

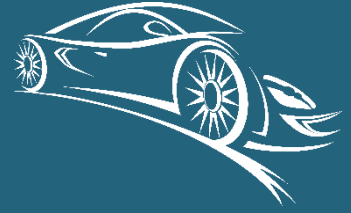


**REAL-TIME TIRE MODELS FOR ANALYSIS AND SIMULATIONS:
PERFORMANCE OPTIMIZATION, THERMODYNAMICS
AND INNOVATIVE MULTI-PHYSICAL MAGIC FORMULA**



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





GROWTH PATH



"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 MOTORSPORT TEAMS



PROMETEON



GOODYEAR



Jun-Dec
2016

Jan-May
2017

Jun-Sep
2017

Oct-Dec
2017

Jan-Jun
2018

Jul-Dec
2018

Jan-Apr
2019



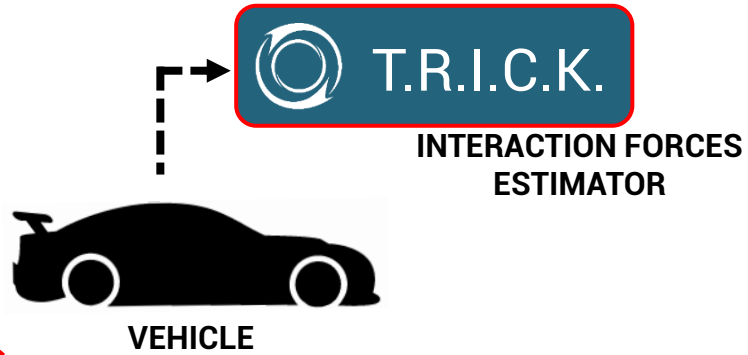


A MODULAR PLATFORM

FOR TIRE ANALYSIS AND MODELLING

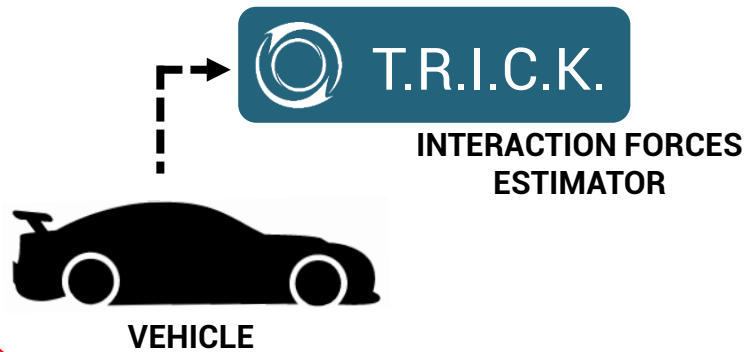


SCENARIO I
vehicle and tires
development



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

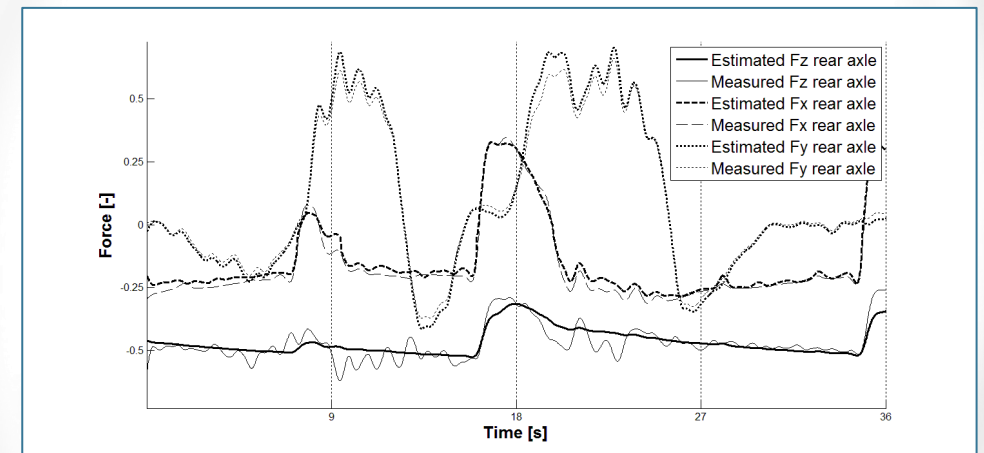
SCENARIO I
vehicle and tires
development



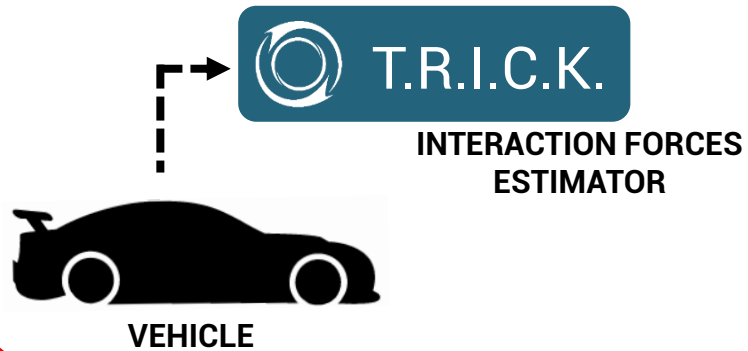
T.R.I.C.K.: Tyre/Road Interaction Characterization & Knowledge

- 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 I vehicle and tires development

