MegaRide Tire Characterization and Modelling Technologies

7(+) PRODUCTS FOR A MODULAR TIRE SIM PLATFORM

2 PERFORMANCE TOOLS

T.R.I.C.K.
from vehicle onboard sensors to tire data

adheLAB
multiphysical tire data analysis and MF-ID

4 PHYSICAL MODELS (RIDEsuite)

adheRIDE
advanced MF
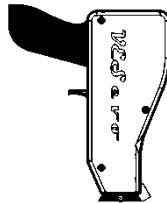
weaRIDE
tire wear model

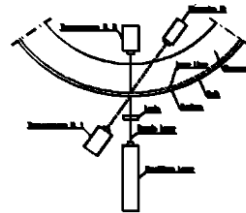**thermoRIDE**
tire thermal model

threedeeRIDE
multicontact model

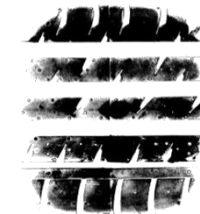## 1 INNOVATIVE DEVICE + TESTBENCHES

VESevo
nondestructive tread compound analyzer

thermobench
tire thermal analysis

footprints-ID
shape & contact pressure

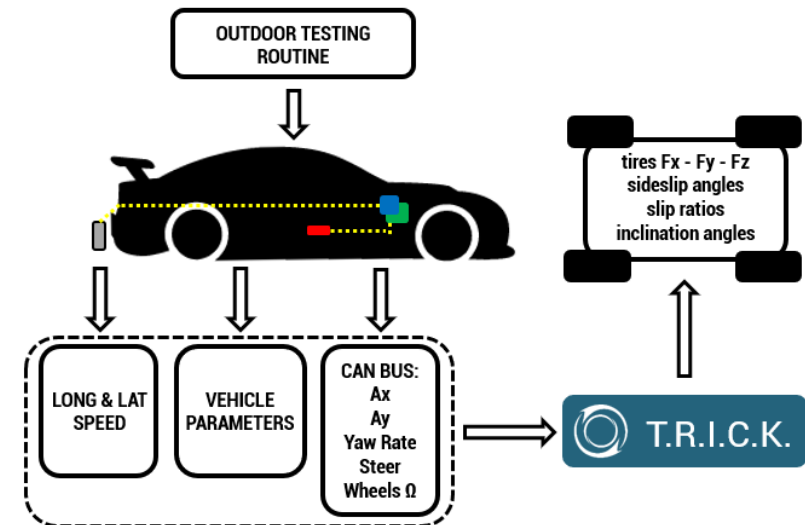# PERFORMANCE TOOLS – <u>T.R.I.C.K.</u>

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In case data on tire interaction forces are not available to the customer (from test benches, dyno hubs, trailers, …) TRICK methodology has been conceived to "convert" vehicle data in tire data, useful to analyze performance and to feed the processing tools and models

- PHYSICAL VEHICLE MODEL

- FROM ONBOARD STANDARD SENSORS TO TIRE FORCES EVALUATION

- SPECIFIC OUTDOOR TESTING PROCEDURE

- REAL TIRES / REAL ROAD / REAL CONDITIONS

OUTDOOR TESTING
ROUTINE

LONG & LAT
SPEED

VEHICLE
PARAMETERS

CAN BUS:
Ax
Ay
Yaw Rate
Steer
Wheels Ω

T.R.I.C.K.

tires Fx - Fy - Fz
sideslip angles
slip ratios
inclination angles

PERFORMANCE TOOLS – <u>T.R.I.C.K.</u>
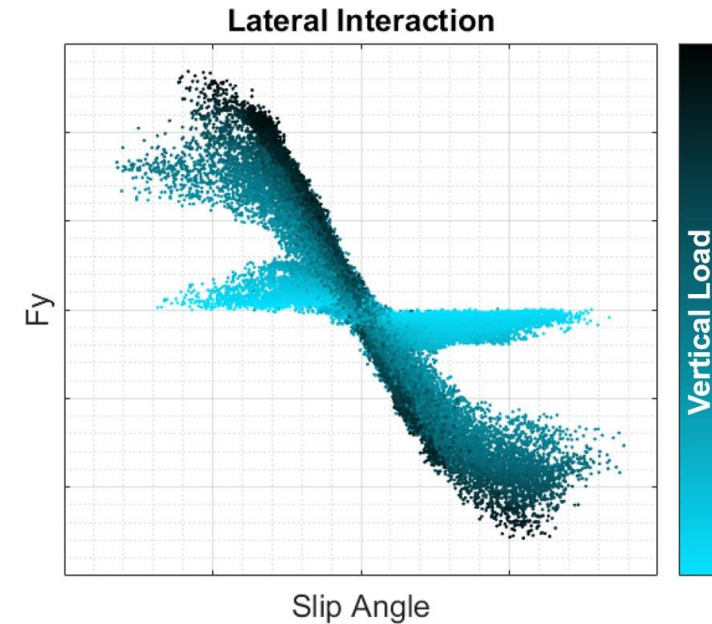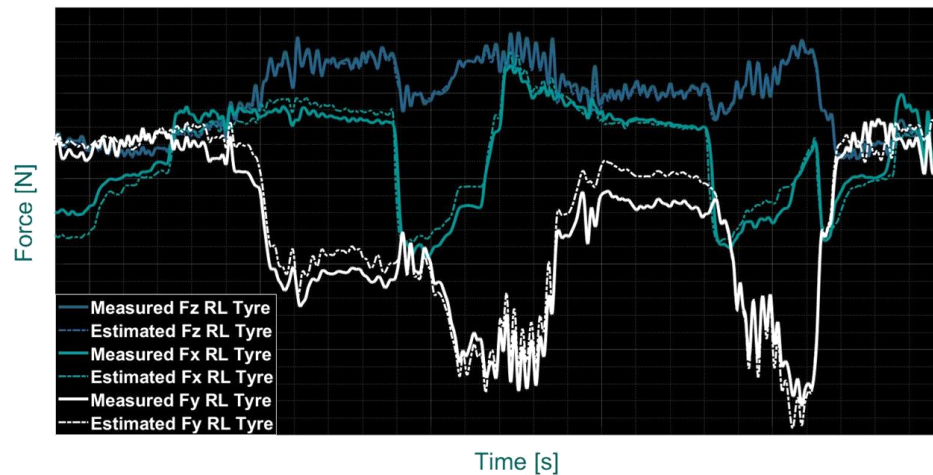
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Lateral Interaction

PERFORMANCE TOOLS – <u>adheLAB</u>
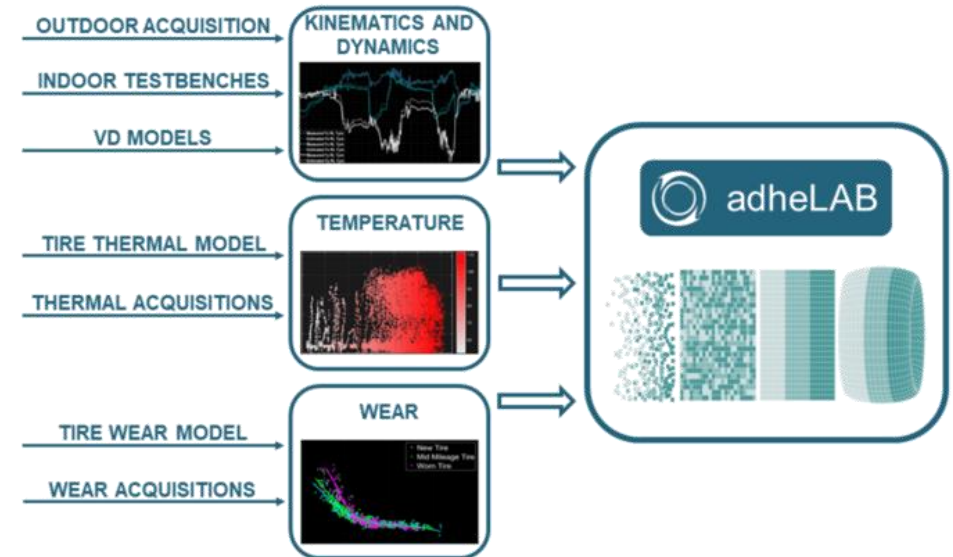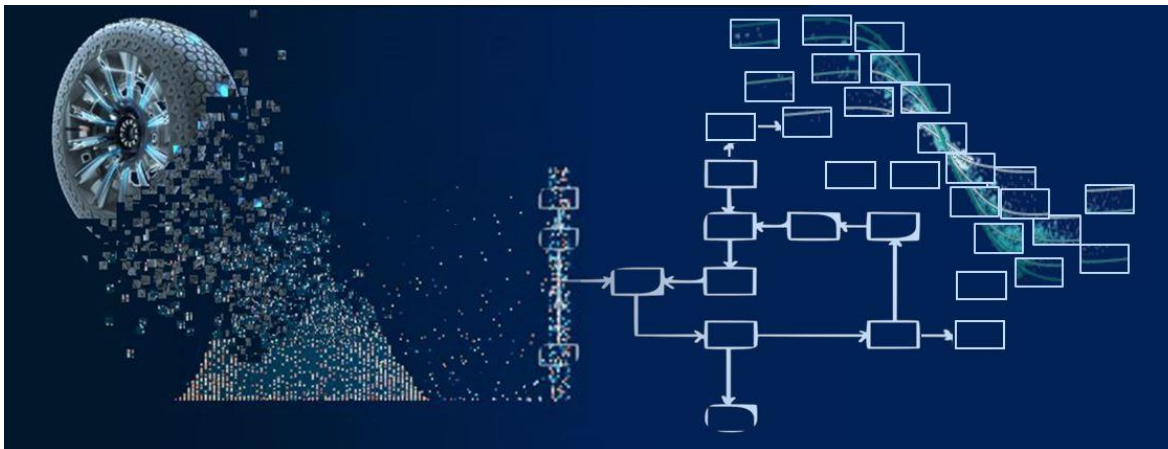
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Once tire multiphysical data (kinematics, dynamics, temperature, wear, viscoelasticity, road roughness, …) are available, **adheLAB** tool is designed to manage their intrinsic complexity, allowing to perform multi-variable optimization, decoupling and identifying the single effects of each physical domain (and of RIDEsuite modules)

