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INCREASING DRIVING PERFORMANCE THROUGH VIRTUAL INTEGRATION OF INTELLIGENT CHASSIS, SUSPENSION AND DRIVETRAIN SYSTEMS

Increasing Vehicle Driving Performance through Virtual Integration of Intelligent Chassis, Suspension and Drivetrain Systems

3DEXPERIENCE CONFERENCE
EUROCENTRAL 2024
REIMAGINE THE FUTURE. TRANSFORM TODAY.
16 - 17 October, 2024

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Intelligent Automotive Solutions

HUAWEI

Intelligent Driving

HUAWEI ADS Advanced Intelligent Driving

Smart Cockpit

HarmonyOS Intelligent Cockpit

Intelligent Driving Control

HUAWEI Smart Vehicle Dynamics

Software-defined Vehicle

HUAWEI iDVP (intelligent digital vehicle platform)

Harmony Intelligent Mobility Alliance

HUAWEI

M5 AITO
Smart Sport SUV

HUAWEI Advanced Intelligent Driving

SERES

M7 AITO
Smart Fullsize SUV

HUAWEI Advanced Intelligent Driving | Versatile Comfort Large Cockpit

SERES

M9 AITO
Smart Flagship SUV

HUAWEI iDVP | HUAWEI Advanced Intelligent Driving | Versatile Luxury

SERES

S7 LUXEED
Smart Sport Sedan

HUAWEI Smart Vehicle Dynamics | HUAWEI Advanced Intelligent Driving | HUAWEI iDVP

CHERY

S9 STELATO
Smart Executive Sedan

HUAWEI Smart Vehicle Dynamics | HUAWEI Advanced Intelligent Driving | HUAWEI iDVP

BAIC

Complexity of Vehicle Motion Control

ACTUATORS		Degree of freedom - DoF						
	Direction	X+	X-	Y	Z	Roll	Pitch	Yaw
	Motor							
	Brake							
	Front Steering							

3 actuators for 6 dof

Driver input: Steering wheel angle + Pedal angle (brake + throttle)

Direct actuation	
Indirect actuation	

Benz Patent-Motorwagen
[Source Mereceds-Benz]

