JONAS GRÖTZINGER / EDAG

FROM EMOTION TO INNOVATION:
CRAFTING NEXT LEVEL VEHICLE MOTION CONTROL WITH EDAG ZERO PROTOTYPE LAB

YOUR GLOBAL MOBILITY AND
INDUSTRY ENGINEERING EXPERTS

EDAG

EMOTION
DRIVER IMPRESSION

Lap Performance

Driving Comfort

VEHICLE MOTION CONTROL
STATUS QUO – EFFECT CHAIN

Vehicle Motion

Driver Input	Vehicle Actuation
Driver decision	steer
	accelerate
	brake

VEHICLE MOTION CONTROL
WHY VMC – VEHICLE CONFIGURATION

Central Computing Architecture

X-By Wire Drive System

AD and Remote Control

VEHICLE MOTION CONTROL
VMC WITH DRIVER IN THE LOOP

Vehicle Motion

Driver Input	Processing	Vehicle Actuation

VMC decision

3D Motion Control

Control Allocation

VMC

- steer
- accelerate
- brake
- body control

VEHICLE MOTION CONTROL
DEVELOPMENT PROCESS

Function Req.

Function Modelling

Virtual Function Test

Software Code Generation

Virtual Application

Physical Vehicle Integration

Final Application (physical vehicle)

Function Confirm (physical vehicle)

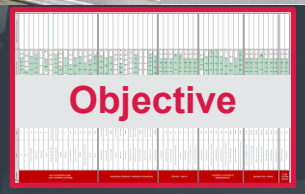
Subjective evaluation (driver centric development)

VEHICLE MODEL
GOING VIRTUAL

Subjective

Ride & Handling accuracy update for VMC use case

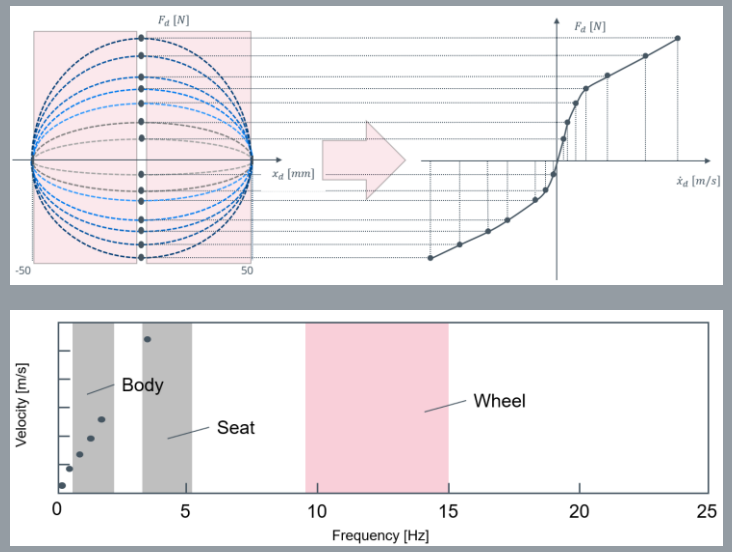
Suspension System update



Objective

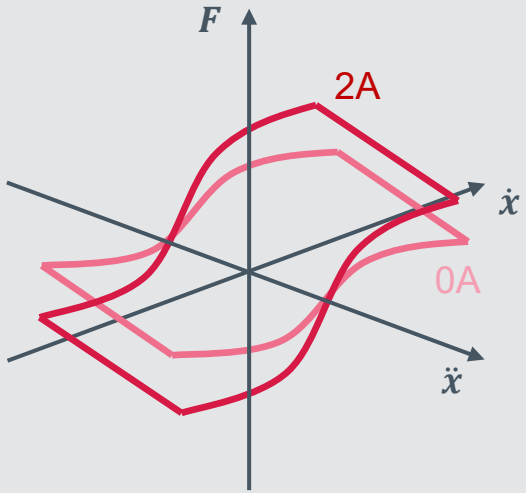
VEHICLE MOTION CONTROL
GOING VIRTUAL - DAMPER MODEL

Industrie Standard: Force-velocity curve



Missing Frequency / acceleration dependency
Inaccurate overall frequency bandwidth