OUTDOOR ACQUISITION → KINEMATICS AND DYNAMICS
INDOOR TESTBENCHES →
VD MODELS →

TIRE THERMAL MODEL → TEMPERATURE
THERMAL ACQUISITIONS →

TIRE WEAR MODEL → WEAR
WEAR ACQUISITIONS →

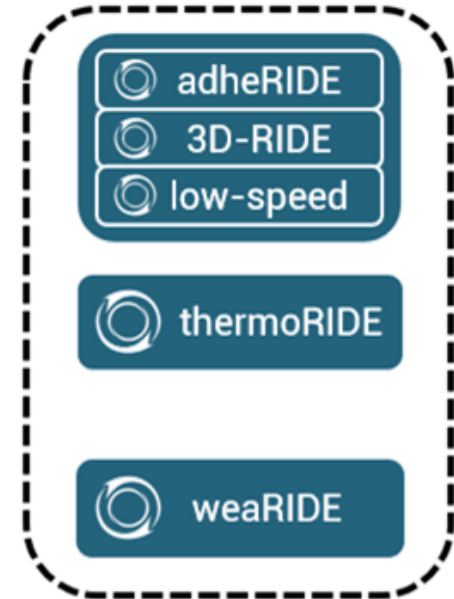→ adheLAB

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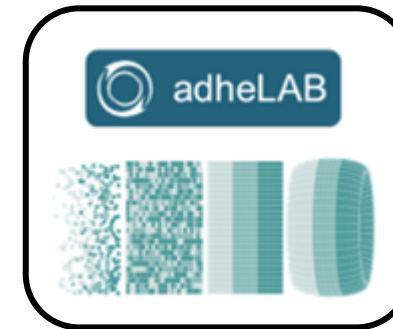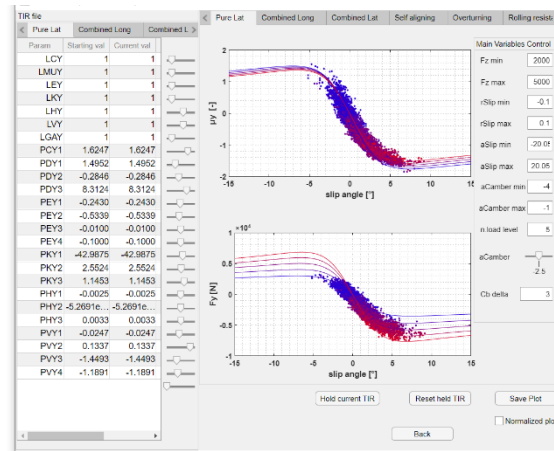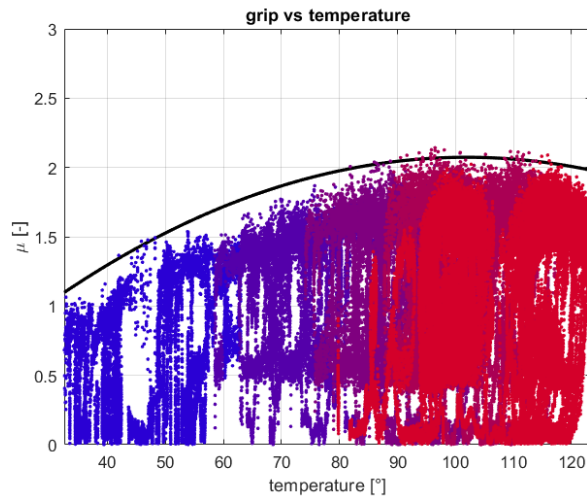
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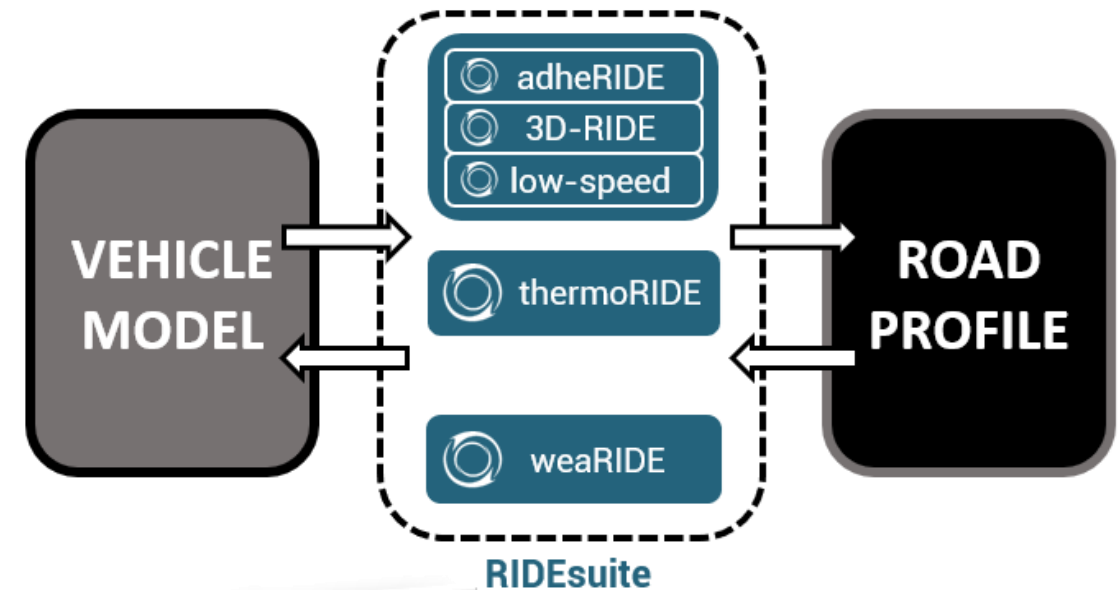

adheLAB

adheRIDE
3D-RIDE
low-speed

thermoRIDE

weaRIDE

PHYSICAL MODELS: RIDEsuite – <u>thermoRIDE</u>

4 PHYSICAL MODELS (RIDEsuite)

adheRIDE
advanced MF

weaRIDE
tire wear model

thermoRIDE
tire thermal model

threedeeRIDE
multicontact model

Physical Models developed by MegaRide constitute the **RIDEsuite**. It comprises four main elements, able to simulate in detail the physical effects characterizing a vehicle interacting with the external environment:
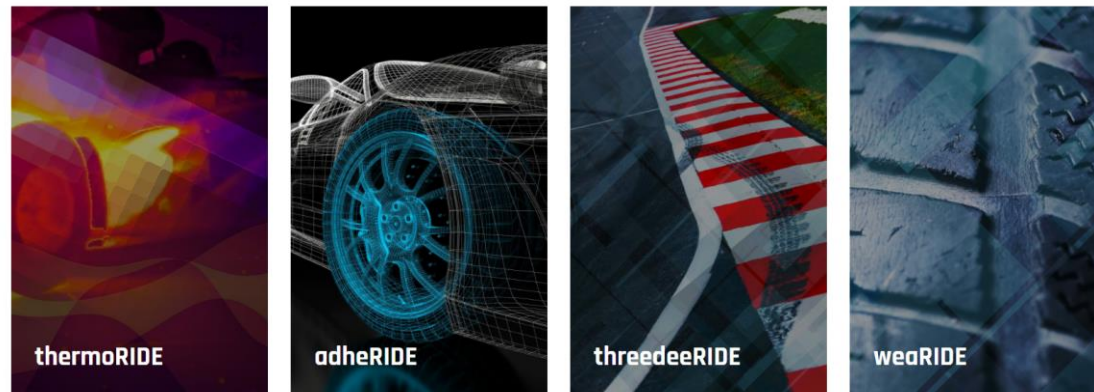
thermoRIDE   adheRIDE   threedeeRIDE   weaRIDE