Complexity of Vehicle Motion Control

In future

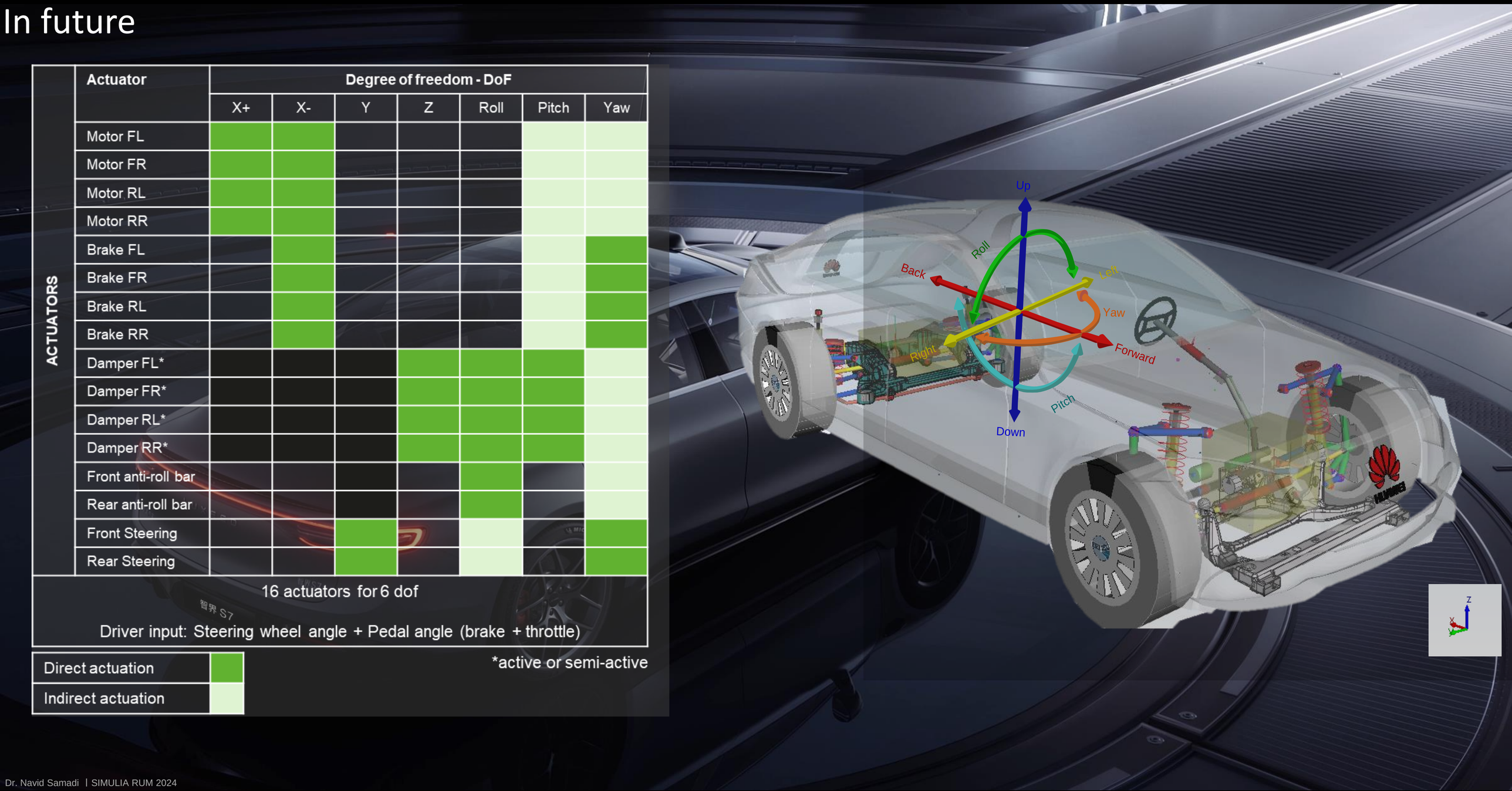
ACTUATORS	Actuator	Degree of freedom - DoF						
		X+	X-	Y	Z	Roll	Pitch	Yaw
	Motor FL	■	■					
	Motor FR	■	■					
	Motor RL	■	■					
	Motor RR	■	■					
	Brake FL		■					■
	Brake FR		■					■
	Brake RL		■					■
	Brake RR		■					■
	Damper FL*				■	■	■	
	Damper FR*				■	■	■	
	Damper RL*				■	■	■	
	Damper RR*				■	■	■	
	Front anti-roll bar					■		
	Rear anti-roll bar					■		
	Front Steering			■				■
	Rear Steering			■				■

16 actuators for 6 dof

Driver input: Steering wheel angle + Pedal angle (brake + throttle)