High-fidelity, AI-driven damper model

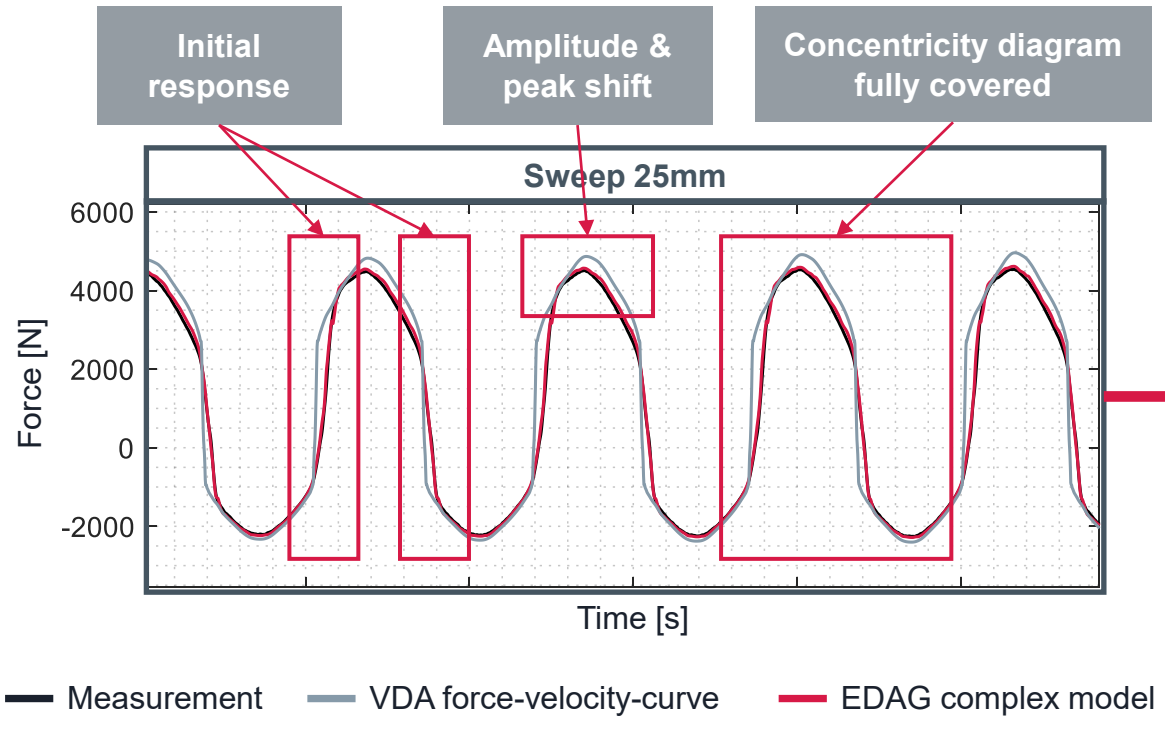


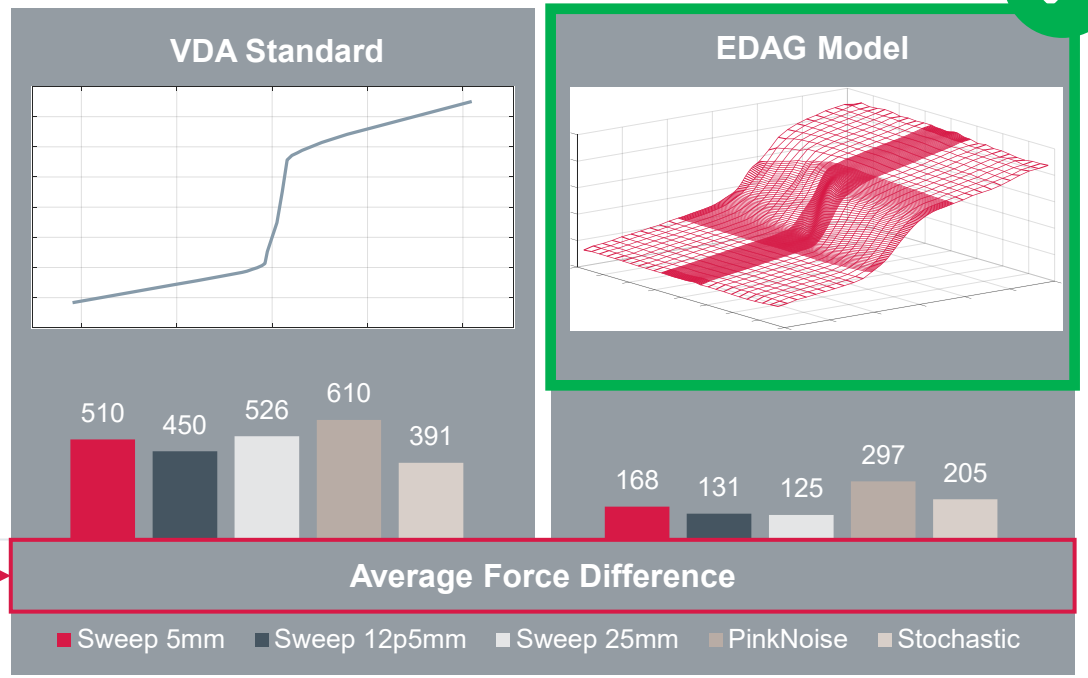
- Gas-Pressure-Force
- Friction-Force
- Continuous frequency bandwidth
- Low-Level-Control