VEHICLE MODEL

adheRIDE
3D-RIDE
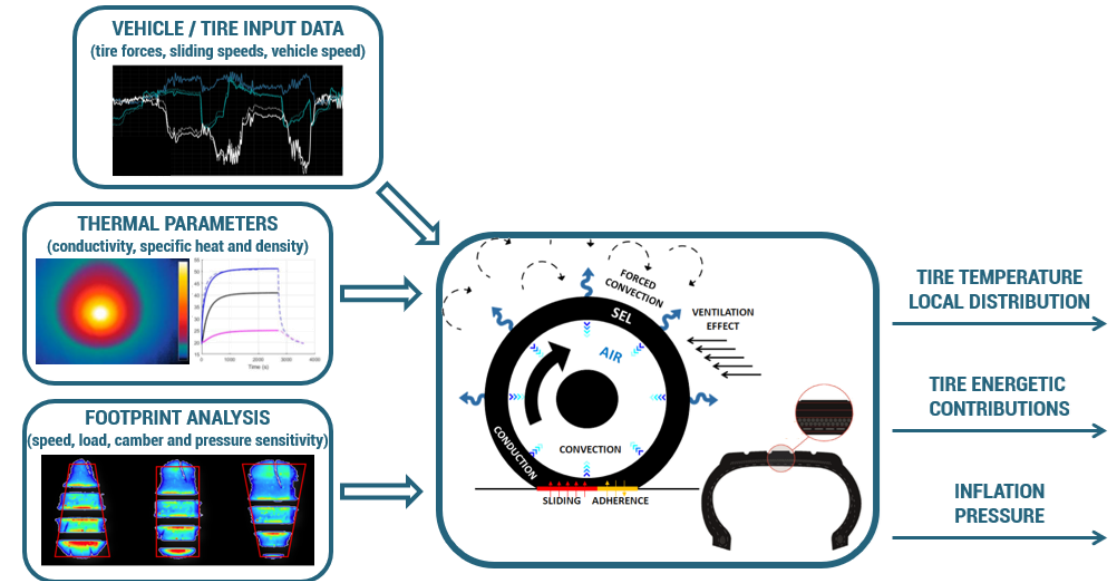low-speed

thermoRIDE

weaRIDE

RIDEsuite

ROAD PROFILE

PHYSICAL MODELS: RIDEsuite – <u>thermoRIDE</u>

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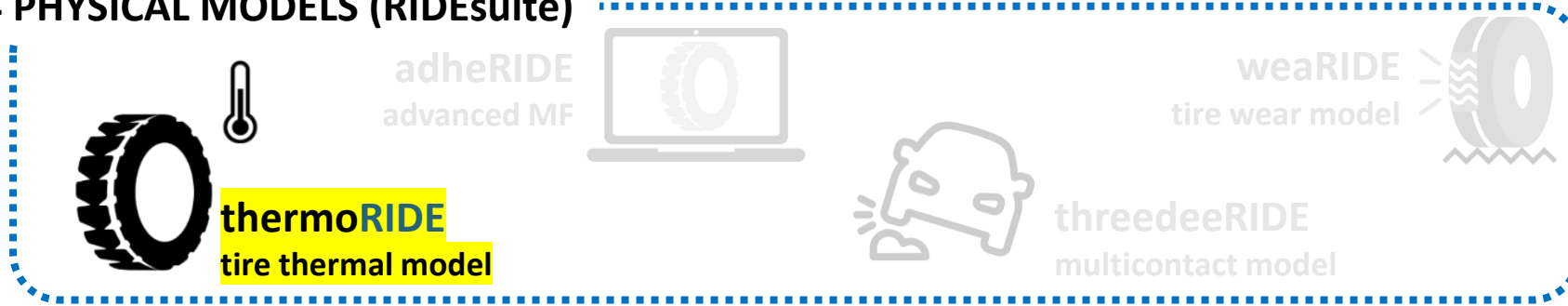threedeeRIDE
multicontact model

thermoRIDE is a physical-analytical tire thermal model, currently employed by vehicle and tire manufacturing companies and in motorsport, developed with the aim to:

• PREDICT LOCAL TIRE THERMAL DISTRIBUTION AND ITS EFFECT ON VEHICLE PERFORMANCE

• SIMULATE TIRE THERMAL BEHAVIOUR IN REAL-TIME ENVIRONMENTS RECEIVING IN INPUT VEHICLE DATA

• UNDERSTAND AND OPTIMIZE TIRE BEHAVIOUR WITH CONSEQUENTIAL SETTING OF PROPER VEHICLE SETUP

VEHICLE / TIRE INPUT DATA
(tire forces, sliding speeds, vehicle speed)

THERMAL PARAMETERS
(conductivity, specific heat and density)

FOOTPRINT ANALYSIS
(speed, load, camber and pressure sensitivity)

FORCED CONVECTION
VENTILATION EFFECT
SEL
AIR
CONDUCTION
CONVECTION
SLIDING ADHERENCE

TIRE TEMPERATURE LOCAL DISTRIBUTION

TIRE ENERGETIC CONTRIBUTIONS

INFLATION PRESSURE

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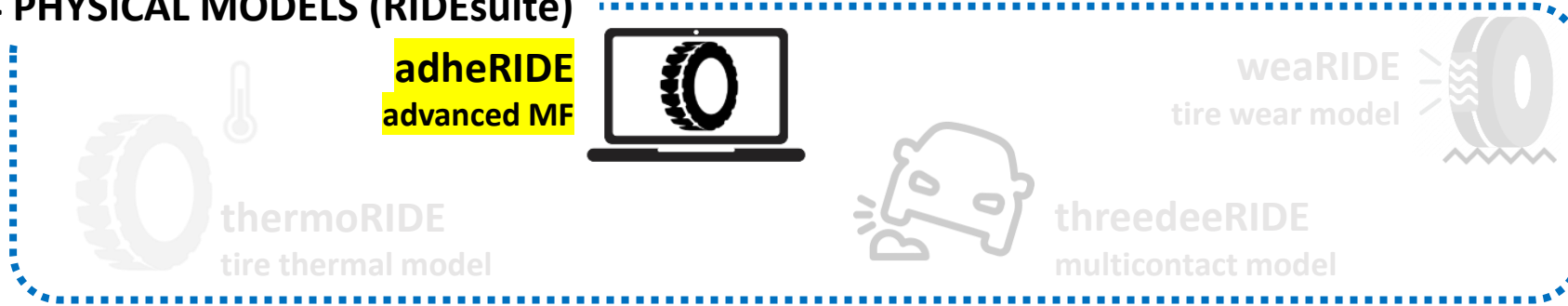threedeeRIDE
multicontact model

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- **NONDESTRUCTIVE THERMAL CHARACTERIZATION**

- **ACCOUNTING FOR WEAR & DEGRADATION EFFECTS**

- **DISCRETIZATION UP TO 8 DIFFERENT LAYERS, 16 DIFFERENT RIBS, IN REAL-TIME FOR BOTH DESKTOP AND DIL APPLICATIONS**

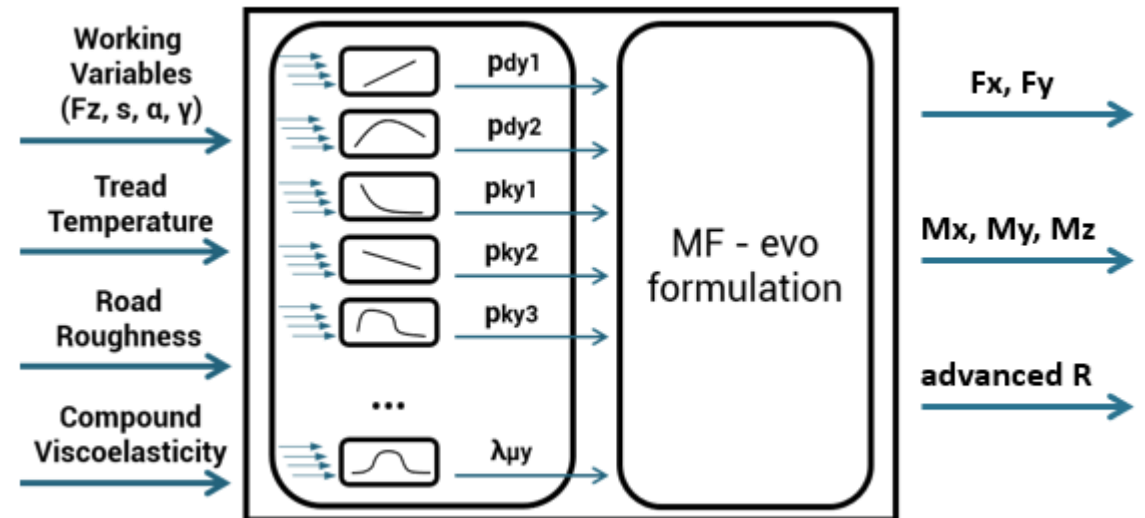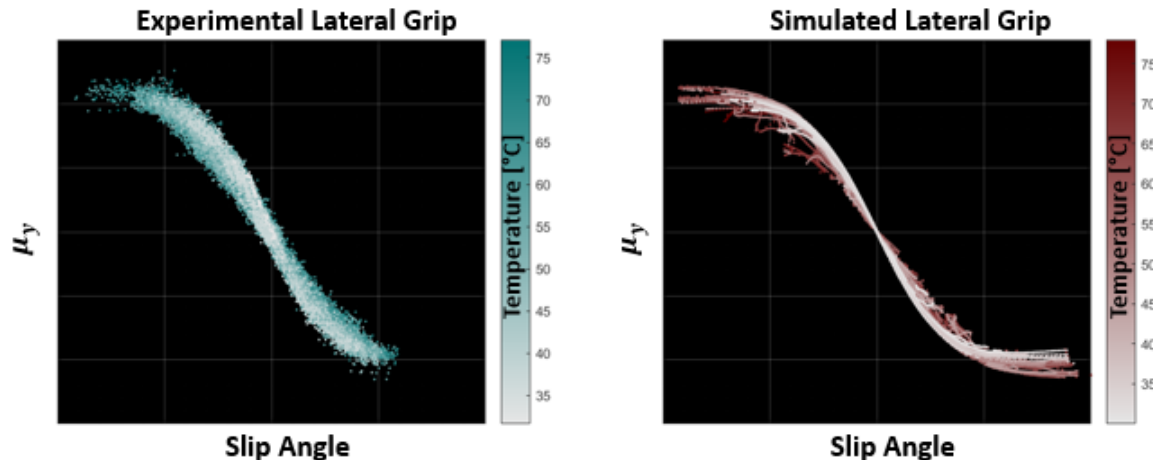- **COMPLIANT WITH ANY TIRE SIZE AND BRAND**