Direct actuation	■
Indirect actuation	

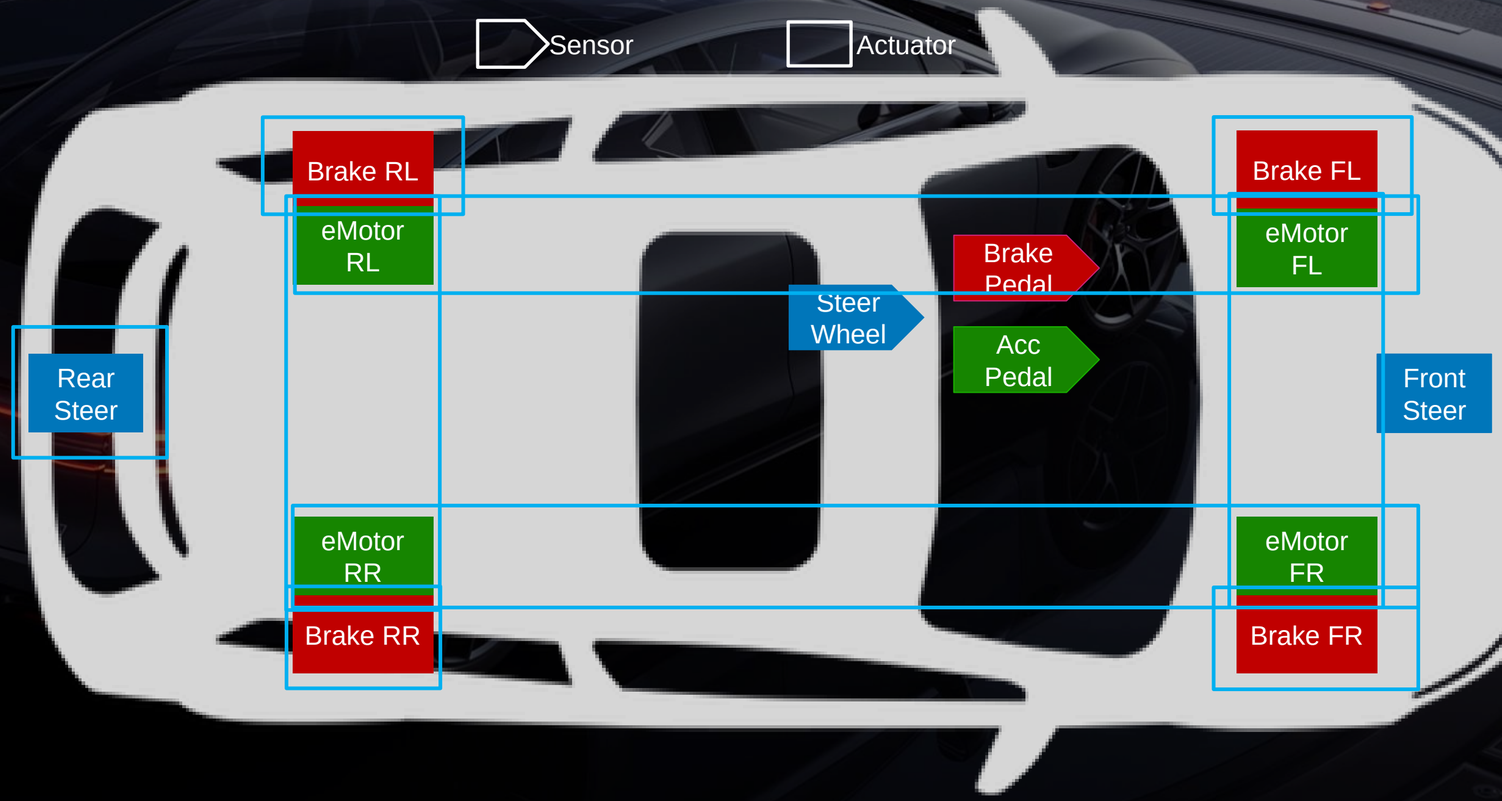
*active or semi-active



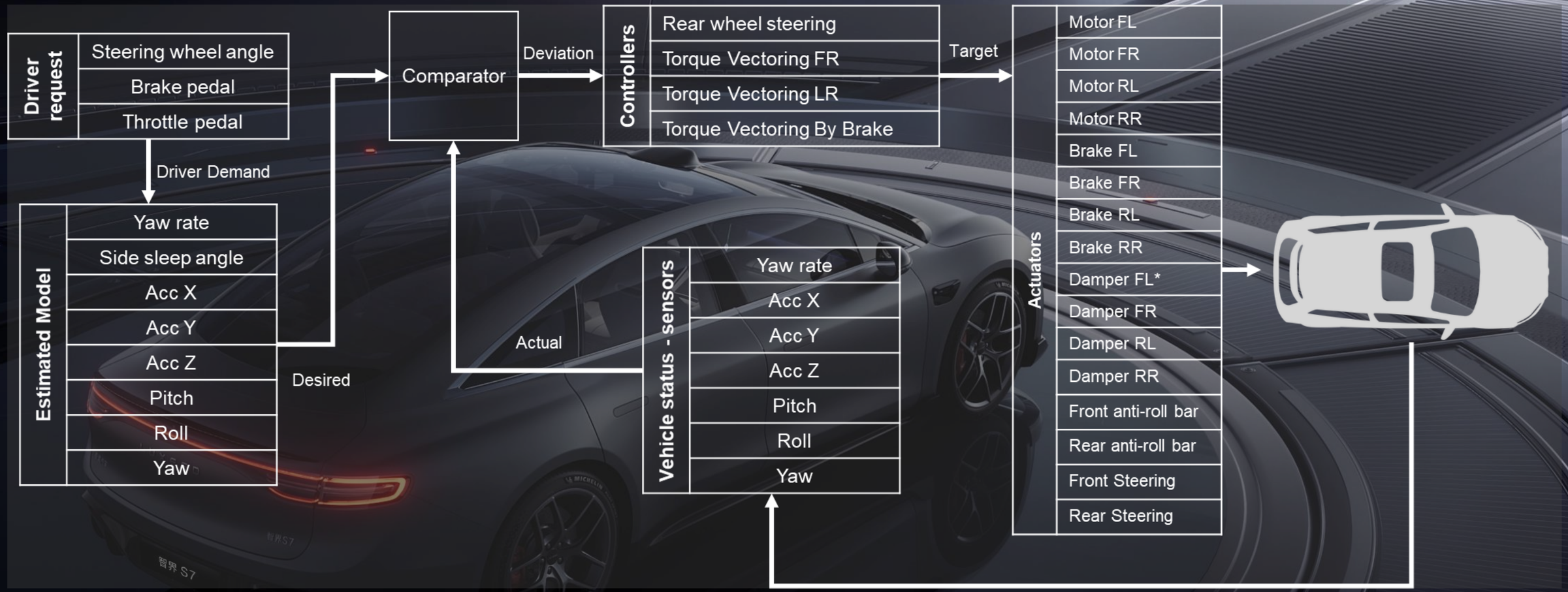
Motion Degrees of Actuation

Influence on Yaw-Rate

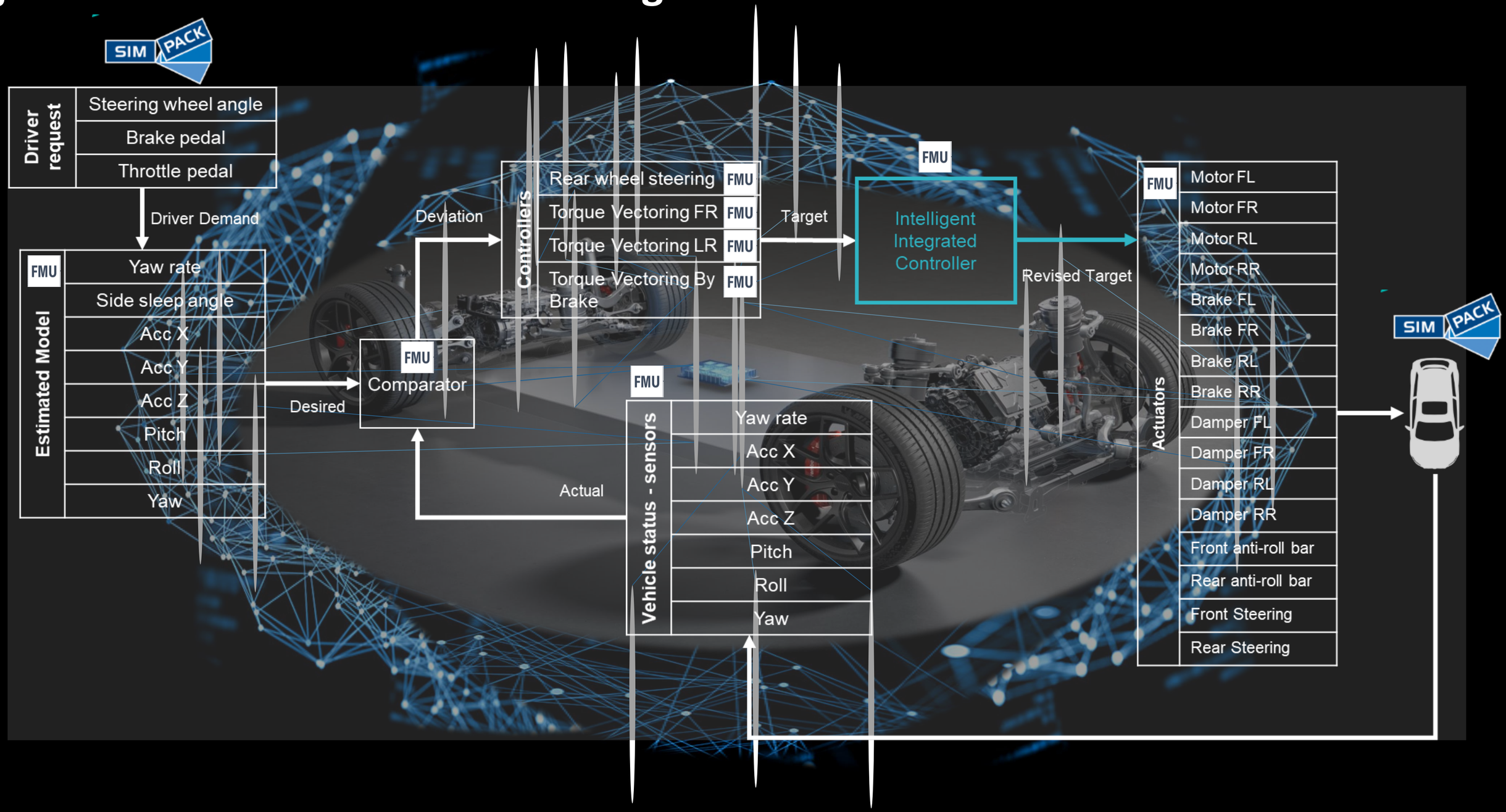
Function	Actuator	DoF	Acronym
Rear wheel steering	Specific rear steering	Yaw	RWS
Torque Vectoring FR	Front and rear powertrain	Yaw	TVFR
Torque Vectoring LR	Left and right powertrain	Yaw	TVLR
Torque Vectoring By Brake	Brakes independently actuated	Yaw	TVBB



