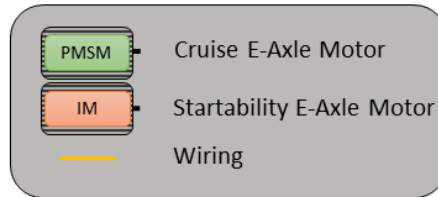
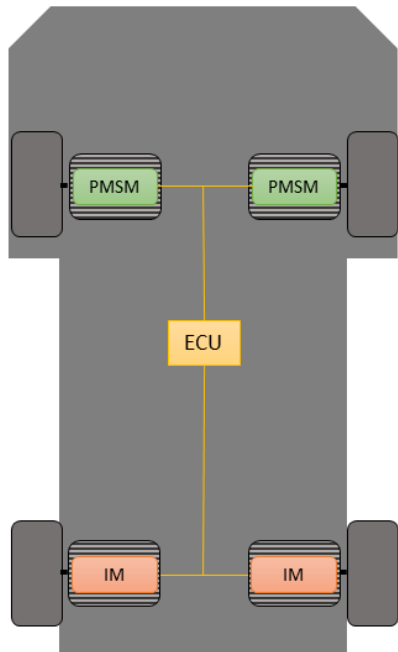
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UNIVERSITY OF TECHNOLOGY

Jonas Persson and Jonathan Åkesson

Department of Mechanics and Maritime Sciences
Chalmers University of Technology

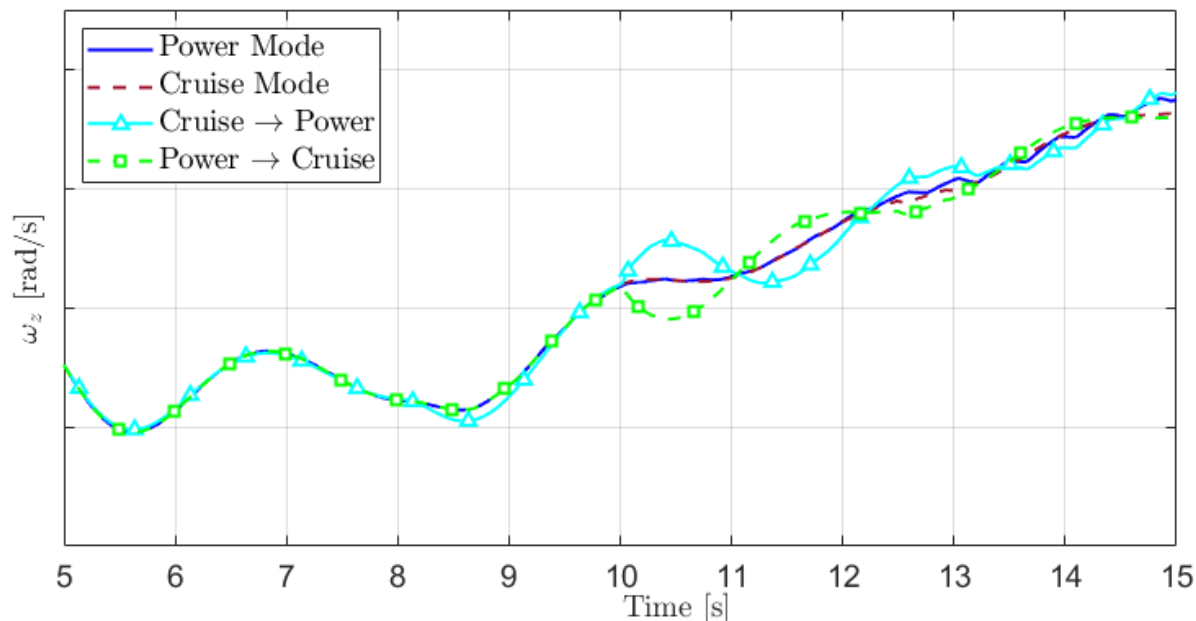
V O L V O

Background



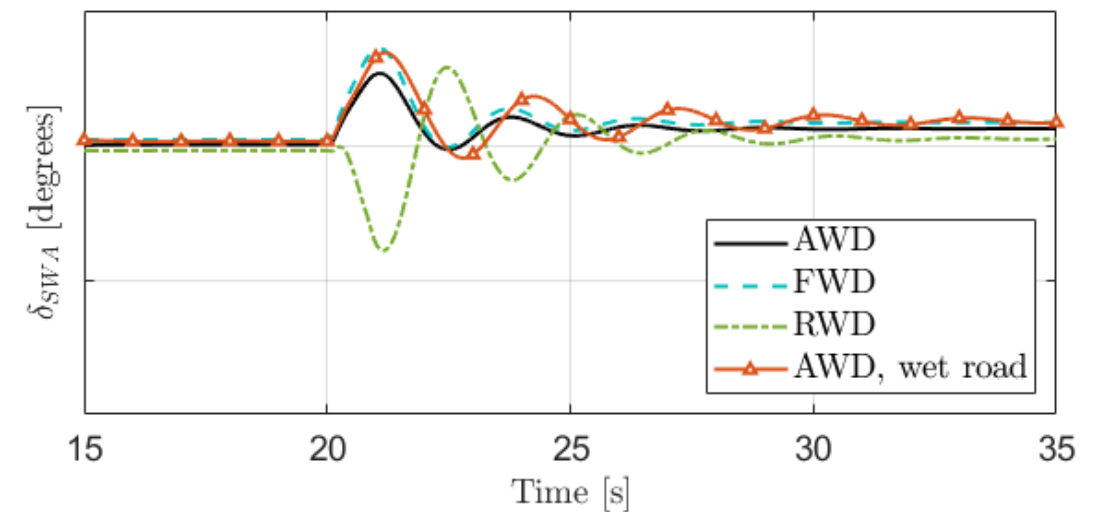
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- Separate motors on left and right side allows for micromanaging of lateral dynamics through torque vectoring.

Yaw Rate



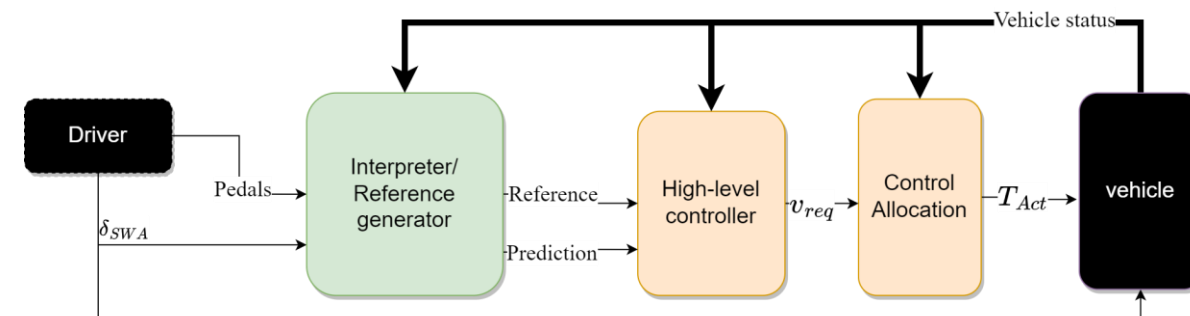
Yaw rate for acceleration during cornering. At 10s, switch in power distribution between e-axes introduce a yaw moment on the vehicle.

Steering Wheel Angle



Steering wheel angle while accelerating during cornering. At 20s, step increase in speed causing different distributions of power to behave differently.