PHYSICAL MODELS: RIDEsuite – adheRIDE

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advanced MF

weaRIDE
tire wear model

thermoRIDE
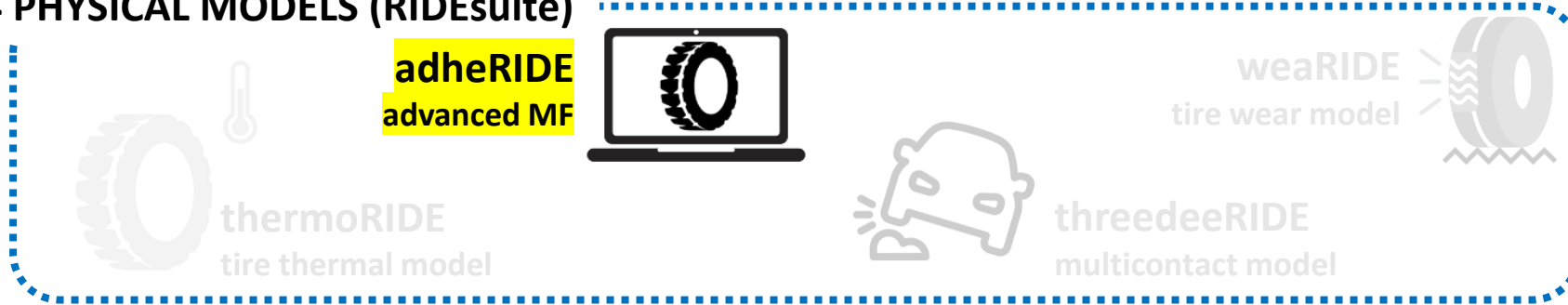tire thermal model

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multicontact model

adheRIDE represents an advanced Pacejka-based interaction model, whose parameters are no longer static throughout the entire run, but are variable with physical dependencies (temperature, wear, road roughness and compound viscoelasticity) provided by RIDEsuite modules

Experimental Lateral Grip

μ_y — Slip Angle — Temperature [°C]

Simulated Lateral Grip

μ_y — Slip Angle — Temperature [°C]

Working Variables (F_z, s, α, γ) → pdy1
Tread Temperature → pdy2
Road Roughness → pky1
Compound Viscoelasticity → pky2, pky3 ... λμy

MF - evo formulation → Fx, Fy
Mx, My, Mz
advanced R

PHYSICAL MODELS: RIDEsuite – <u>adheRIDE</u>

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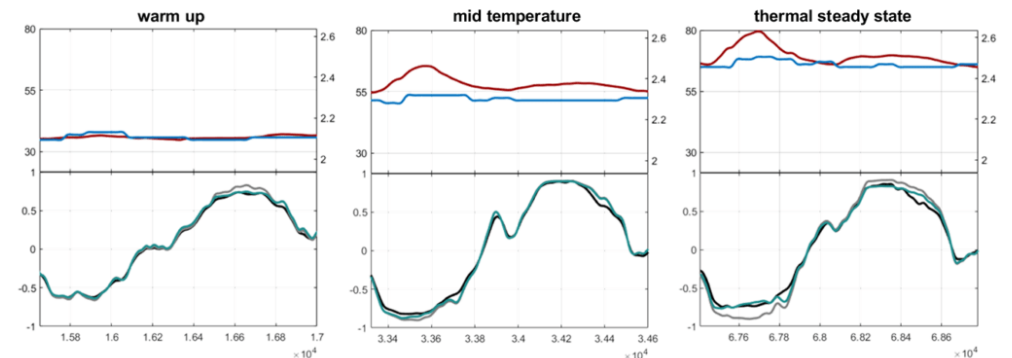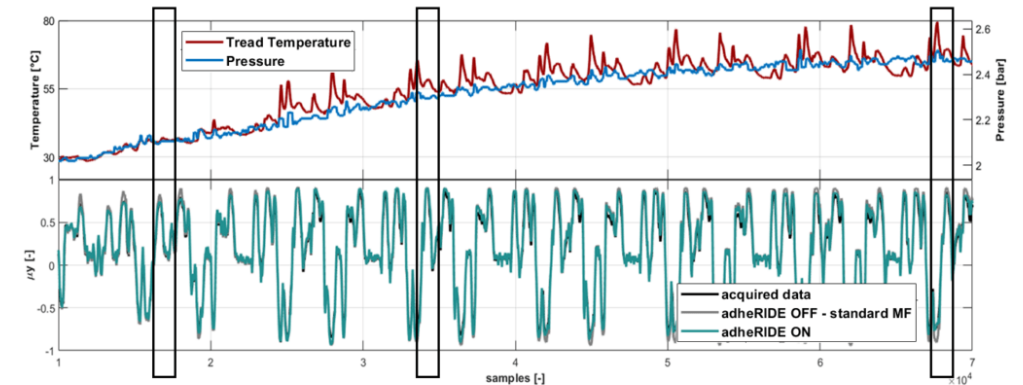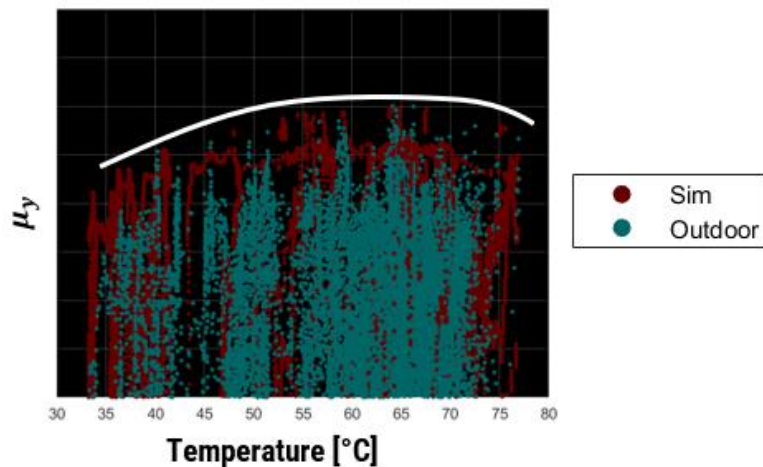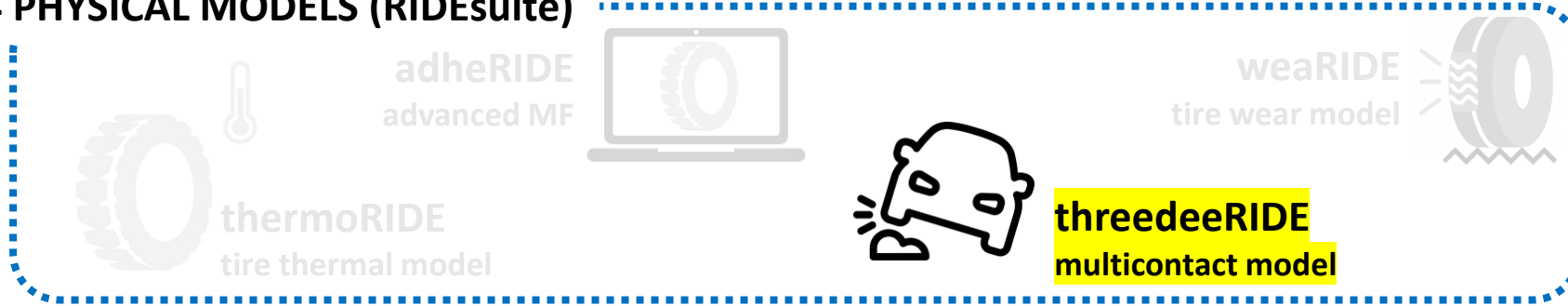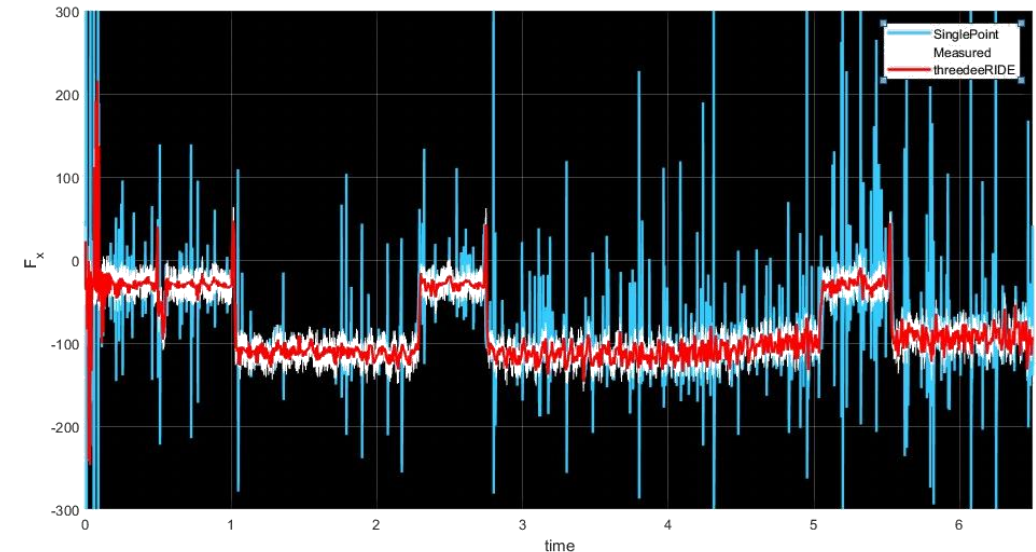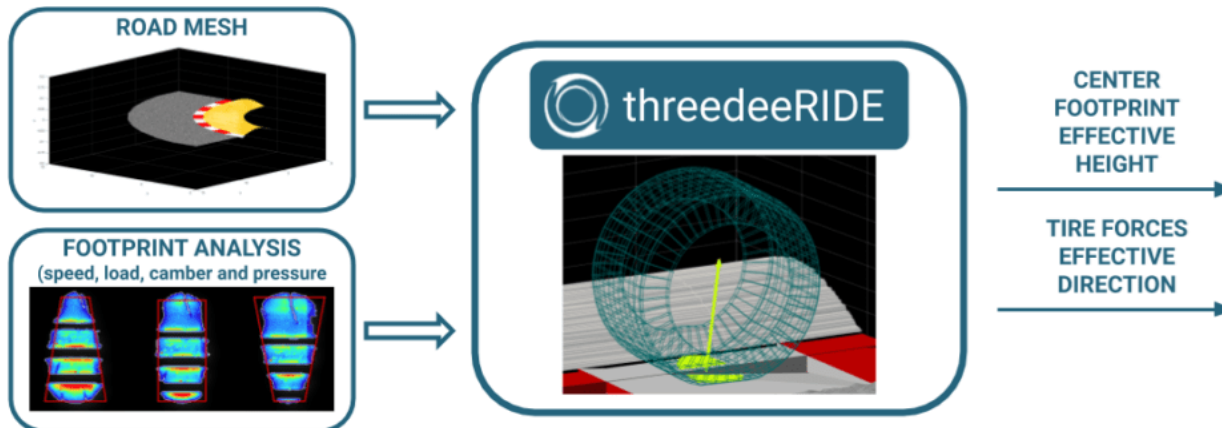
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tire thermal model

