
LAMBORGHINI

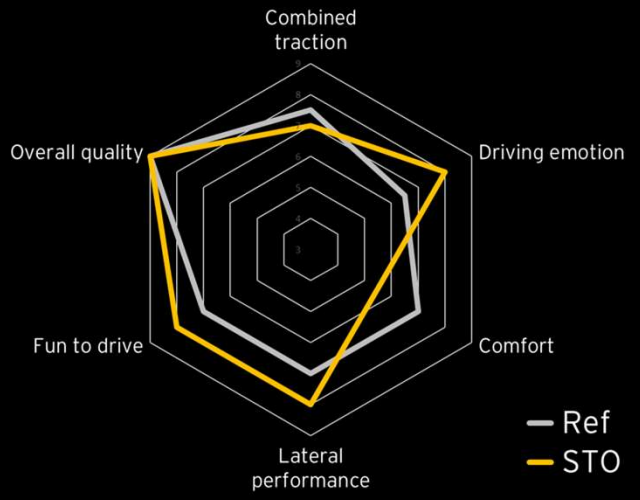
Optimal coupling of suspension setup and tire dynamic footprint through FEM modelling and DiL approach

Giuseppe Sgoluppi (presenter)
Giovanni Caputi Gennaro
Automobili Lamborghini S.p.A.

Alfredo Corollaro (presenter)
Paolo Di Luise
Bridgestone EMIA

Huracan STO
Overview and goals

- V10 engine 640 hp
- Track oriented - RWD
- 0-100km/h → 3,0 s
- 100-0km/h → 30 m



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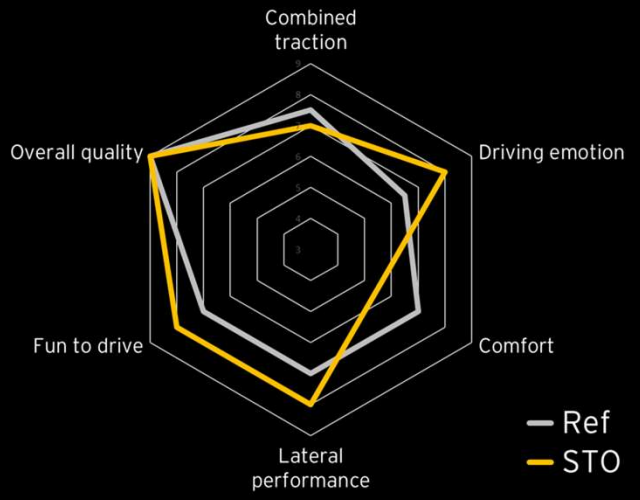
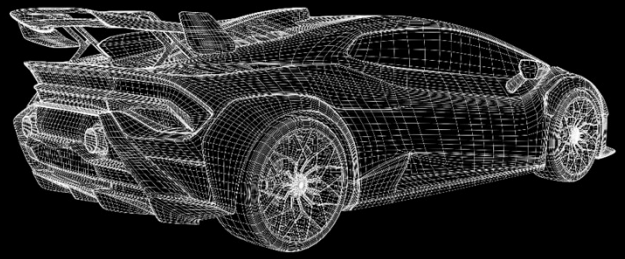


Tire development focused on:

- Optimizing traction capabilities
- Improving turn exit at low speed
- Optimizing combined traction behavior

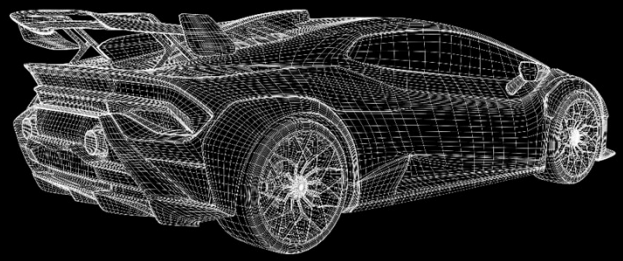
Huracan STO
Optimization workflow



LAMBORGHINI
FULL VEHICLE
DYNAMIC SIMULATION

BRIDGESTONE
TIRE
VIRTUAL PROTOTYPING

Huracan STO
Optimization workflow



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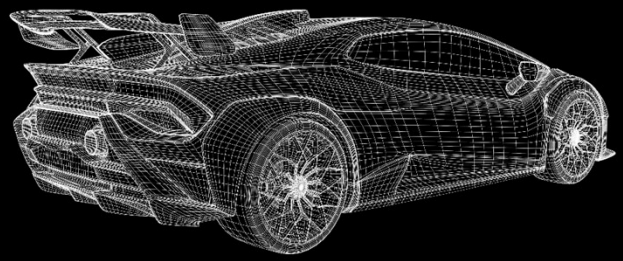

