





Vehicle Dynamics research group

DII - Dipartimento di Ingegneria Industriale
Università degli Studi di Napoli Federico II



megaride

Mega Ride



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II



DIPARTIMENTO DI
INGEGNERIA
INDUSTRIALE






MEGARIDE
APPLIED VEHICLE RESEARCH



**MODELS AND TECHNOLOGIES
TO OPTIMIZE VEHICLE / ROAD INTERACTION**



COMPANY HIGHLIGHTS

- "TIRE TECHNOLOGY OF THE YEAR" @ TIRE TECHNOLOGY EXPO 2018 
- GROWING TEAM (x3) AND REVENUES (x10) IN 3 YEARS WITH NO DEBT / NO EQUITY 
- EXCLUSIVE INTERACTIONS WITH TIREMAKERS AND MOTORSPORT TEAMS 



RESEARCH HIGHLIGHTS

- AWARDED BY “M.I.T. YOUNG INNOVATORS UNDER 35” 2018
- VD RESEARCH GROUP RESOURCES FROM 6 TO 13 PEOPLE IN 3 YEARS
- SUPPORT OF “TYRE LAB” UNIVERSITY FACILITY FOR EXPERIMENTAL ACTIVITIES



research partners



business partners



customers



and...



modelling
predictivity
drivingsimulator
motorcycle
racing
smart
design
performance
spacejka
grip
car
biotelemetry
research
virtualsensors
physicalmodels
friction
mechanics
machinelearning
simulations
mobility
optimization
automotive
motorsport
vehicle
tyres

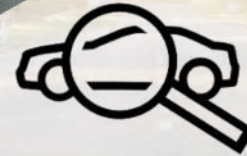
4 PhD + 1 post-doc

about 25 master thesis per year

about 15 bachelor thesis per year



WHAT WE DO - FOR CAR&TIRE MAKERS



**TIRE CHARACTERIZATION AND
ANALYSIS FROM VEHICLE DATA**



**GRIP EVALUATION FOR CONTROL
LOGICS AND SMART MOBILITY**



**COST AND TIME SAVINGS IN
TIRE & VEHICLE DEVELOPMENT STAGES**



WHAT WE DO - IN REALTIME SIMULATIONS



**FEEL TIRE GRIP & ROAD ROUGHNESS
VARIATIONS IN DRIVING SESSIONS**



**PREDICTIVE METHODOLOGIES AND
PHYSICAL CHARACTERIZATIONS**



**HIGHLY RELIABLE &
REALISTIC VIRTUAL TIRES**





WHAT WE DO - FOR MOTORSPORT



VEHICLE SETUP OPTIMIZATION FOR
PERFORMANCE ENHANCEMENT



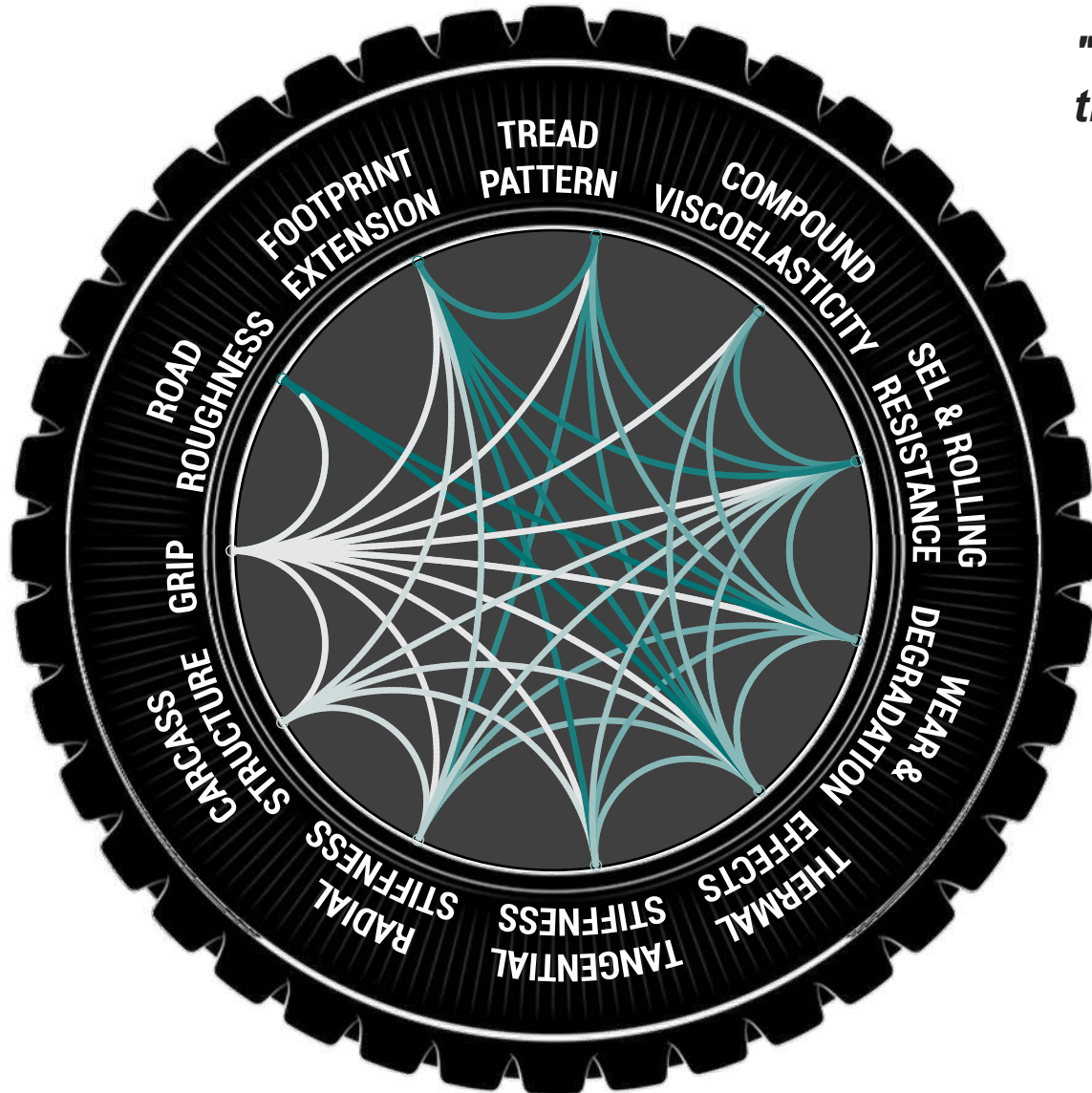
RESEARCH OF TREAD TEMPERATURE
FOR MAXIMUM TIRE GRIP



INNOVATIVE PATENTED DEVICES FOR
NONDESTRUCTIVE COMPOUND ANALYSIS



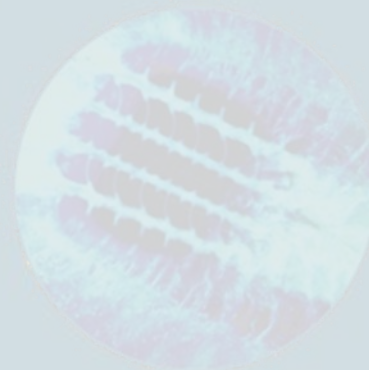
A HOLISTIC VIEW IN TIRE MODELLING



"For every complex problem there is a solution that is clear, simple, and wrong"

H. L. Mencken

PHYSICAL TIRE MODELS FOR REAL-TIME SIMULATIONS



weaRIDE

A MODULAR PLATFORM

FOR TIRE ANALYSIS AND MODELLING

adheRIDE

adheLAB

T.R.I.C.K.



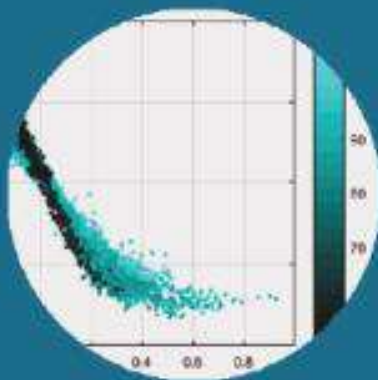
PERFORMANCE ANALYSIS AND CHARACTERIZATION



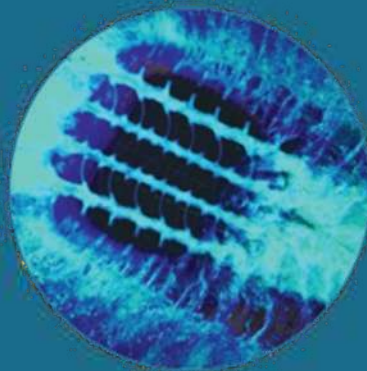
PHYSICAL TIRE MODELS FOR REAL-TIME SIMULATIONS



thermoRIDE



adheRIDE



threedeeRIDE



weaRIDE

T.R.I.C.K.



adheLAB



PERFORMANCE ANALYSIS AND CHARACTERIZATION



TOWARDS TIRE DIGITAL TWIN

2 PERFORMANCE TOOLS



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



adheLAB
multiphysical tire data
analysis and MF-ID

TIRE MULTIPHYSICAL MODELLING

4 PHYSICAL MODELS (RIDEsuite)



thermoRIDE
tire thermal model

adheRIDE
advanced MF



threedeeRIDE
multicontact model

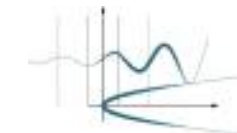
weaRIDE
tire wear model



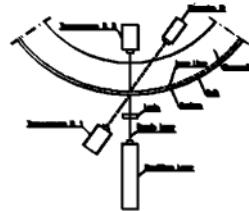


SMARTIFYING TIRE PARAMETERIZATION

1 INNOVATIVE DEVICE + TESTBENCHES

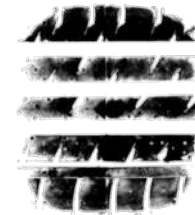


VESevo
nondestructive tread
compound analyzer



thermobench
tire thermal analysis

footprints-ID
shape & contact pressure





7(+) TOOLS FOR A MODULAR TIRE 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)



thermoRIDE
tire thermal model

adheRIDE
advanced MF

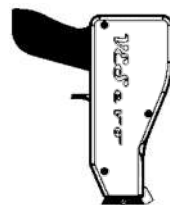


threedeeRIDE
multicontact model

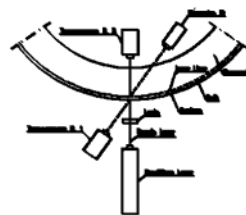
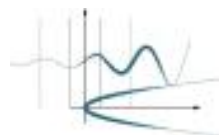
weaRIDE
tire wear model



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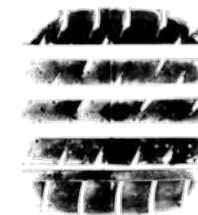