threedeeRIDE
multicontact model

threedeeRIDE is a three-dimensional real-time tire multicontact model, conceived with the aim to overcome the typical issues linked to single contact tire models. It enhances feelings and realism of the driving experience, properly evaluate the kinematics at the tire/road interface.
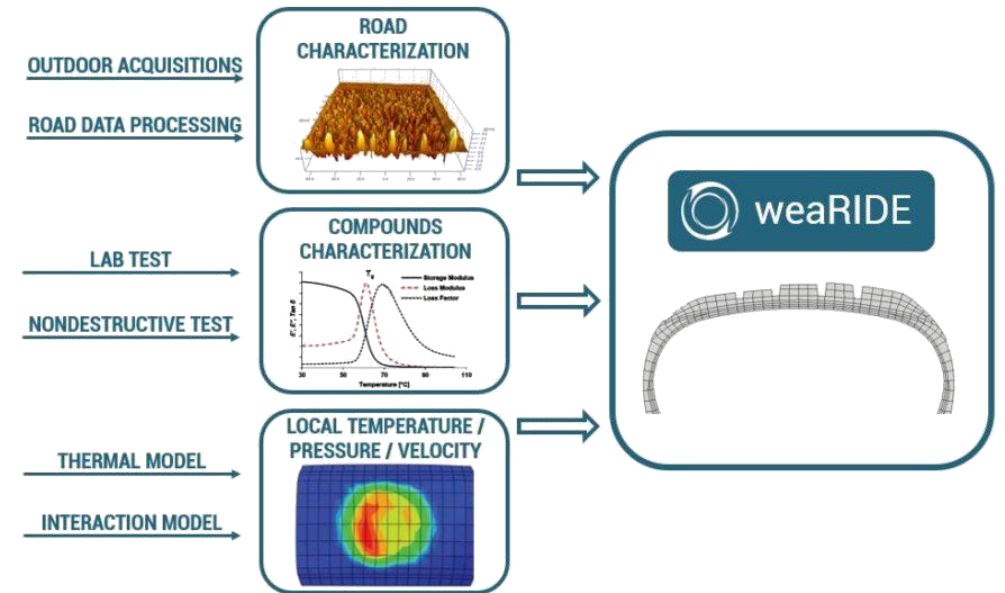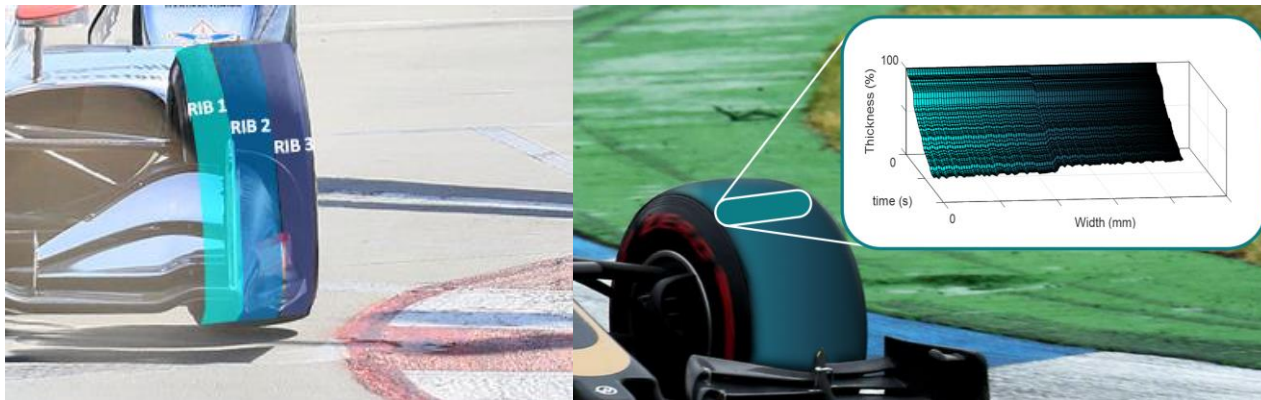
ROAD MESH

FOOTPRINT ANALYSIS
(speed, load, camber and pressure

threedeeRIDE

CENTER
FOOTPRINT
EFFECTIVE
HEIGHT

TIRE FORCES
EFFECTIVE
DIRECTION

PHYSICAL MODELS: RIDEsuite – **weaRIDE**

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The multiphysical approach proposed by MegaRide is completed by the wear model **weaRIDE**, developed to consider tread wear and tire degradation phenomena involved in tire lifecycle and in races, taking into account aspects concerning road and tire compound characterizations, and local thermal phenomena occurring within the contact patch.

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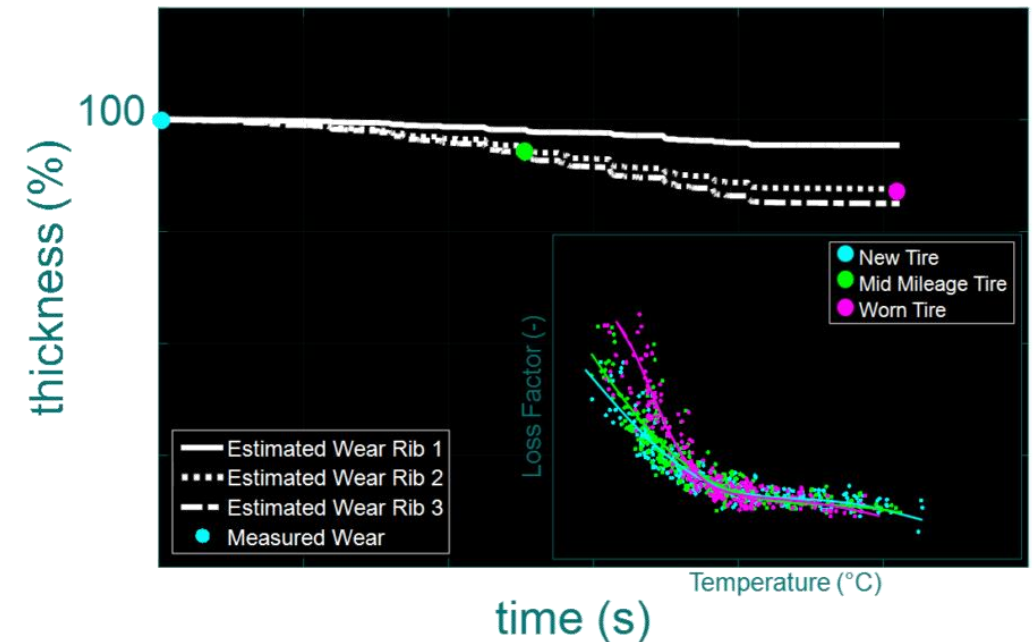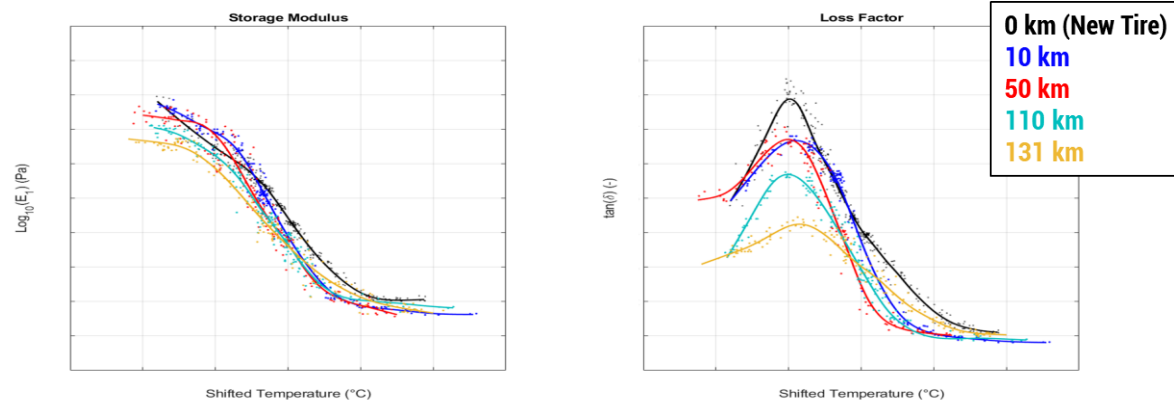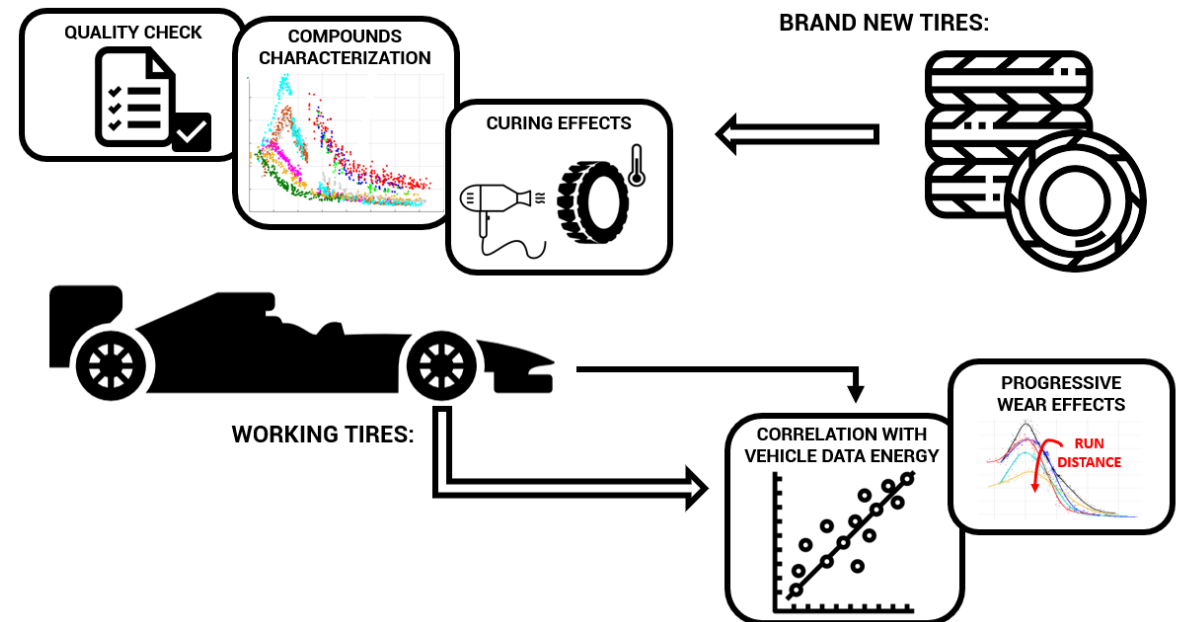
Tire Analysis – <u>VESevo</u>