Conventional Vehicle Motion Controls Logic



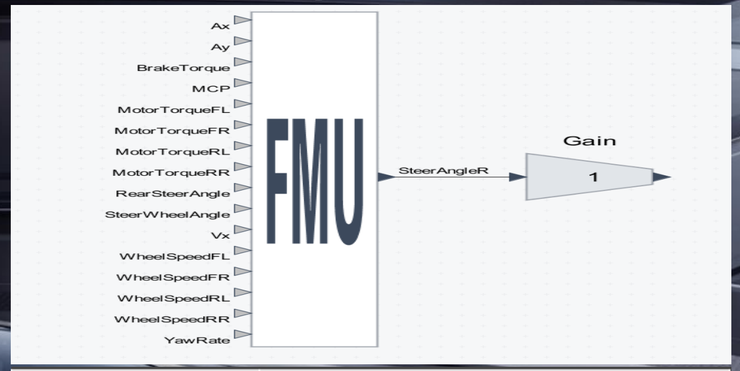
Adjusted Vehicle Motion Controls Logic



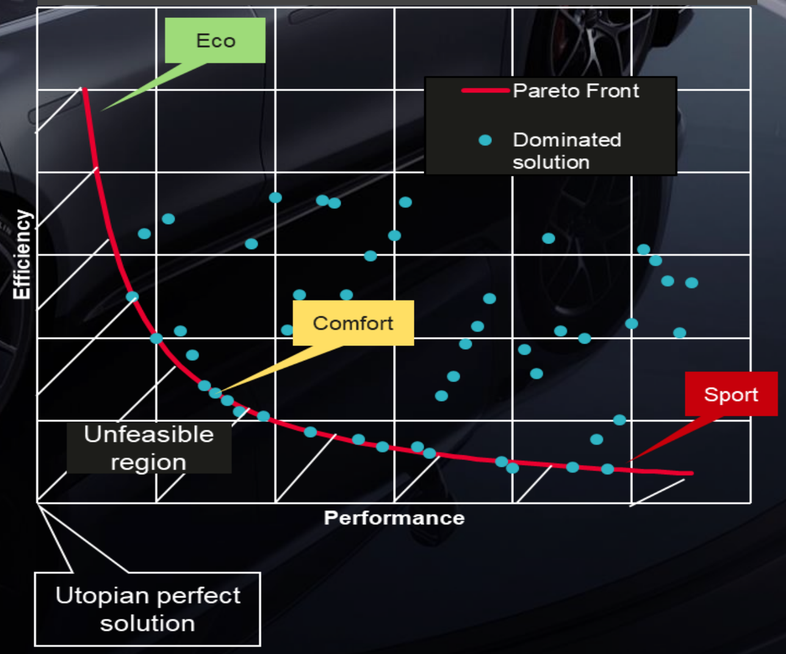
Analysis of Actuator Influence on Vehicle Motion

Design point	Gains			
	Rear Wheel steering	Torque Vectoring FR	Torque Vectoring LR	Torque Vectoring By Brake
DP0	0%	0%	0%	0%
DP1	100%	0%	0%	0%
DP2	0%	100%	0%	0%
DP3	0%	0%	100%	0%
DP4	0%	0%	0%	100%
DP5	80%	0%	60%	80%
DP6	100%	60%	20%	80%
DP7	80%	40%	80%	100%
DP8	80%	100%	40%	0%
DP9	40%	20%	40%	80%
DP10	40%	60%	60%	0%
DP11	20%	100%	60%	0%
DP12	80%	0%	40%	80%
DP13	80%	0%	100%	60%
DP14	0%	40%	20%	20%
DP15	...	...	...	...