VESevo
nondestructive tread
compound analyzer



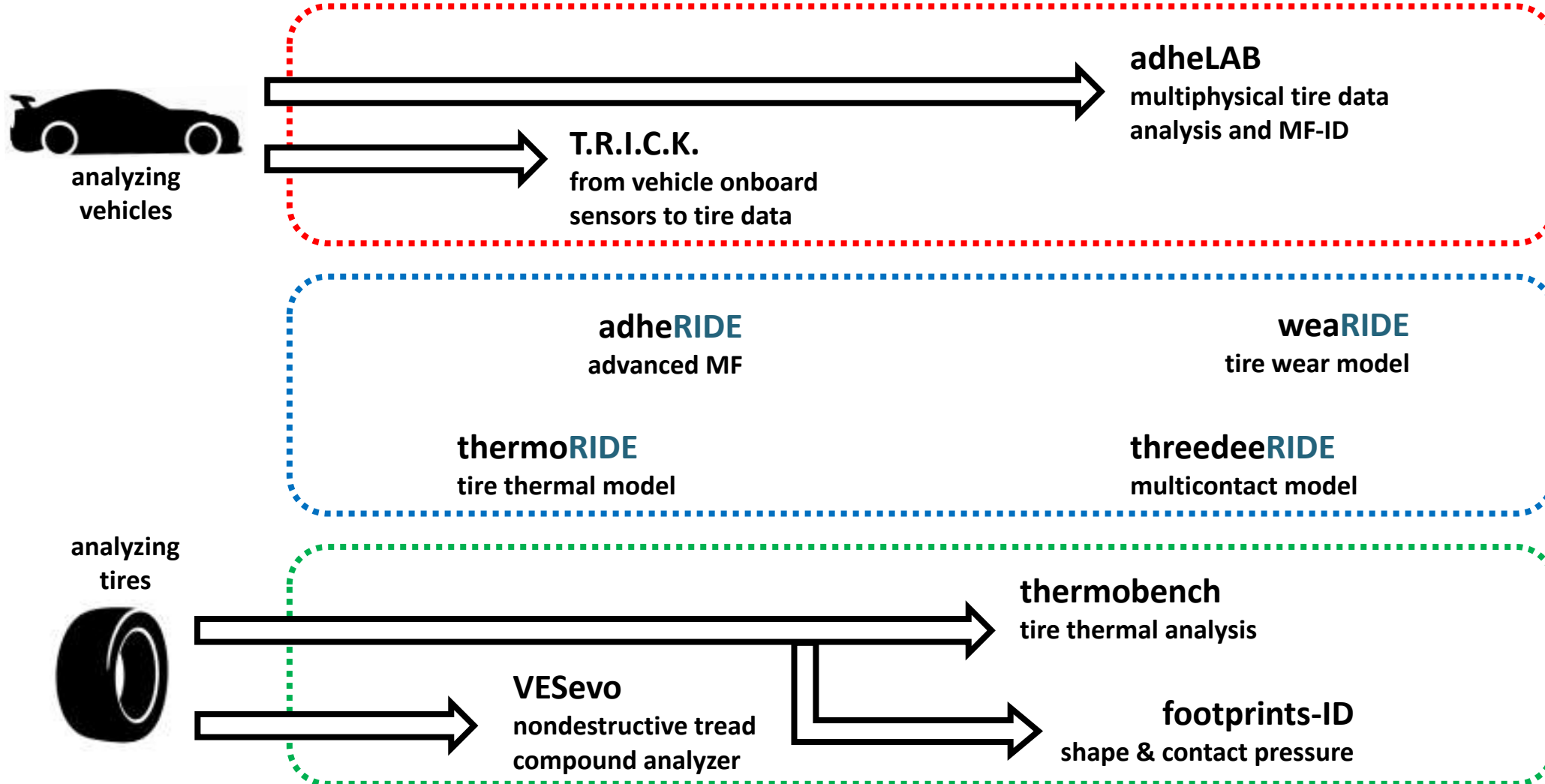
thermobench
tire thermal analysis

footprints-ID
shape & contact pressure



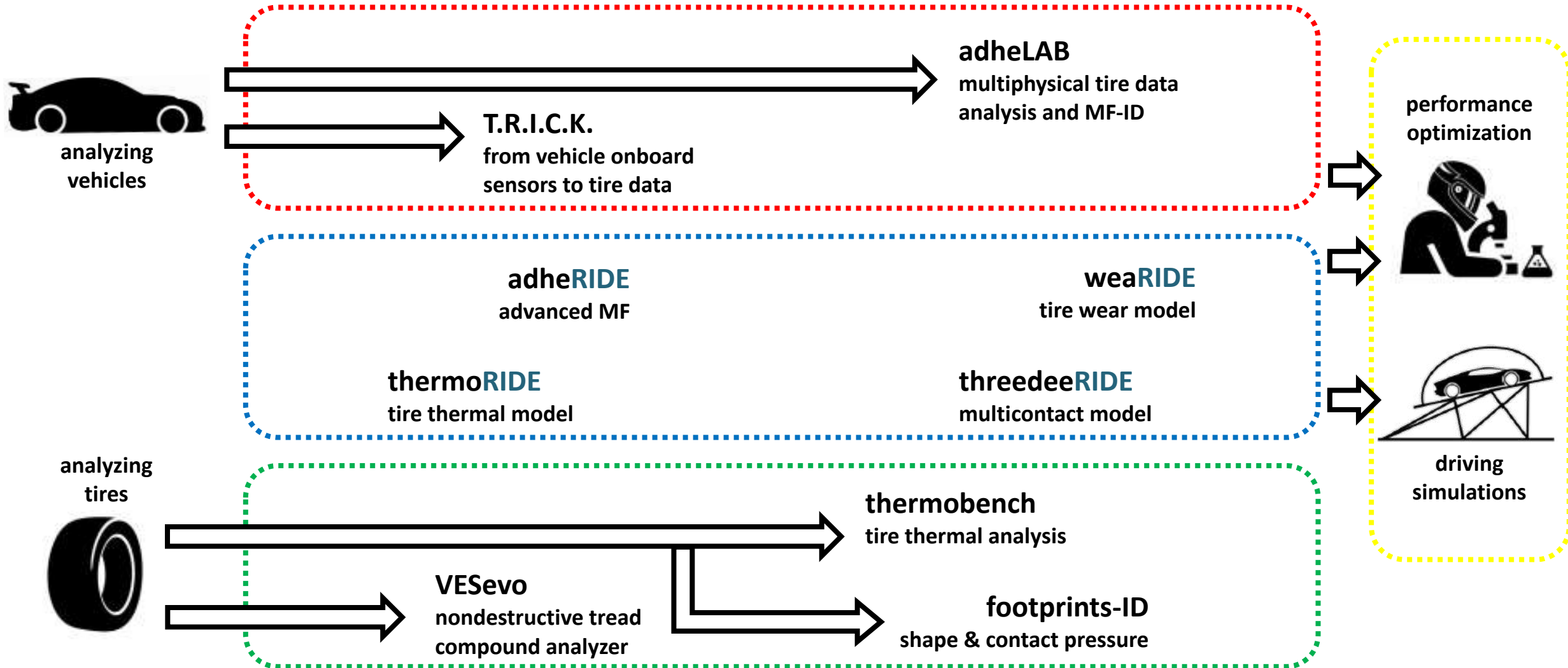


"FEEDING" THE PLATFORM



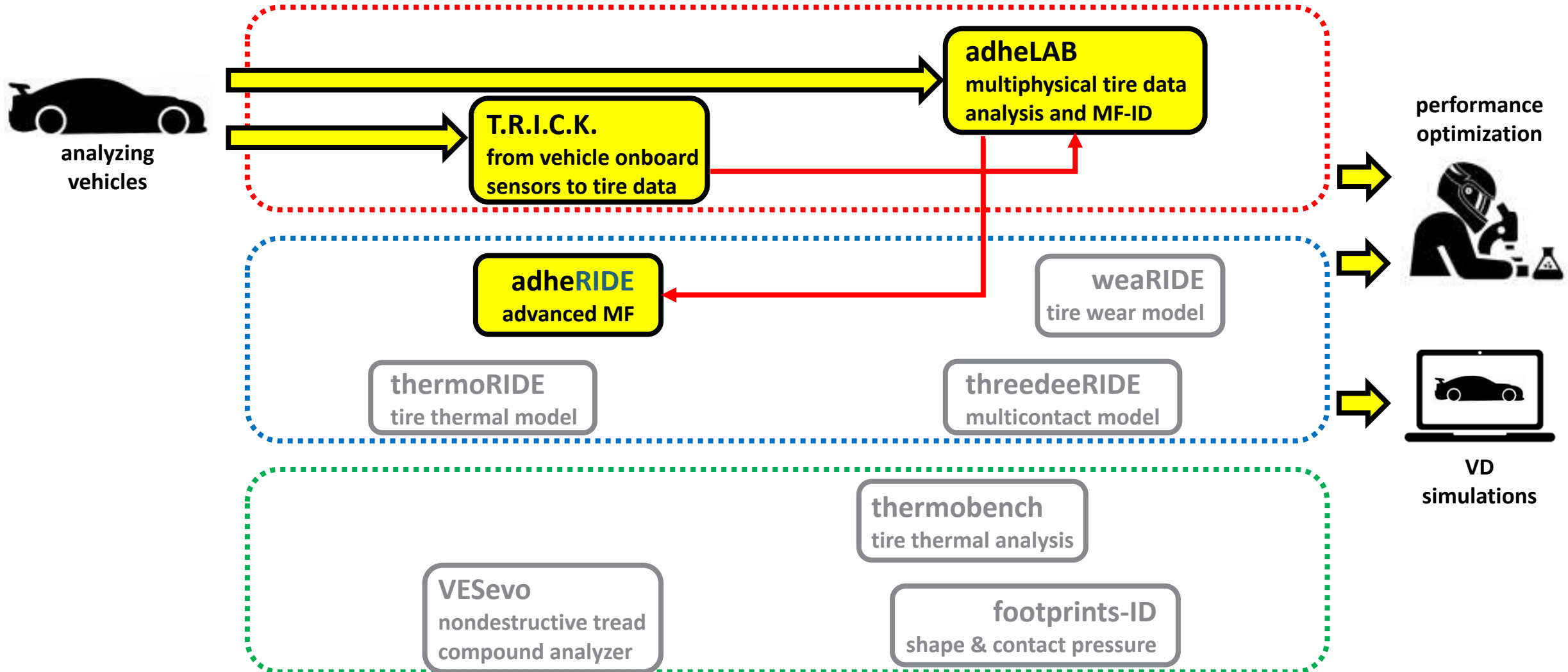


THE FINAL TARGETS



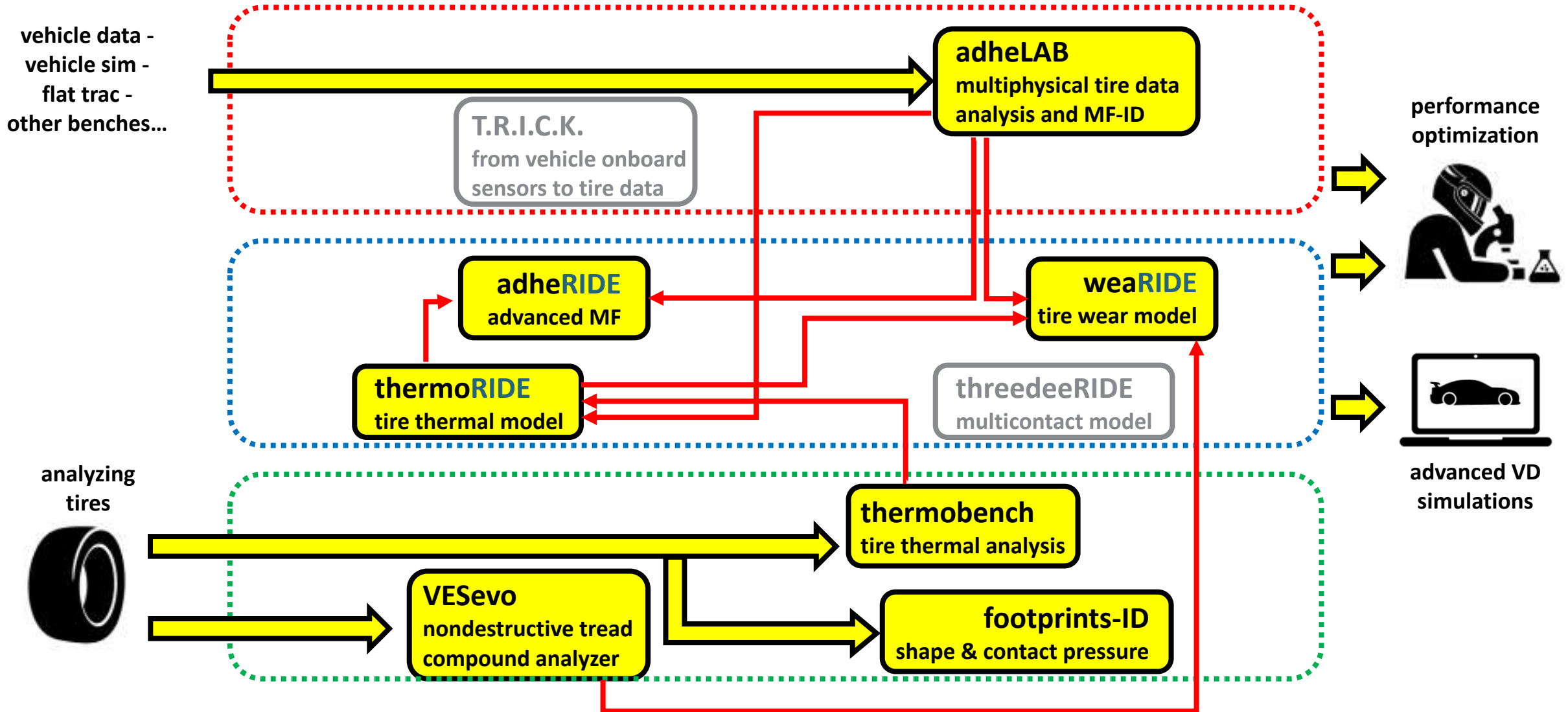


CASE STUDIES – 1. BASIC VEHICLE/TIRE DEV



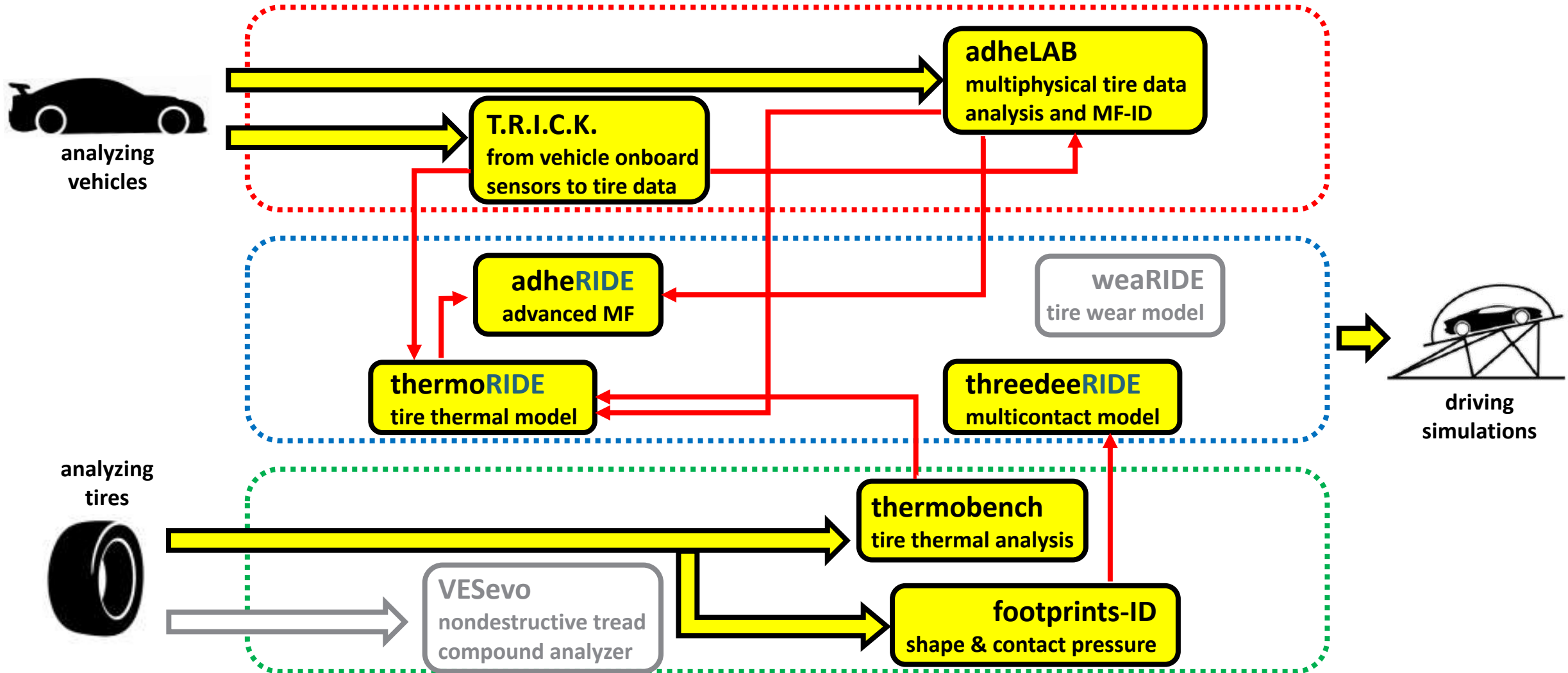


CASE STUDIES – 2. PERFORMANCES FOR RACING



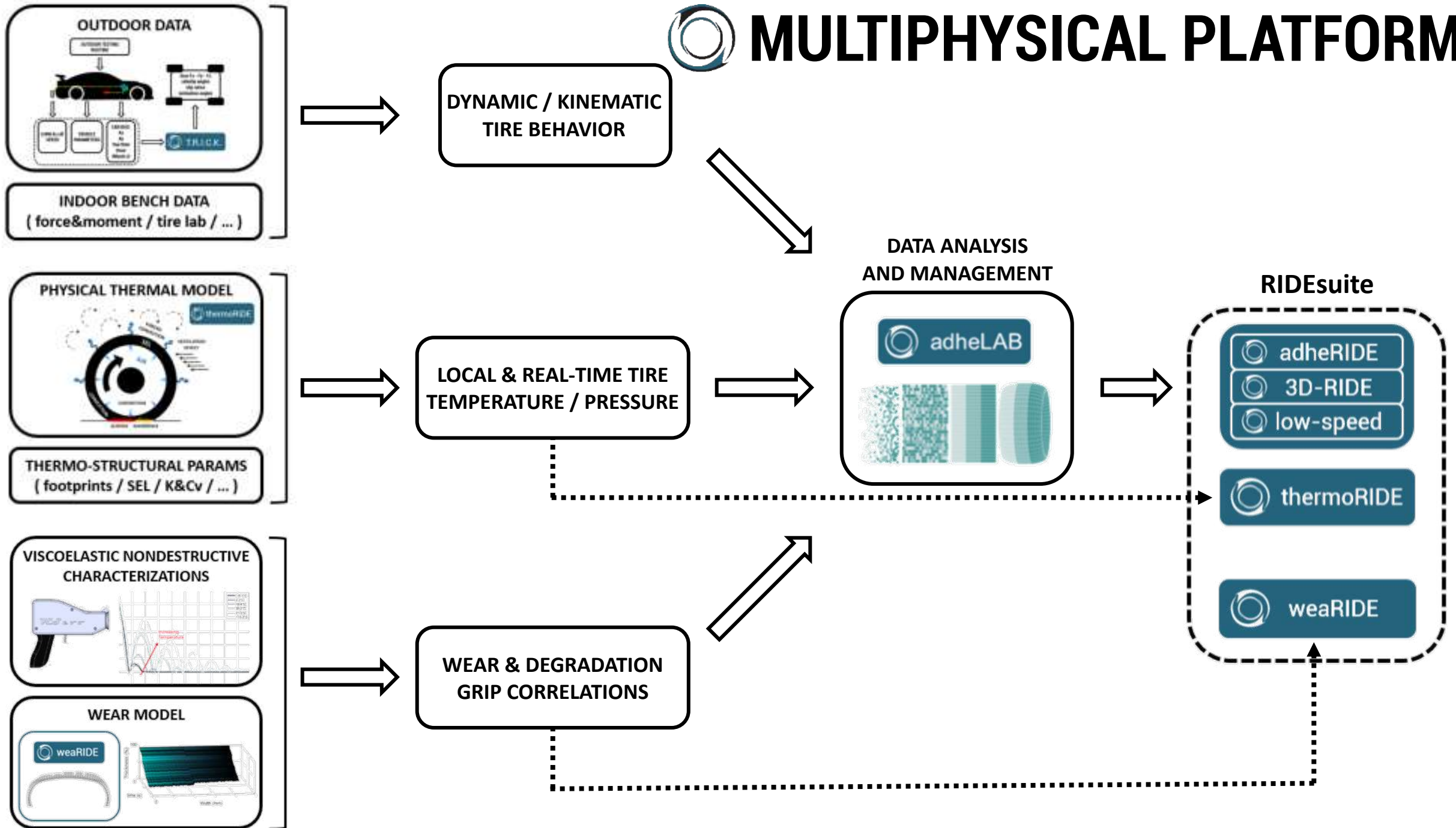


CASE STUDIES – 3. FROM REAL TO DIGITAL TWIN

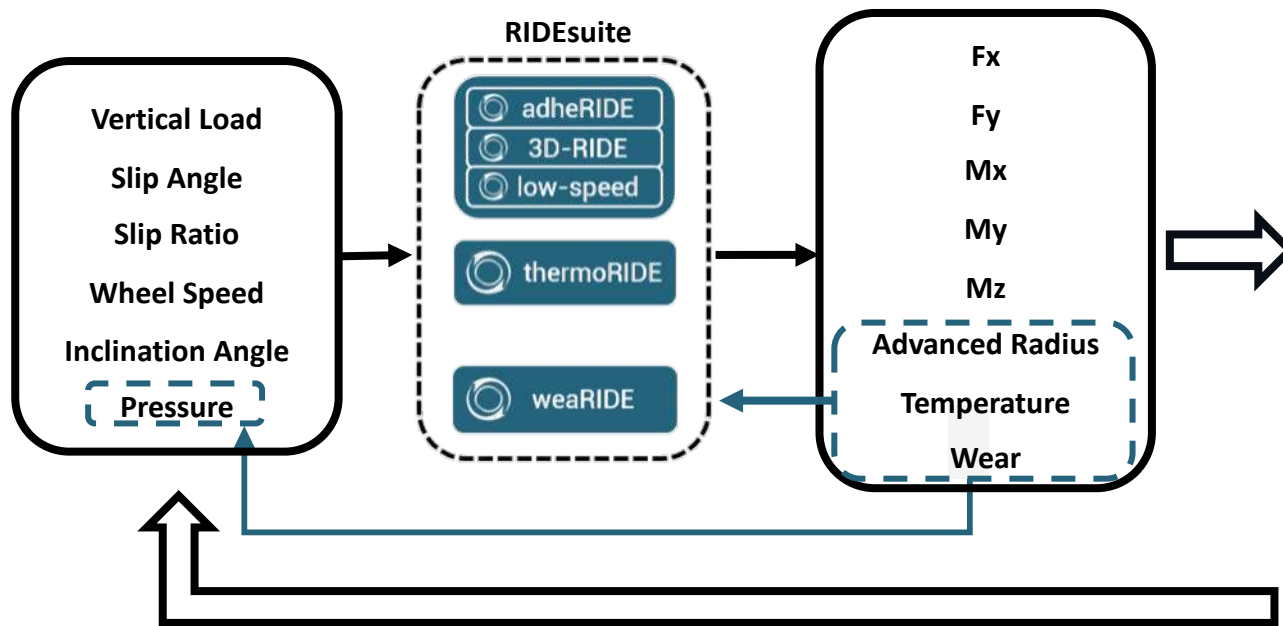




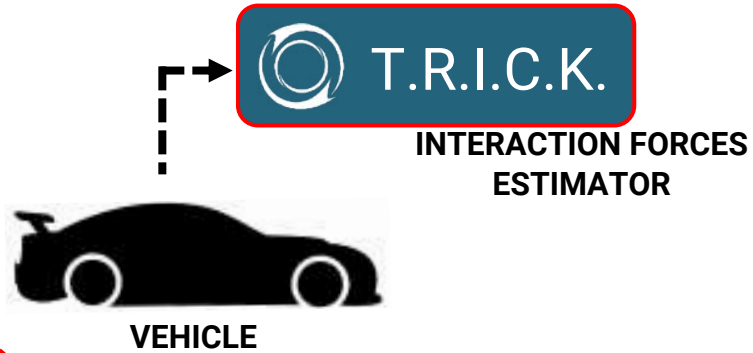
MULTIPHYSICAL PLATFORM



RIDEsuite: a modular multiphysical platform
for a holistic view of tires behavior



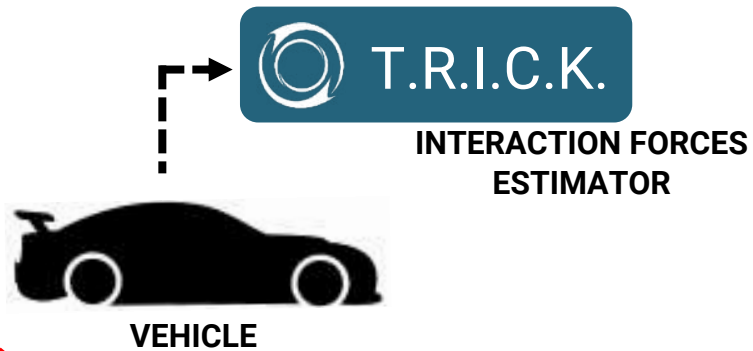
SCENARIO I
vehicle and tires
development



T.R.I.C.K.: Tire/Road Interaction Characterization & Knowledge

SCENARIO A

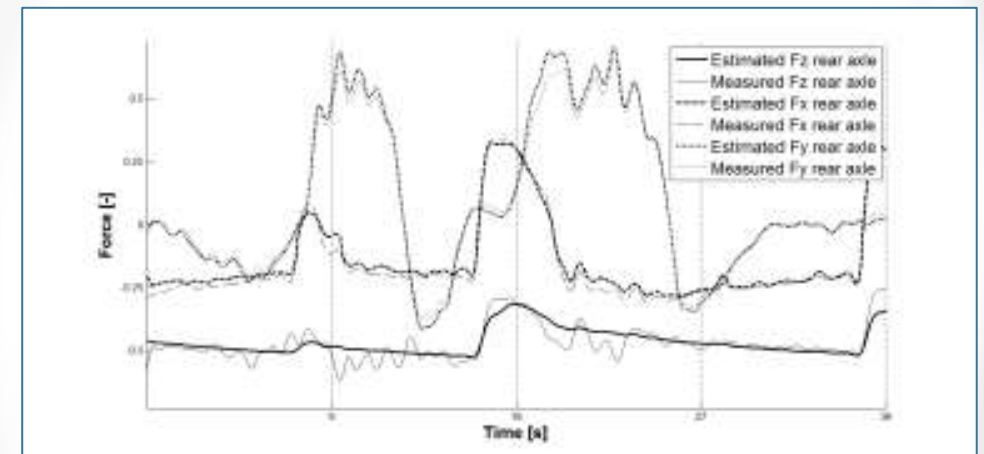
vehicle and tires