1 INNOVATIVE DEVICE + TESTBENCHES

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nondestructive tread compound analyzer

thermobench
tire thermal analysis

footprints-ID
shape & contact pressure

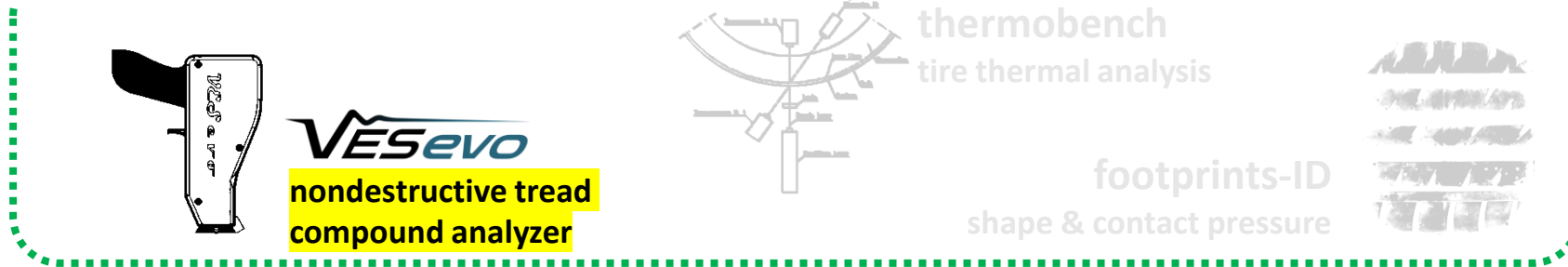**In the last year a new hardware has been developed and launched:**
VESevo tire compounds characterization device. Its features:

- NONDESTRUCTIVE TIRE VISCOELASTIC TESTING
- PORTABLE, FAST AND EASY TO USE
- LIVE TRACK DATA FOR DEVELOPING RACING STRATEGIES
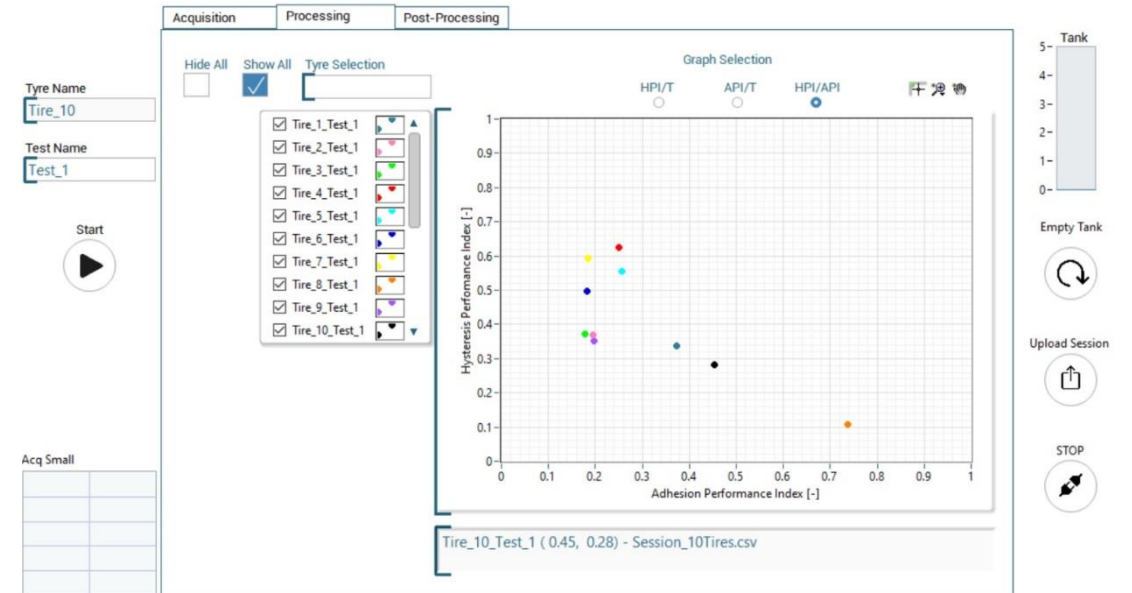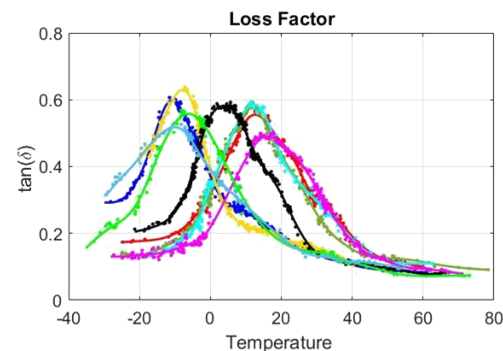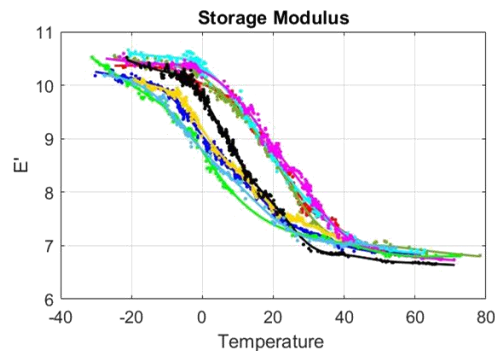- OBJECTIVE DATA FOR PHYSICAL GRIP AND WEAR MODELS

BRAND NEW TIRES:

QUALITY CHECK

COMPOUNDS CHARACTERIZATION

CURING EFFECTS

WORKING TIRES:

CORRELATION WITH VEHICLE DATA ENERGY

PROGRESSIVE WEAR EFFECTS

RUN DISTANCE

Tire Analysis – <u>VESevo</u>

1 INNOVATIVE DEVICE + TESTBENCHES

thermobench
tire thermal analysis

nondestructive tread compound analyzer

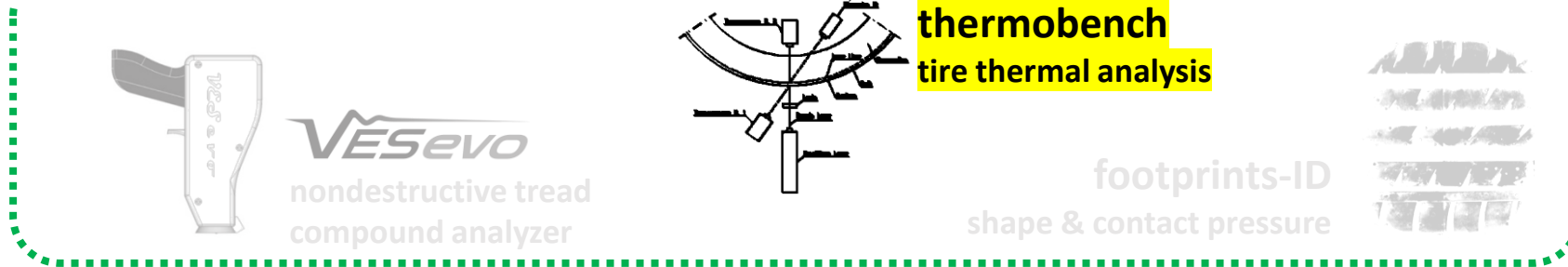footprints-ID
shape & contact pressure

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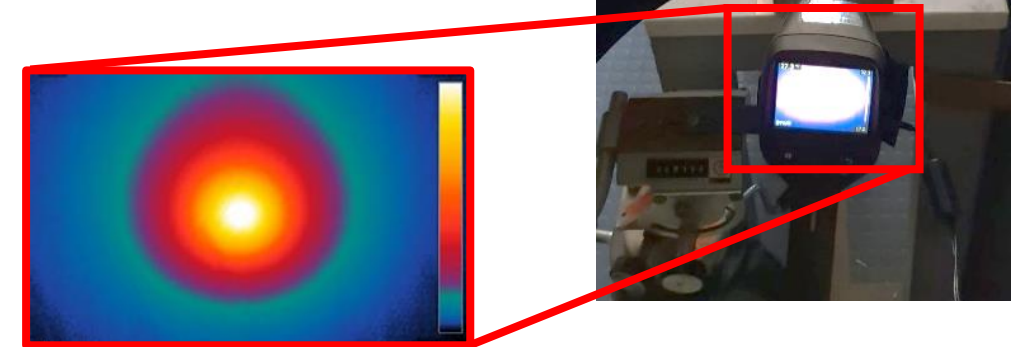- **OBJECTIVE DATA FOR PHYSICAL GRIP AND WEAR MODELS**

Tire Analysis – <u>Thermal Bench</u>

1 INNOVATIVE DEVICE + TESTBENCHES

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nondestructive tread compound analyzer