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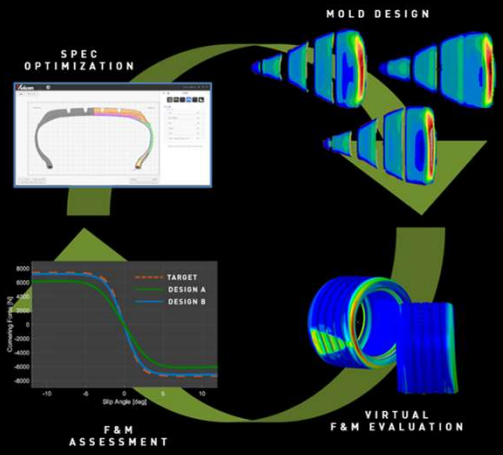
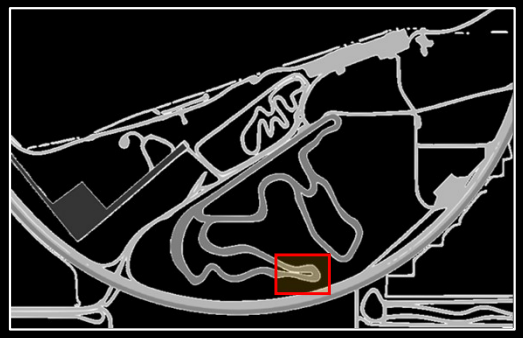
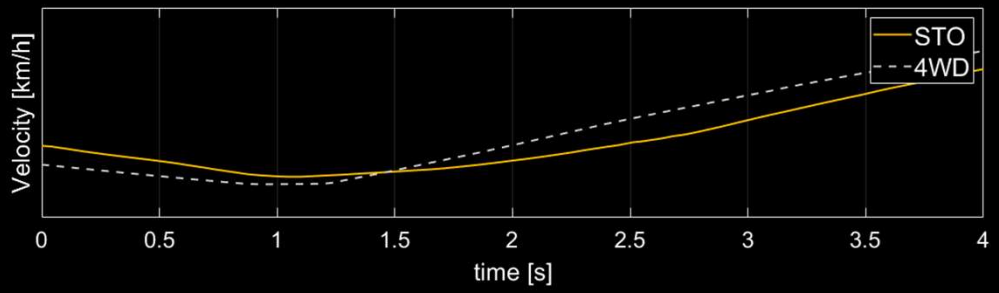
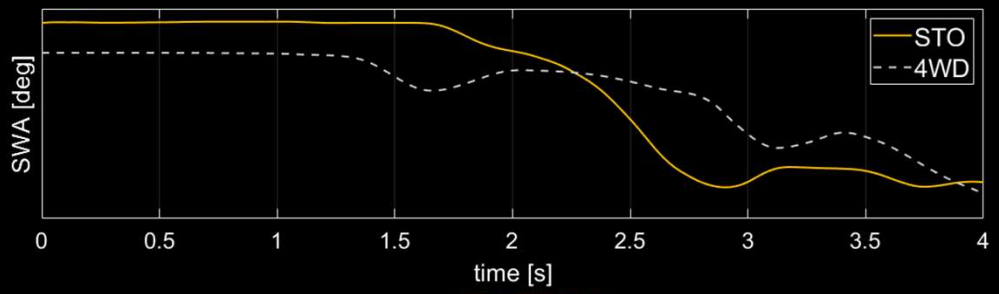