Enhances vertical dynamic use cases

GOING VIRTUAL - DAMPER MODEL

Damper Model Correlation



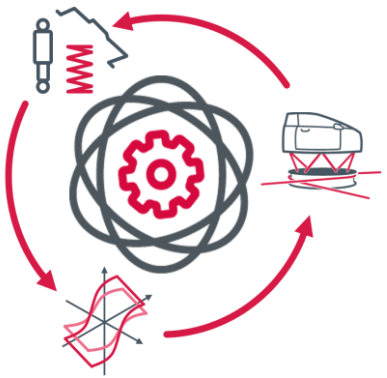


Significantly increased model accuracy
63 % Improvement of average force difference

VEHICLE MODEL
GOING VIRTUAL - ACTUATOR INTEGRATION

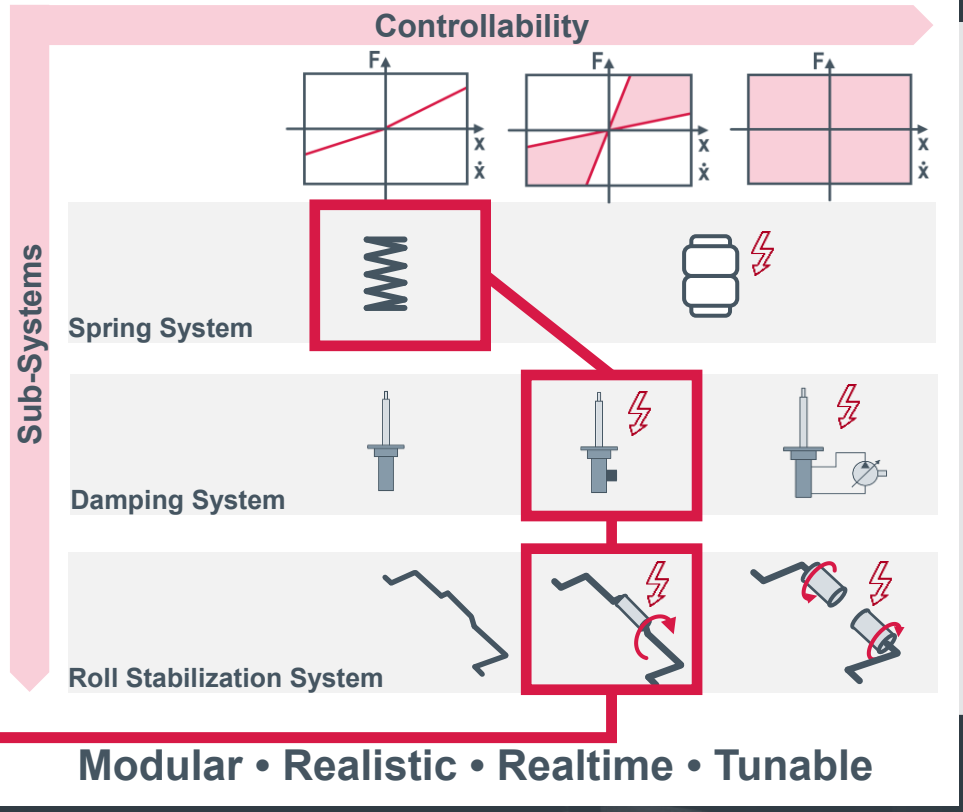
Aktuators

LL Controls

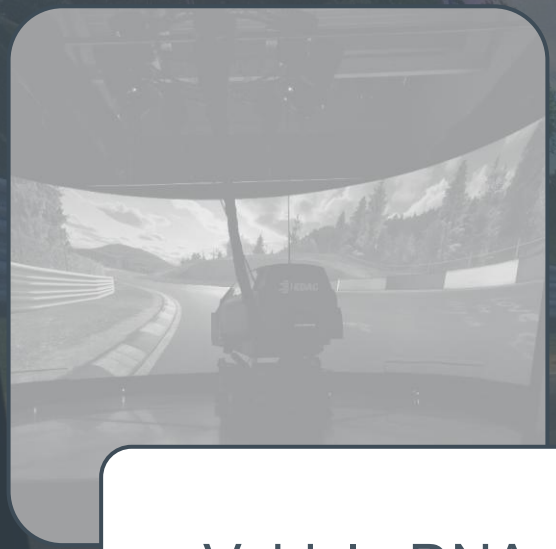


EDAG SuSy
RealDynamics

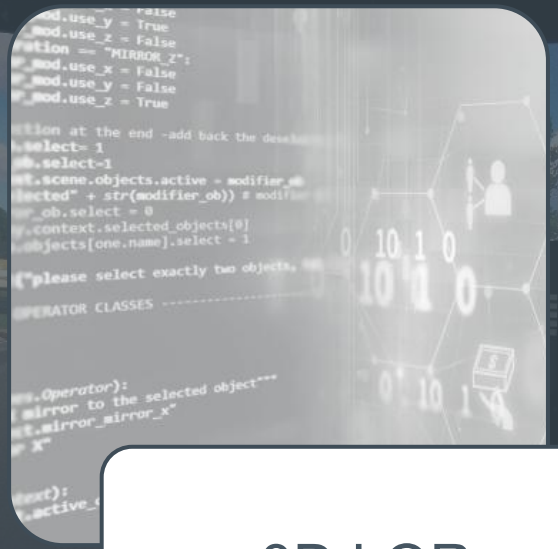
Suspension System Cosimulation Framework