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T.R.I.C.K.: Tire/Road Interaction Characterization & Knowledge

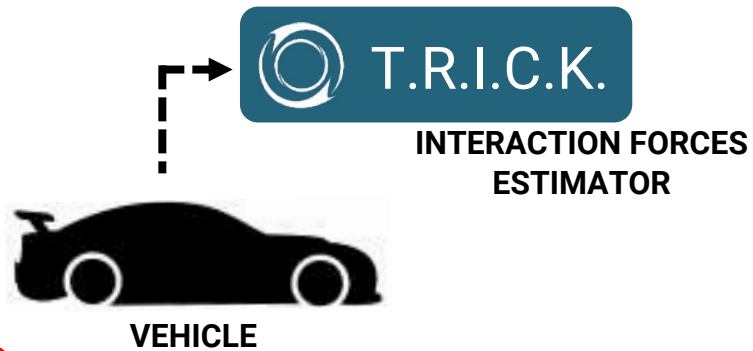
- characterize the tires using the vehicle as a "moving lab"

- PHYSICAL VEHICLE MODEL
- FROM ONBOARD STANDARD SENSORS
TO TIRE FORCES EVALUATION
- SPECIFIC OUTDOOR TESTING PROCEDURE
- REAL TIRES / REAL ROAD / REAL CONDITIONS



SCENARIO A

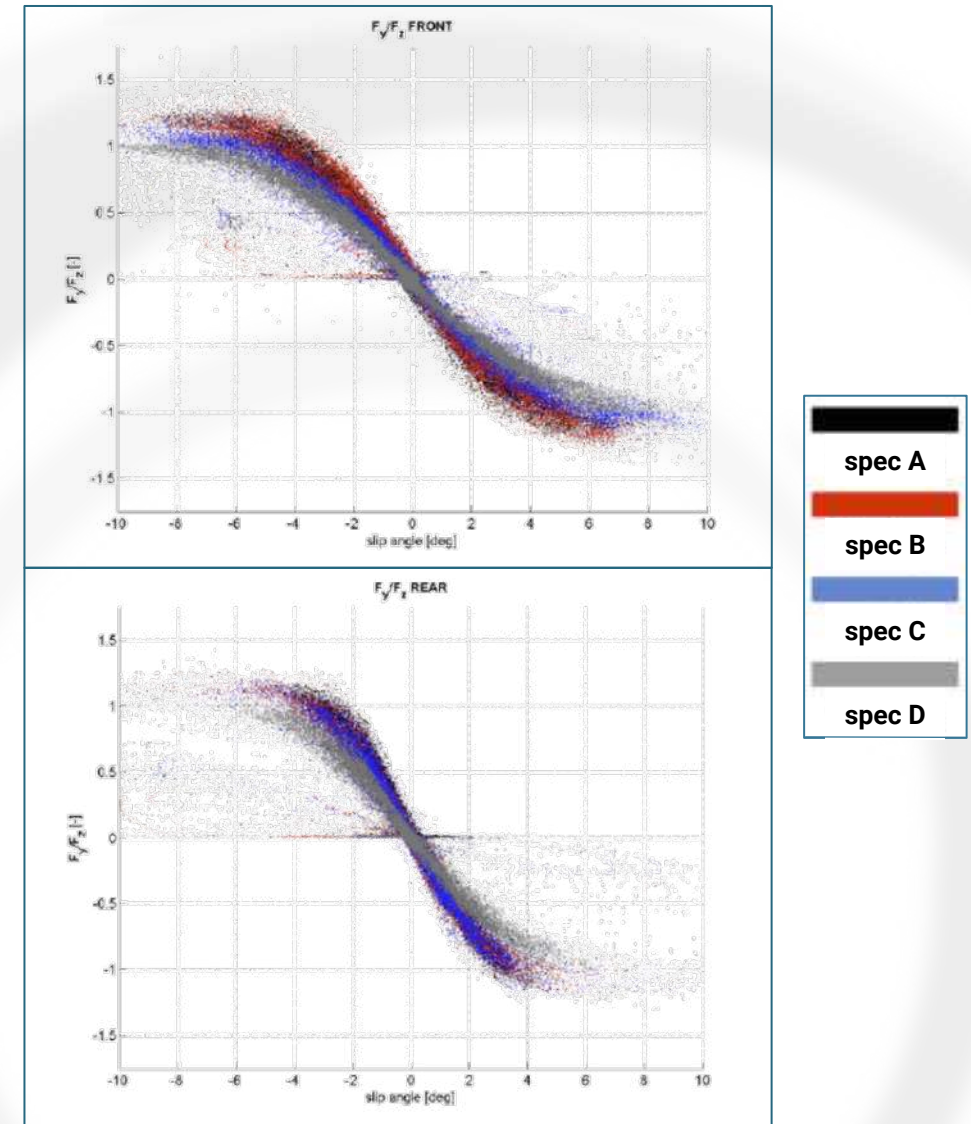
vehicle and tires
development

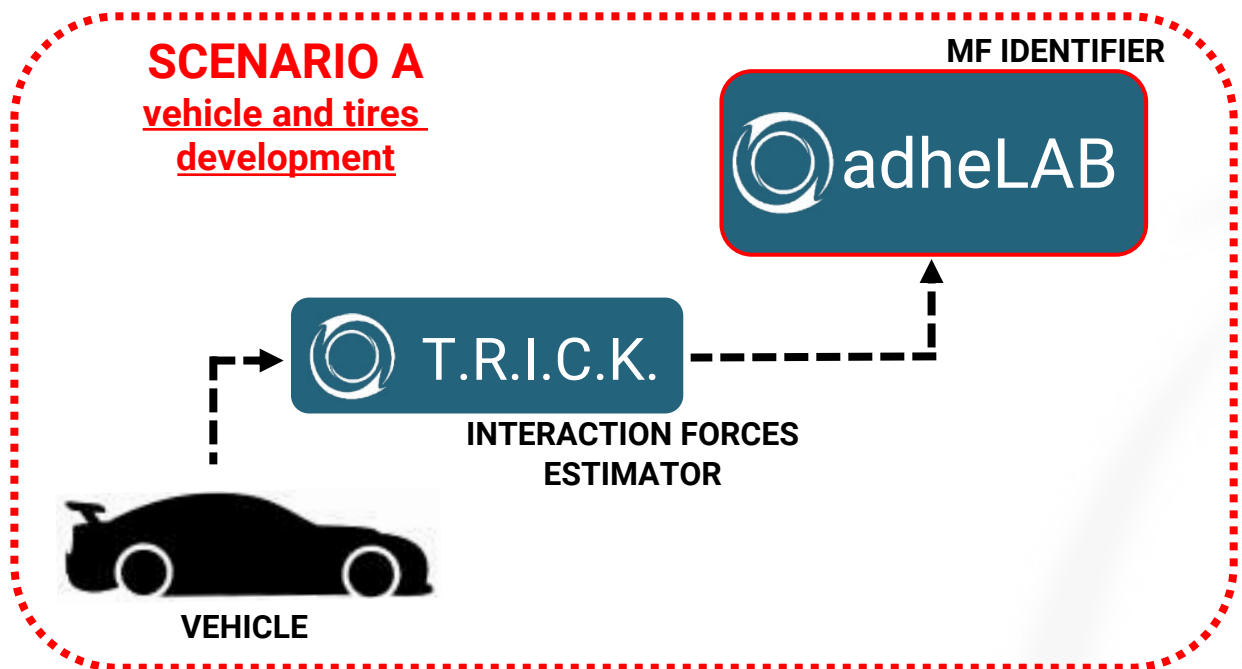


T.R.I.C.K.: Tire/Road Interaction Characterization & Knowledge

- characterize the tires using the vehicle as a "moving lab"
- **objectivize tire and driving performance during testing**

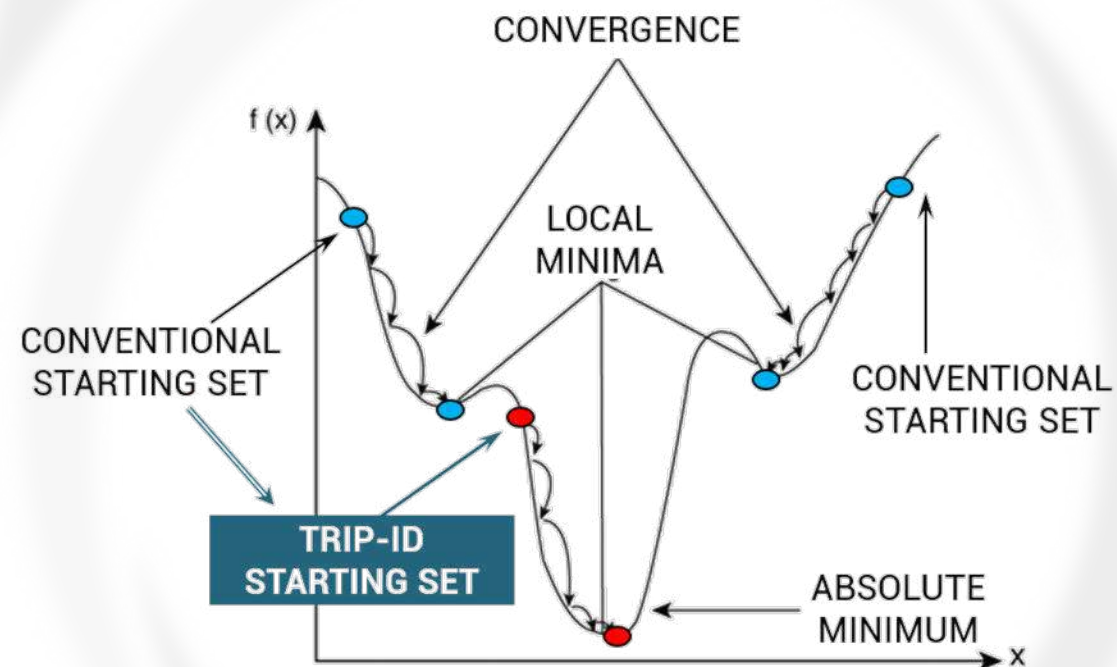
* for further info:
F. Farroni – T.R.I.C.K.: Tire/Road Interaction Characterization & Knowledge – A tool for the evaluation of tire and vehicle performances in outdoor test sessions – Mechanical Systems and Signal Processing – 72-73 808-831 (2016)