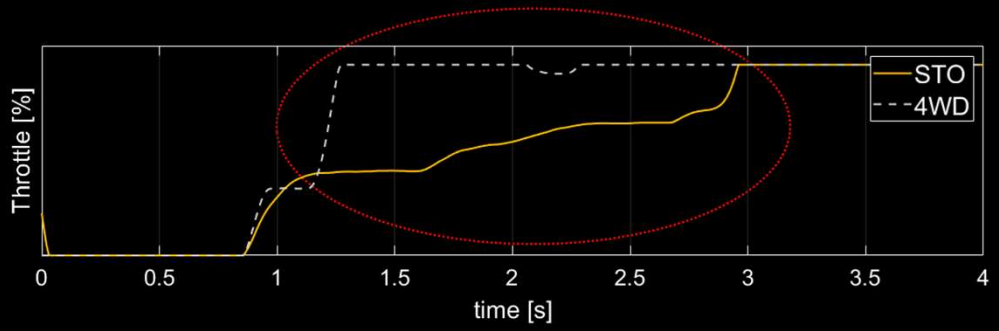
BRIDGESTONE
TIRE
VIRTUAL PROTOTYPING

Use Case
NTC - T5 Hairpin









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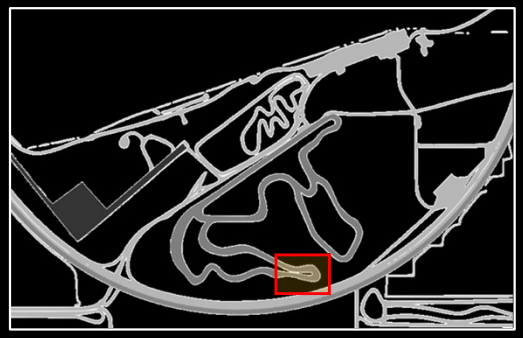