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tire thermal analysis

footprints-ID
shape & contact pressure

Innovative laser-based nondestructive methodology for the identification of thermal conductivity, specific heat and density characteristics vs temperature, of the materials constituting inner tire layers. An identification model-based technique allows to get thermoRIDE physical parameters
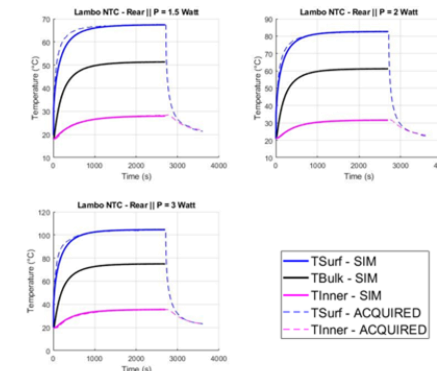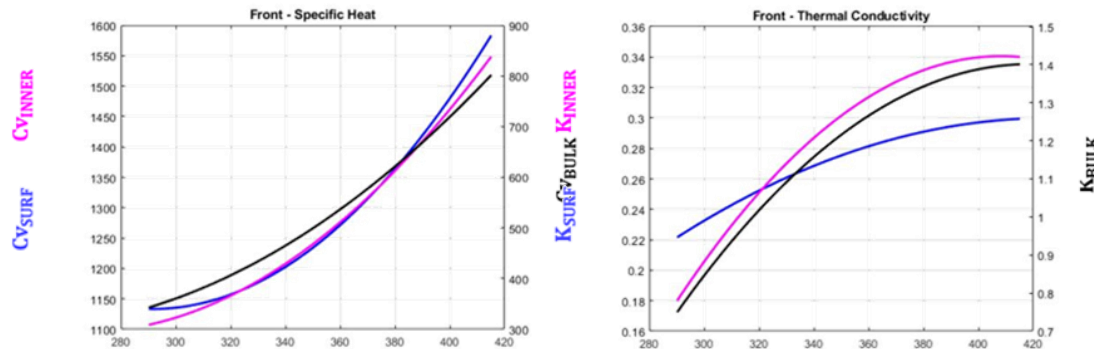
Tire Analysis – <u>Footprints ID</u>

1 INNOVATIVE DEVICE + TESTBENCHES

thermobench
tire thermal analysis

VESevo
nondestructive tread compound analyzer

footprints-ID
shape & contact pressure

Lab hydraulic press allows to vary vertical load, inclination angle and inflation pressure, acquiring shape and pressure distribution

- TEST ON CAR, MOTORBIKE AND LIGHT TRUCK TIRES
- PROPRIETARY TOOL FOR FOOTPRINTS "VIRTUALIZATION"
- DATA USED FOR THERMAL, WEAR AND MULTICONTACT MODELS
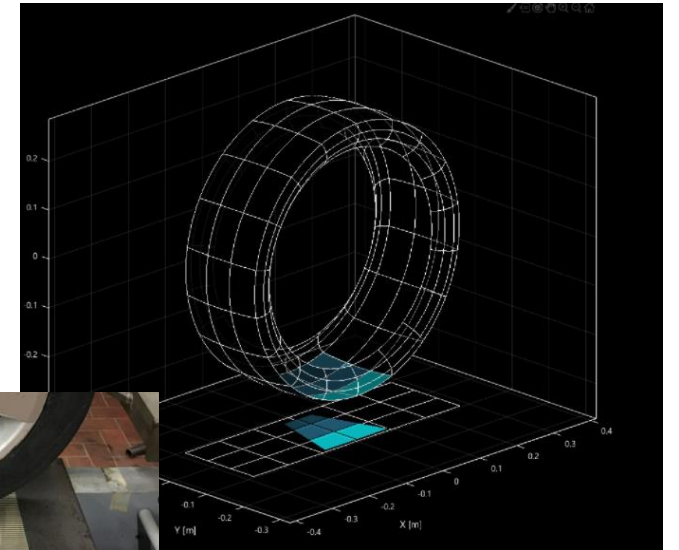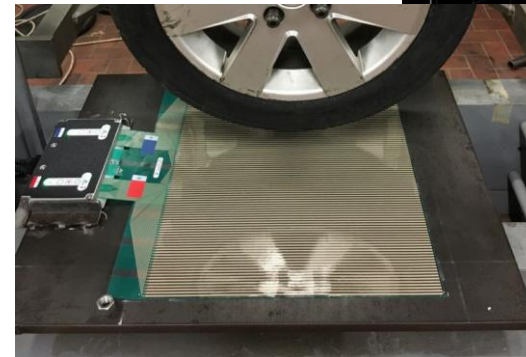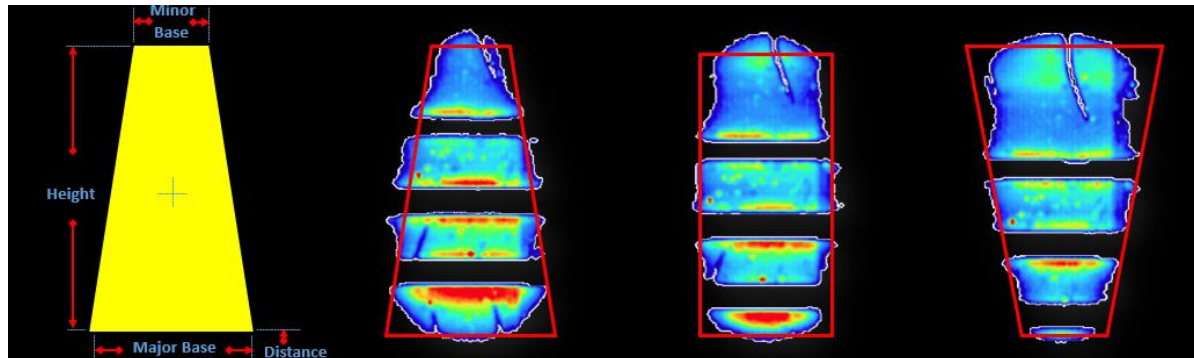
CASE STUDIES – 1. BASIC VEHICLE/TIRE DEV

analyzing vehicles

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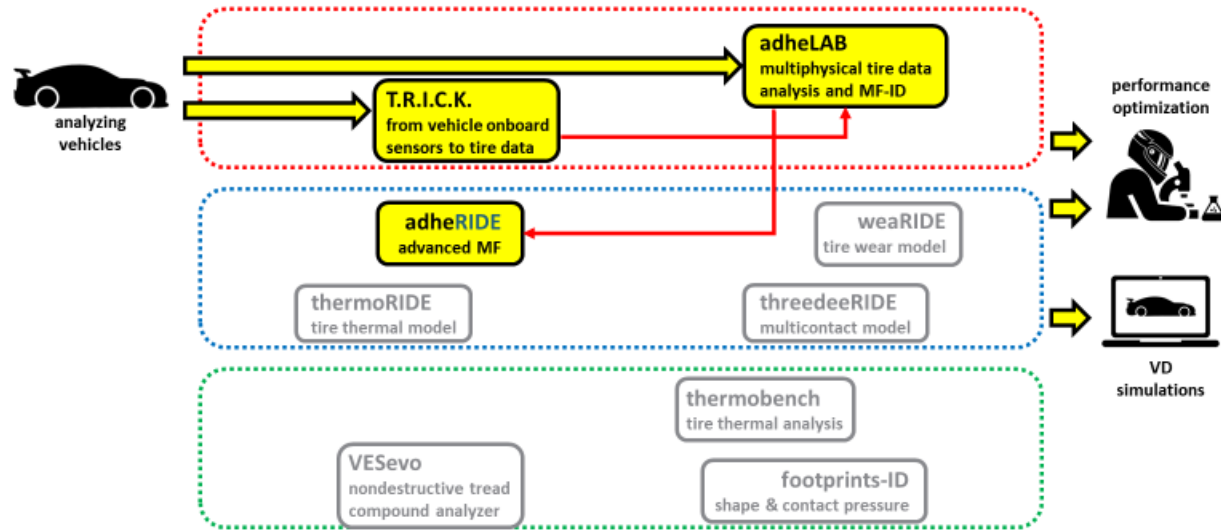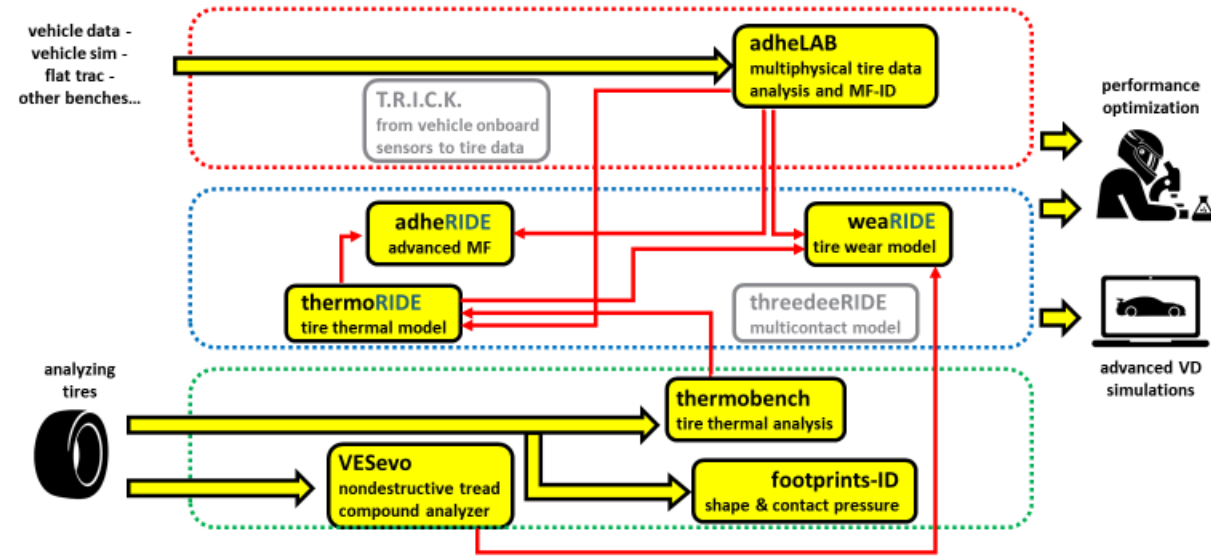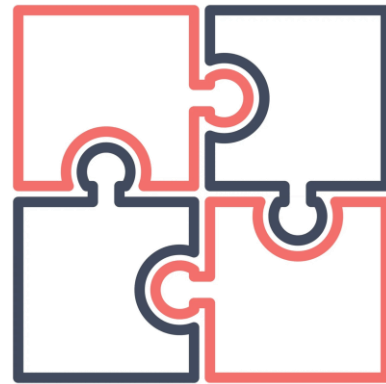from vehicle onboard sensors to tire data