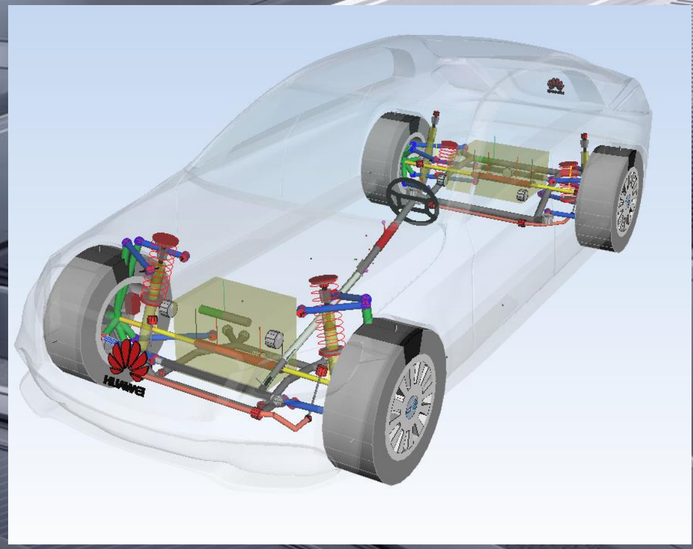
multiple FMUs



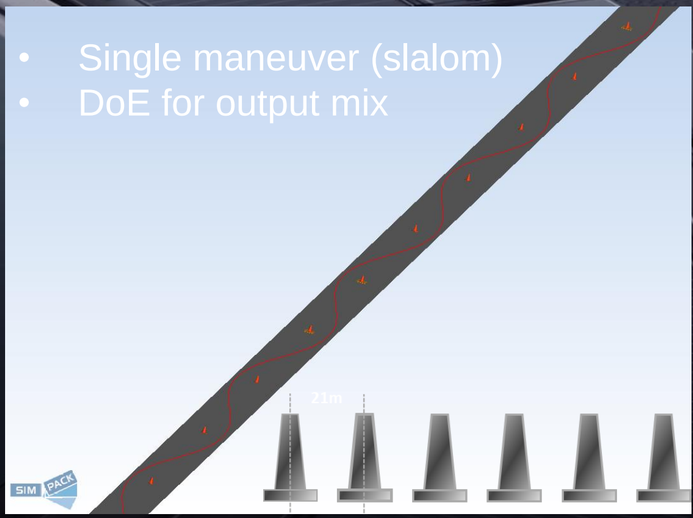
Modes	Goals
ECO	Save energy. Reduce tire wear.
Comfort/ADS	Minimize body motion (Roll, Vertical Displacement)
Sport	Max lateral and long acceleration