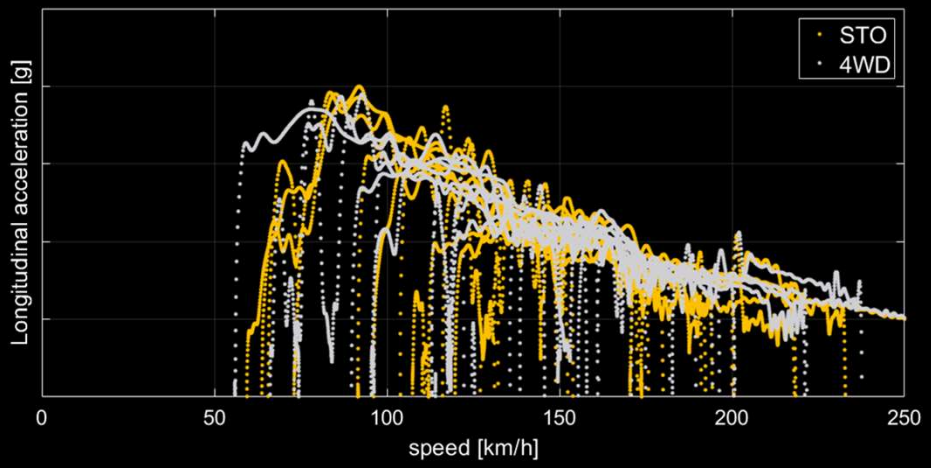
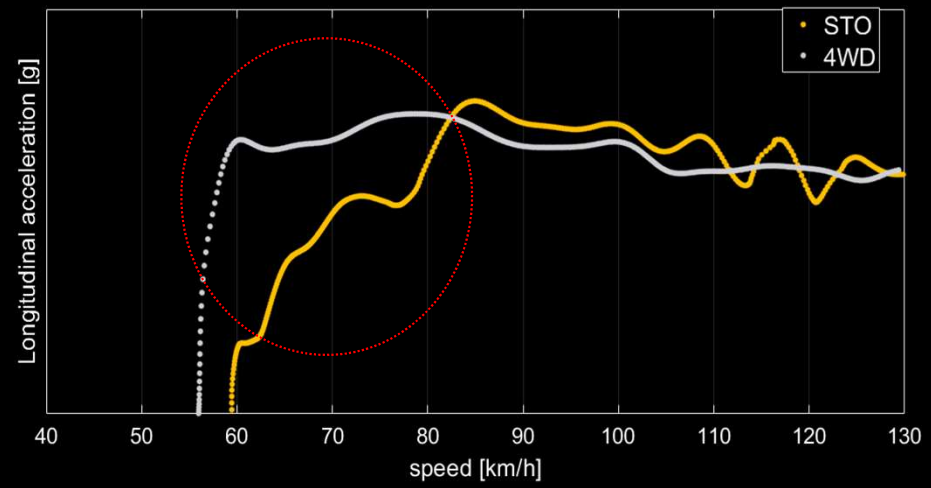
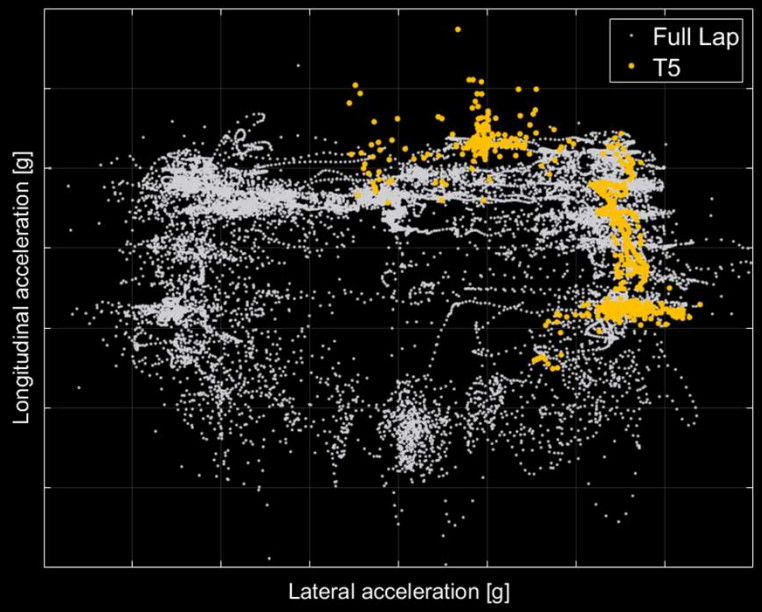
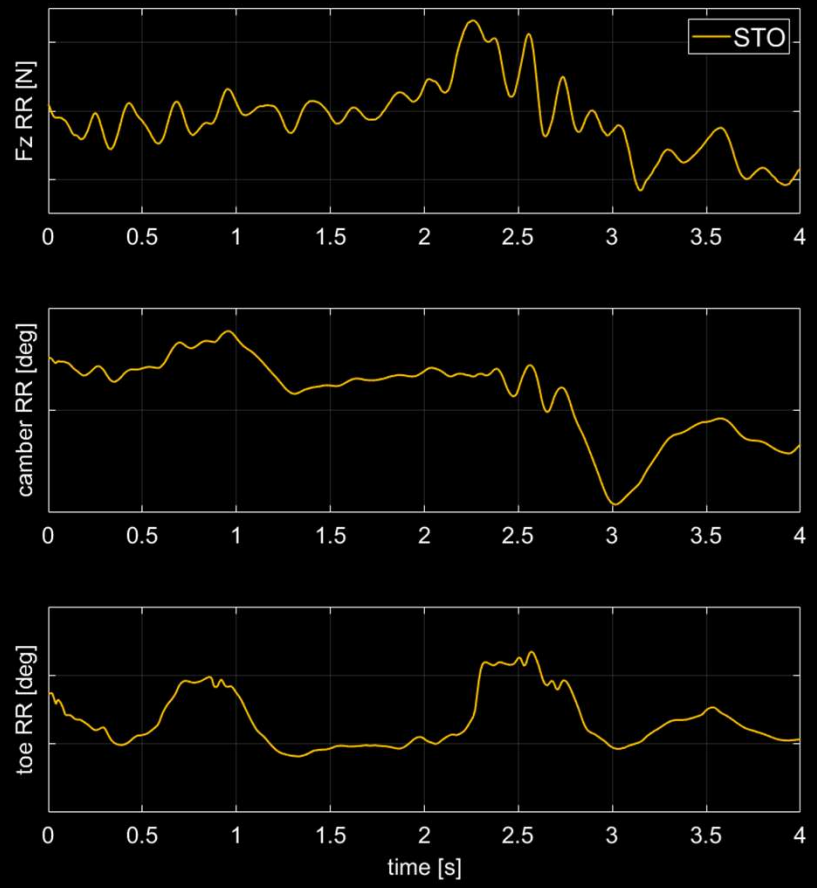