Our Solution



- MPC based approach to generate v to the control allocator
- Control allocator distributing global force to actuator level
- Interpretation of driver's input to generate references
- Rate of change for steering wheel angle and yaw rate
- Yaw rate controller based on bicycle model

ON TORQUE VECTORING TO IMPROVE STEERING PREDICTABILITY WHILE MINIMISING POWER LOSS IN HEAVY ELECTRIC VEHICLES USING MODEL PREDICTIVE CONTROL



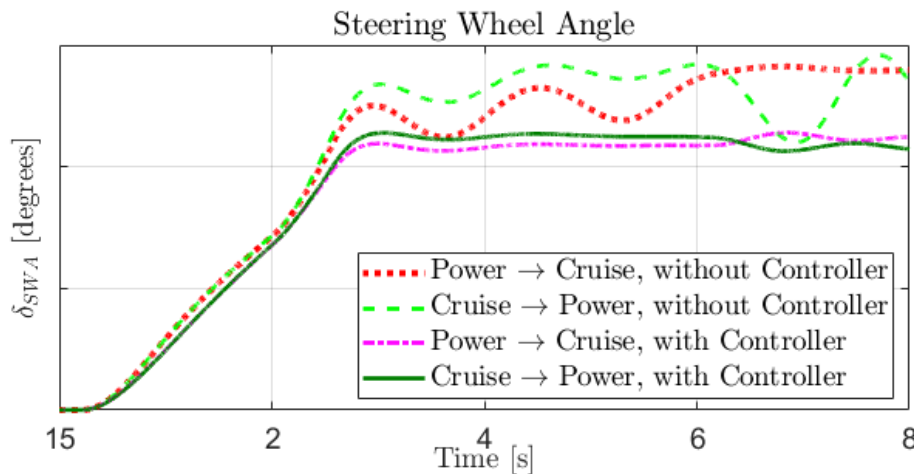
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V O L V O

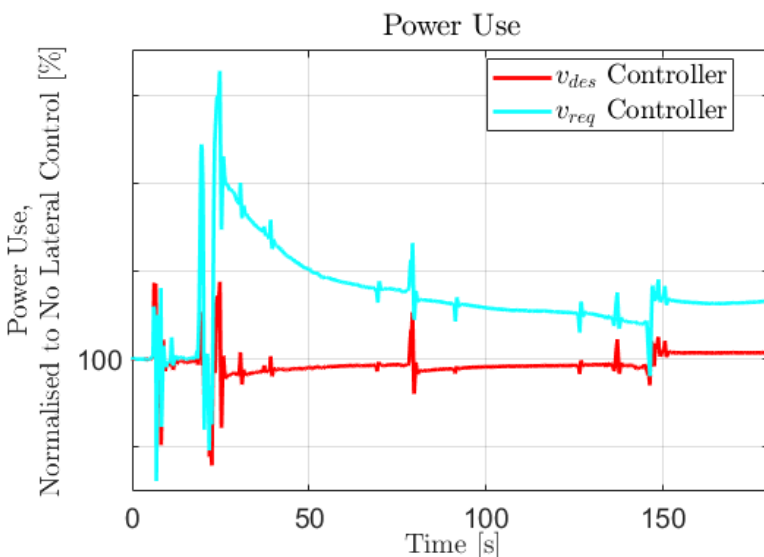
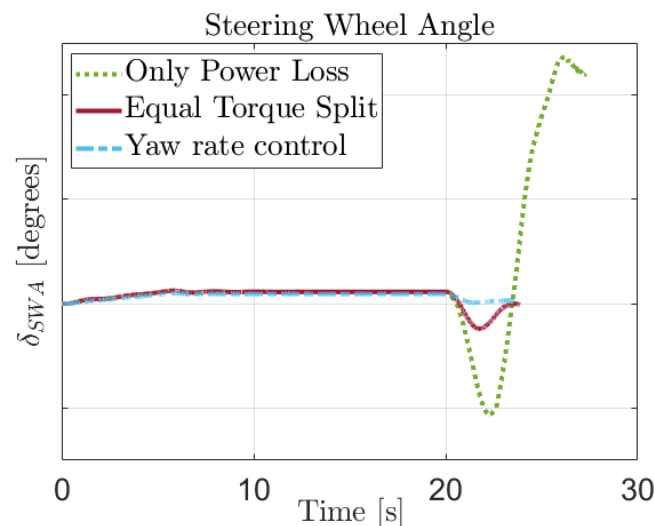
Predictable steering behaviour with Torque Vectoring



Steering wheel angle for emergency braking during cornering. Yaw rate controller aids in lateral stability, resulting in:

- less lateral sway,
- shorter braking distance
- and a more manageable manoeuvre for the driver.

Switch in propulsion mode during steady state cornering. Yaw rate controller aids the driver in lateral stability during mode switch.



- Short haul driving simulation, road from Hällered to Alingsås (approx. 2.8 km).
- Lateral control reduce degrees of freedom and restricts power loss optimisation.
- A second controller (v_{des}) constructed to only engage when necessary, resulting in lower power use compared to previously.

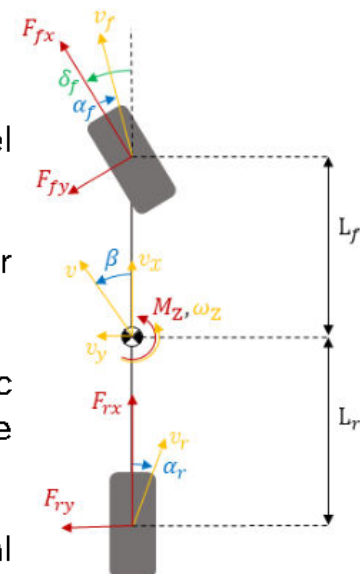
The Model

$$\dot{x} = Ax + Bu + C\delta_f + D \quad \min_z \quad \frac{1}{2}z^T Hz + g^T z$$

$$s.t. \quad A_{eq} \cdot z = b_{eq}$$

$$A_{in} \cdot z \leq b_{in}$$

$$x = \begin{bmatrix} \dot{v}_x \\ v_x \\ \omega_z \\ \beta \end{bmatrix} \quad u = \begin{bmatrix} T_{fl} \\ T_{fr} \\ T_{rl} \\ T_{rr} \end{bmatrix} \quad z = \begin{bmatrix} x \\ u \end{bmatrix}$$



- MPC evolves the linear model over a time horizon.
- Single track model with linear tyre dynamics for yaw control.
- MPC solves quadratic optimisation to find the optimal control sequence u^* .
- Steering angle and external forces are treated as disturbances.

Conclusion

Lateral control using torque vectoring on heavy vehicles allows for:

- reduced braking distance during cornering;
- increased stability on low friction surfaces;
- reduced steering compensation from driver during emergency manoeuvres;
- and minimised change in vehicle behaviour, originating from power loss optimisation.

All this, with minimal increase in power use.

Poster 3:

***Continuously controlled damping tuning on
four poster rig***

Jesper Ramsberg, VCC & Chalmers



Development of method for objective tuning of semi active dampers on a four poster rig