MBS Simpack Vehicle model



- Single maneuver (slalom)
- DoE for output mix



Improvement Potentials of Intelligent Vehicle Motion Controls

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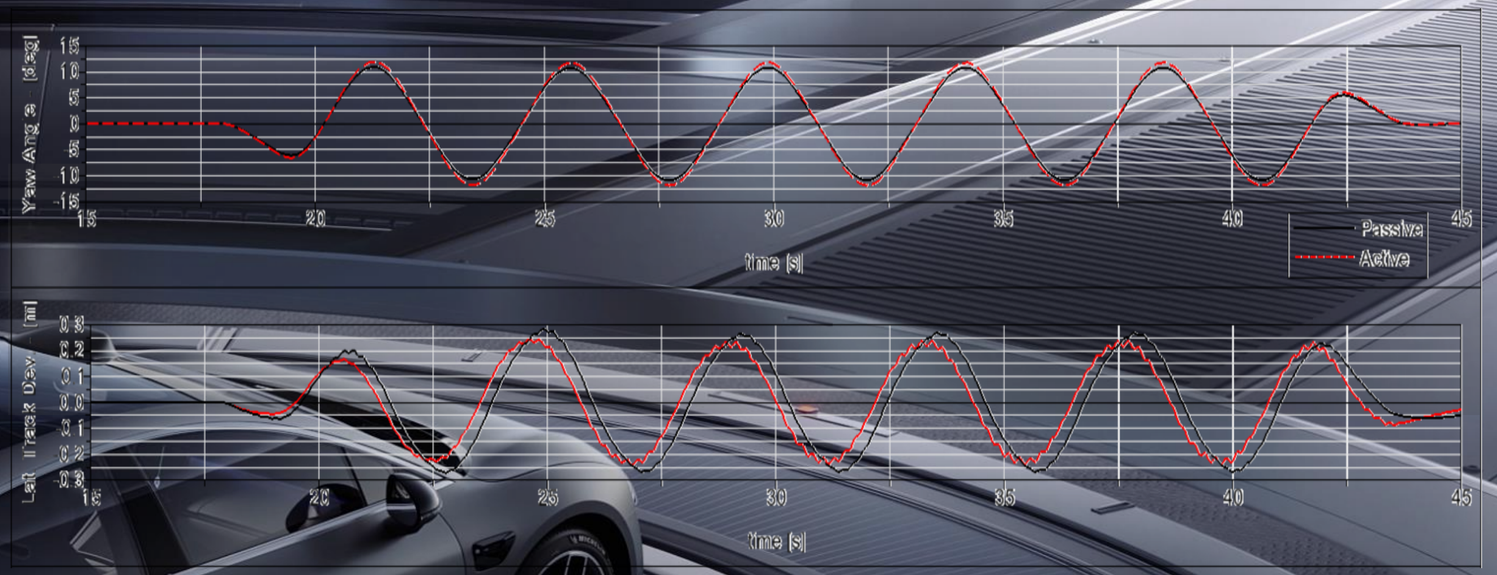
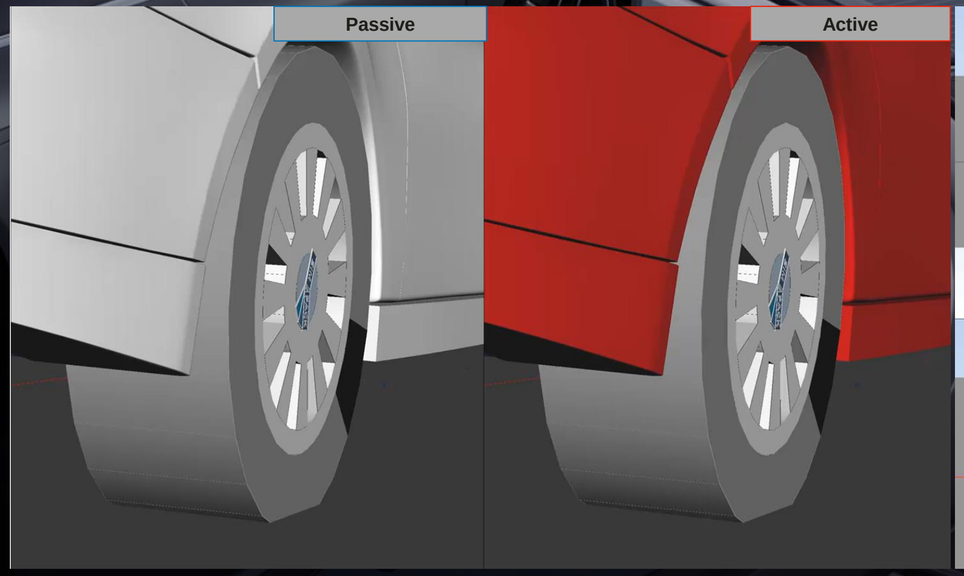
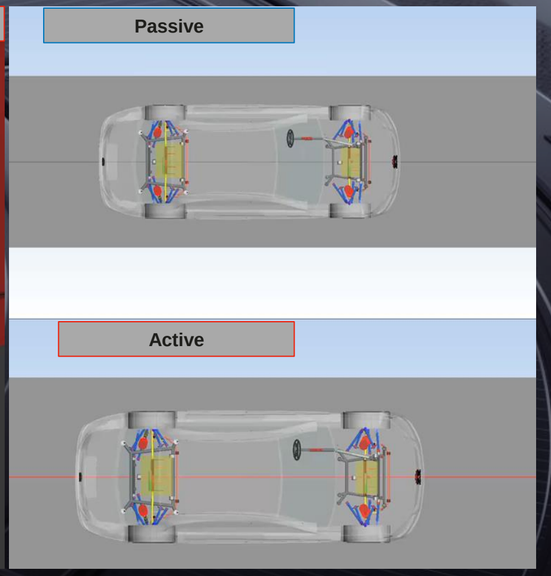
ECO					
Characteristic	Passive	RWS	TV	TV+RWS	Improv
Lateral accel – [m/s^2]	1.12	1.09	1.08	1.10	-2%
Yaw – [deg]	4.8	5.3	5.6	5.4	13%
Steering Wheel angle – [deg]	42	40.2	40.1	41	-2%
Lateral Track deviation – [mm]	120	107	103	105	-13%
Tire Side Slip Angle – [deg]	1.4	1.2	1.6	1.1	-21%
Delta Power demand – [W]	0	200	400	-50	-
RMS values from whole maneuver					