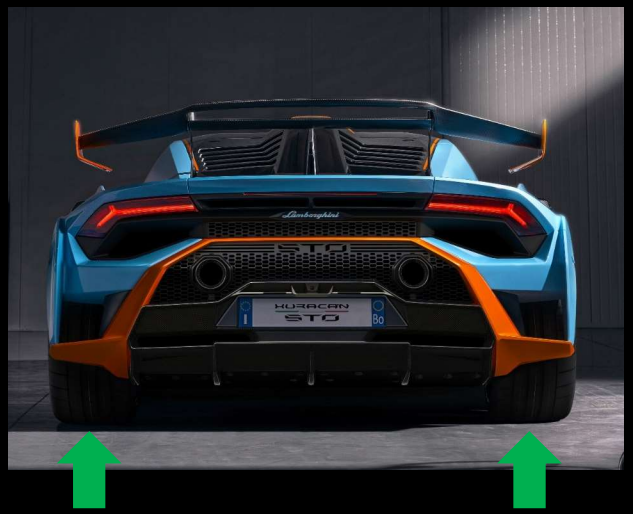
Tire working condition
NTC – T5 Hairpin

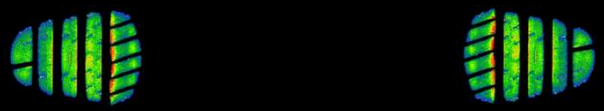




Tire working condition
Static vs T5 Hairpin

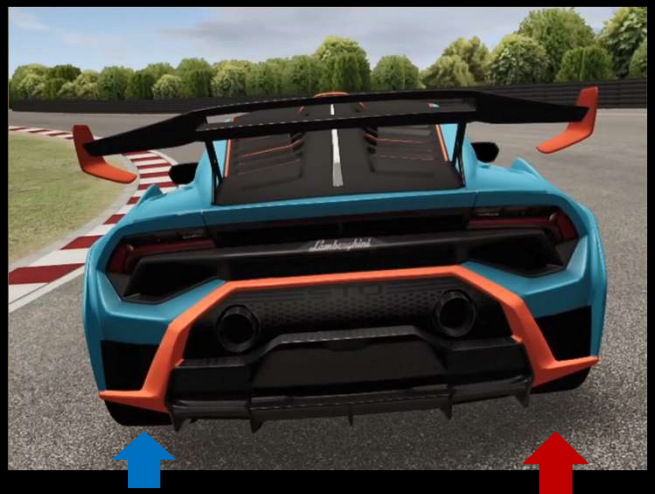
STATIC

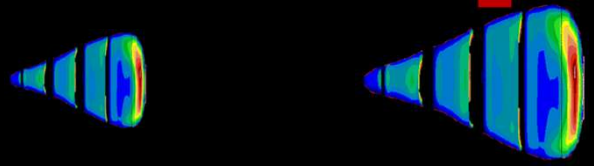




Static loads condition
Static Camber angle
NO Slip angle

NTC – T5

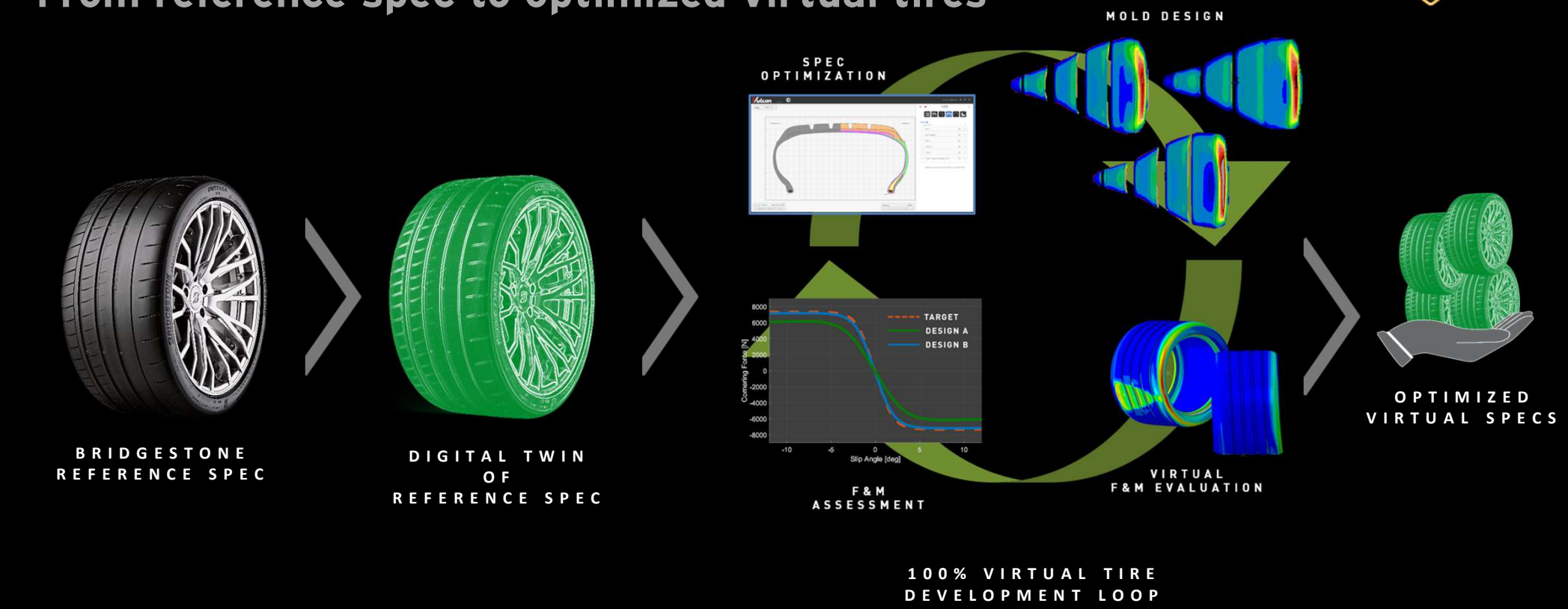




Load transfer condition
Actual T5 Camber angle
Actual T5 Slip angle

Bridgestone Virtual Tire Development

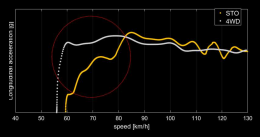
From reference spec to optimized virtual tires

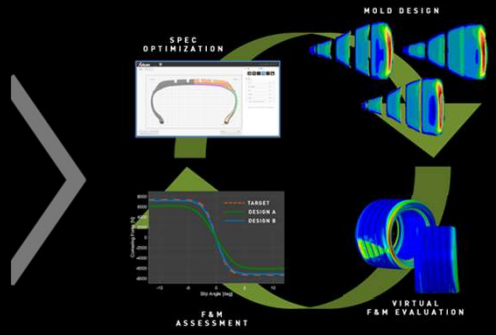


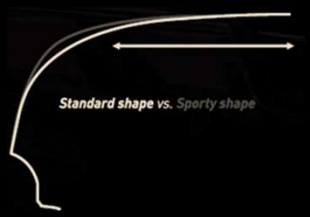
Virtual Tire Development substantially reduced the number of physical loops

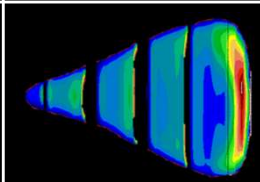
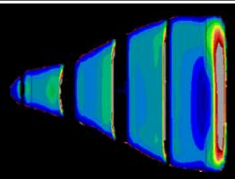
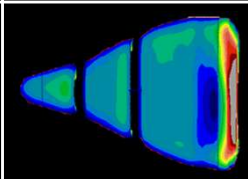
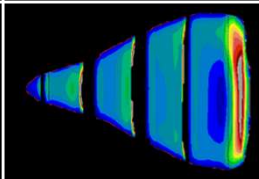
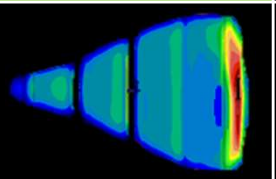
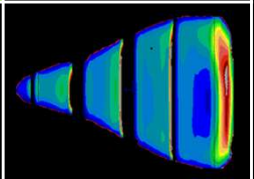
Cavity profile and Pattern design