Jesper Ramsberg

Supervisor: Ajay Daniel, Volvo Cars, Examiner: Fredrik Bruzelius, Chalmers

Chalmers University of Technology & Volvo Cars, Göteborg

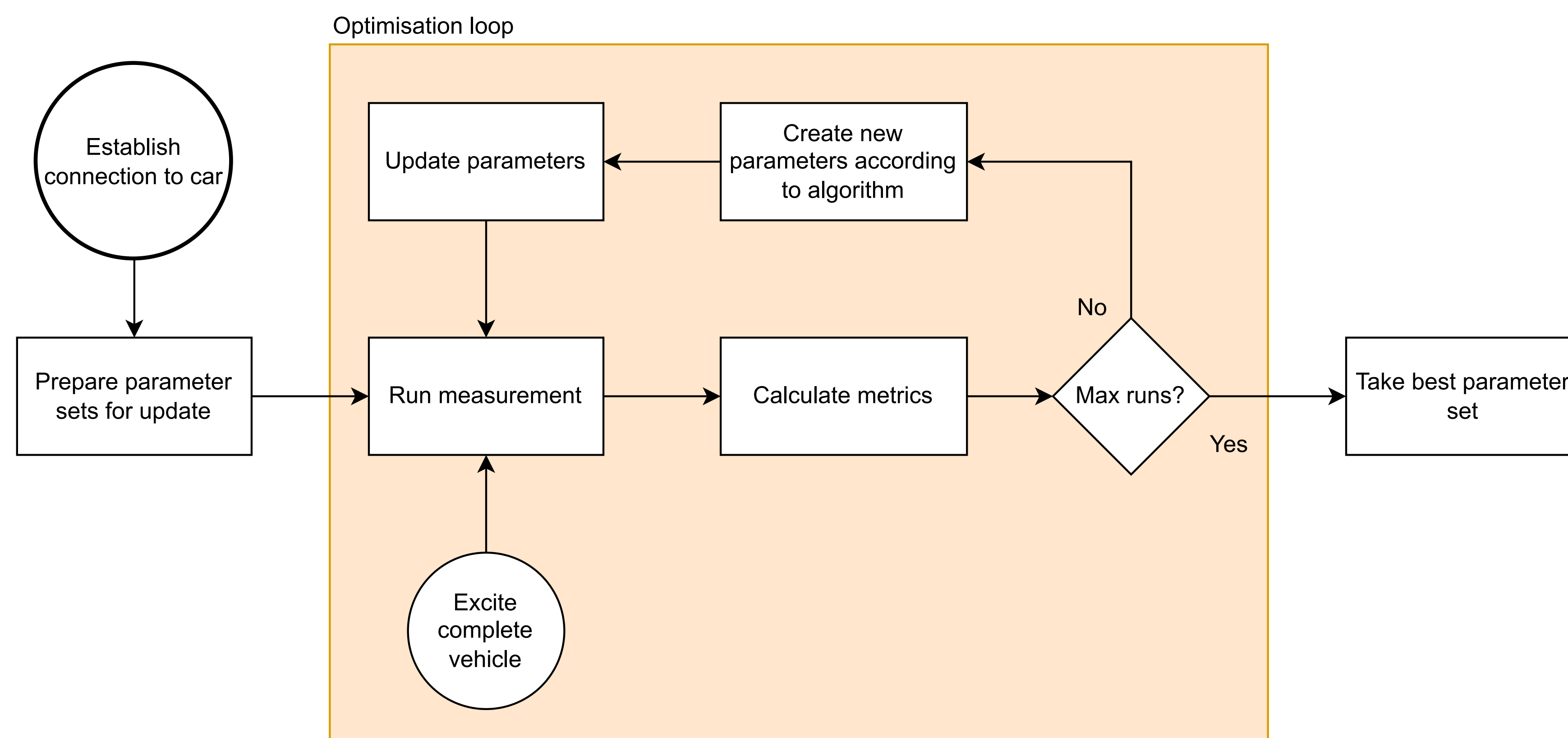


Figure 1: On rig optimisation loop

Introduction

- Active systems in passenger vehicles can improve comfort without comprising as much in handling as could have been traditionally required.
- Semi active dampers, sometimes called CCD, can improve ride quality and comfort while maintaining good handling characteristics
- CCD is often tuned by experienced vehicle dynamicists that can subjectively interpret the vehicle behavior and understand the measured data.
- An objective method for CCD tuning could complement the subjective tuning to achieve an overall better result.
- A four poster rig is useful when repeatedly exciting a complete vehicle.
- Combining subjective judgement with objective measurement on the rig can be a useful tool for creating damper settings

- An optimisation was setup with the new metric in combination with and abruptness metric
- Genetic algorithm was used in CAE
- Patternsearch was used on the rig
- A complete vehicle with CCD was setup in the optimisation loop



Figure 3: Vehicle setup on rig for optimisation

What has been done

- Initially a primary ride metric suitable for CCD was found
- Metric was validated on four poster rig in a blind study.
- Experienced vehicle dynamicists took part in the study

- The vehicle is excited continuously with a realistic recorded road
- A computer was connected to the ECU controlling the CCD and updating the controller according to the algorithm.

Results and further work

- A good metric for primary ride control was found in
$$\text{Primary ride control} = \frac{\text{RMS}(V_{\text{body}})}{\text{RMS}(V_{\text{Road}})}$$
- Metric has clear trend between control and the amount of damping
- A solid optimisation method on the rig updated the damper parameters in an effective way.
- A blind test done on track proved that the optimisation had effect on the damper settings
- The cost function must be tuned well to achieve desirable results from the optimisation, a good balance between primary ride control and abruptness. Or extended with more ride properties to cover the broader spectrum of ride comfort

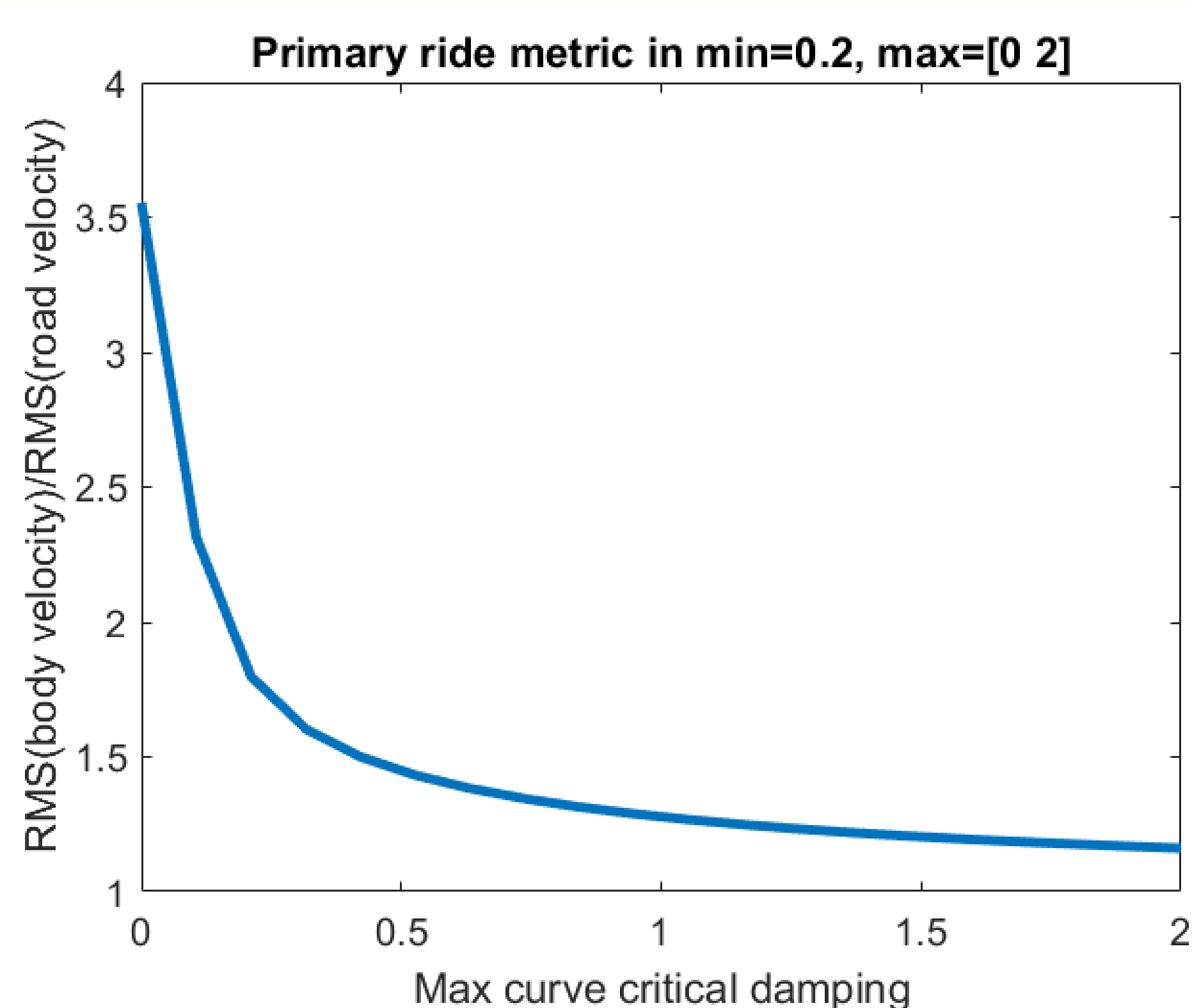


Figure 2: Relation between critical damping and primary ride

Poster 4:

***Optimised force distribution algorithm and
model***

Guglielmo Nappi and Sanjay Banerjee, Scania &
KTH



Sanjay & Guglielmo

Optimised force distribution algorithm and model

Thesis topic and model overview



Aim:

Deliver a proven auto-generated vehicle model, limited to longitudinal and lateral forces inputs to solve the optimal force distribution between available force actuators and predict body dynamics.

Model characteristics:

Reconfigurable: The model is auto-generated from the available variant codes for the vehicles.

Prediction model: The model is valid and estimates accurately the body dynamics in longitudinal and lateral motion.

Dynamic model: Not limited to kinematic approximations as it includes forces in input.