SPORT					
Characteristic	Passive	RWS	TV	TV+RWS	Improv
Lateral accel – [m/s^2]	1.12	1.09	1.08	1.05	-6%
Yaw – [deg]	4.8	5.3	5.6	5.7	19%
Steering Wheel angle – [deg]	42	40.2	40.1	39.5	-6%
Lateral Track deviation – [mm]	120	107	103	100	-17%
Tire Side Slip Angle – [deg]	1.4	1.2	1.6	1.8	29%
Delta Power demand – [W]	0	200	400	500	-
RMS values from whole maneuver					







Vehicle Dynamics System Set Up

Front Suspension

Double Wishbone, Air-Spring, Semi-Active-Damping

Rear Suspension

Five-Link, Air-Spring, Semi-Active-Damping

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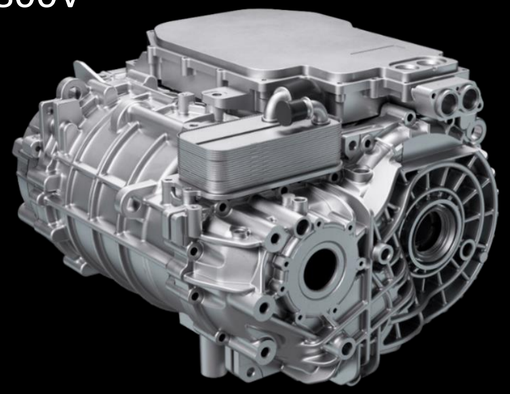
DriveONE 800V

Front 150 kW

asynchronous electric drive



Rear 215 kW

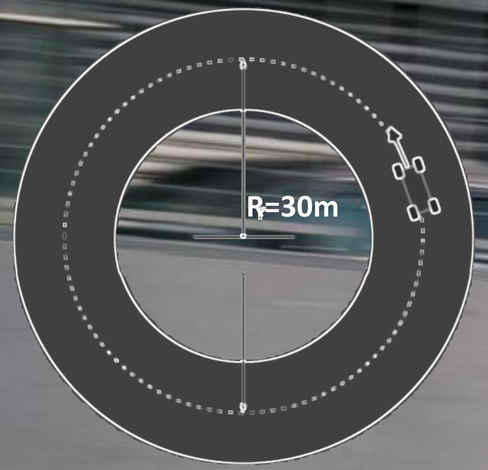
permanent magnet
synchronous electric drive

HUAWEI Smart Vehicle Dynamics

Intelligent vehicle control platform

Performance Validation of DCC activated in Sport+ Mode

Steady State Cornering and Slalom



30m Circle	Avg. Speed (measured)	Avg. Lat. Accel. (measured)
Sport Mode	58.3 kph	0.903 g*
Sport+ Mode	61.5 kph	0.929 g*
Improvement	+5,4 %	+2,9 %

21m Slalom	Avg. Speed (measured)	Avg. Lat. Accel. (measured)	Avg. Steering Angle Demand (measured)
Sport Mode	68.4 kph	0.65 g	
Sport+ Mode	69.6 kph	0.74 g	
Improvement	+1,7 %	+11.7 %	-2,4 %

*Calculated lat.accel. SM 0.89 g and SM+ 0.99 g impr. +10%

Performance Validation of DCC activated in Sport+ Mode

Handling Track Results

Thank you

DASSAULT SYSTEMES

Virtual Worlds
for Real Life

THANK YOU FOR YOUR INTEREST