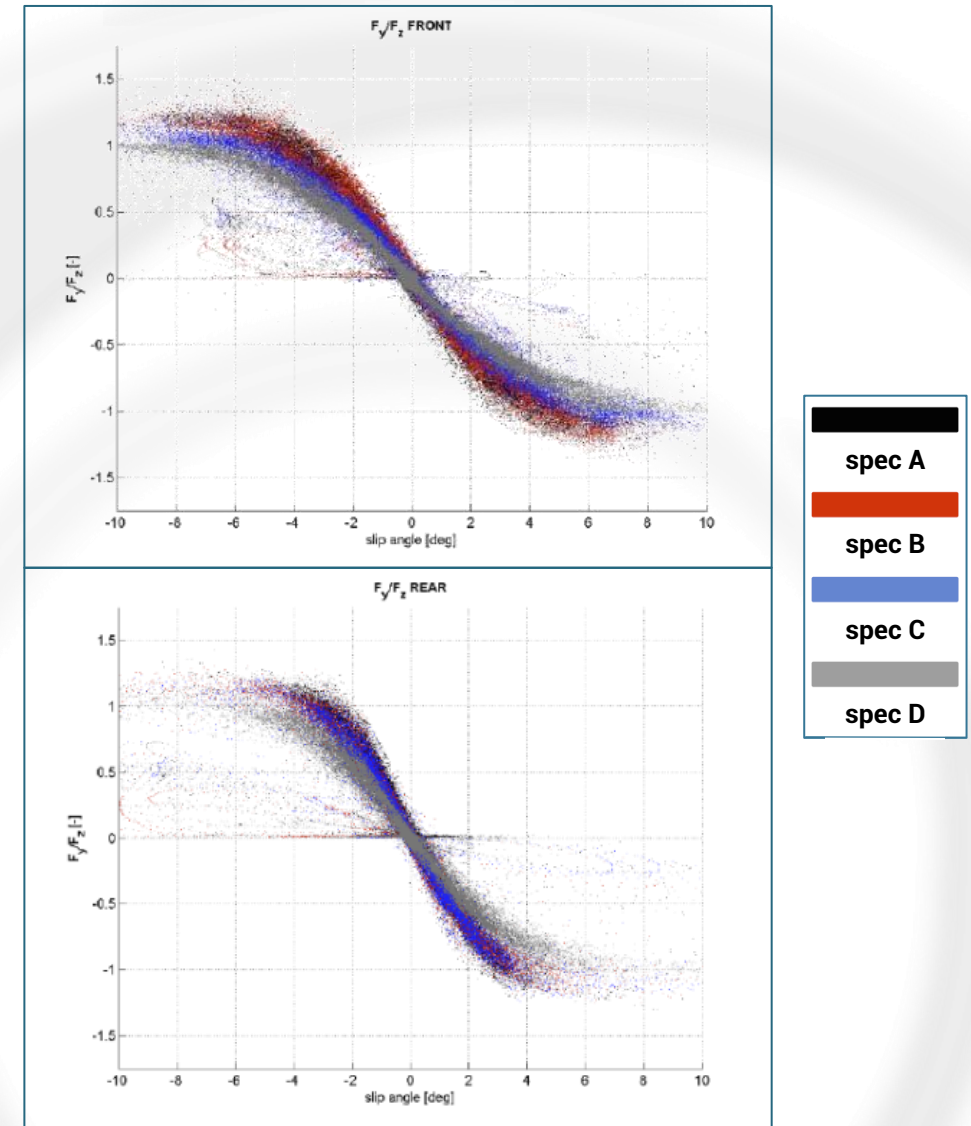


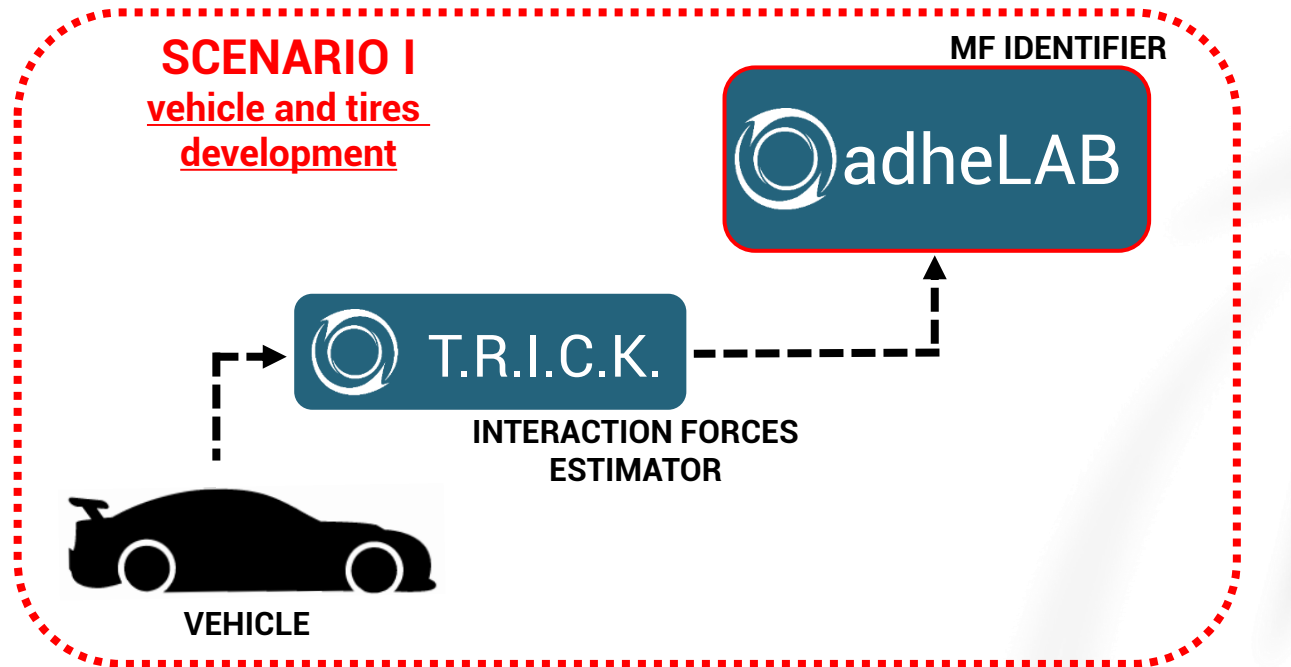
T.R.I.C.K.: Tyre/Road Interaction Characterization & Knowledge

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

* for further info:

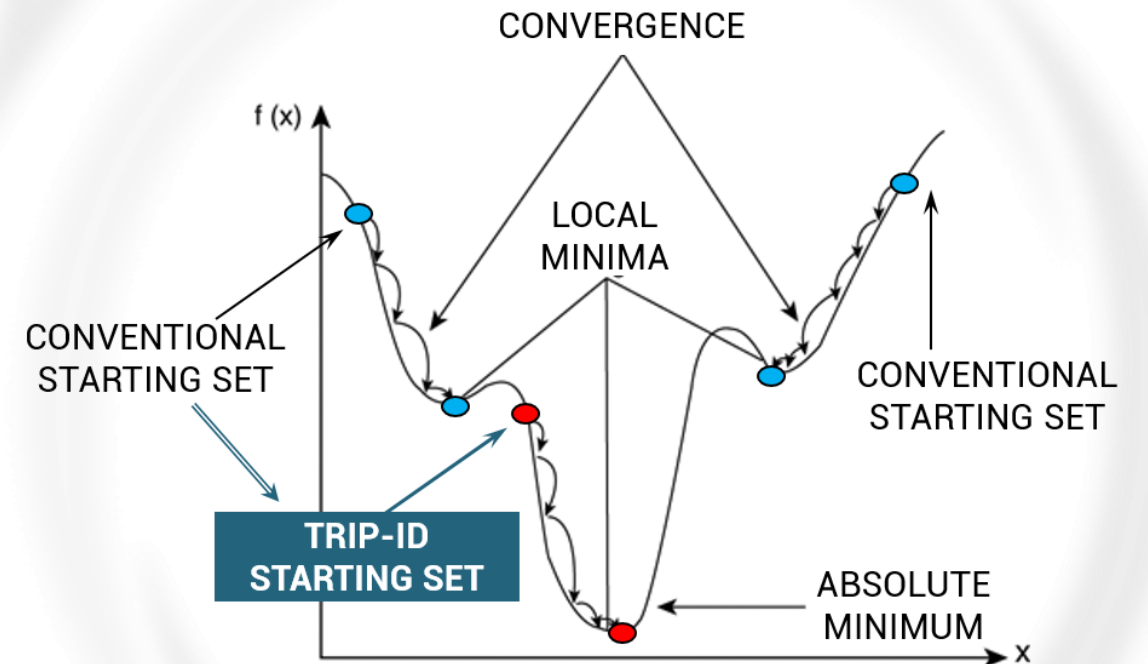
F. Farroni - T.R.I.C.K.: Tire/Road Interaction Characterization & Knowledge - A tool for the evaluation of tire and vehicle performances in outdoor test sessions - Mechanical Systems and Signal Processing - 72-73 808-831 (2016)