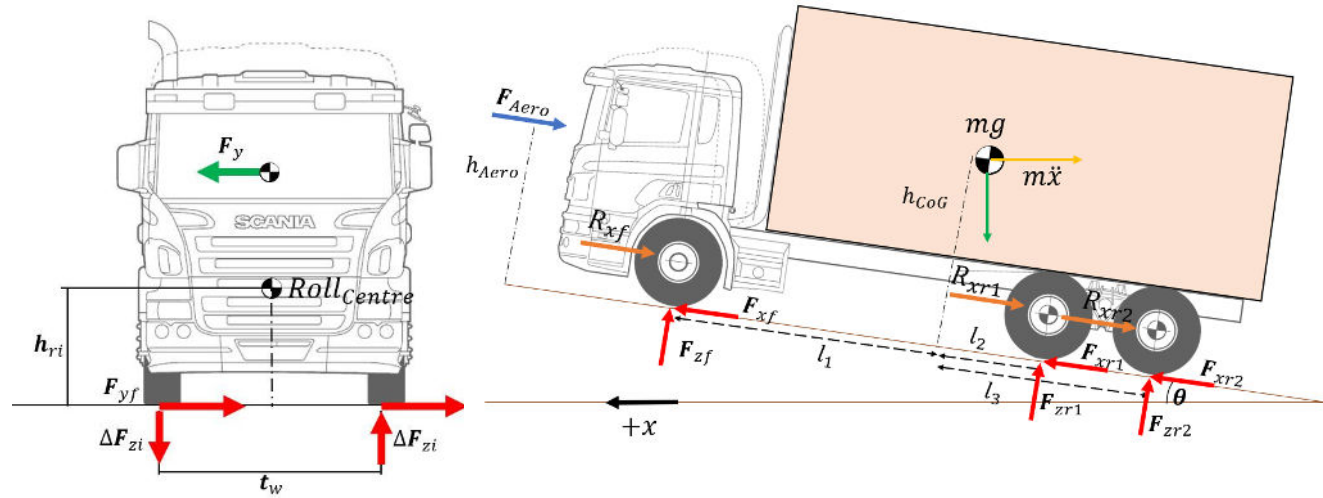
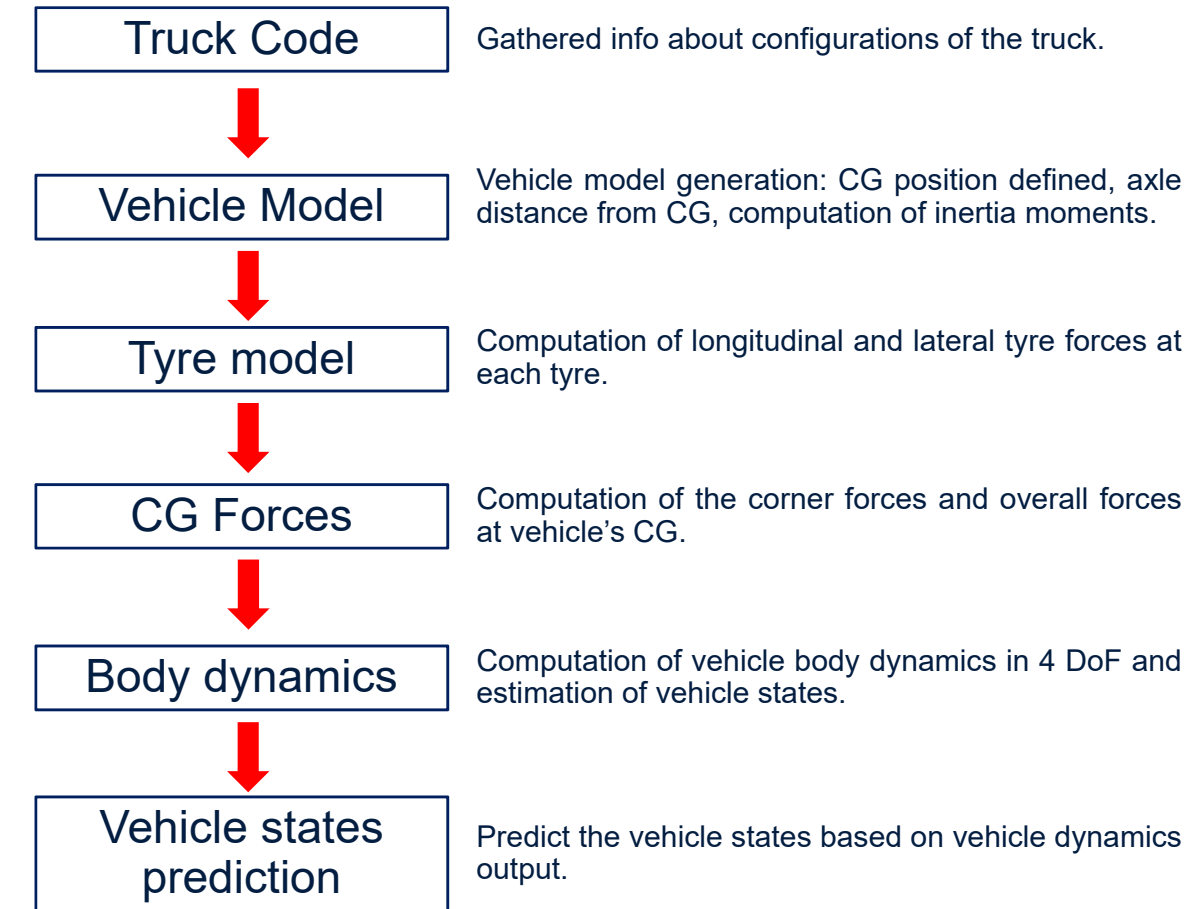
Controllable: Includes requested force from the driver.

Test Procedure:

- Isolated **longitudinal** dynamics manoeuvre
- Isolated **lateral** dynamics manoeuvres
- **Combined** longitudinal and lateral dynamics
- Hill climbs

Software used:

Vehicle modelling based on Simulink with MATLAB 2020b scripts.

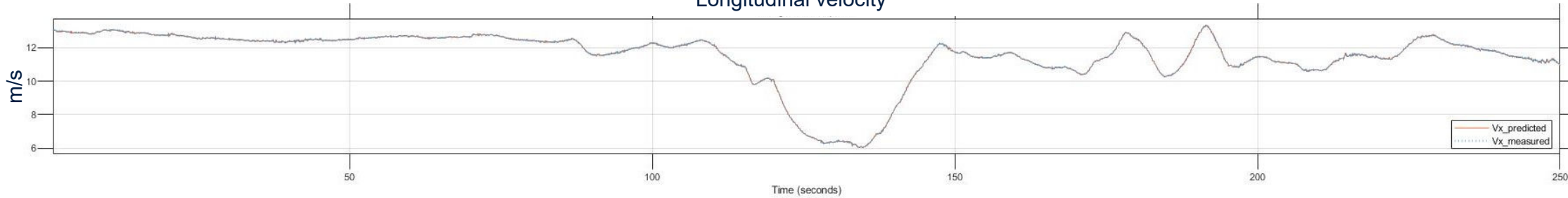


Test procedure and results

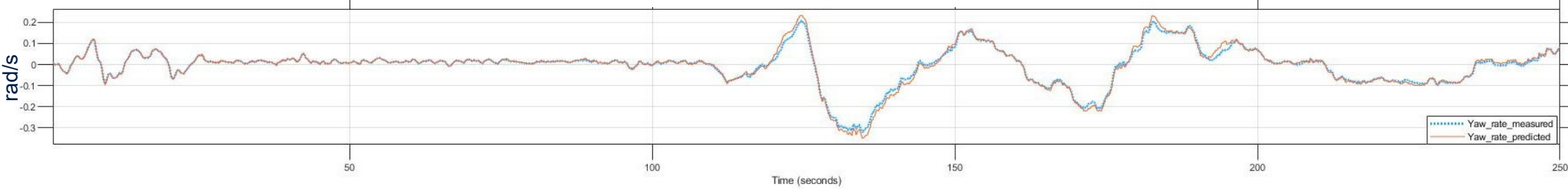


- Measured parameter
- Estimated parameter

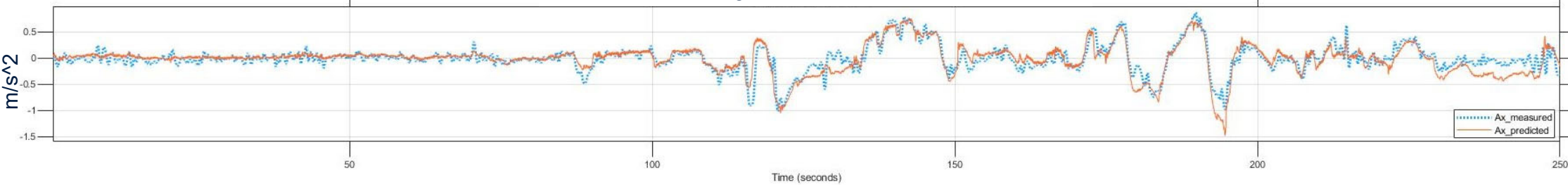
Longitudinal velocity



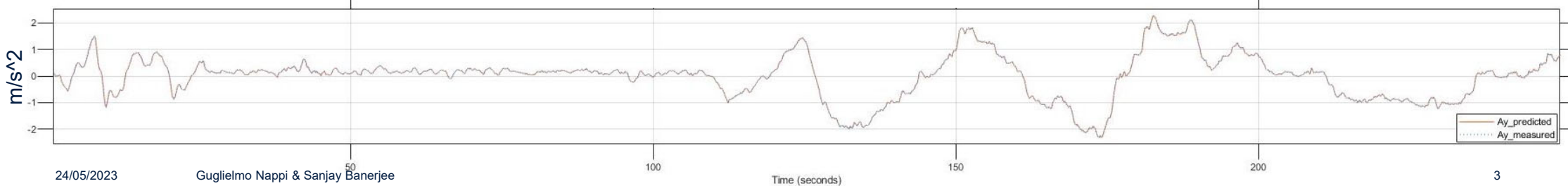
Yaw rate



Longitudinal acceleration



Lateral acceleration



Poster 5:

***Modelling and measurements of singularity-
induced vehicle motion during low-speed
driving***

Luca Mereu, Politecnico di Torino & Chalmers



Modelling and measurements of singularity-induced vehicle motion during low-speed driving

LUCA MEREU

CHALMERS UNIVERSITY OF TECHNOLOGY

Supervisor: Mats Jonasson, VEAS, M2

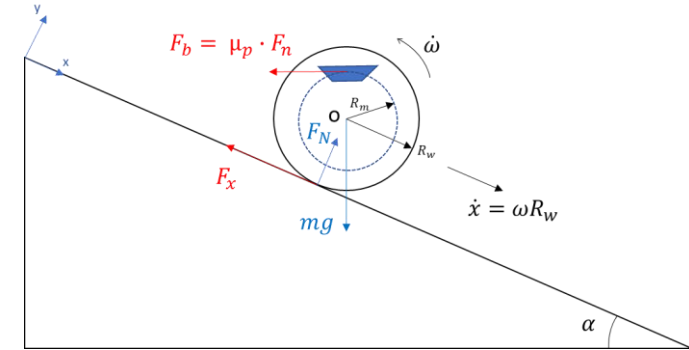
Examiner: Petri Piiroinen, Division of Dynamics, M2

Background and problems

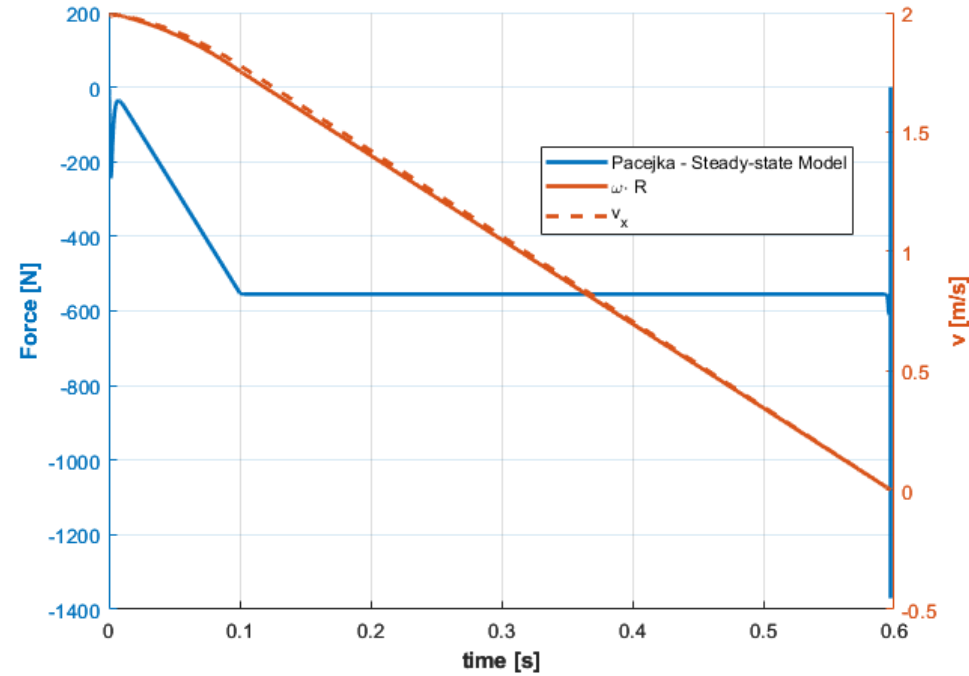
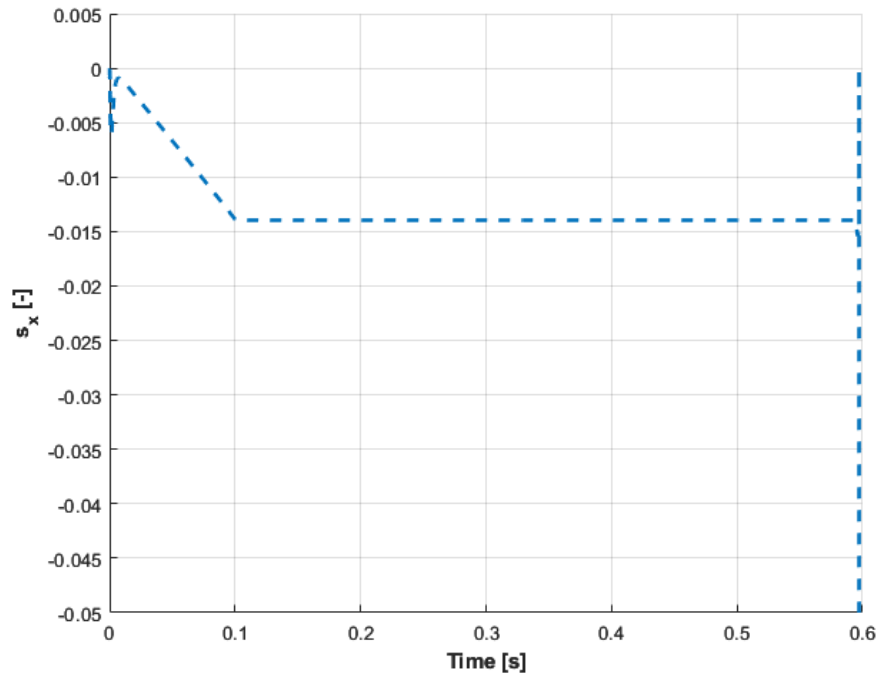
slip variable

$$s_x = \frac{\omega \cdot R - v_x}{|\omega \cdot R|} \longrightarrow F_x = D \cdot \sin(C \cdot \tan^{-1}(B \cdot (1 - E)) \cdot s_x + E \cdot \tan^{-1}(B \cdot s_x))$$

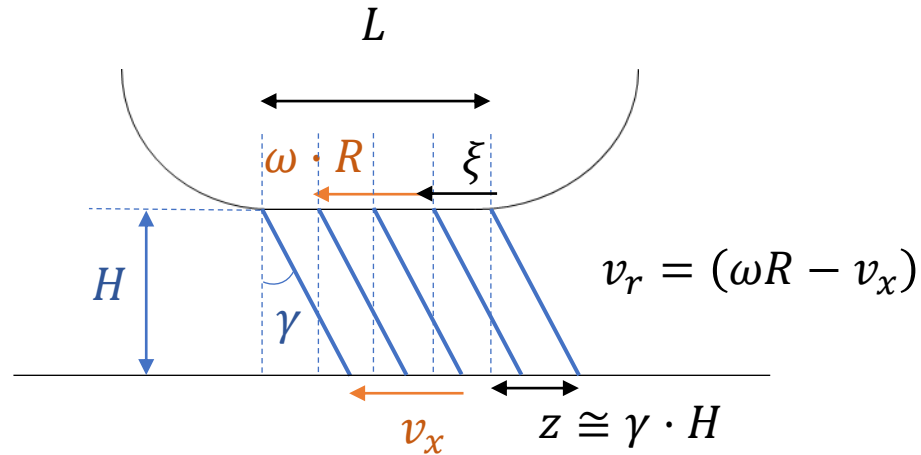
Classic (Pacejka) force models



What happens when $\omega \cdot R$ is close to 0?