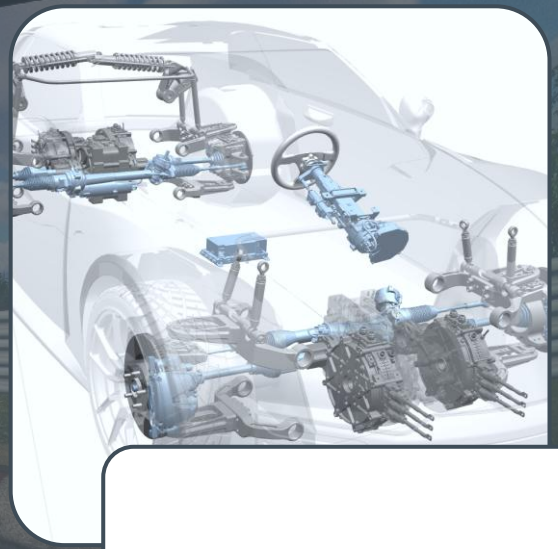
VEHICLE MOTION CONTROL
CONTROL STRATEGY



Vehicle DNA Generator

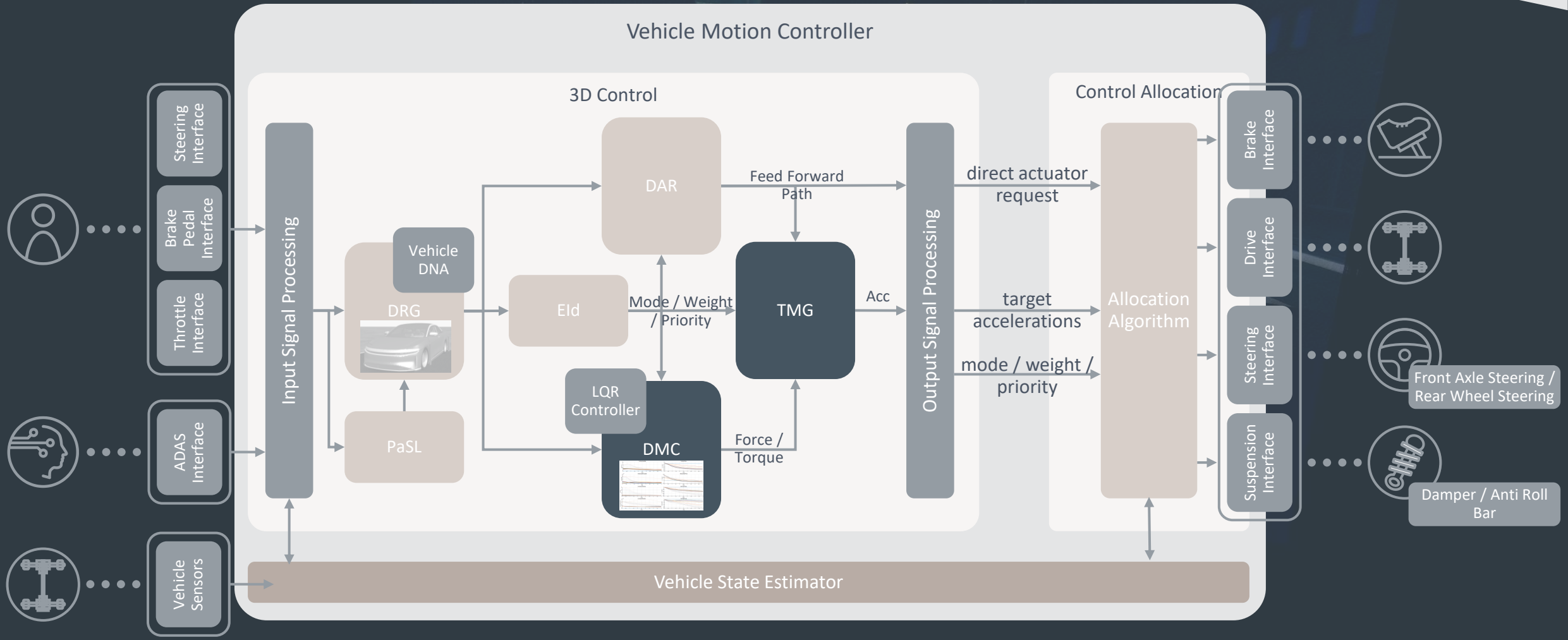


3D LQR Controller



Control Allocation

VEHICLE MOTION CONTROL
ARCHITECTURE

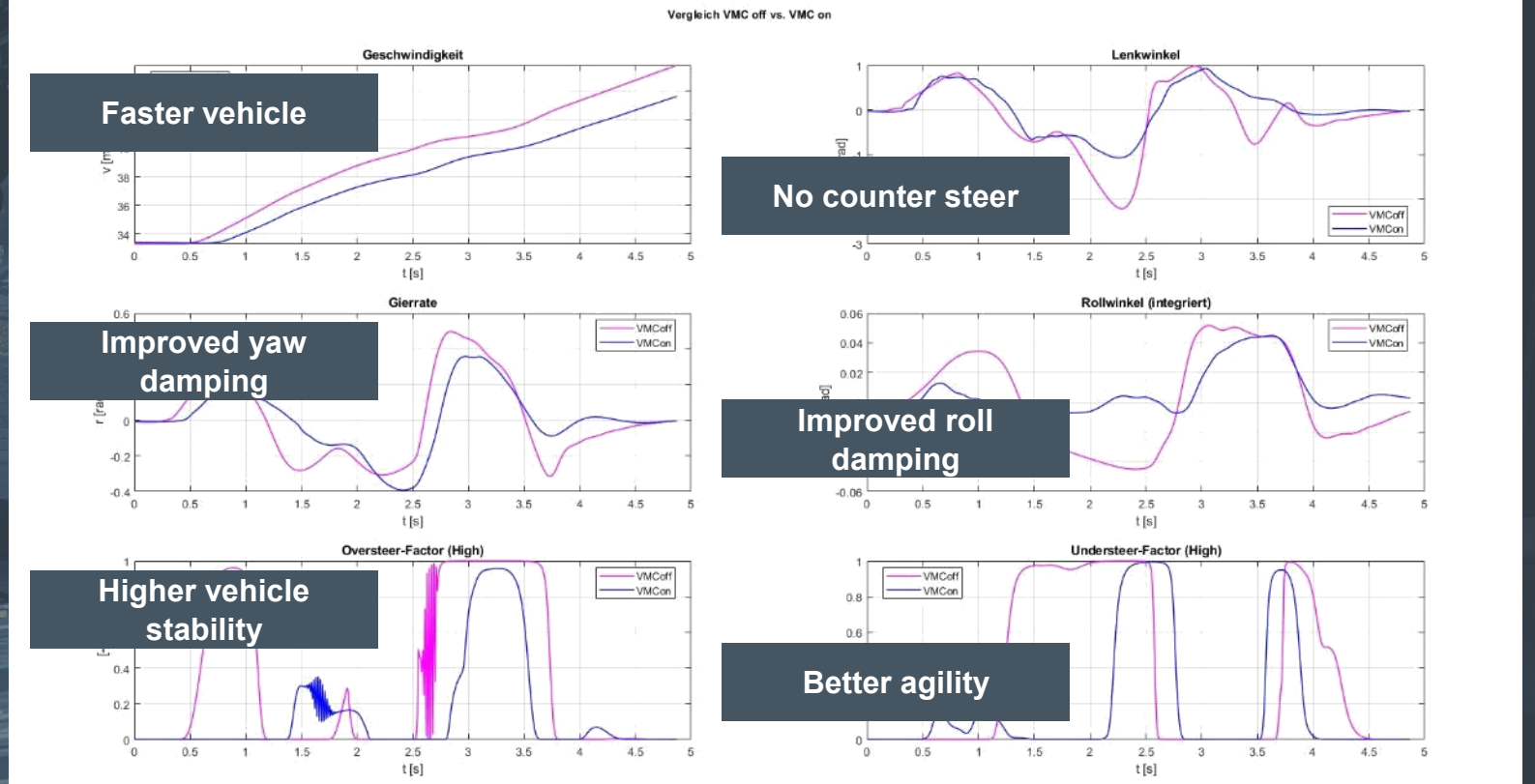