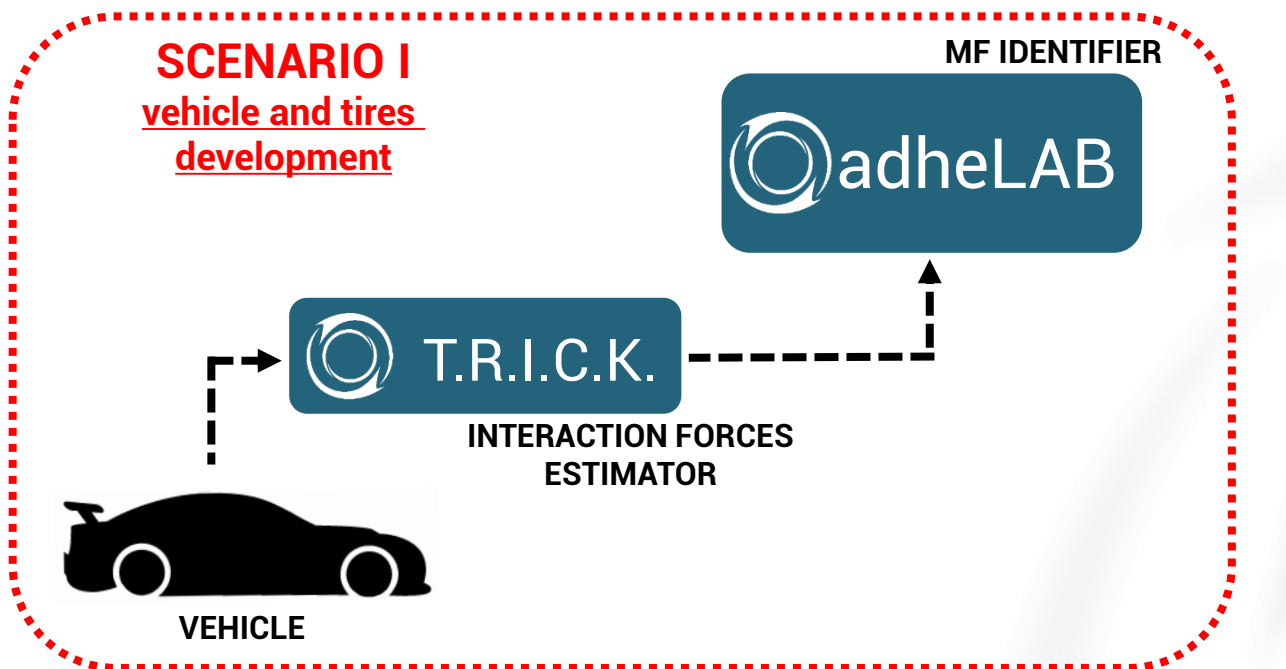




adheLAB: Tyre/Road Interaction Parameters IDentification

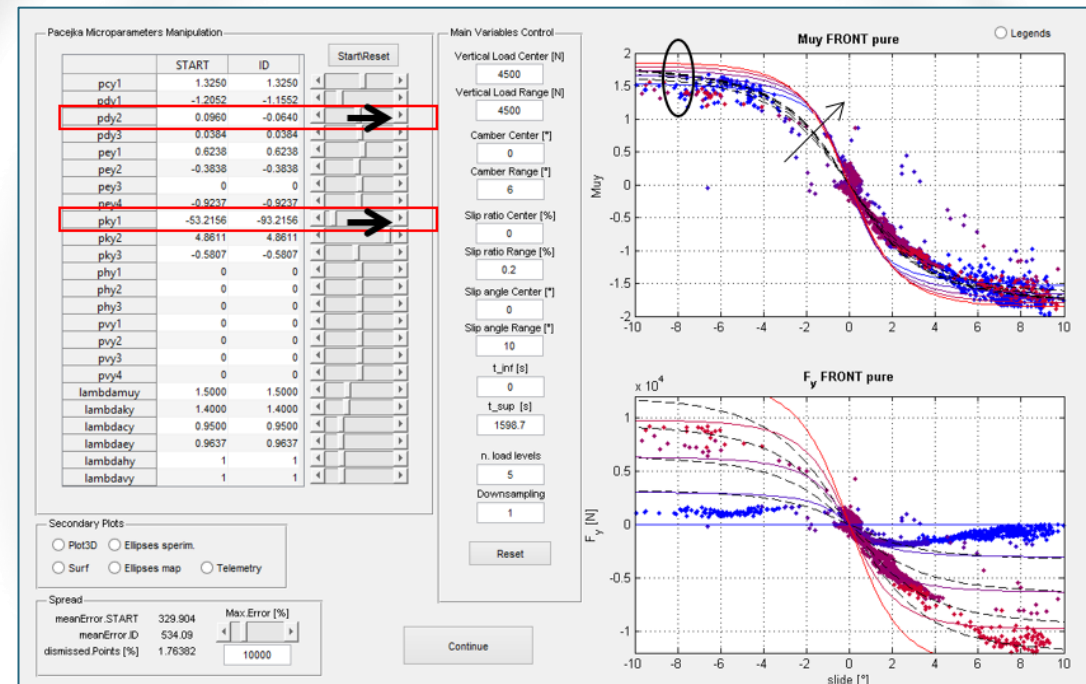
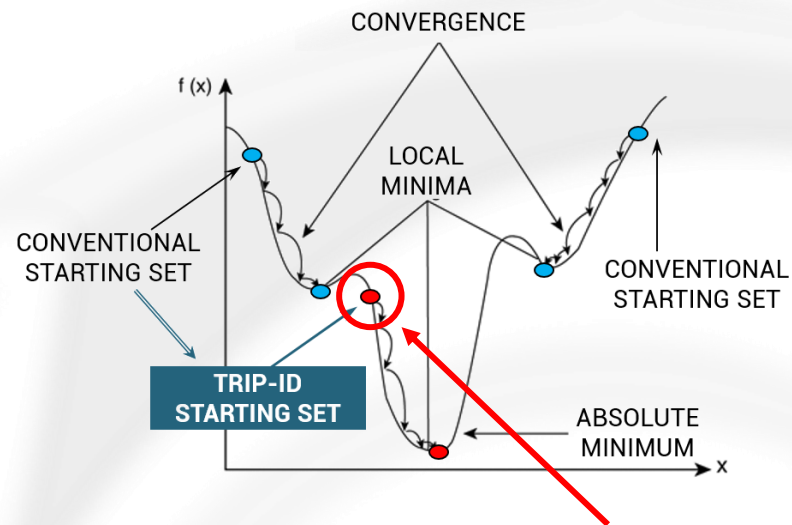
- a tool for multi-variable optimization applied to MF formulation