LuGre Distributed Tyre Model

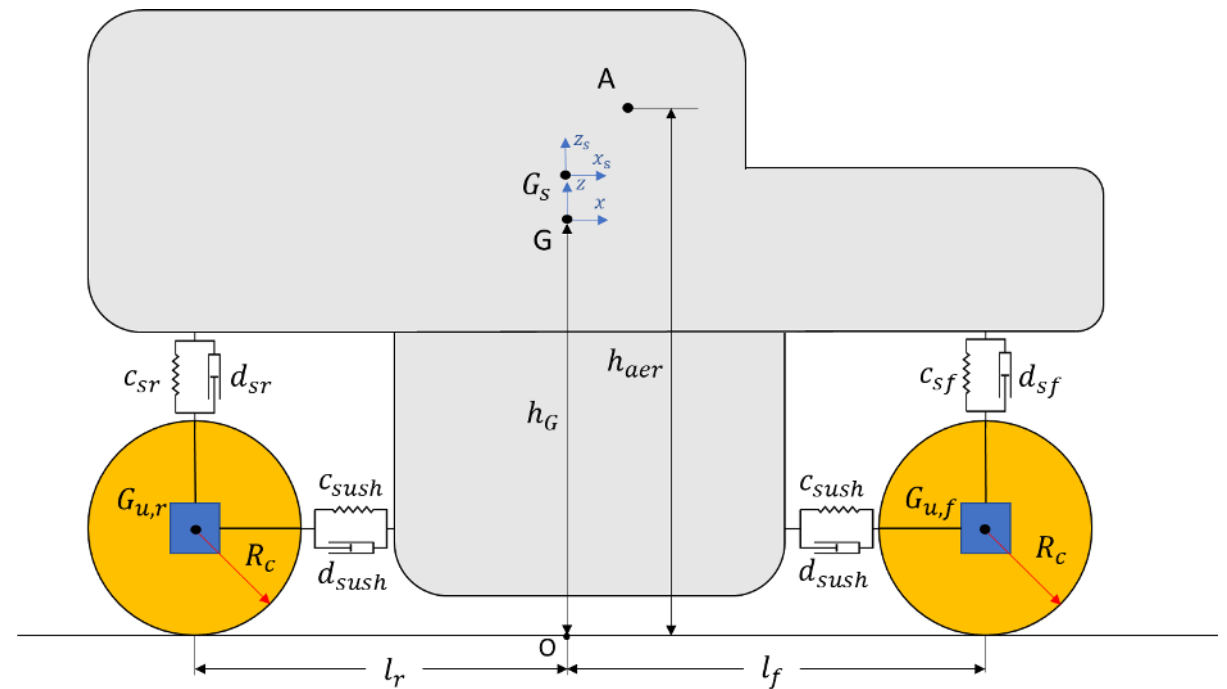


$$F_x = \sum_{i=1}^N \mu(v_r(t), N) \cdot p(N) \cdot \Delta \xi$$

With $p(\xi)$ being the load distribution within the contact patch.

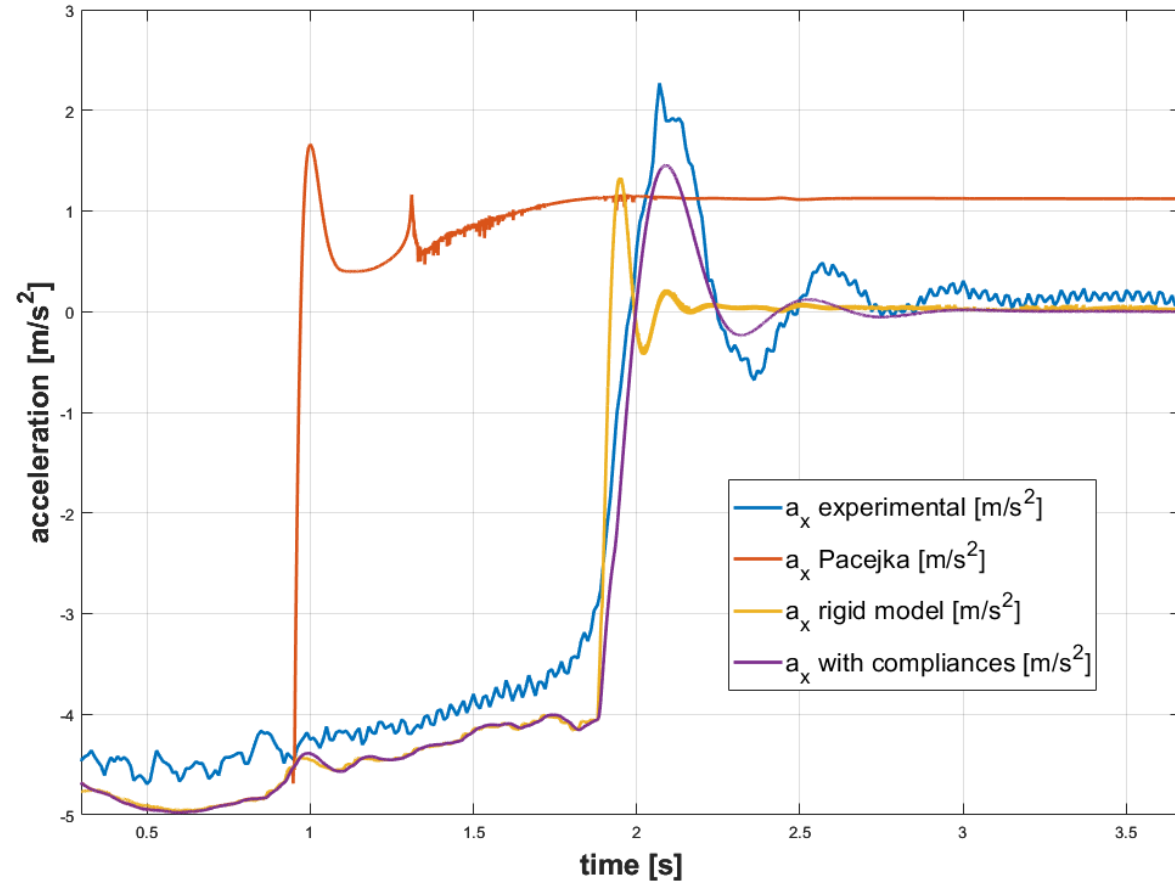
The friction term $\mu(v_r(t), \xi)$ takes into account the bristles deflection behaviour.

The LuGre friction model is implemented in a complete longitudinal vehicle model to capture and compare the acceleration behaviour of a real car braking manoeuvre.

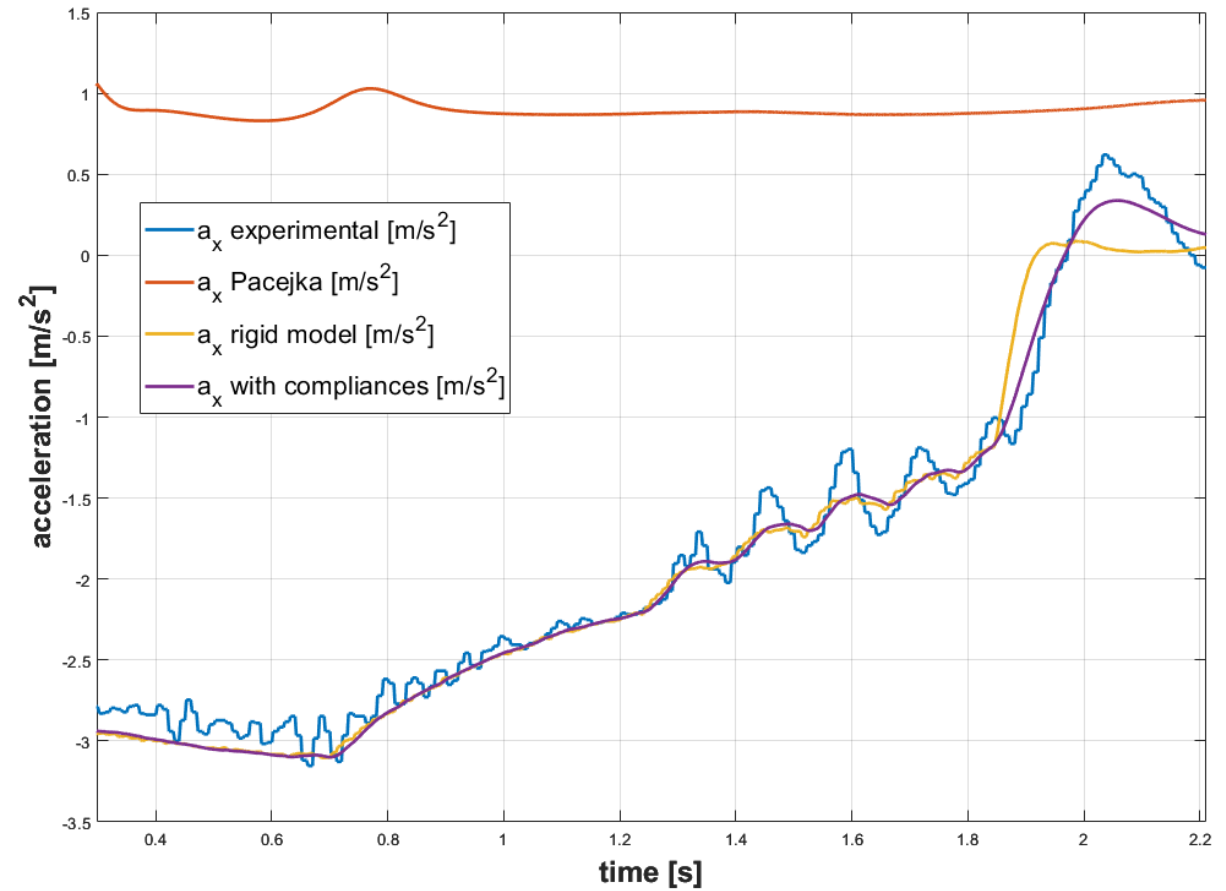


Vehicle model results

Braking on asphalt



Braking on ice



For the classic model, the slip has been modified to run at zero speed.