VEHICLE MOTION CONTROL
PERFORMANCE SIMULATION RESULTS

VEHICLE PERFORMANCE SIMULATION

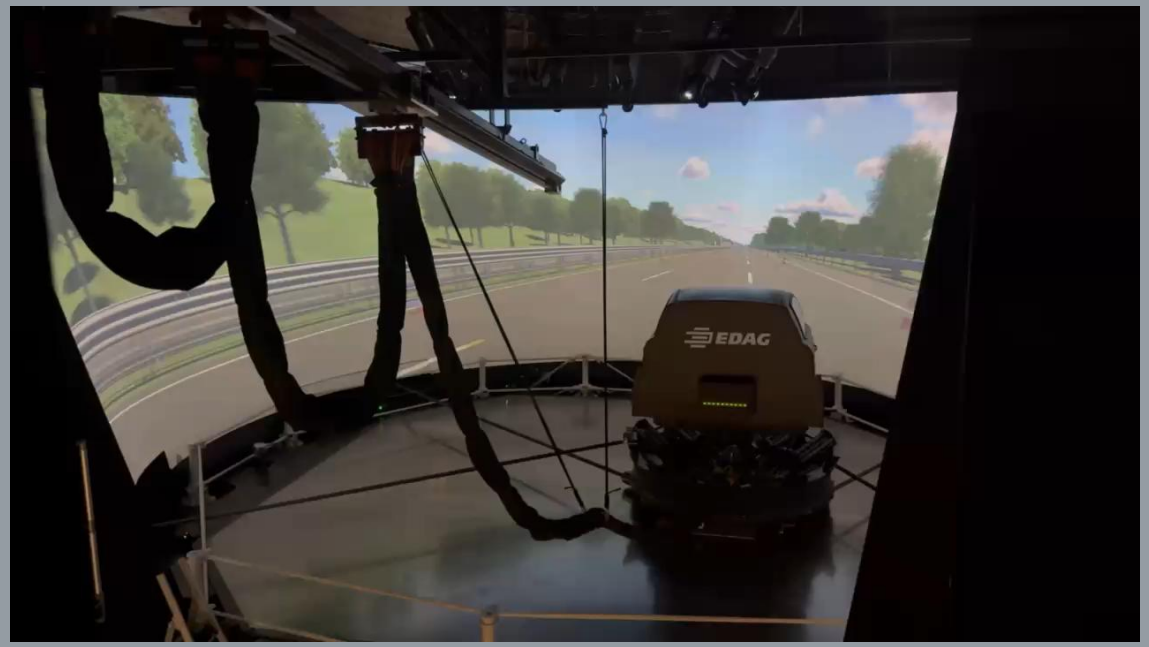
VEHICLE: LUCID AIR

MANOEUVRE: ISO DOUBLE LANECHANGE



VEHICLE MOTION CONTROL
DIL PERFORMANCE SIMULATION

VMC off