Optimization of Footprint to maximize the grip



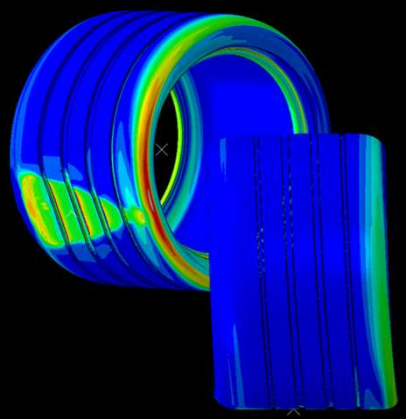




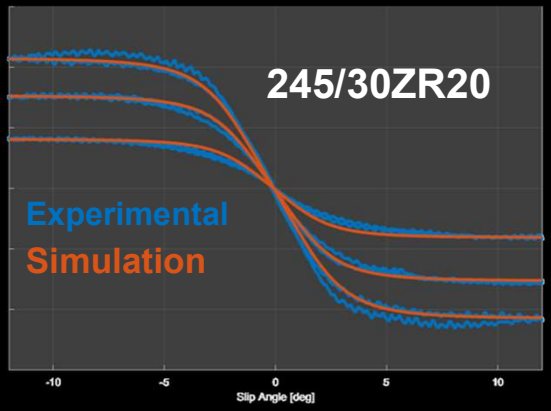
	REFERENCE	OPTION A	OPTION B	OPTION C	OPTION D	OPTION E
Footprint in Cornering						
Contact Area (Cornering)	100%	99%	102%	100%	107%	105%
Outside Shoulder Contact Area	100%	100%	105%	101%	106%	104%
Cornering Force Peak Forecast on real tires	100%	92%	106%	96%	111%	109%

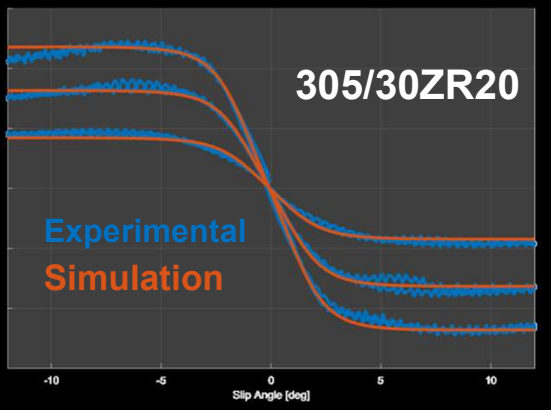
Virtual Tire Development allowed to compare several different tire design in a very short time

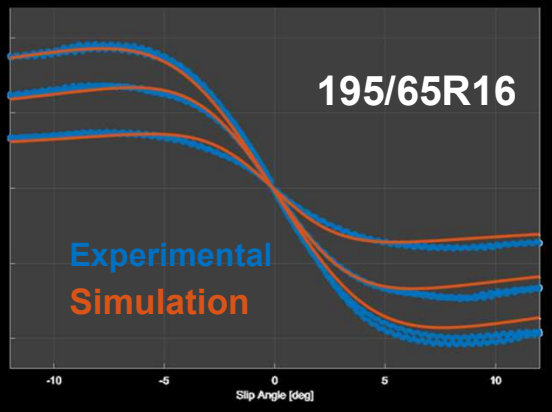
Virtual F&M Evaluation
From FEM modelling to MF-Tyre for vehicle simulations