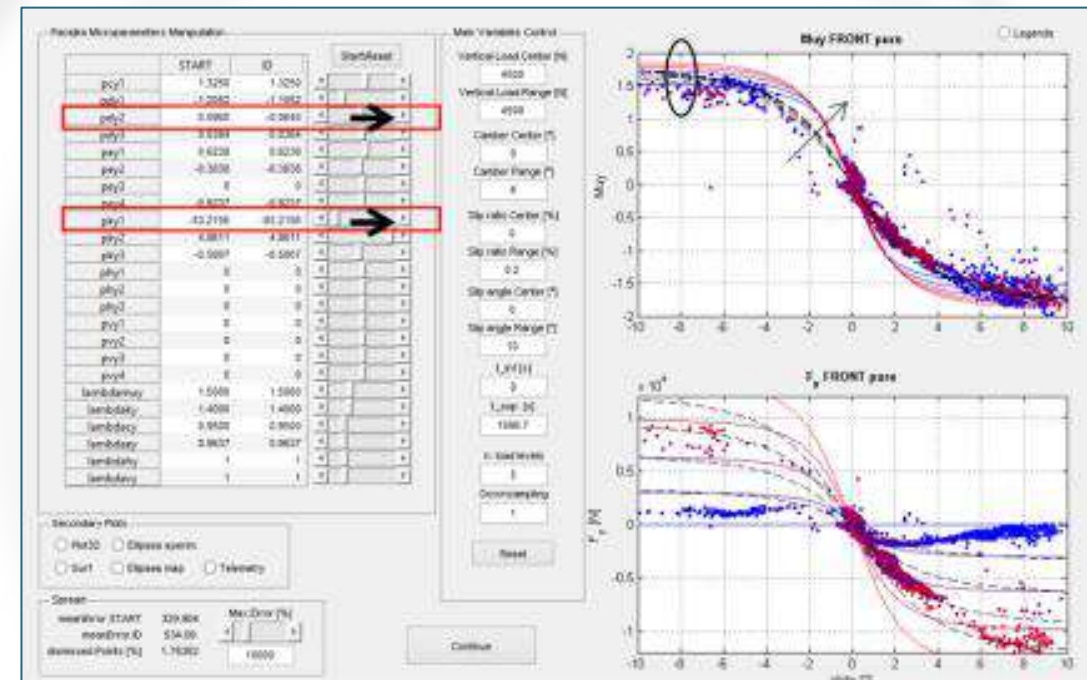


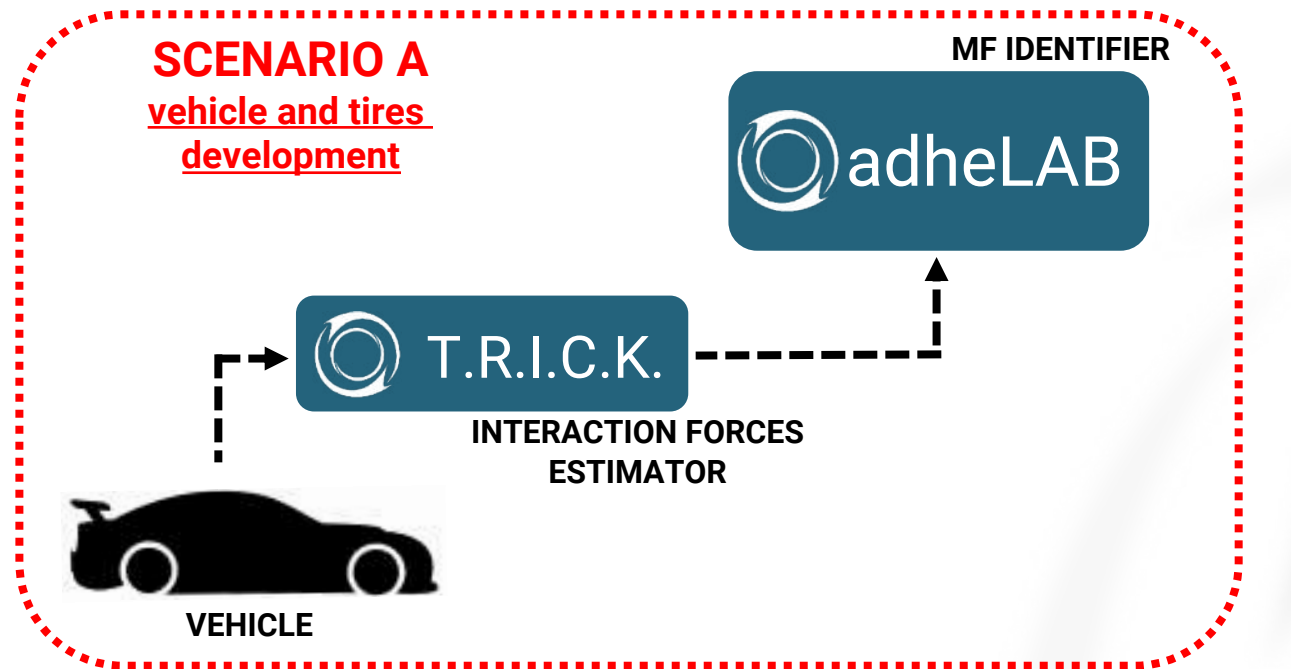


adheLAB: Tire/Road Interaction Parameters Identification

- a tool for multi-variable optimization applied to MF formulation





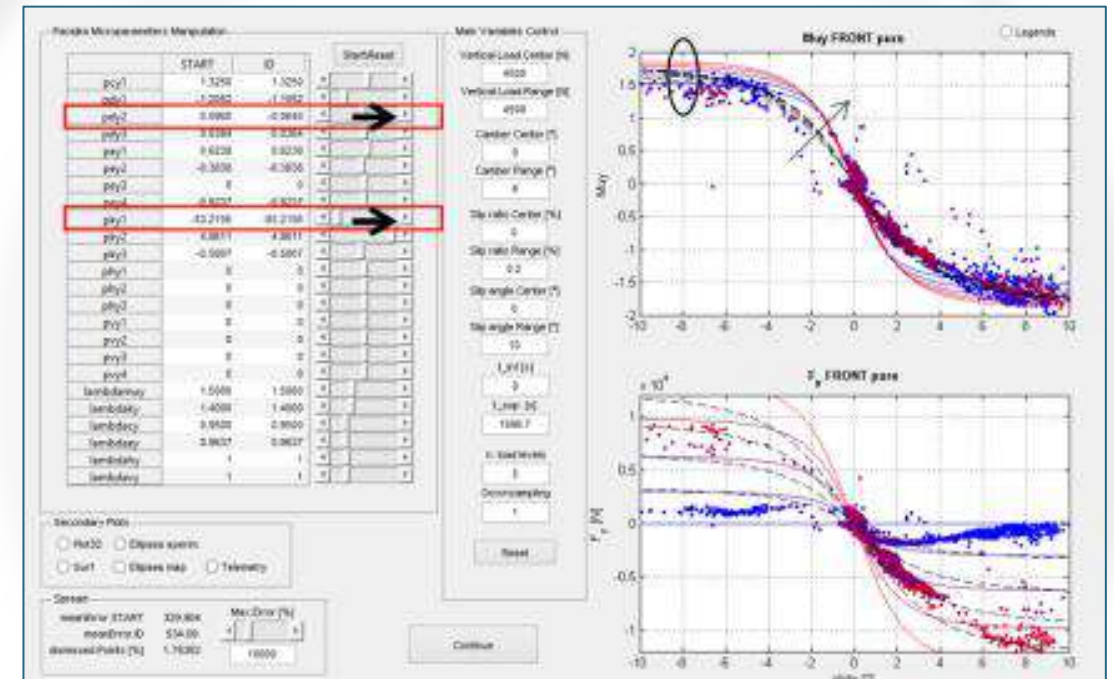


adheLAB: Tire/Road Interaction Parameters Identification

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* for further info:
F. Farroni, R. Lamberti, N. Mancinelli, F. Timpone - TRIP-ID: A tool for a smart and interactive identification of Magic Formula tyre model parameters from experimental data acquired on track or test rig - Mechanical Systems and Signal Processing - (2018)

- PACEJKA PLOTTING TOOL
- TIR FILES VALIDATION
- VIRTUAL TIRES DATABASE CREATOR



MF IDENTIFIER



INTERACTION FORCES
ESTIMATOR



VEHICLE

SCENARIO B

advanced simulations
and performance optimization

TIRES

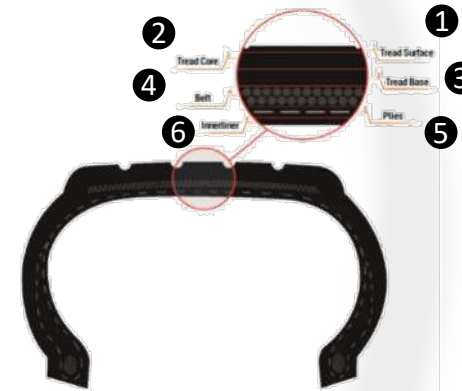
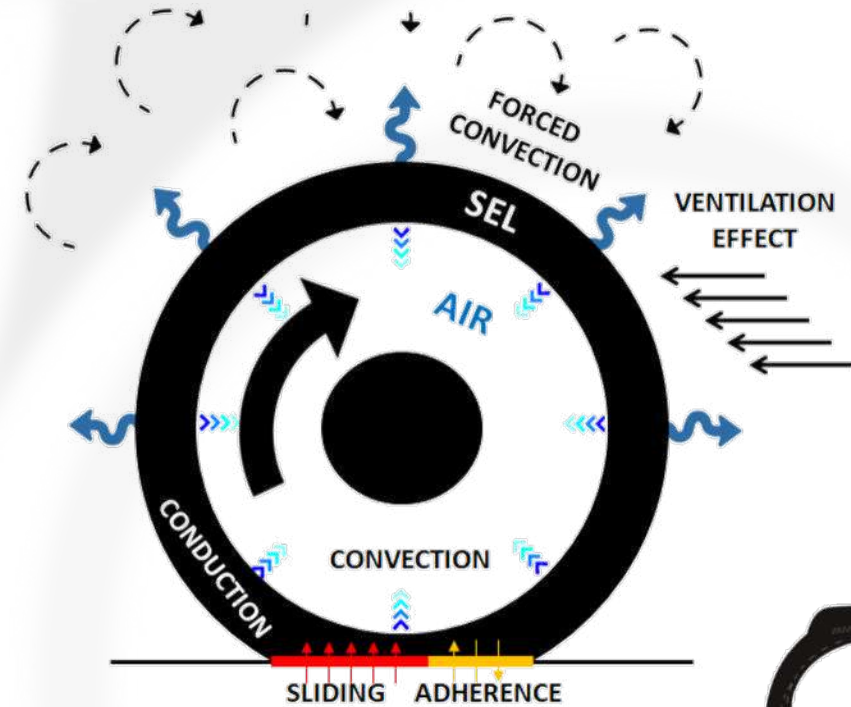


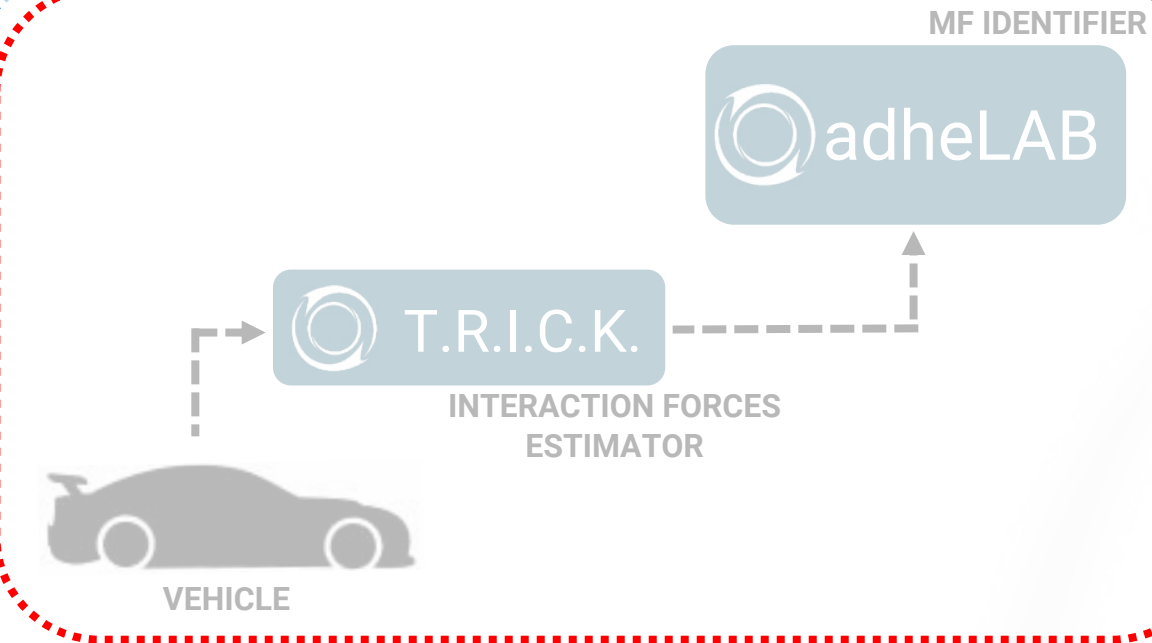
THERMAL
CHARACTERIZATION



thermoRIDE:

- a real-time physical tire thermal model for performance analysis and simulations





SCENARIO B
advanced simulations
and performance optimization

TIRES



THERMAL
CHARACTERIZATION



thermoRIDE:

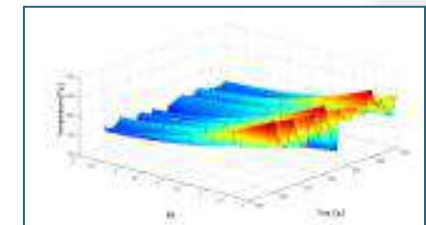
- a real-time physical tire thermal model for performance analysis and simulations



- NONDESTRUCTIVE
THERMAL
CHARACTERIZATION

- ANY TIRE SIZE
AND BRAND

- DISCRETIZATION UP TO
8 DIFFERENT LAYERS
16 DIFFERENT RIBS
IN REAL-TIME



MF IDENTIFIER



INTERACTION FORCES
ESTIMATOR



VEHICLE

SCENARIO B

advanced simulations
and performance optimization



TIRES

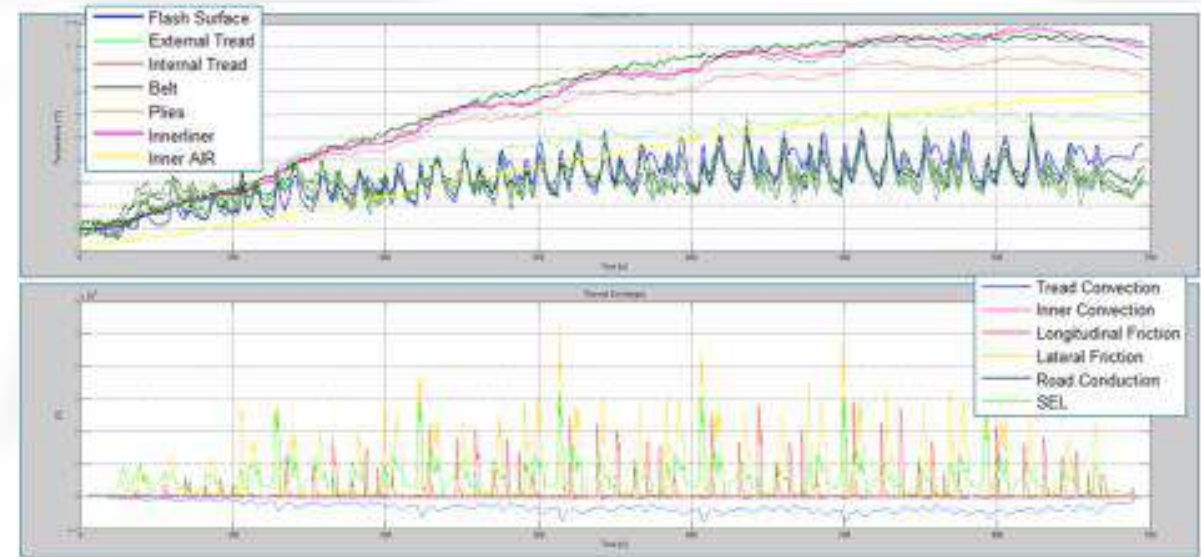


THERMAL
CHARACTERIZATION



thermoRIDE:

- a real-time physical tire thermal model for performance analysis and simulations



- INNER PRESSURE AND TREAD WEAR EFFECTS

- SPECIFIC ANALYSIS ON HEATING SOURCES
AND COOLING CAUSES

* for further info:

F. Farroni, M. Russo, A. Sakhnevych, F. Timpone - TRT EVO: Advances in real-time thermodynamic tire modeling for vehicle dynamics simulations - Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering- (2019)

MF IDENTIFIER



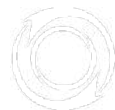
INTERACTION FORCES
ESTIMATOR



VEHICLE

SCENARIO B

advanced simulations
and performance optimization



TIRES

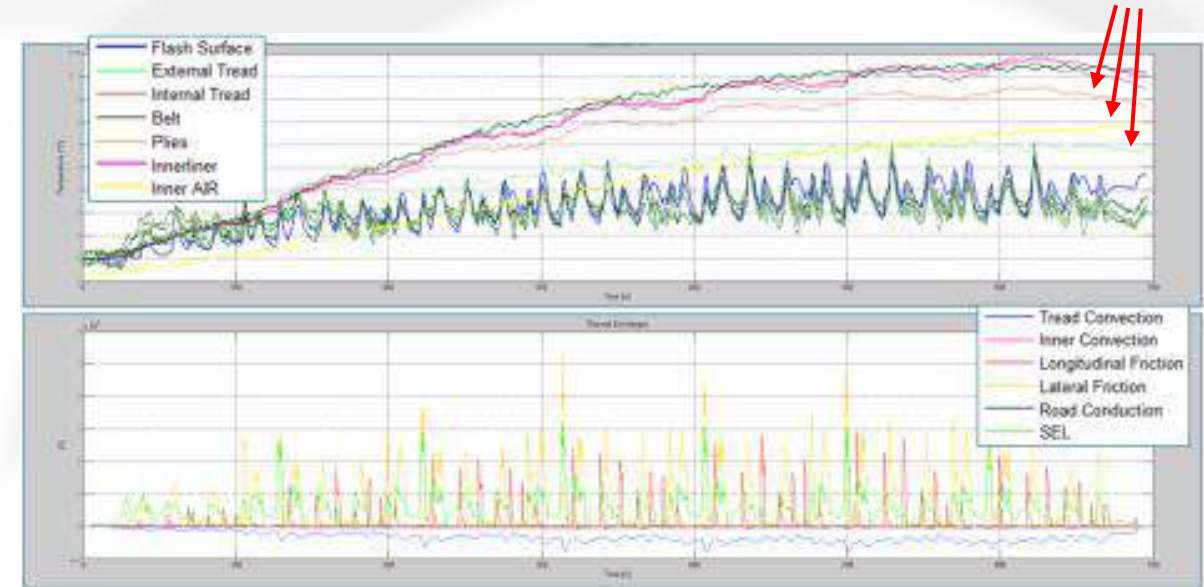


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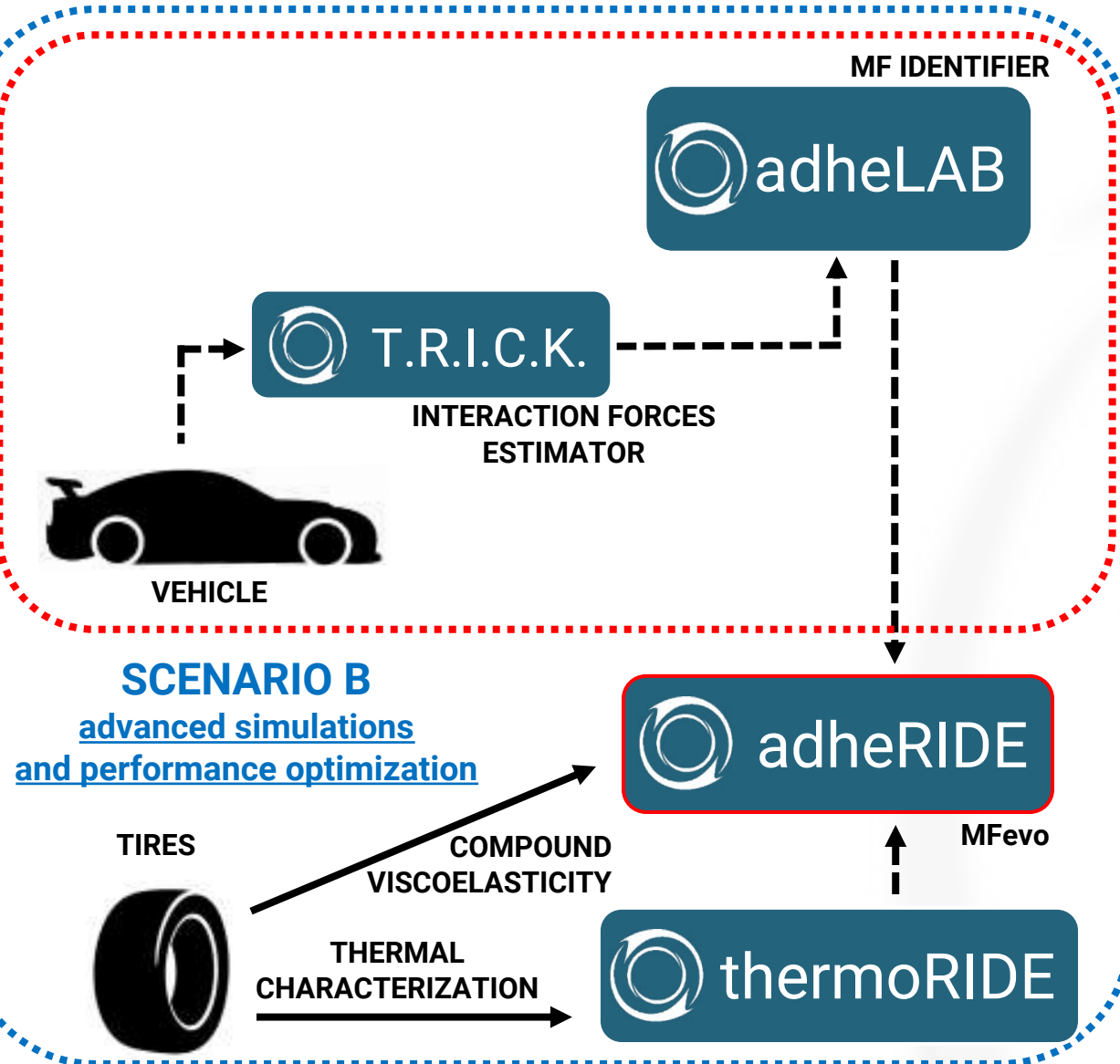
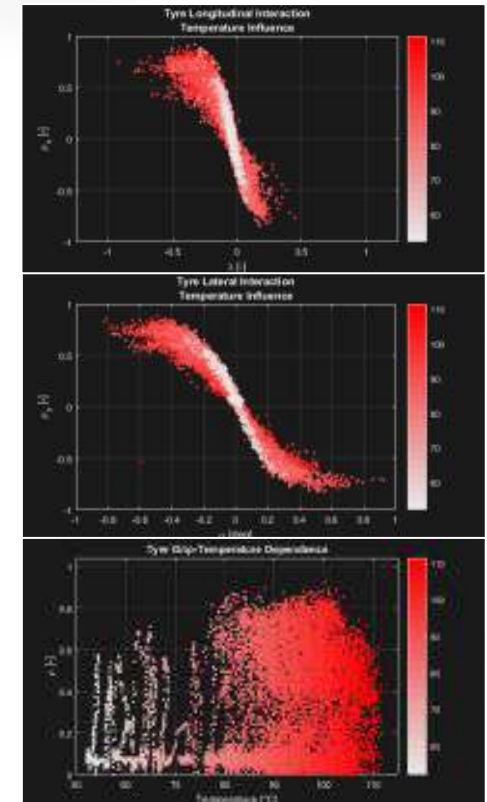
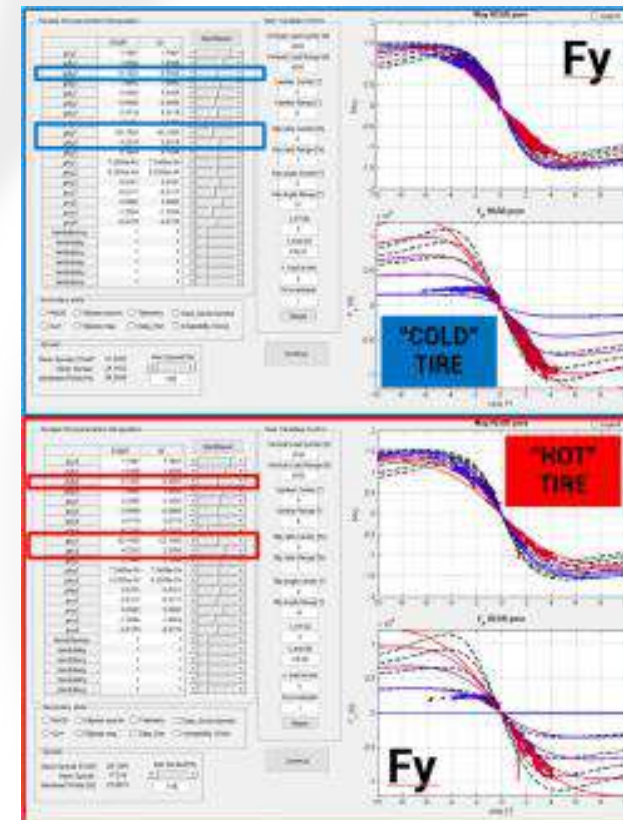
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adheRIDE:

- an innovative Pacejka's MF model sensitive to:

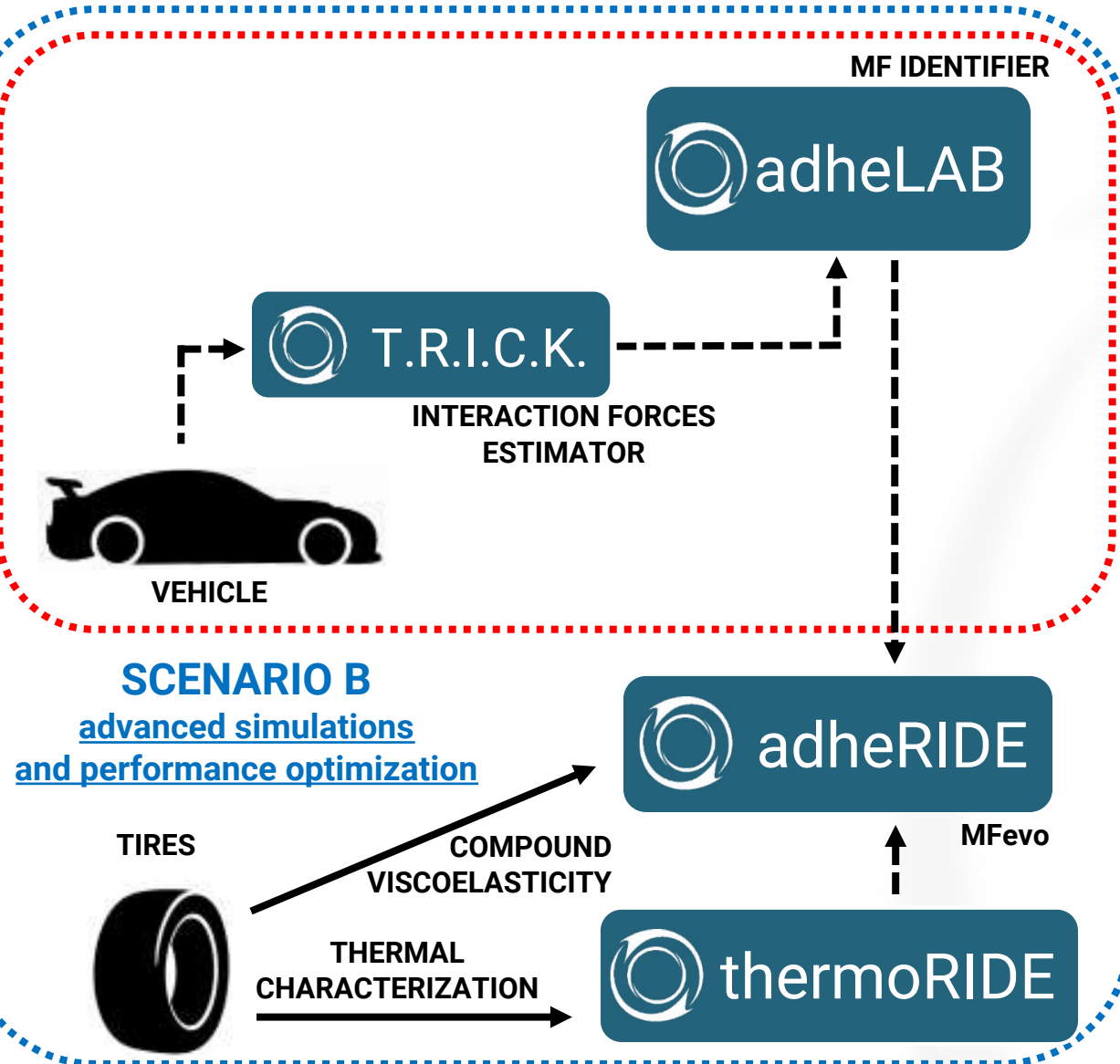
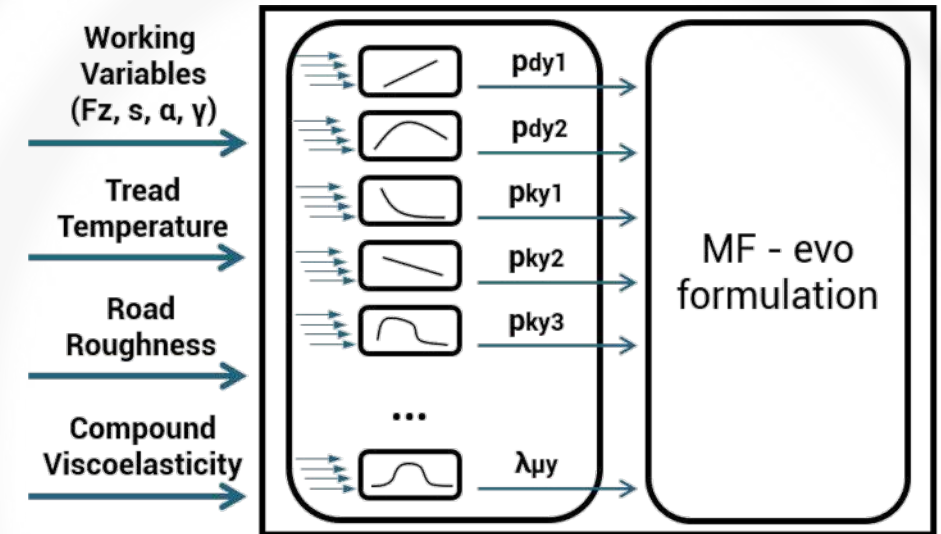
- TIRE TEMPERATURE
- COMPOUND VISCOELASTICITY
- ROAD ROUGHNESS



adheRIDE:

- an innovative Pacejka's MF model sensitive to:

- TIRE TEMPERATURE
- COMPOUND VISCOELASTICITY
- ROAD ROUGHNESS



MF IDENTIFIER



INTERACTION FORCES
ESTIMATOR



VEHICLE

SCENARIO C

multiphysical modular
tire sim platform

TIRES



THERMAL
CHARACTERIZATION

COMPOUND
VISCOELASTICITY



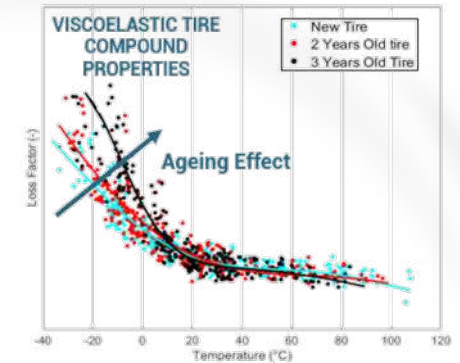
MFevo



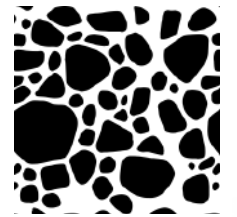
weaRIDE:

- an energy-based tire wear and degradation model

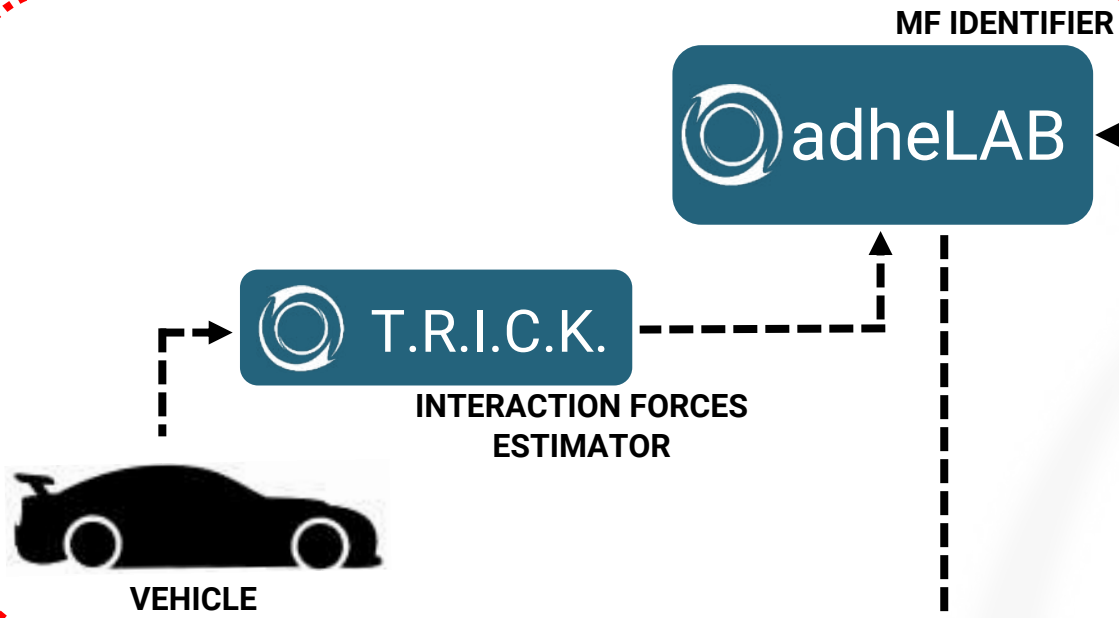
- REAL-TIME TREAD THICKNESS REDUCTION
- WEAR EFFECTS ON THERMODYNAMICS
- DEGRADATION EFFECTS ON GRIP



WEAR MODEL



ROAD
ROUGHNESS



SCENARIO C
multiphysical modular
tire sim platform



COMPOUND
VISCOELASTICITY

THERMAL
CHARACTERIZATION

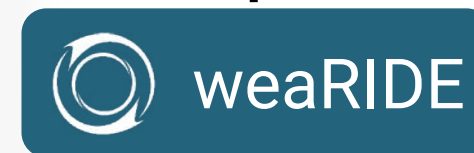
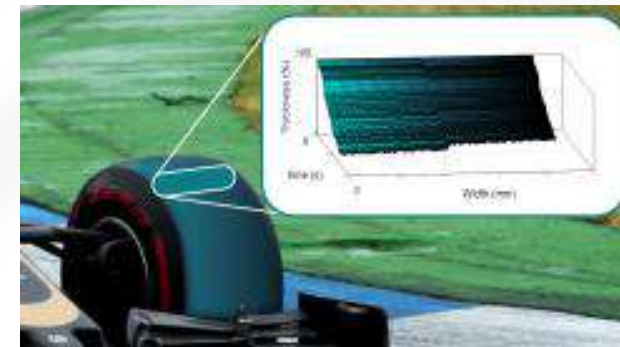


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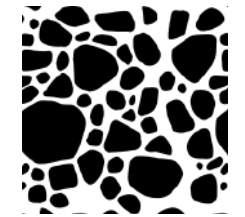
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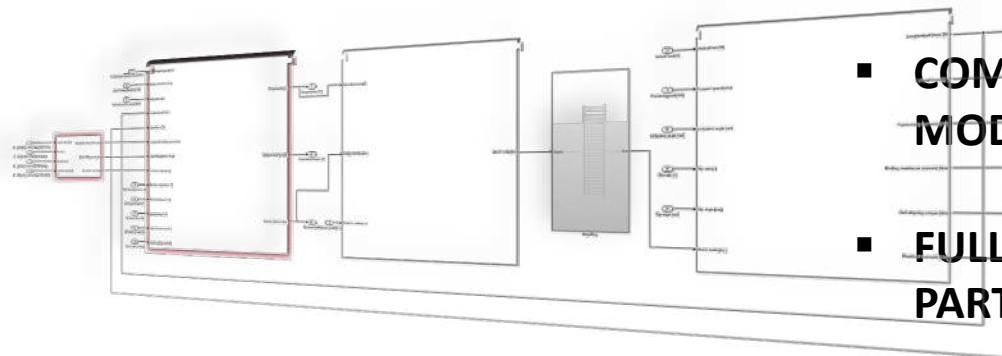
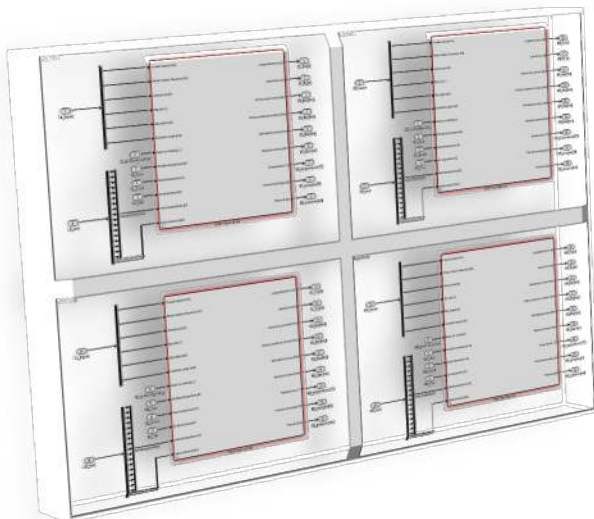
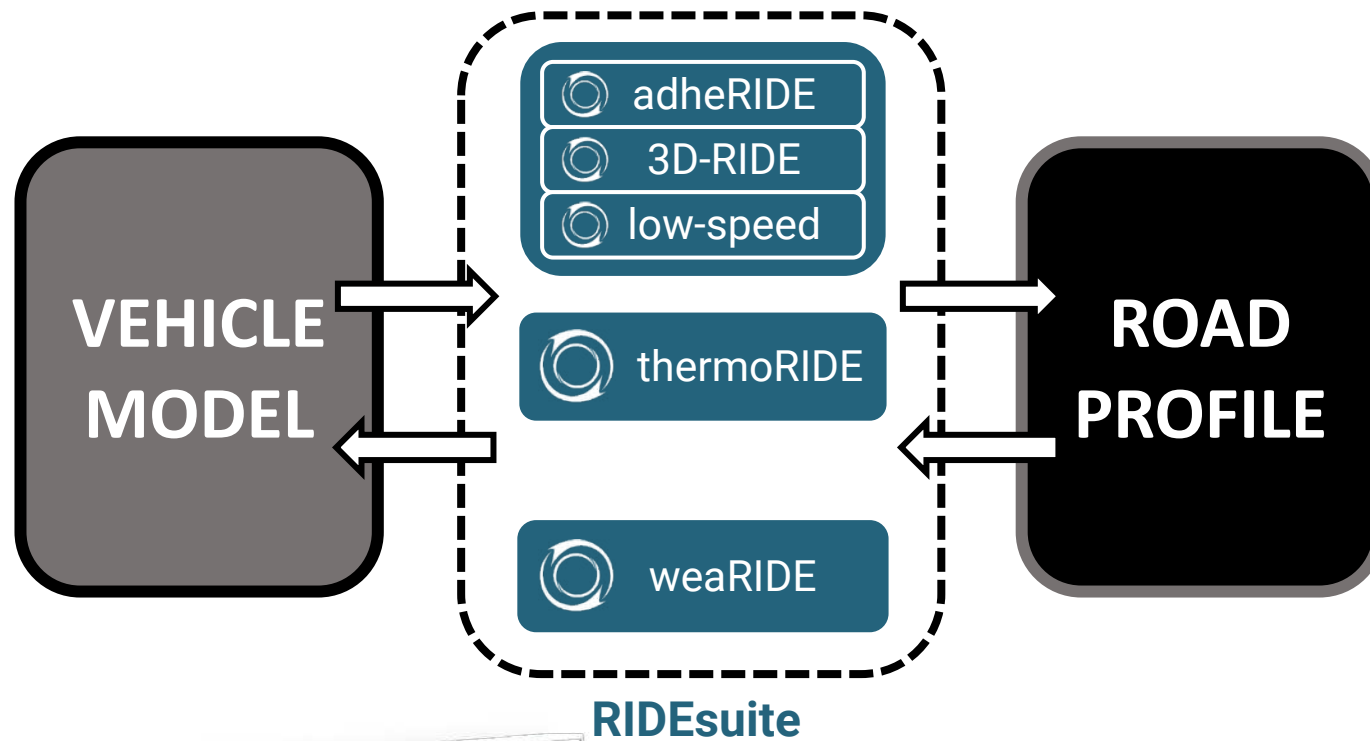


WEAR MODEL



ROAD
ROUGHNESS

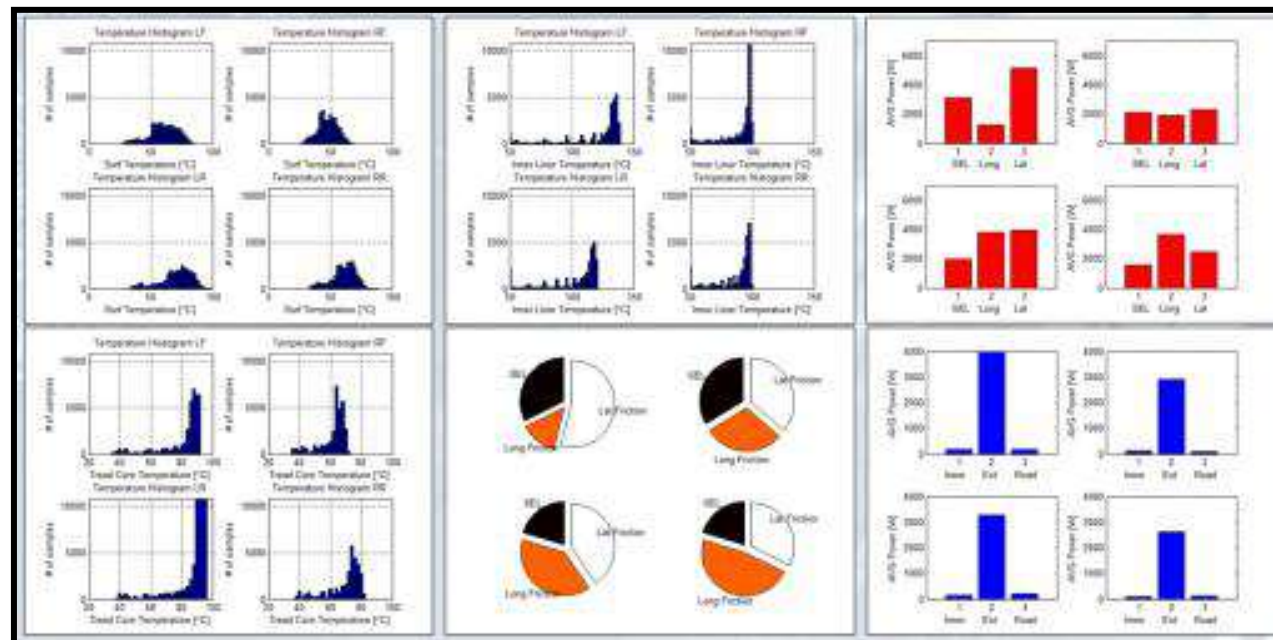
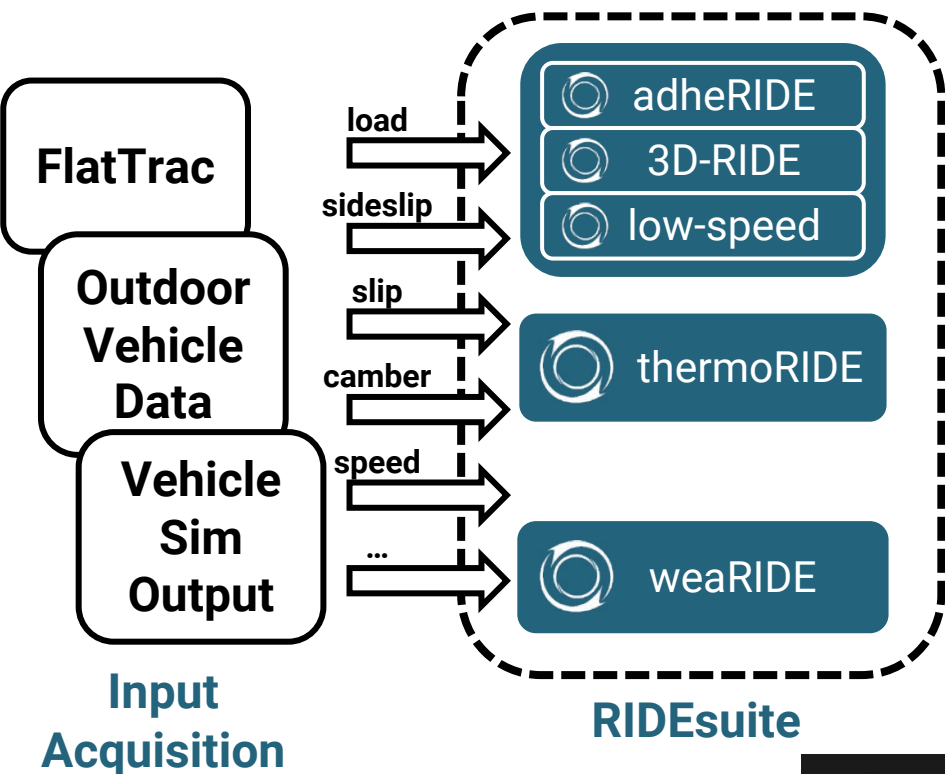
RIDEsuite – A SIM LAYER BETWEEN VEHICLE & ROAD



- COMPLIANCE TO ANY TIRE INTERACTION MODEL AND SIM ENVIRONMENT
- FULL MODULARITY DEPENDING ON PARTNERS' REQUIREMENTS AND NEEDS