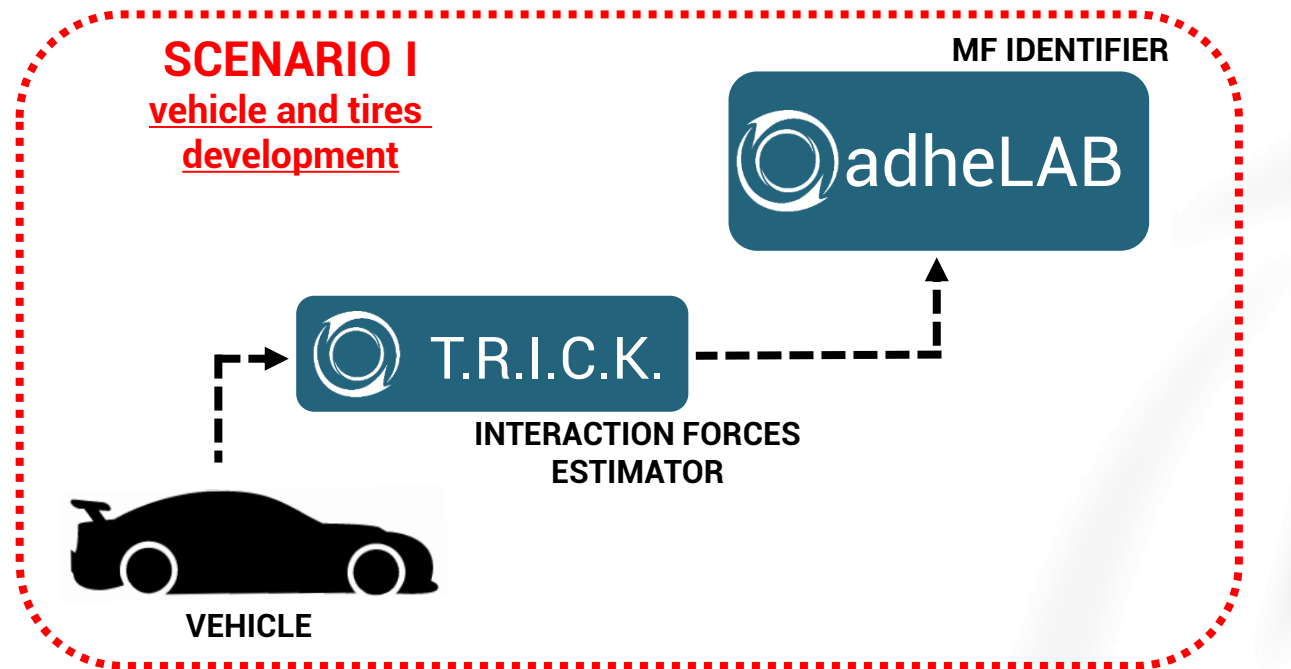




adheLAB: Tyre/Road Interaction Parameters Identification

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

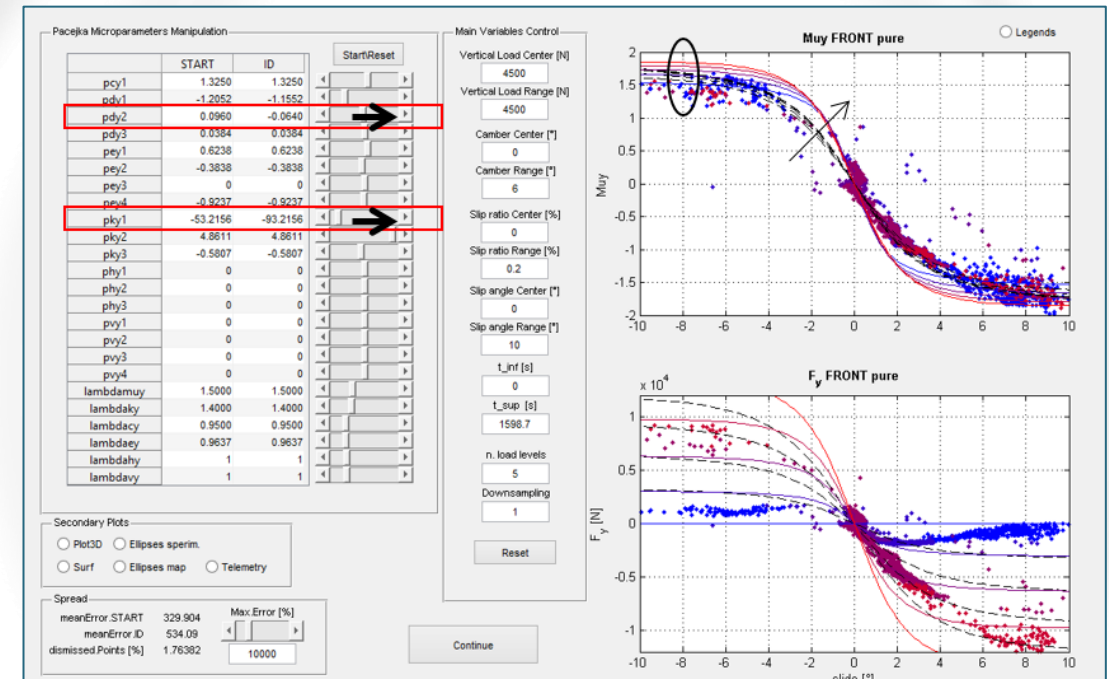




adheLAB: Tyre/Road Interaction Parameters Identification

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

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

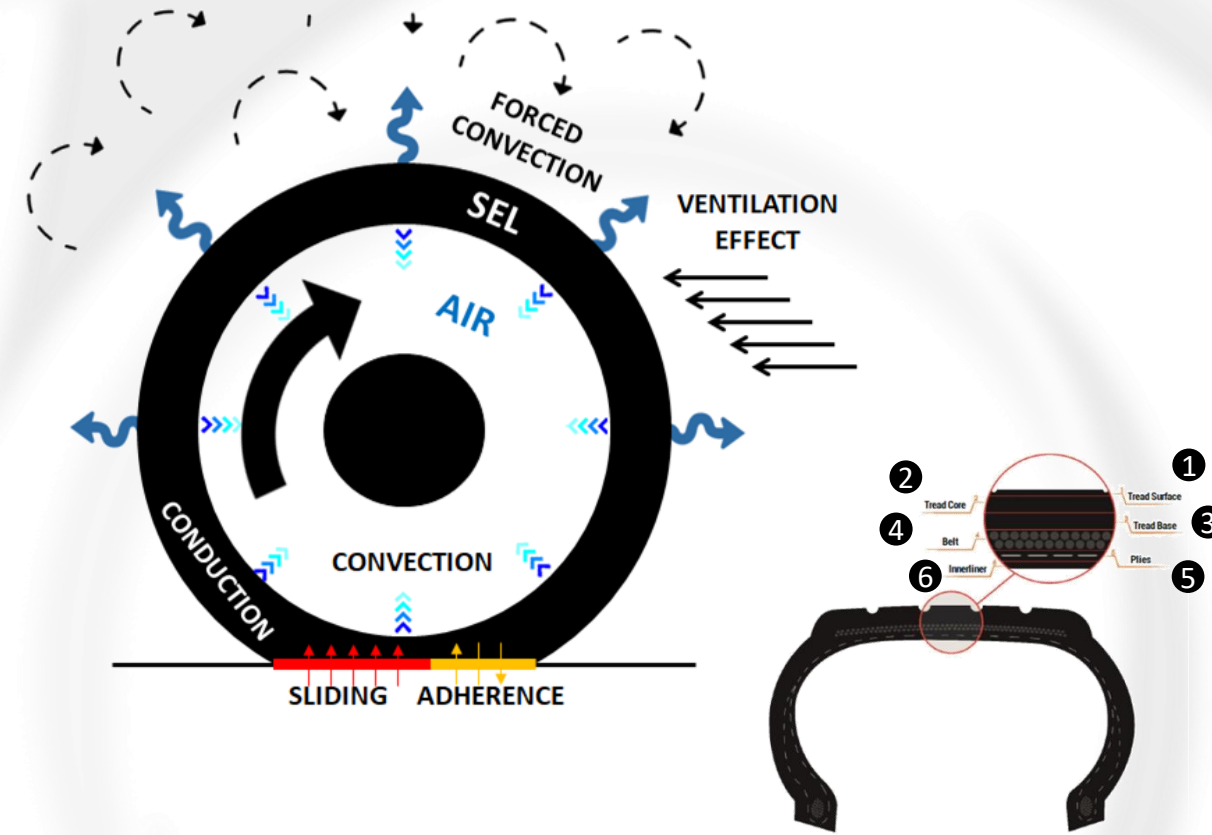


* for further info:

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)

thermoRIDE:

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



MF IDENTIFIER

adheLAB

T.R.I.C.K.

INTERACTION FORCES
ESTIMATOR

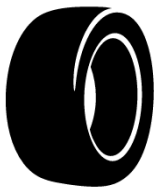


VEHICLE

SCENARIO II

advanced simulations
and performance optimization

TIRES



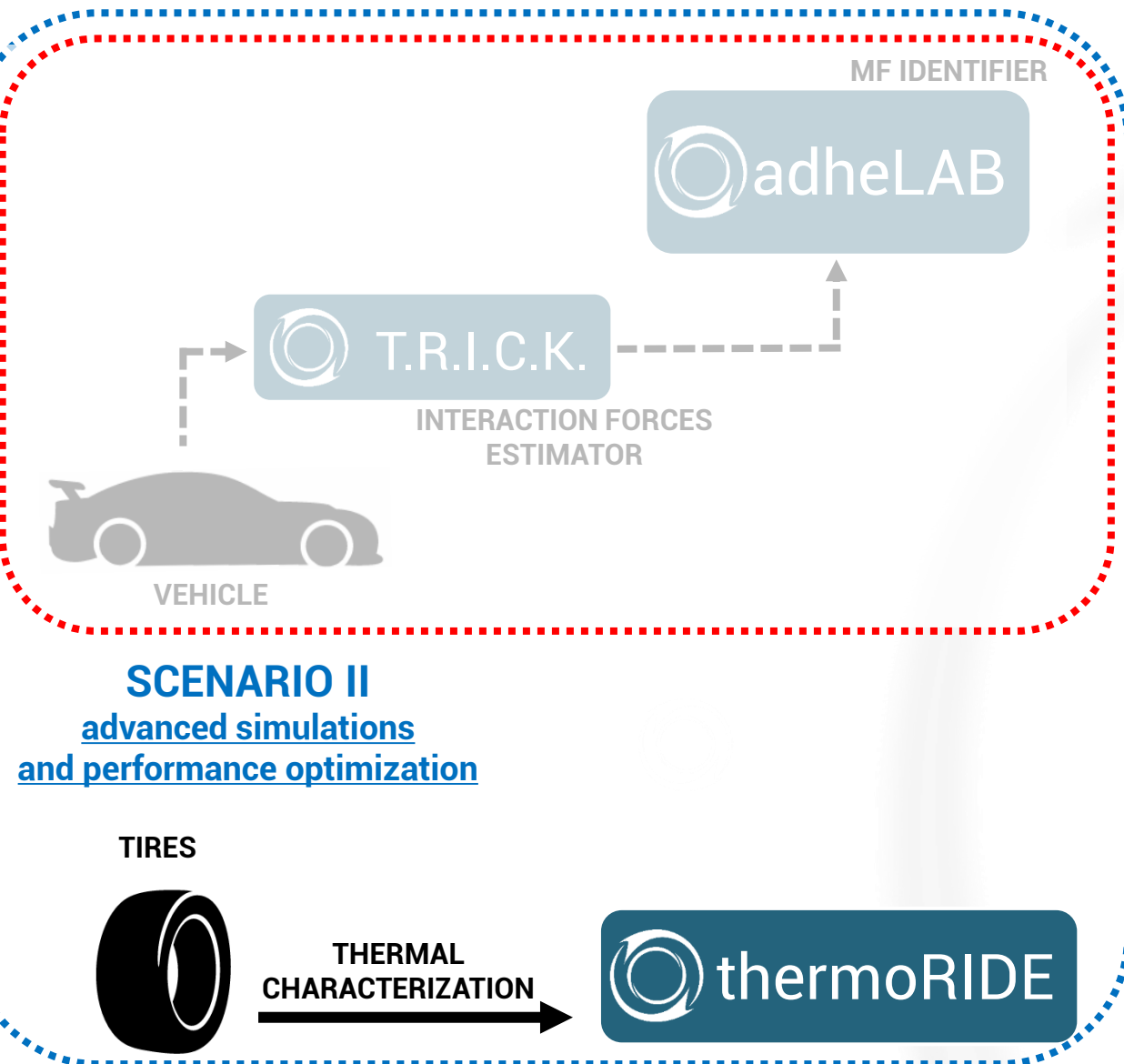
THERMAL
CHARACTERIZATION

thermoRIDE

* exclusive in motoGP for



and in Formula E and DTM for **Audi Sport**



thermoRIDE:

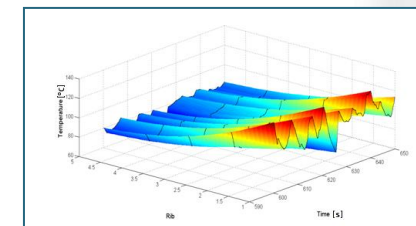
- a real-time physical tire thermal model for performance analysis and simulations