VIRTUAL
F&M EVALUATION







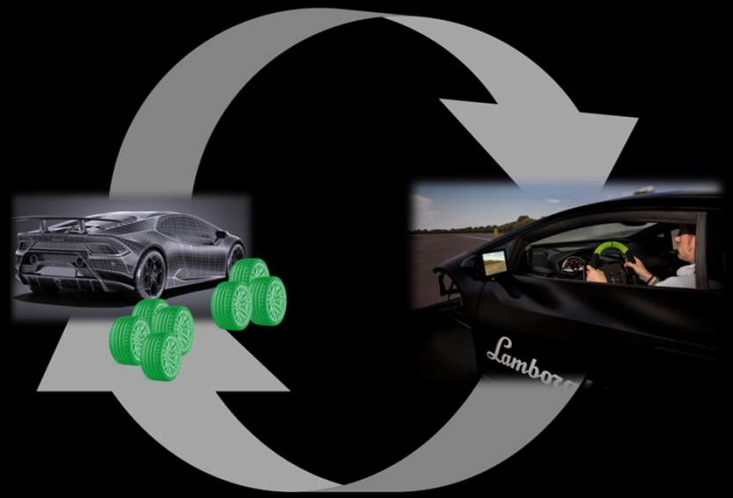
MF-TYRE OF VIRTUAL
TIRES

Virtual F&M Evaluation allowed to build MF-Tyre of fully virtual specs

Driver In the loop for tire development

Subjective assessment in a fully virtual environment

OPTIMIZED
VIRTUAL SPECS



SUBJECTIVE ASSESSMENT
WITH DRIVER IN THE LOOP

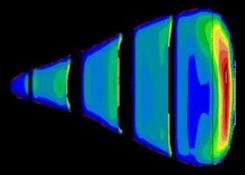
BUILDING OF
OPTIMAL SPECS

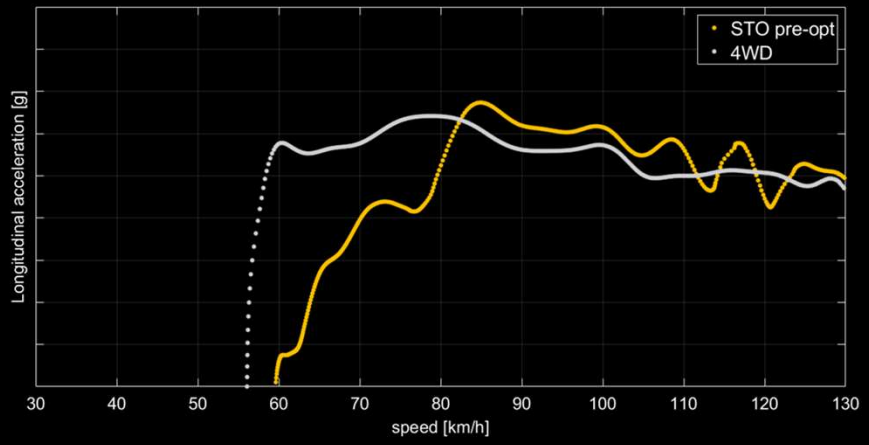
OUTCOMES FULLY
CONFIRMED ON TRACK

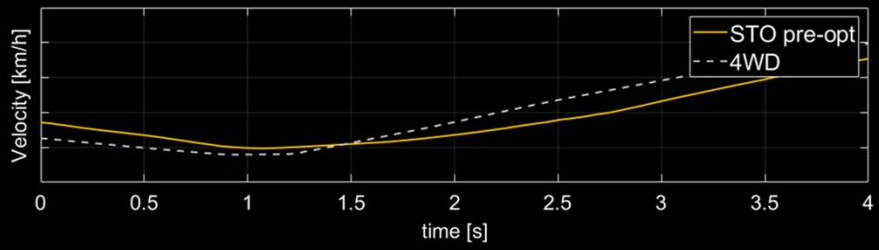
More than 70 different Front-Rear combinations assessed in 2 days