$$s_x = \frac{\omega \cdot R - v_x}{\max(|\omega \cdot R|, 0.1)}$$



Thanks for your attention

LUCA MEREU

CHALMERS UNIVERSITY OF TECHNOLOGY

Supervisor: Mats Jonasson, VEAS, M2

Examiner: Petri Piiroinen, Division of Dynamics, M2



Modelling and measurements of singularity-induced vehicle motion during low-speed driving

LUCA MEREU

CHALMERS UNIVERSITY OF TECHNOLOGY

Supervisor: Mats Jonasson, VEAS, M2

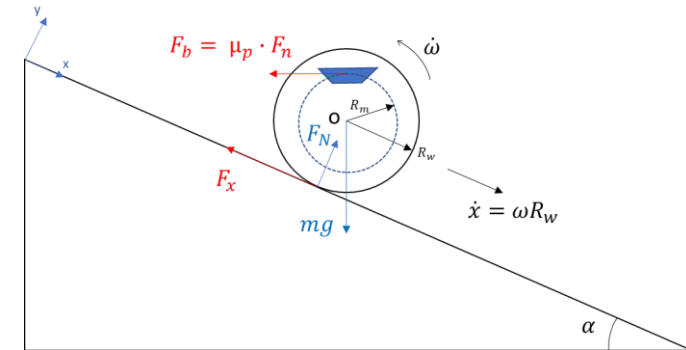
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Background and problems

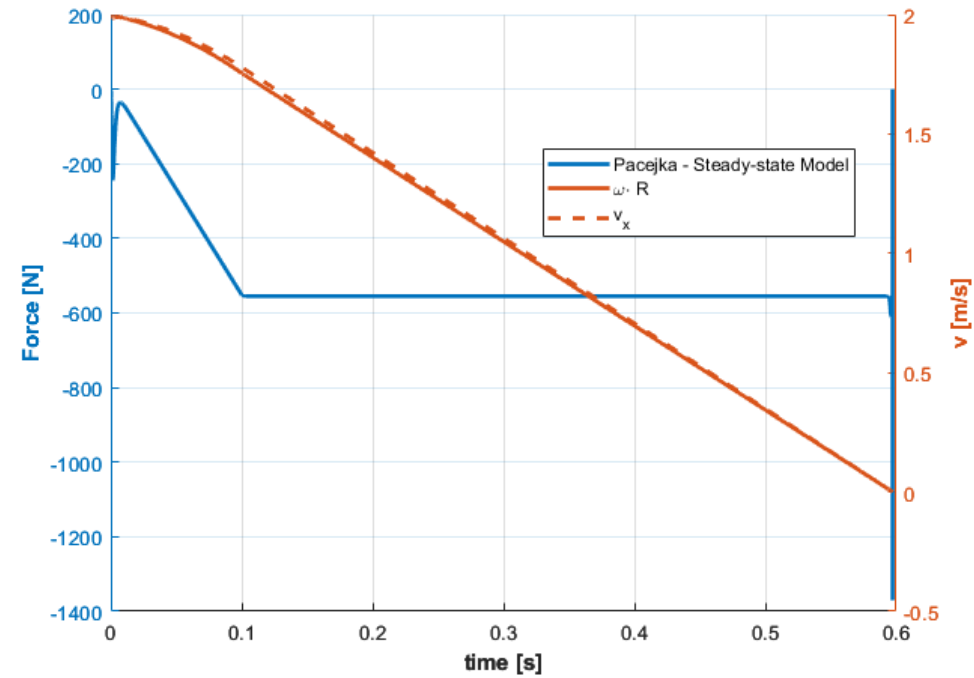
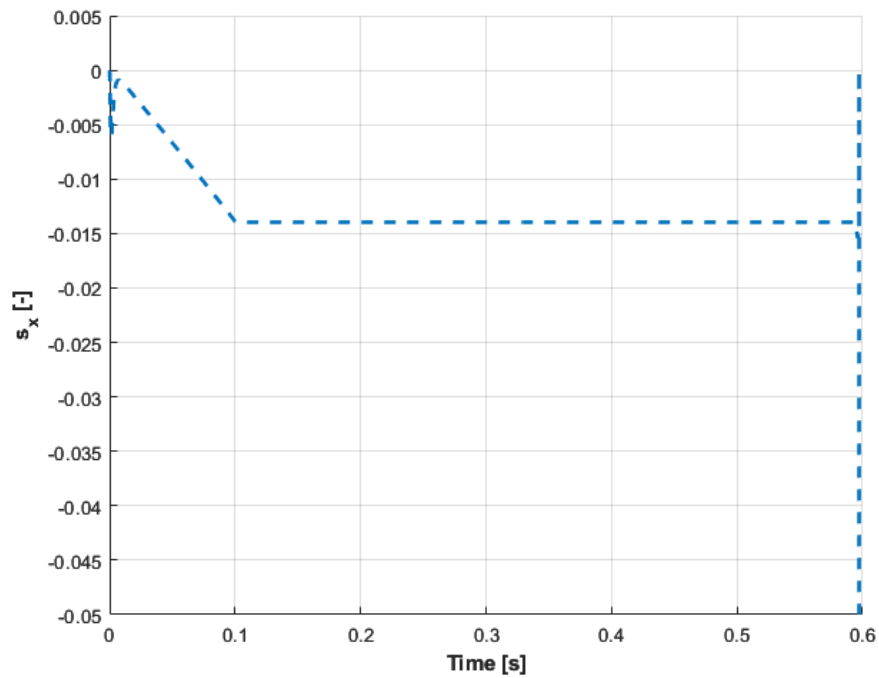
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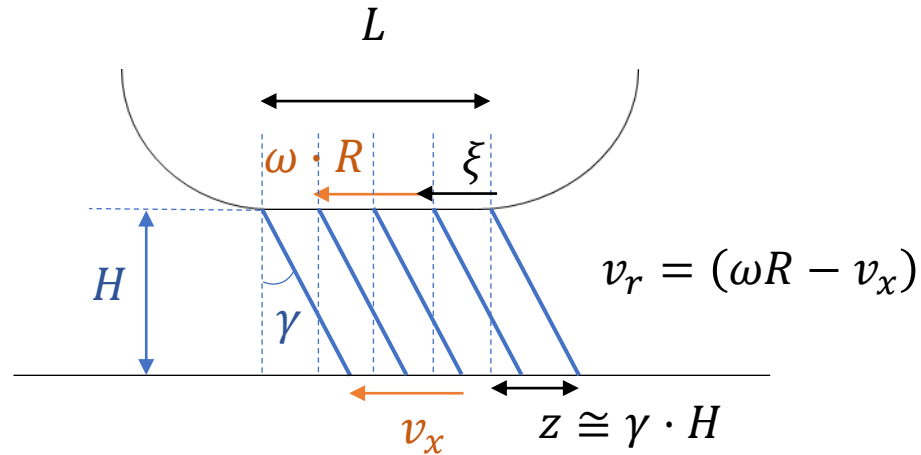
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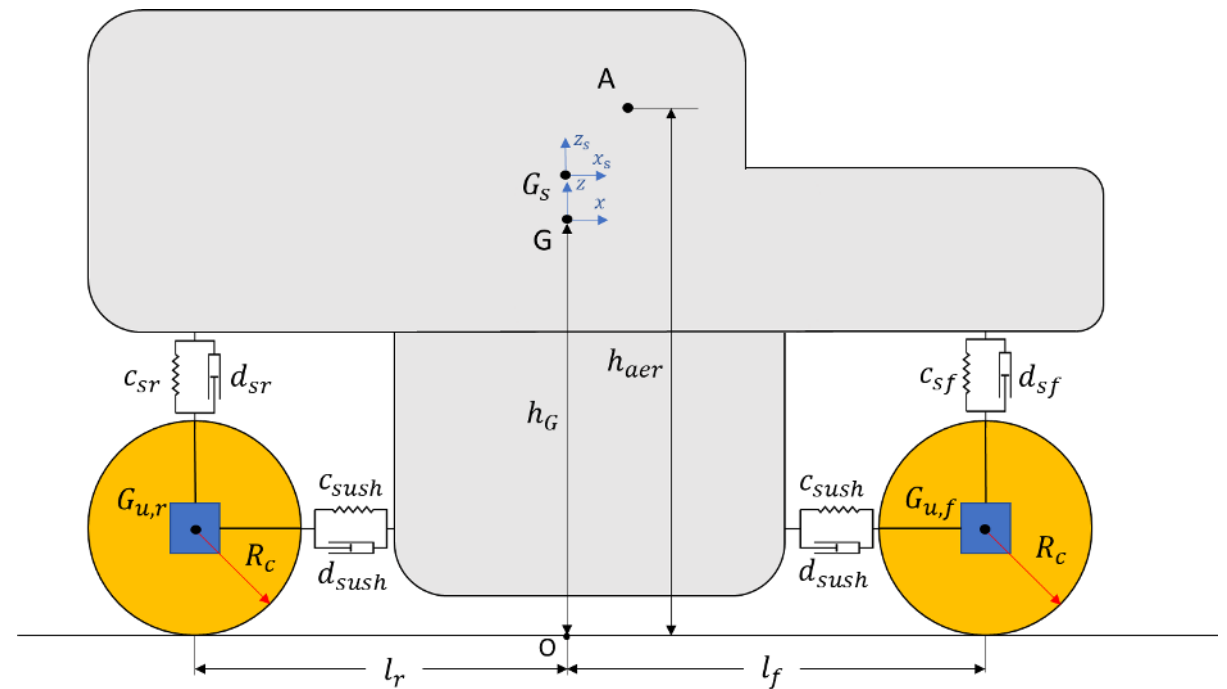