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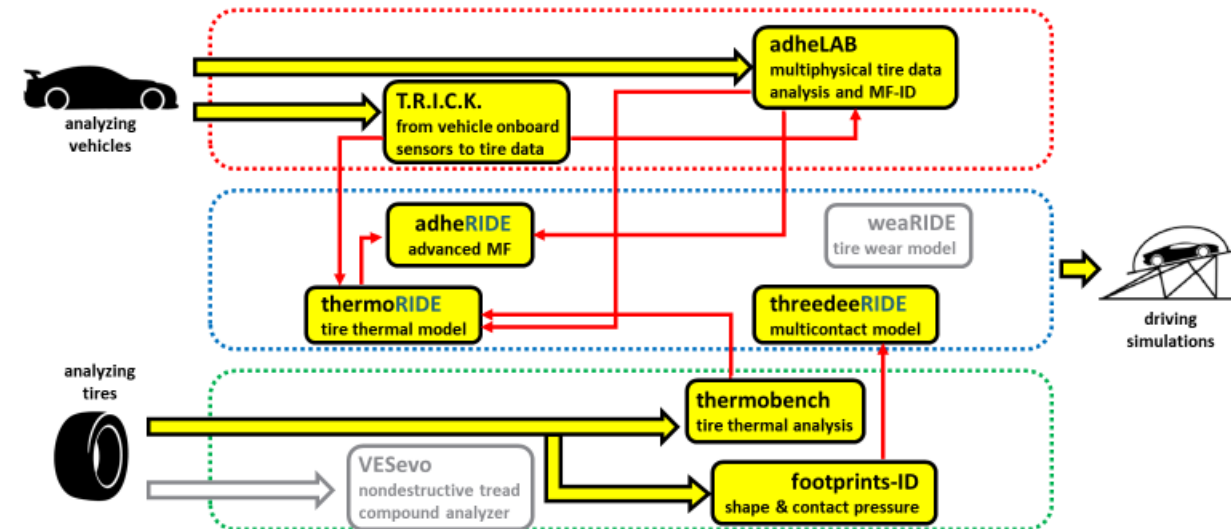
footprints-ID
shape & contact pressure

performance optimization

VD simulations

CASE STUDIES – 2. PERFORMANCES FOR RACING

vehicle data -
vehicle sim -
flat trac -
other benches...

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multiphysical tire data analysis and MF-ID

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advanced VD simulations

CASE STUDIES – 3. FROM REAL TO DIGITAL TWIN

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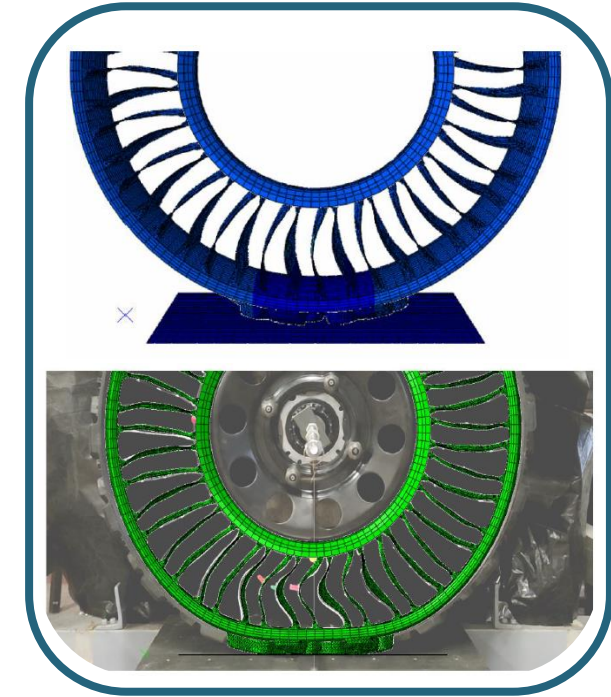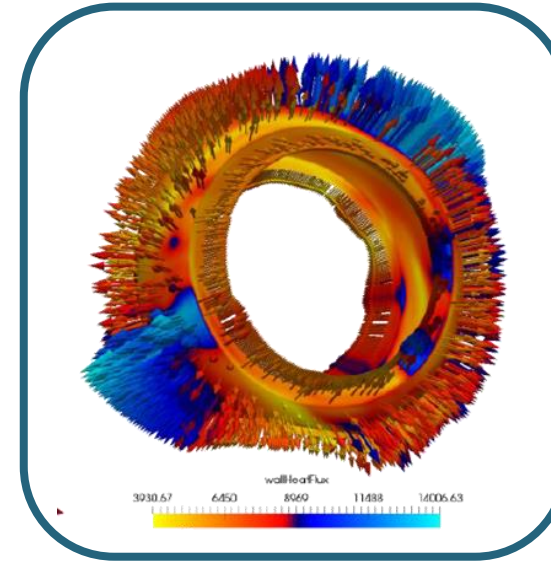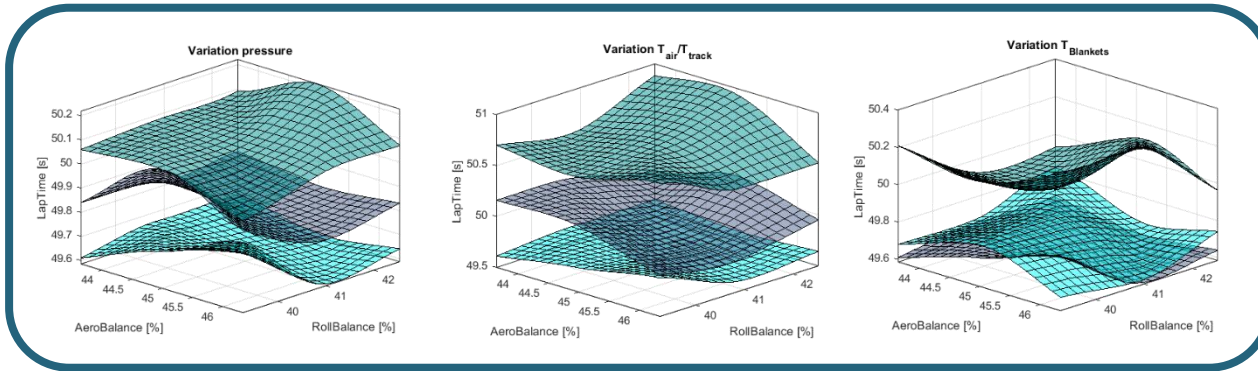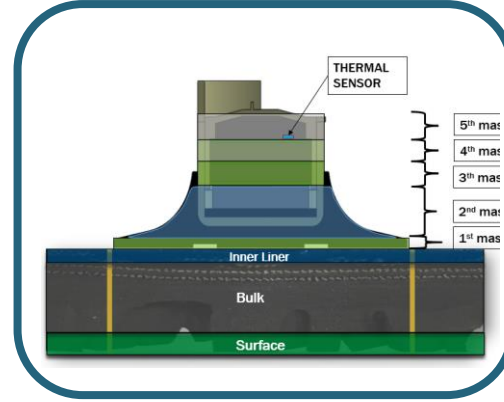shape & contact pressure

driving simulations

THE REPORTED TOOLS CAN BE MIXED AND ASSEMBLED TO CREATE A COMPLETELY CUSTOMIZED TIRE TESTING, ANALYSIS AND SIMULATION PLATFORM, DIFFERENT PER EACH KIND OF USER AND TARGET

...what's more? Bespoke Tire Research
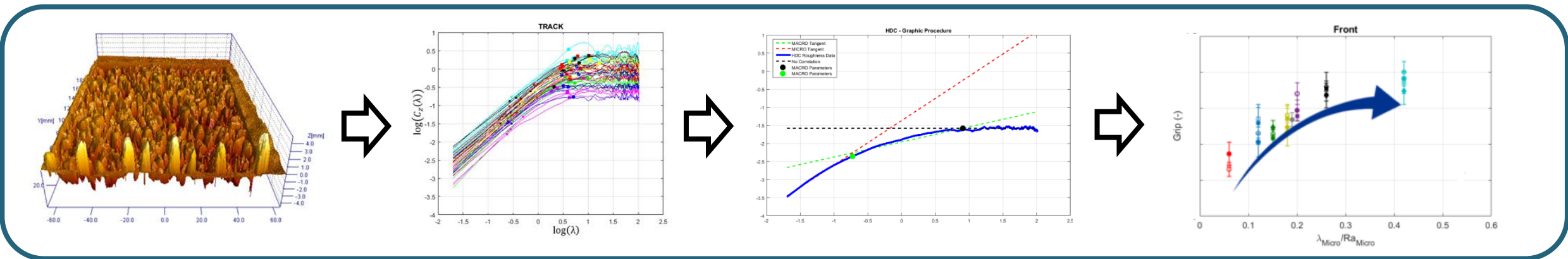
References ([click here for more](#))

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