- **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

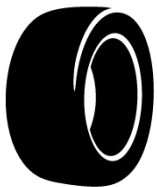


VEHICLE

SCENARIO II

advanced simulations
and performance optimization

TIRES

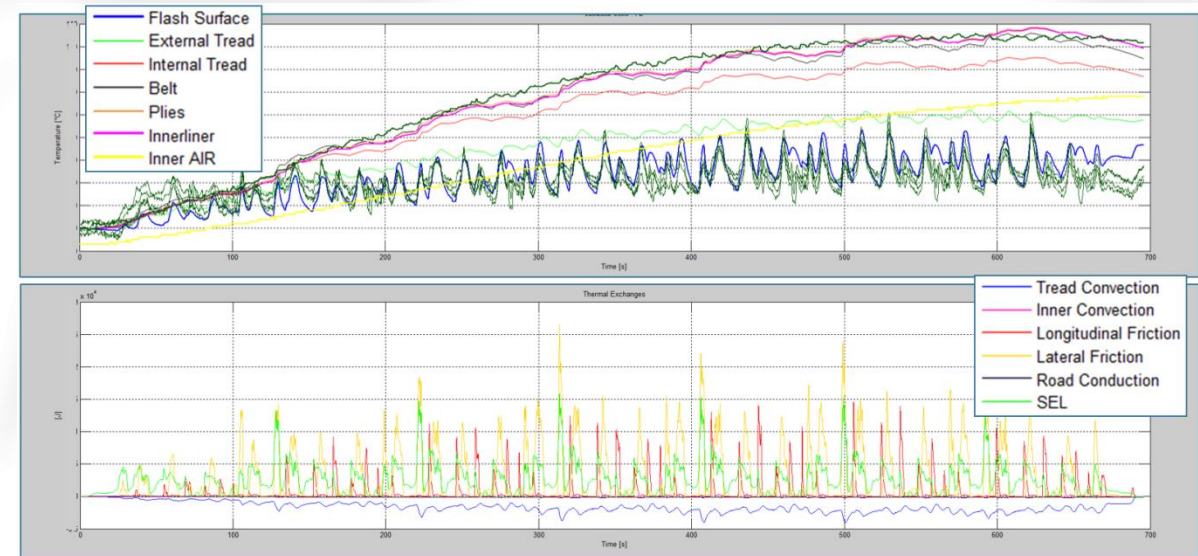


THERMAL
CHARACTERIZATION



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

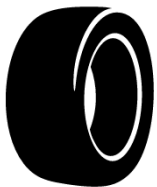


VEHICLE

SCENARIO II

advanced simulations
and performance optimization

TIRES

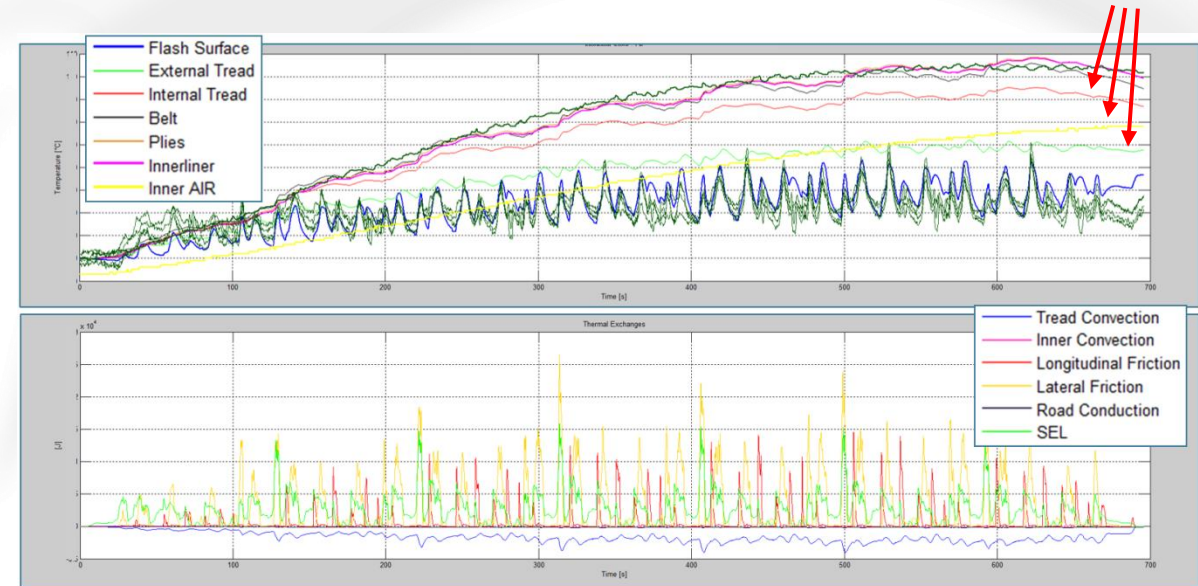


THERMAL
CHARACTERIZATION



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

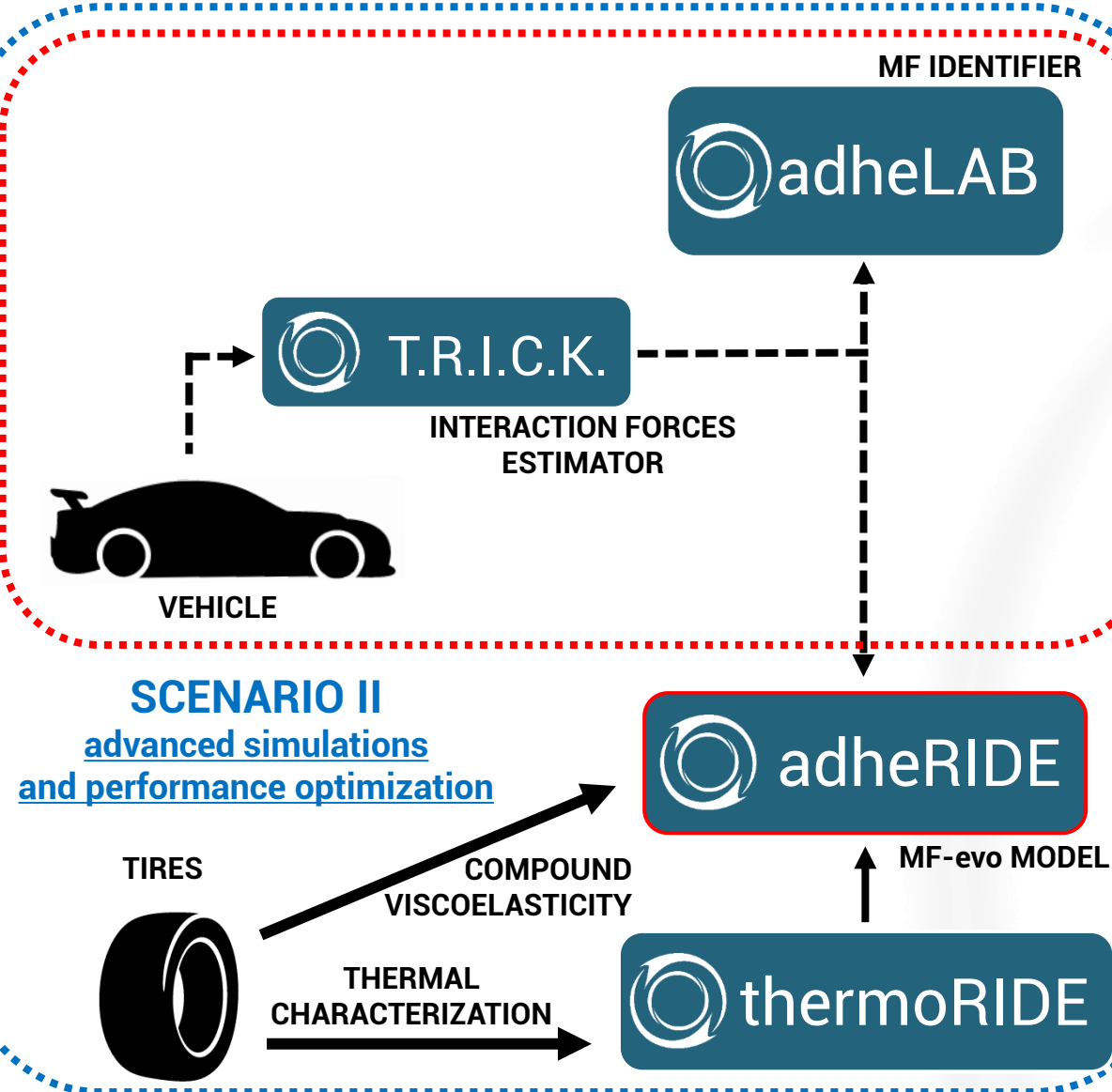
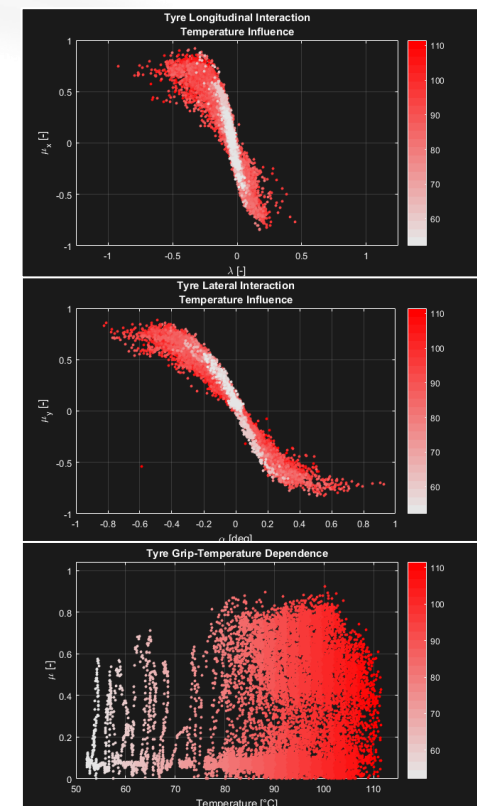
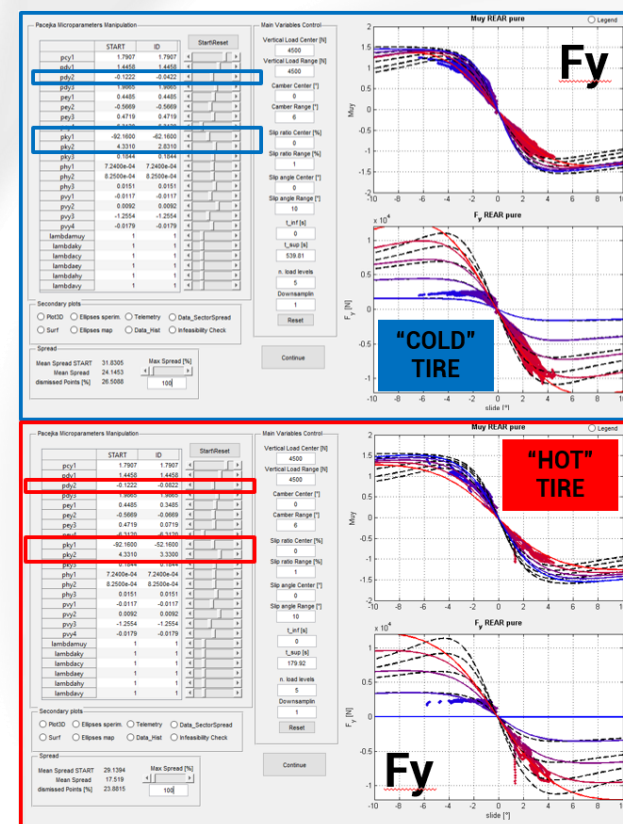
* for further info:

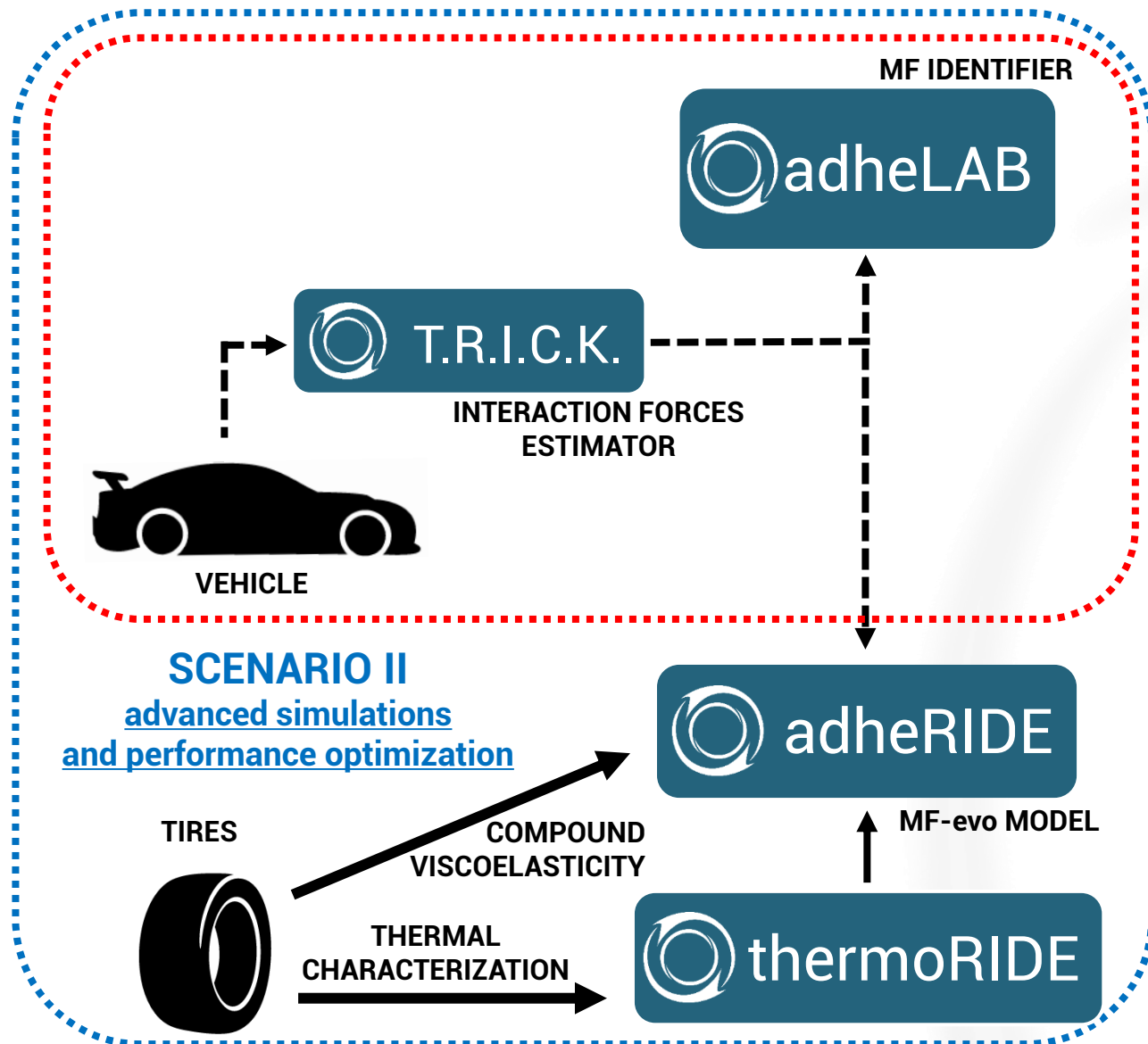
F. Farroni, M. Russo, A. Sakhnevych, F. Timpone - TRT EVO: Advances in real-time thermodynamic tire modeling for vehicle dynamics simulations - Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering- (2019)

adheRIDE:

- an innovative Pacejka's MF model sensitive to:

- TIRE TEMPERATURE
- COMPOUND VISCOELASTICITY
- ROAD ROUGHNESS

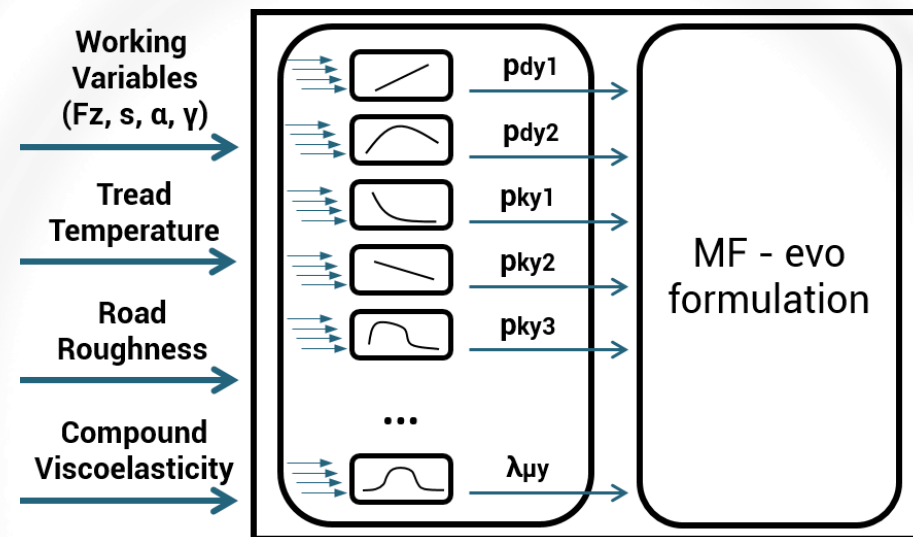


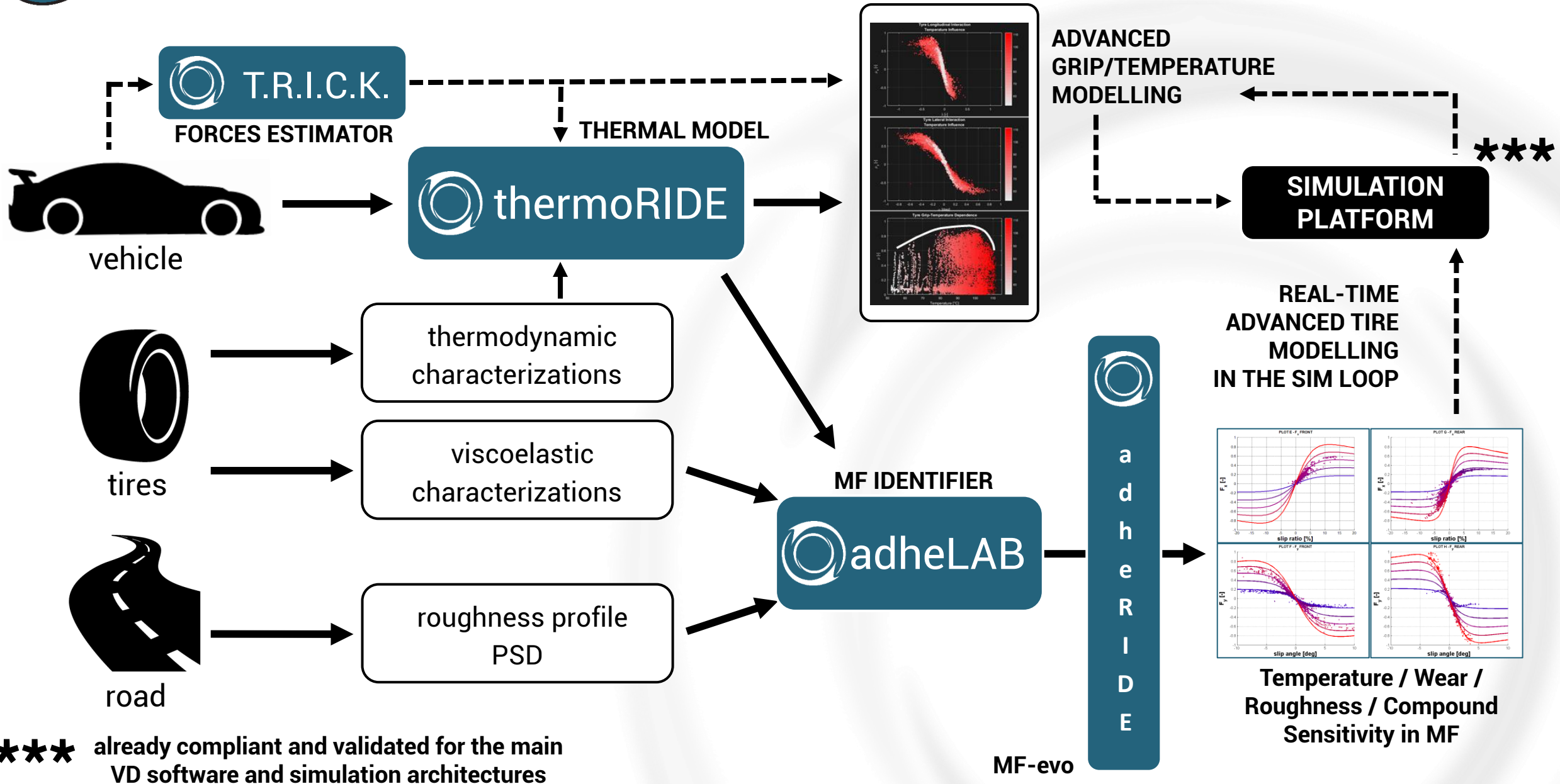


adheRIDE:

- an innovative Pacejka's MF model sensitive to:

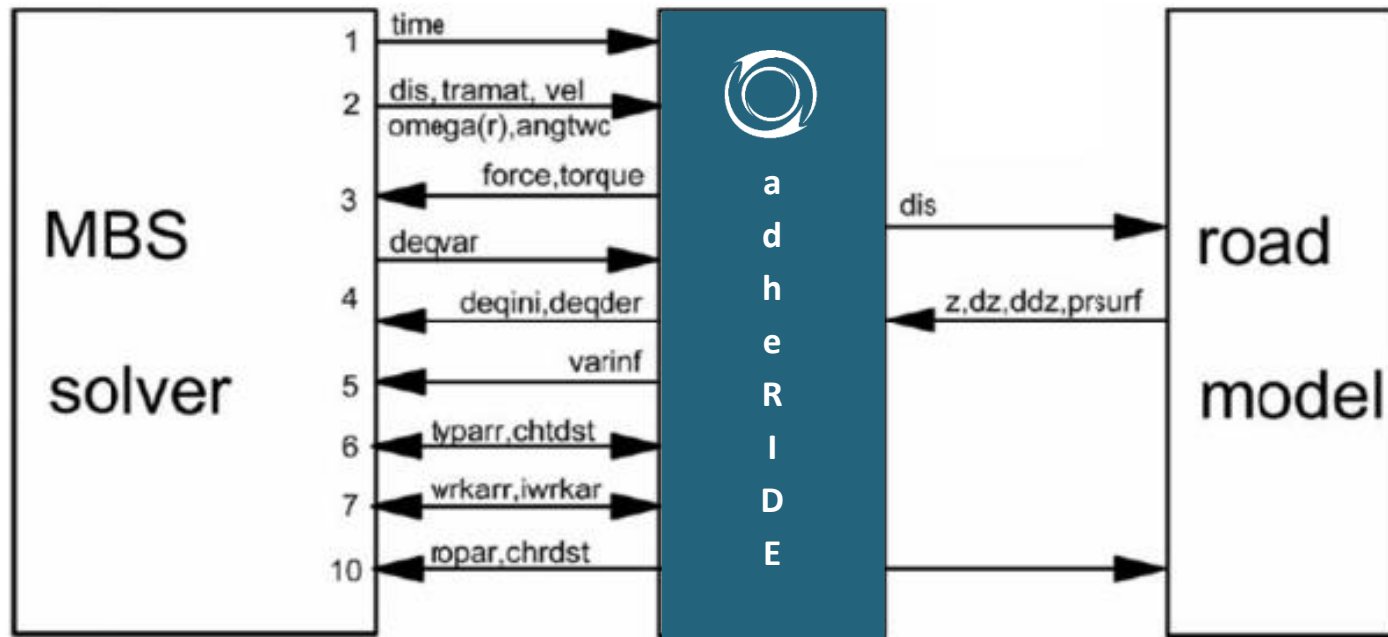
- TIRE TEMPERATURE
- COMPOUND VISCOELASTICITY
- ROAD ROUGHNESS





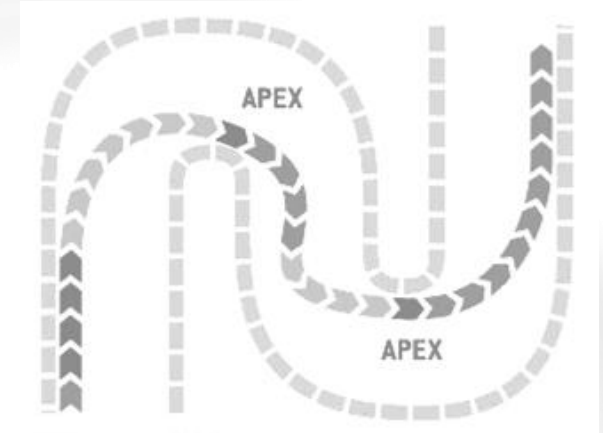
thermoRIDE / adheRIDE & VI-grade MaxPerformance