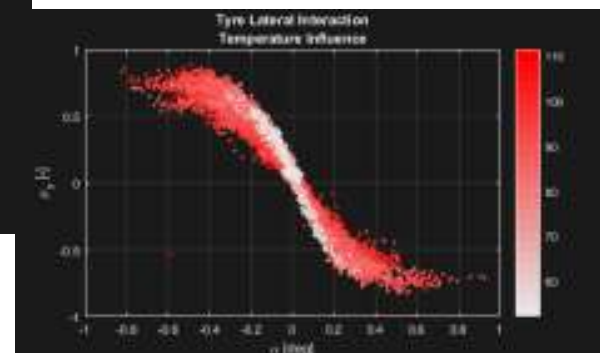
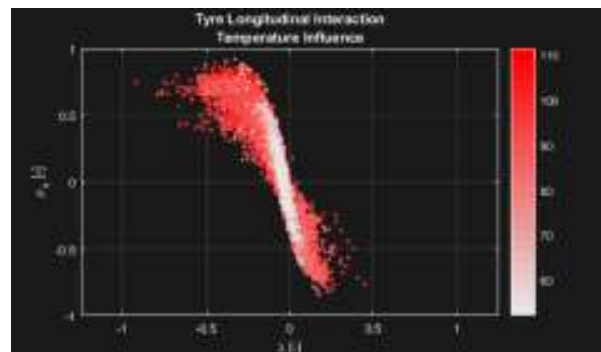


RIDEsuite – APPLICATIONS: ADVANCED ANALYSIS

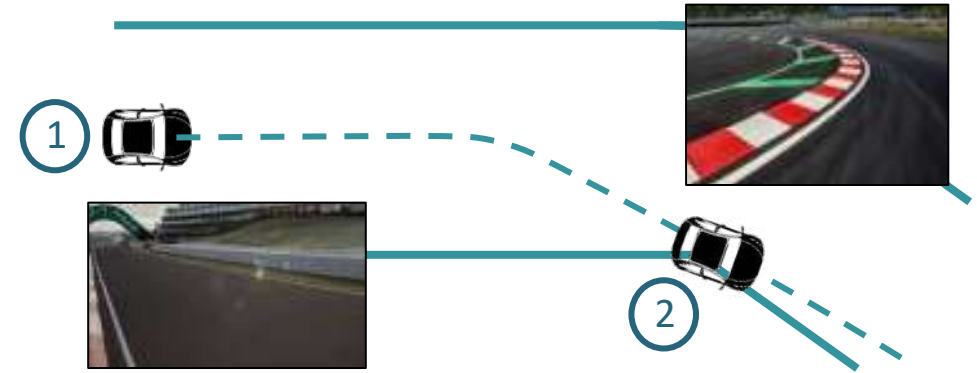
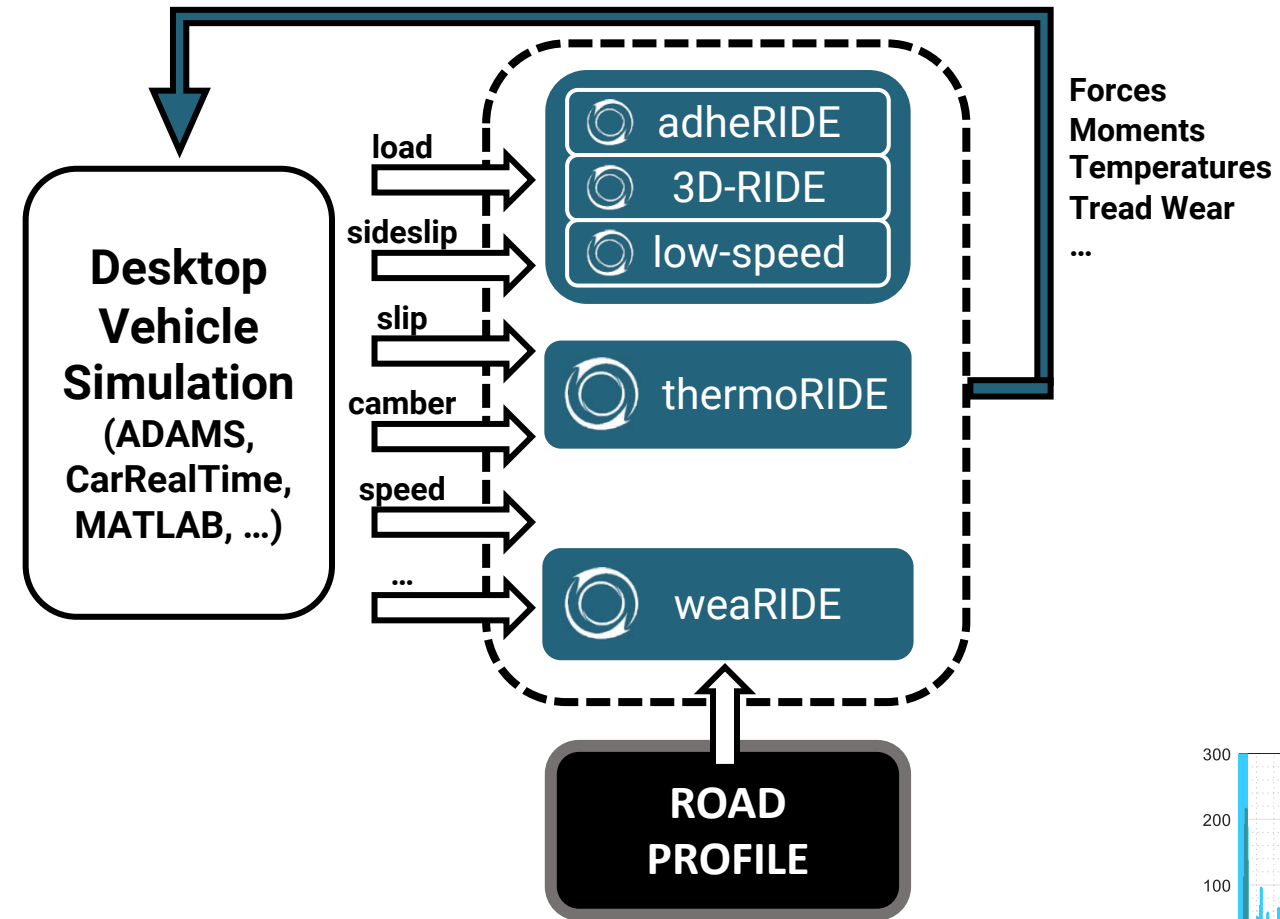


WARM-UP / HEAT EXCHANGE /
THERMODYNAMIC OPTIMIZATION ANALYSIS

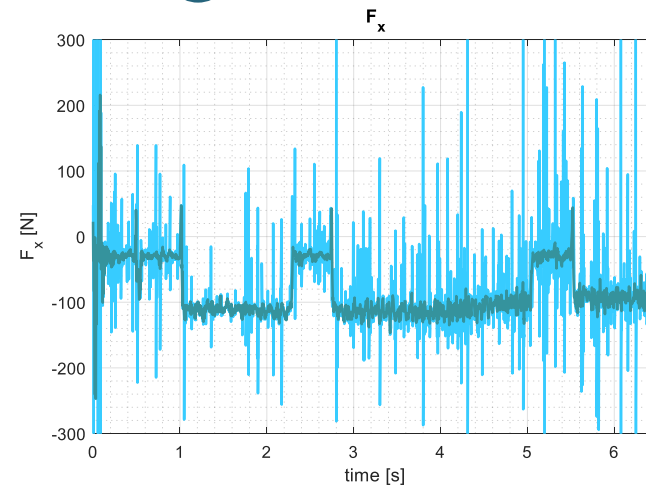
ANALYSIS ON TIRE
DEPENDENCIES FROM
TEMPERATURE / WEAR / ROAD
ROUGHNESS / TREAD VISCOELASTICITY



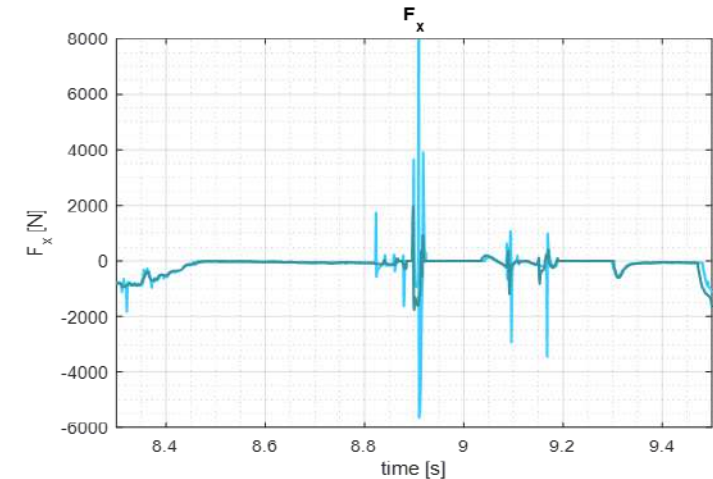
RIDEsuite – APPLICATIONS: “OFFLINE” SIMULATIONS



1 Uneven road



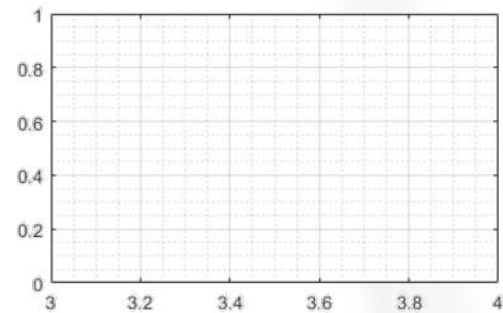
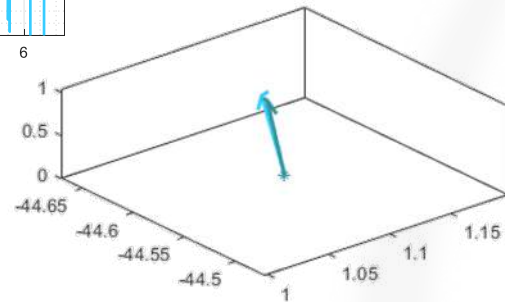
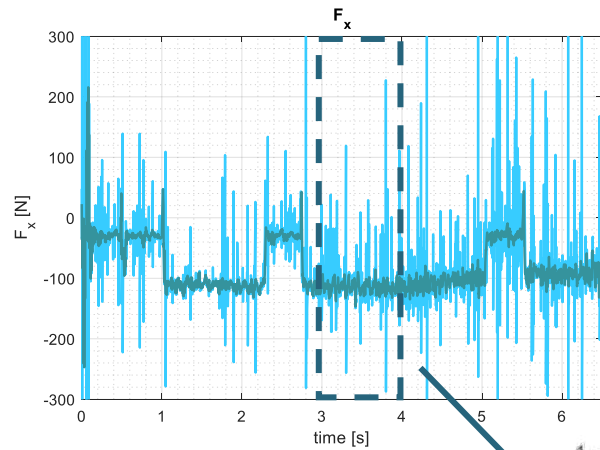
2 Kerb impact



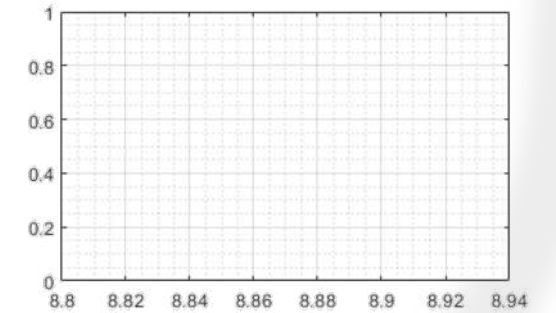
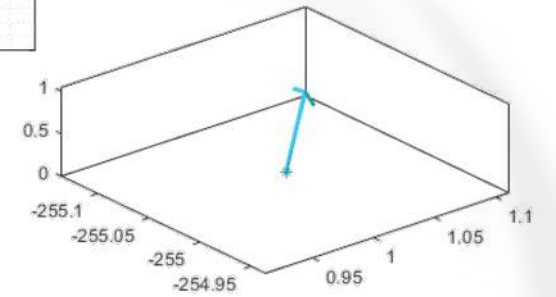
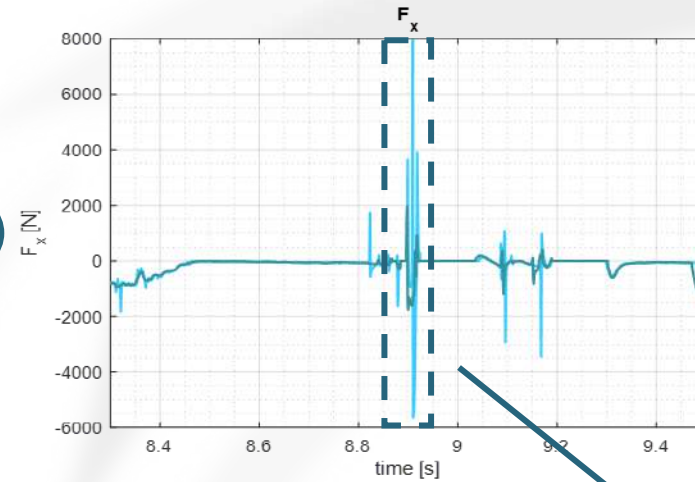
- DYNAMIC SIMULATIONS FOR CAR / BIKE / TRUCK
- TIRES IN THE SIMULATION LOOP ACCOUNTING FOR THERMAL / WEAR / ROAD MESH / SPEED PHENOMENA