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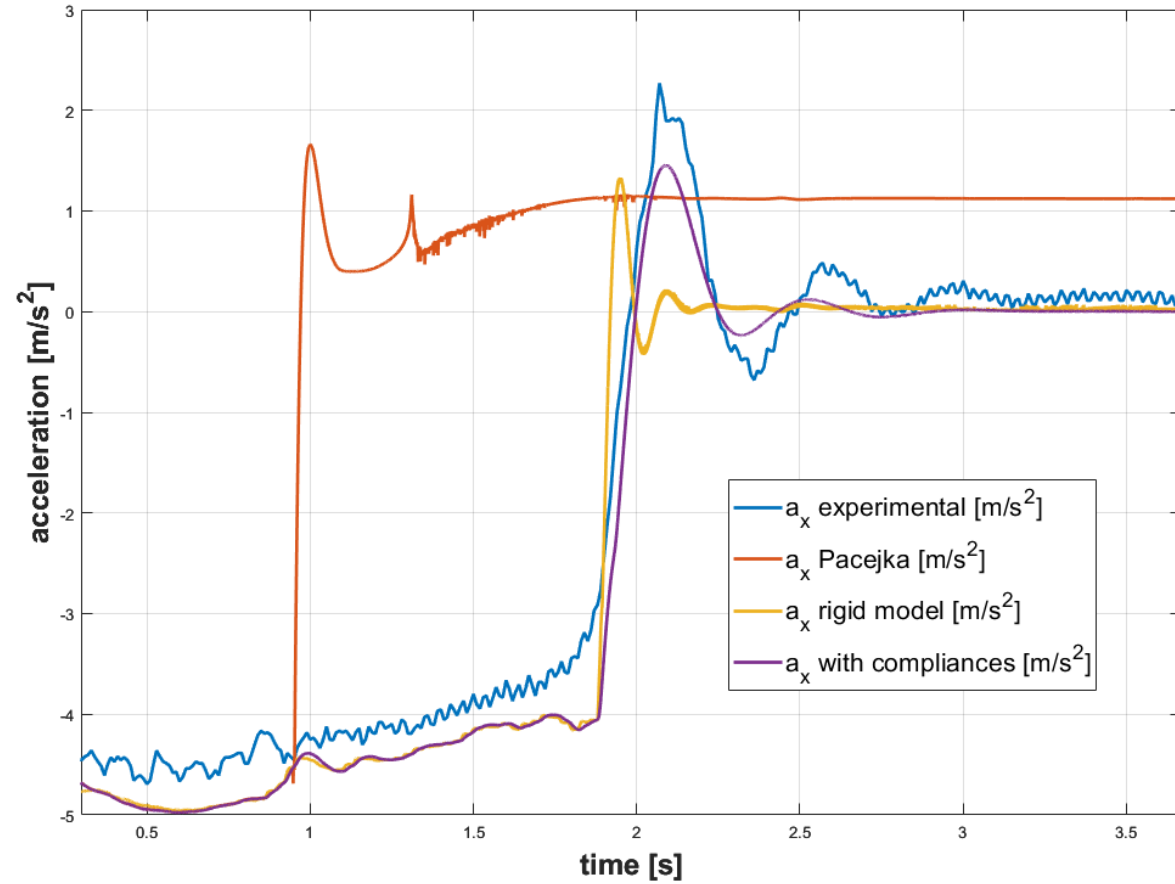
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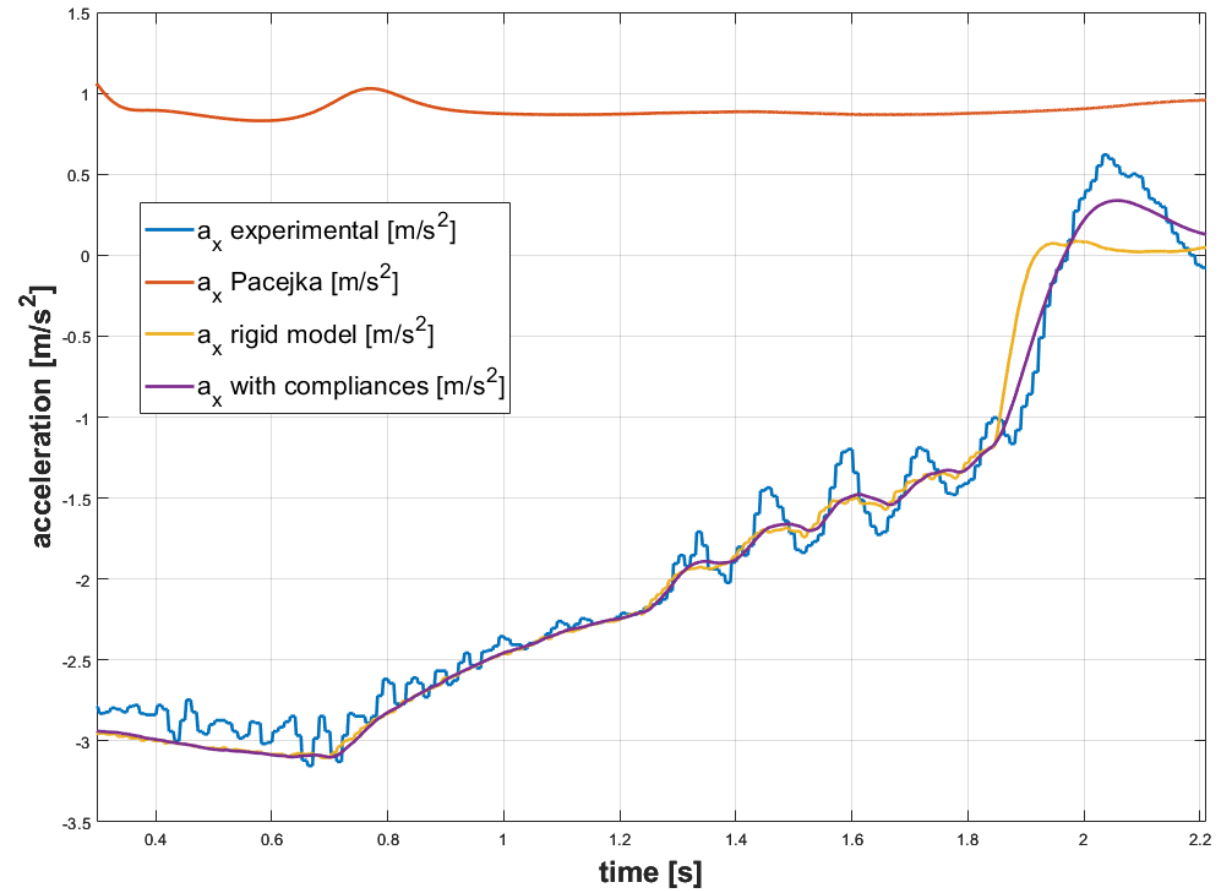


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Thanks for your attention

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