underdamped vehicle Body movement
high amount of counter steer

VMC on

Stable and well damped vehicle movement
Easy to control for the driver

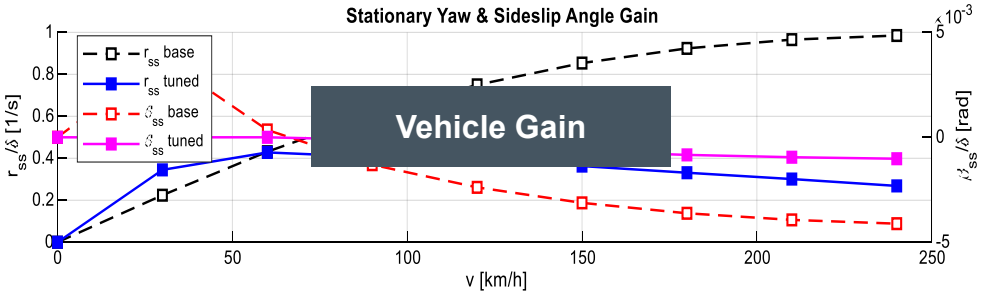
VEHICLE MOTION CONTROL
VMC TUNING

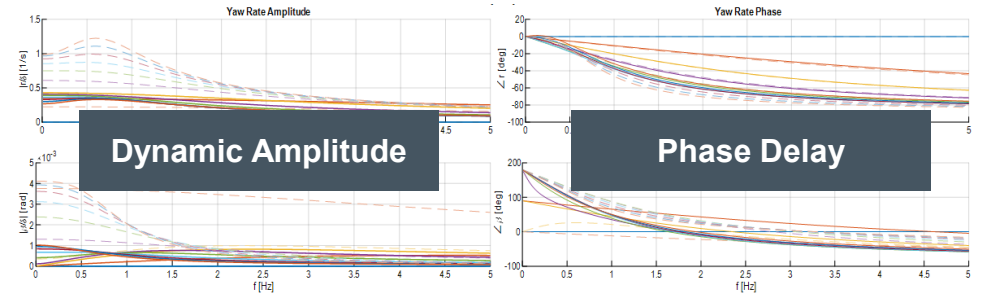
Vehicle DNA Tuning App