Newborn Model: threedeeRIDE

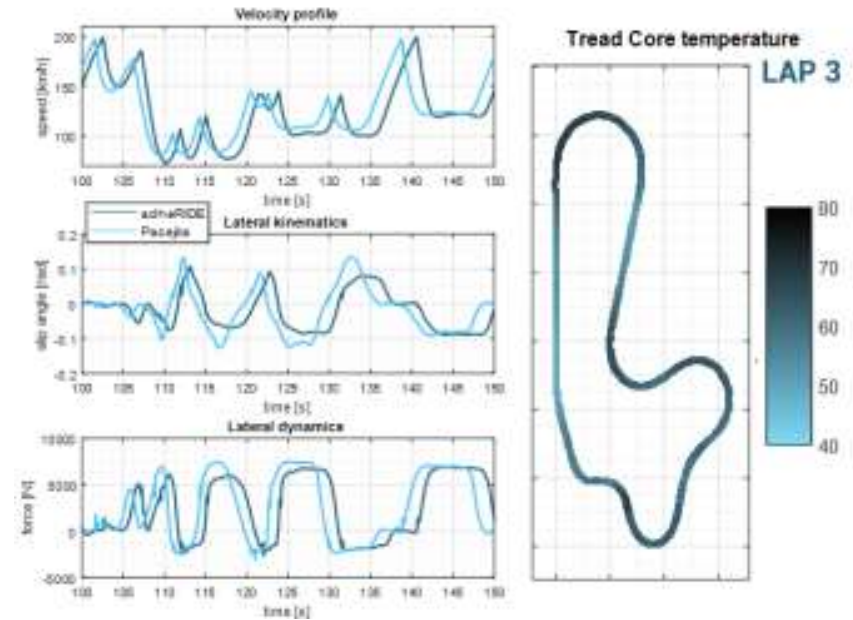
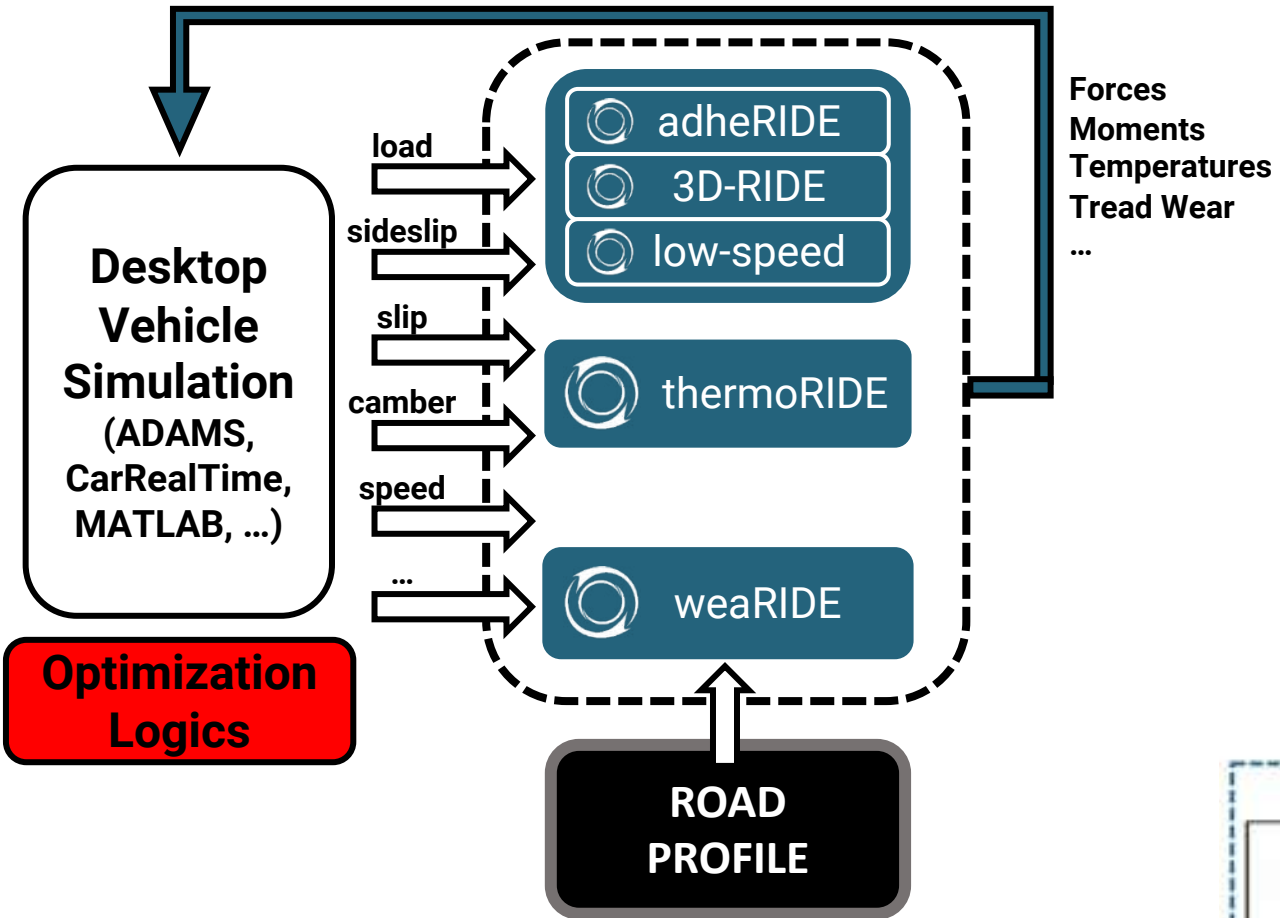
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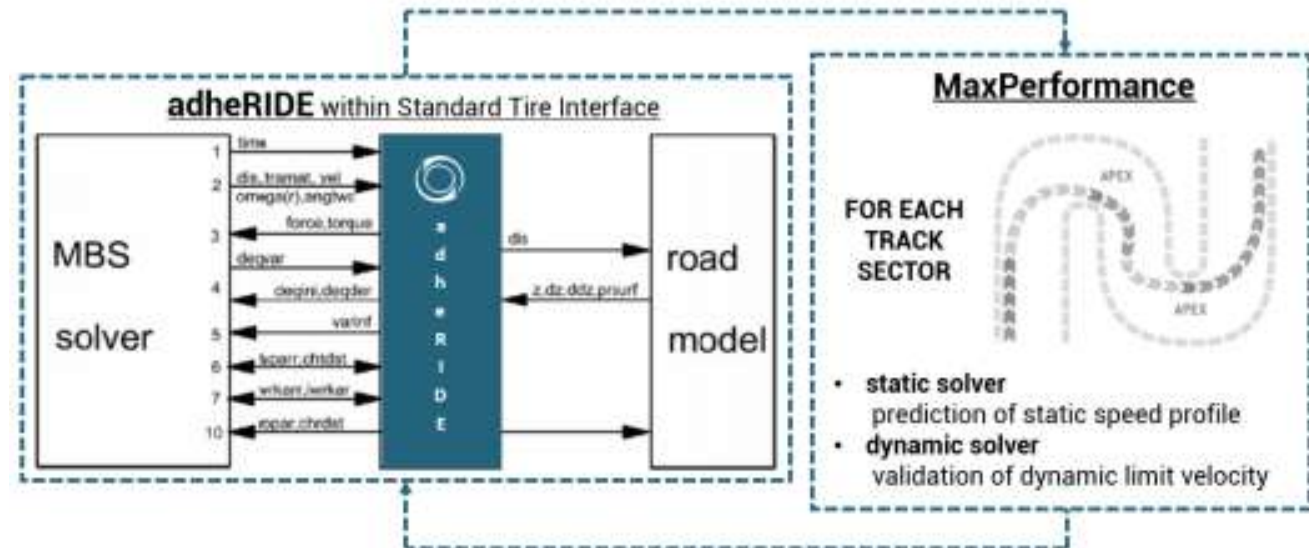
2



RIDEsuite – APPLICATIONS: “OFFLINE” LAPTIME OPT.

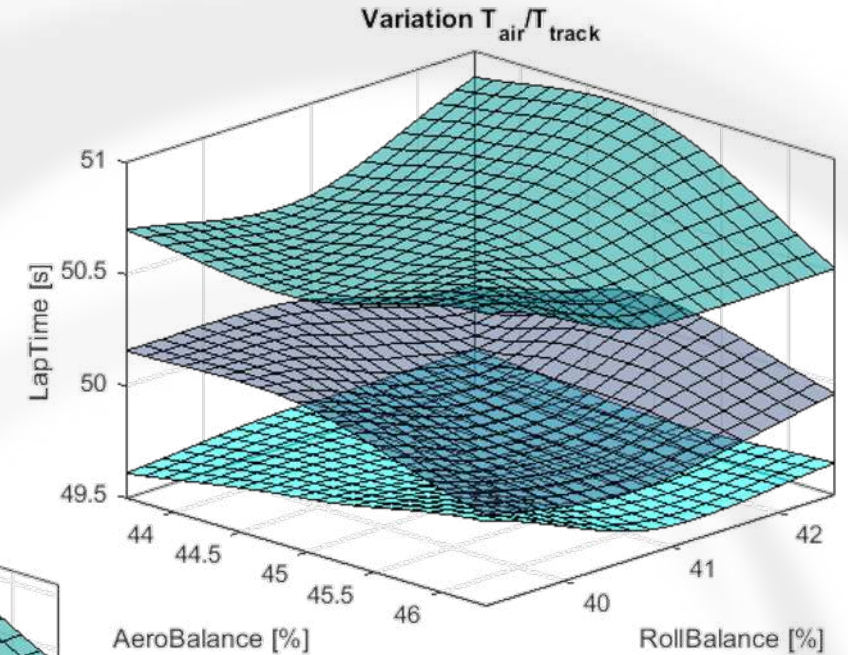
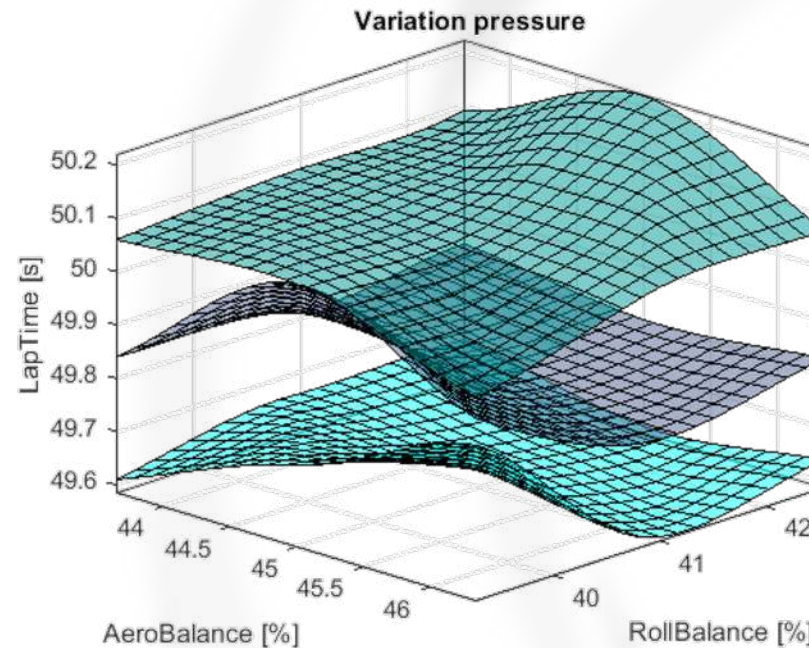
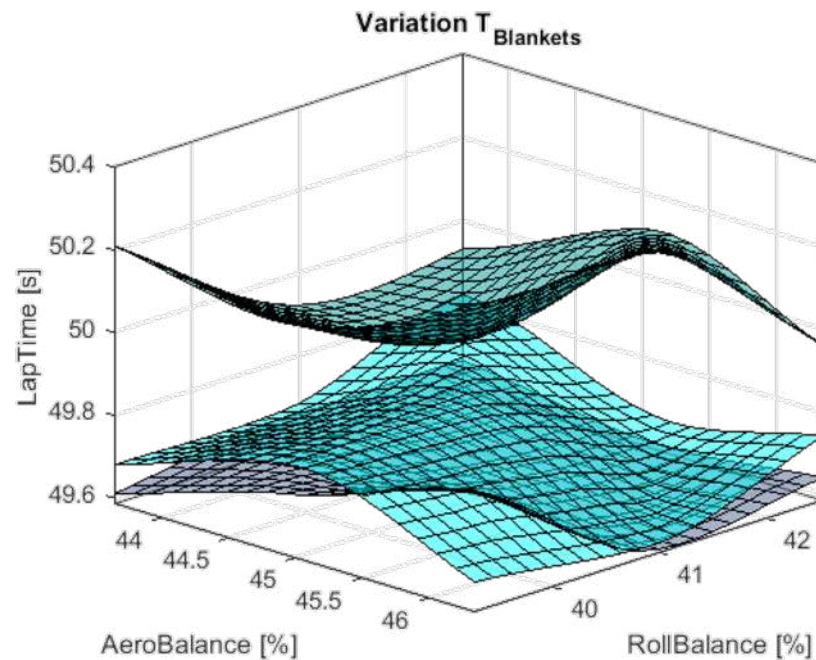


- ADVANCED SETUP OPTIMIZATION (INFLATION PRESSURE / BLANKETS TEMPERATURE / ...)
- GRIP&STIFFNESS VARIATIONS WITH TEMPERATURE IN THE ITERATIVE OPTIMIZATION ALGORITHMS



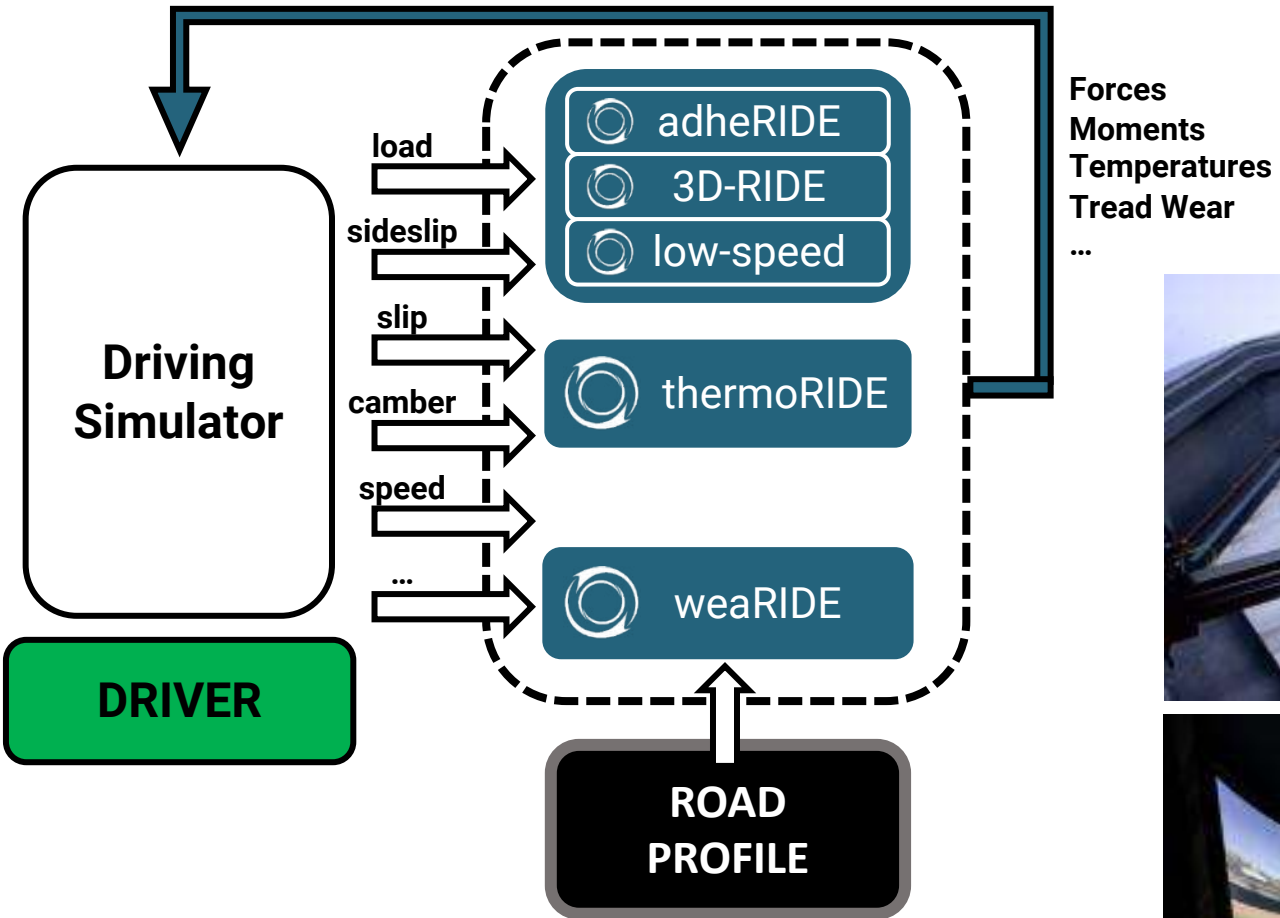
Case study : DOE

How to correct the car setup if conditions are changing?
Case study: 5D DOE with track/air temperature, blankets setting, tire pressure, aero and roll balance



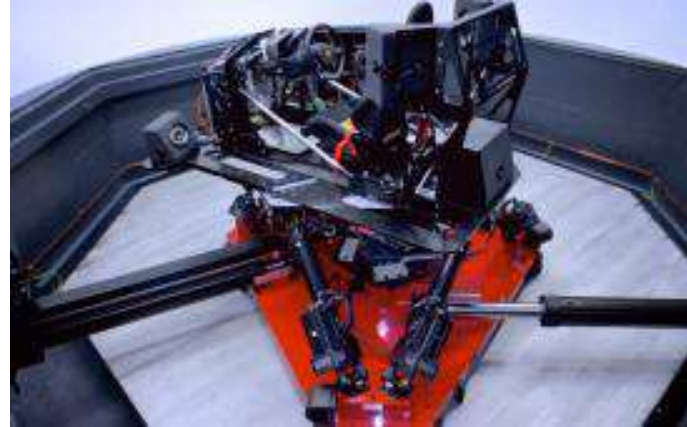
IDENTIFICATION OF THE
OPTIMAL VEHICLE SETUP
ACCOUNTING FOR PHYSICAL
INTERACTION PHENOMENA

RIDEsuite – APPLICATIONS: REALTIME SIMULATIONS



some of the platforms adopting RIDEsuite...

VI-grade @ Ferrari GT – Maranello



VI-grade @ AUDI Sport – Ingolstadt



VI-grade @ Maserati – Modena



AVEHIL @ SkyDrive – Monza

- PHYSICAL MODELS OPTIMIZED FOR REALTIME
- ENHANCED FEELINGS FOR SUBJECTIVE ANALYSIS
- MULTICONTACT AND “LOW SPEED” RIDE MODELS



DEVELOPMENT TOOL OF THE YEAR

2018: VI-grade – DiM250

**2019: MegaRide –
Tire Simulation Pack**





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Università degli Studi di Napoli "Federico II"



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