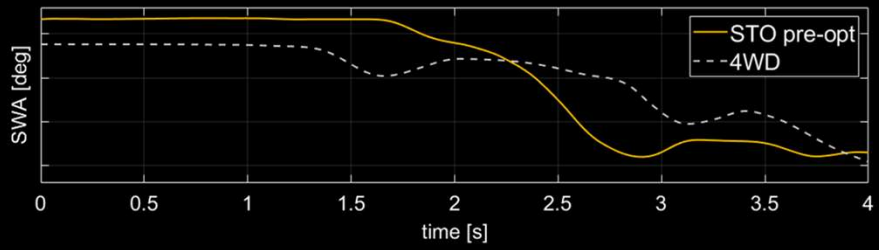
Results
Closing the loop with DiL

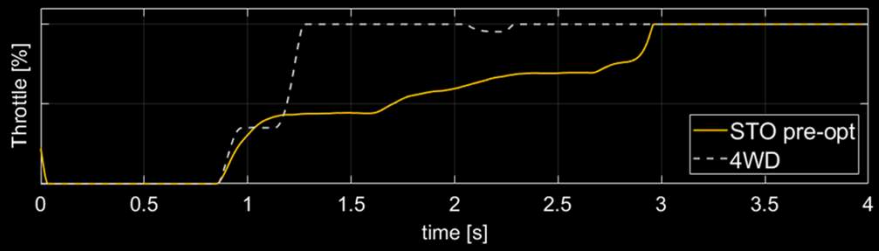
PRE-OPTIMIZATION



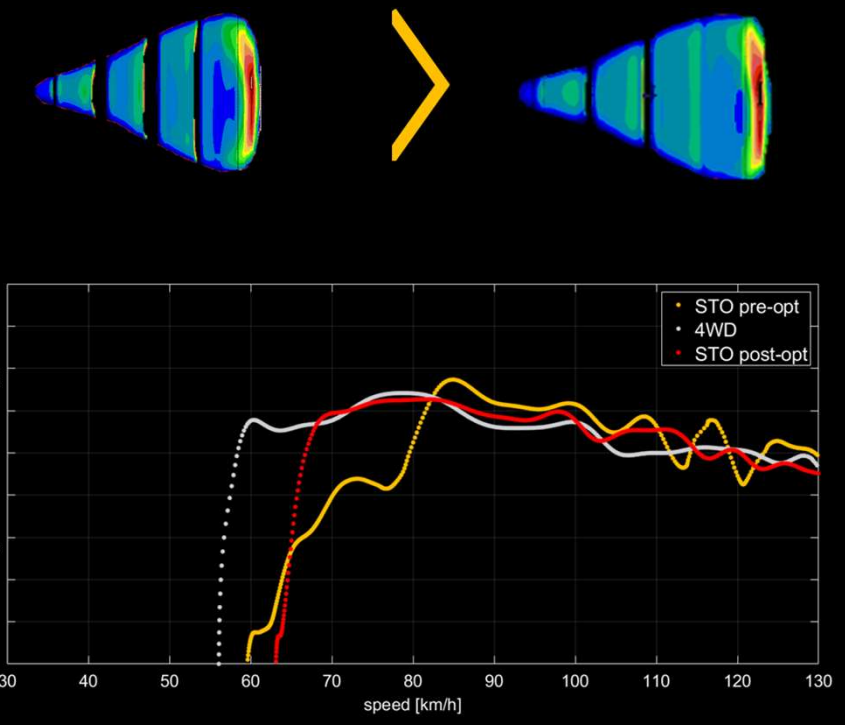


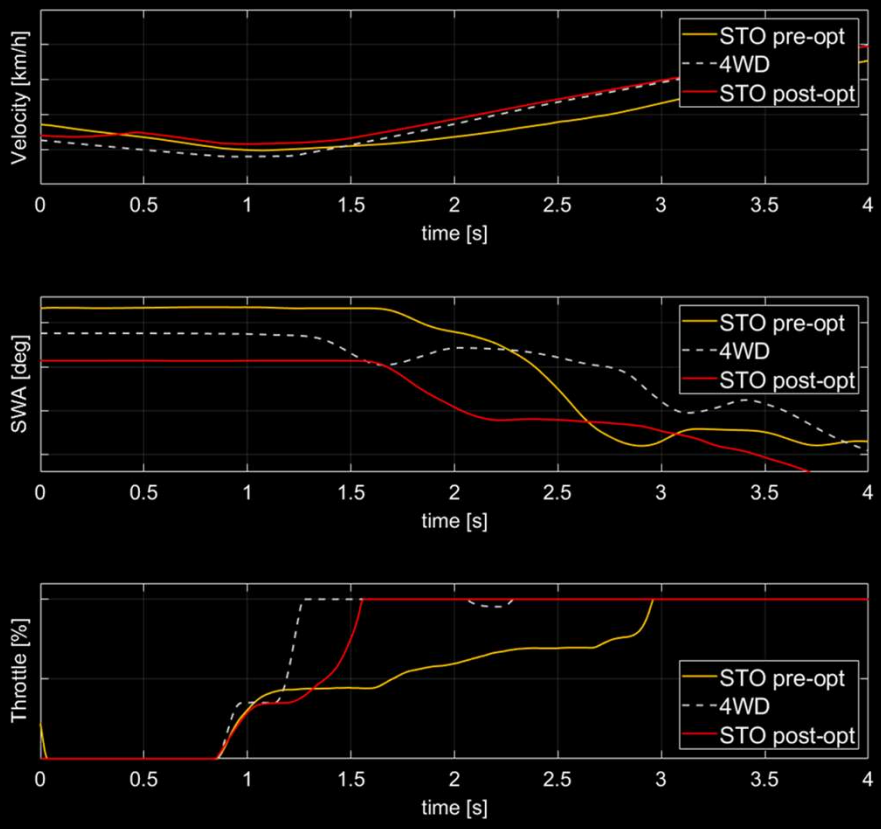






Results
Closing the loop with DiL





Lamborghini/Bridgestone Virtual Development
Exploiting mutual capabilities

EFFICIENCY

Allowed faster response by providing Lamborghini with virtual tires before any physical building saving 75% of time during the development

Virtual Dev.

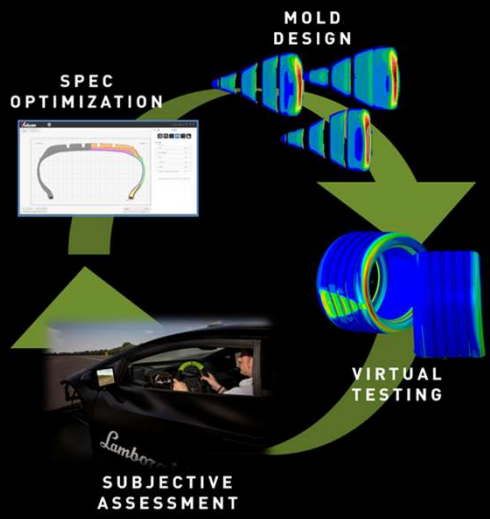
Classical Physical Approach

FUTURE ORIENTED

Provided Lamborghini with 100% virtual models of non-existing products

SUSTAINABLE

Allowed reduction of physical tests on vehicle (-900 km) and CO_2 emission saving up to 200 experimental tires



Lamborghini and Bridgestone made the development efficient and sustainable thanks to its full virtualization


LAMBORGHINI