Stationary

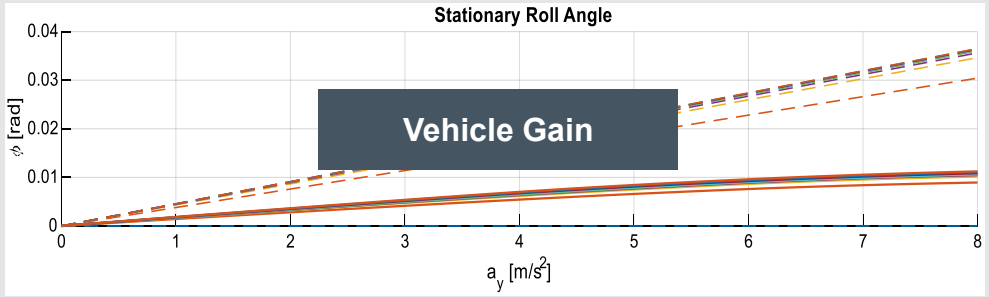
Dynamic

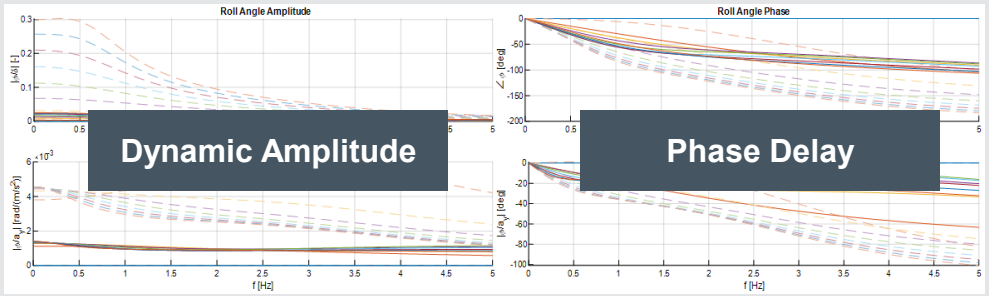
Yawing





Rolling





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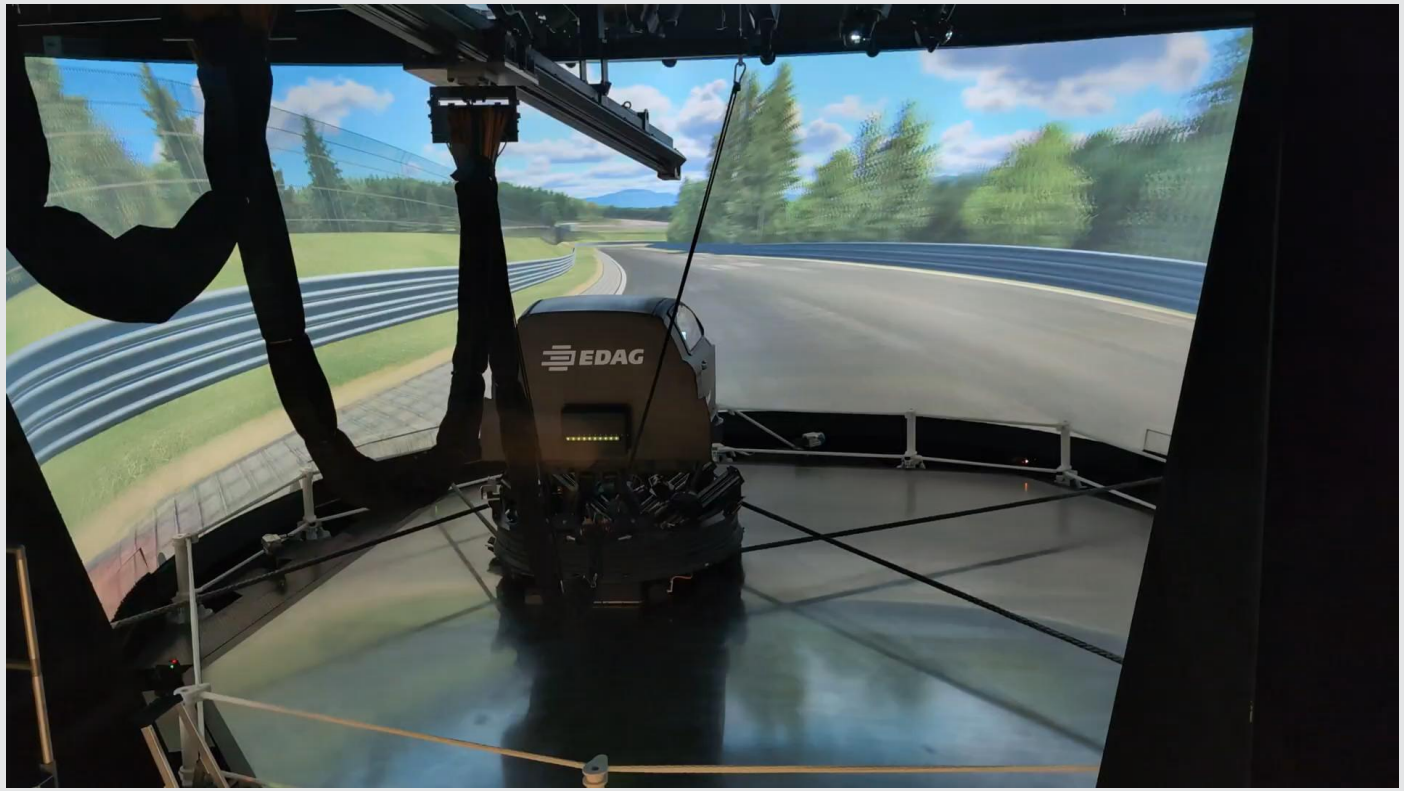
VEHICLE MOTION CONTROL
ACTUATOR OVERVIEW

DIL TESTDRIVE

VEHICLE: **LUCID AIR WITH ESP OFF**

- FFB (Steer by wire)
- Front Axle Steering
- Rear Axle Steering
- 3 Engines
- CDC Damper
- 4 Corner Brakes
- 2 Active Anti Roll Bars

VMC on



VEHICLE MOTION CONTROL
DRIVER IMPRESSION

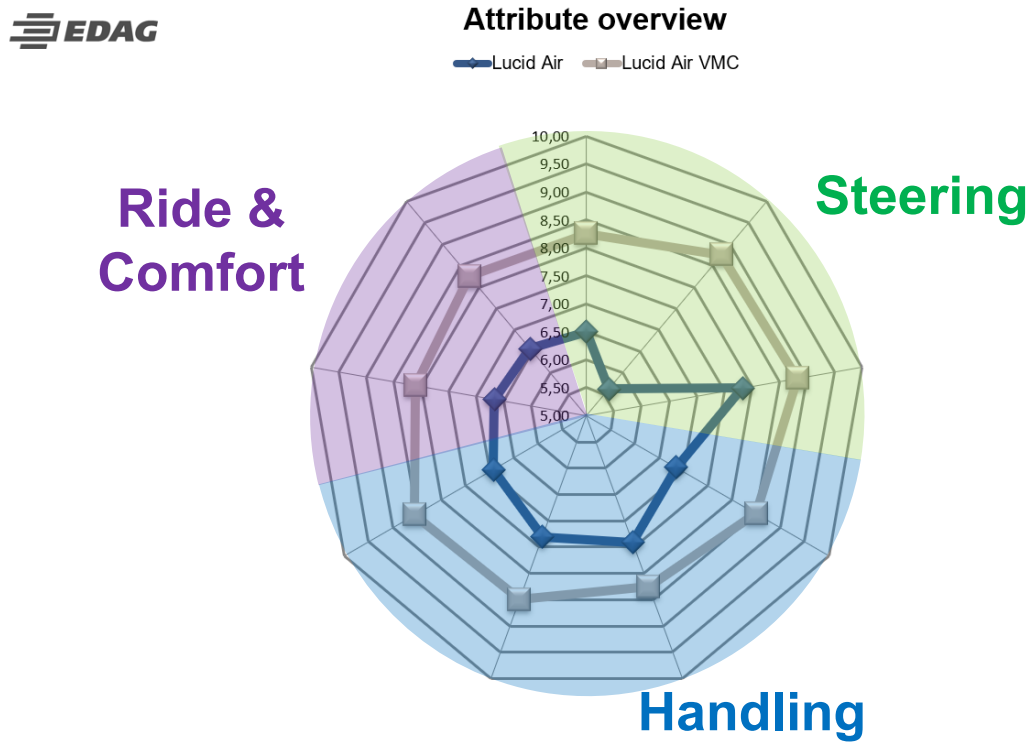
Development

Objective behaviour

Improved vehicle KPIs

- Vehicle speed
- Steering (effort, precision, torque)
- Yaw behaviour
- Roll behaviour
- Stability / Safe
- Agility

Subjective Satisfaction



VEHICLE MOTION CONTROL
REAL WORLD DRIVING

VMC off

Unstable vehicle behavior
High amount of counter steer

VMC on

Stable vehicle movement
Easy to control for the driver

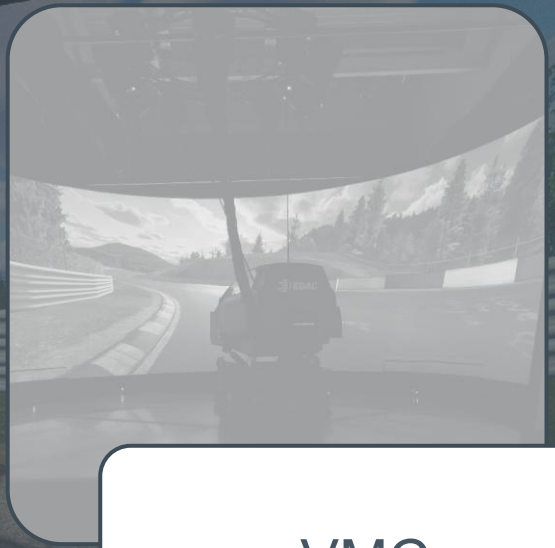
VEHICLE MOTION CONTROL
RESULT

SuSy Framework

Complex Damper Model

ZPL

Zero Prototype Lab



VMC

Vehicle Motion Control

VEHICLE MOTION CONTROL

Jonas Grötzinger

(Vehicle Motion & Performance Vehicle)

Blog
Vehicle Motion Control

Homepage
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