adheRIDE within Standard Tire Interface



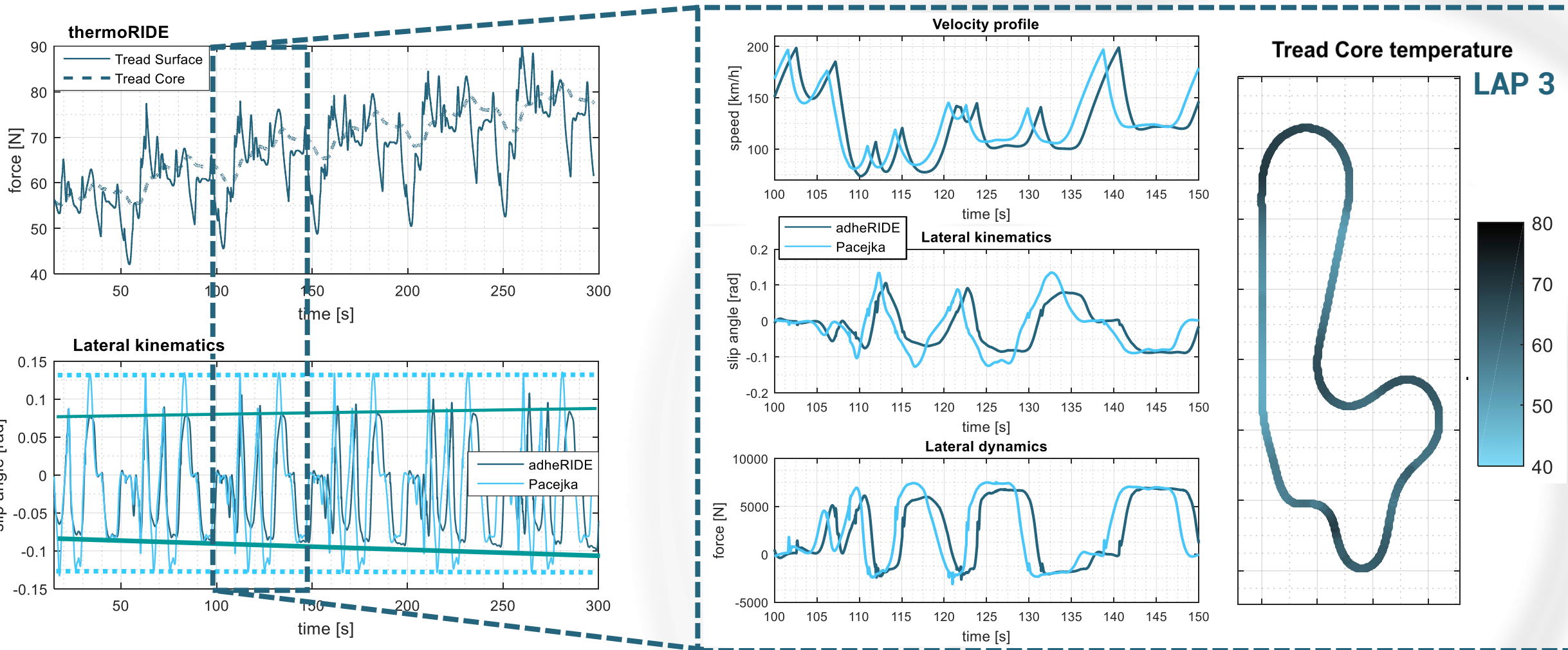
MaxPerformance

FOR EACH
TRACK
SECTOR



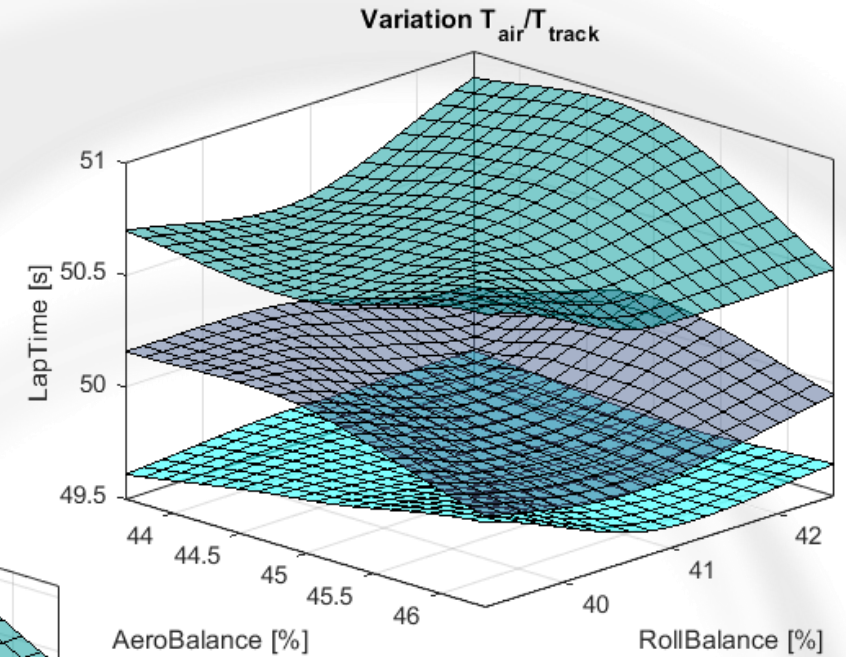
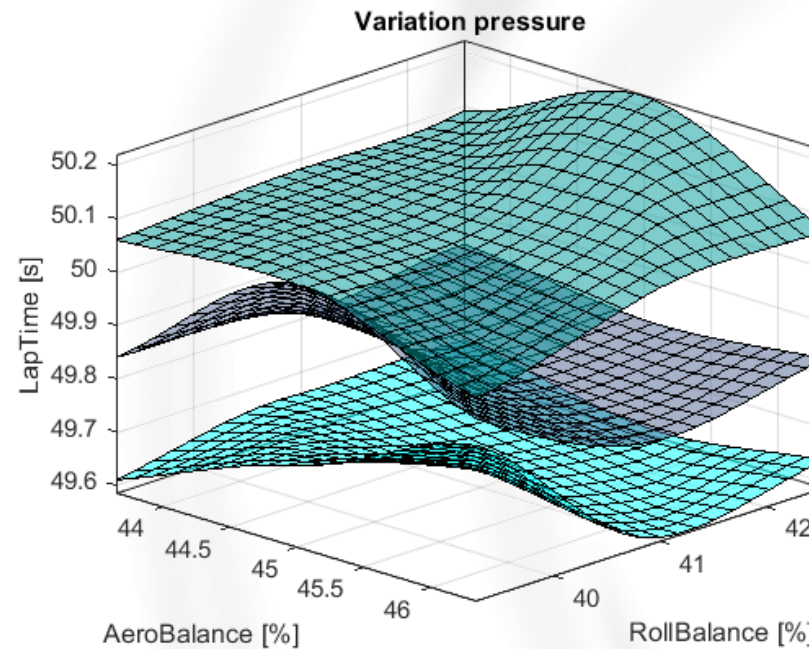
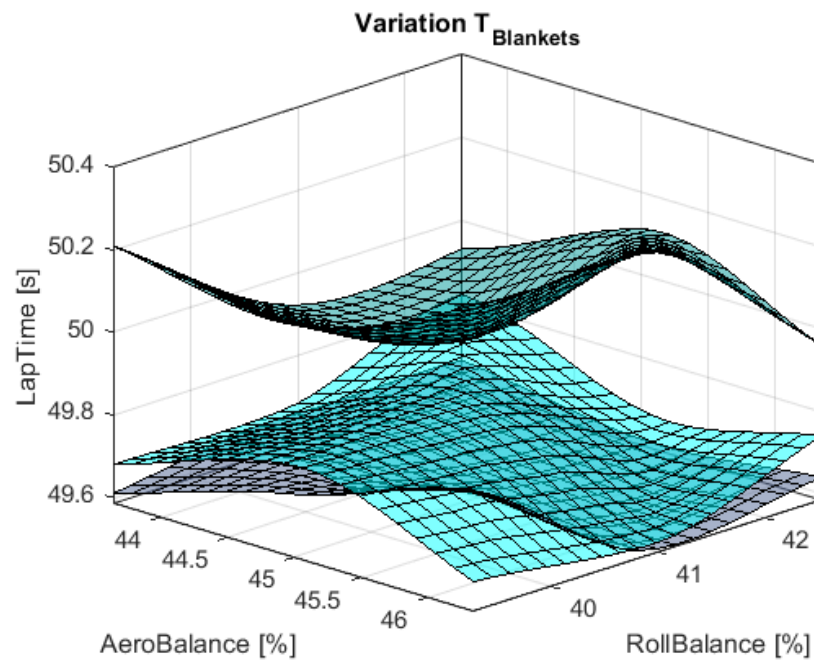
- **static solver**
prediction of static speed profile
- **dynamic solver**
validation of dynamic limit velocity

thermoRIDE / adheRIDE & VI-grade MaxPerformance



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

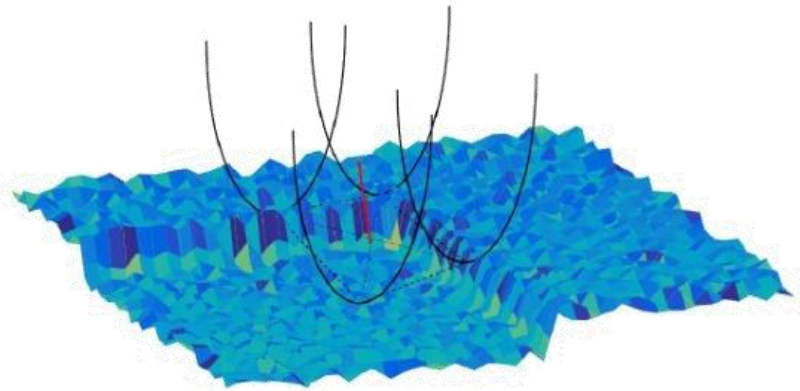


IDENTIFICATION OF THE
OPTIMAL VEHICLE SETUP
ACCOUNTING FOR PHYSICAL
INTERACTION PHENOMENA

Newborn Model: threedeeRIDE

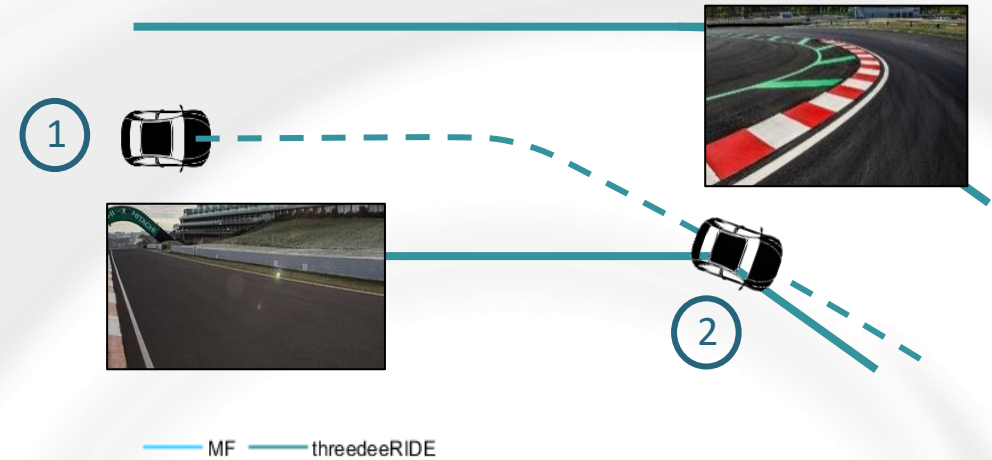
Cam-based muticontact model

- The cam-based multicontact interaction model is used to correctly model the tire/road interface whenever the tire is encountering soil irregularities

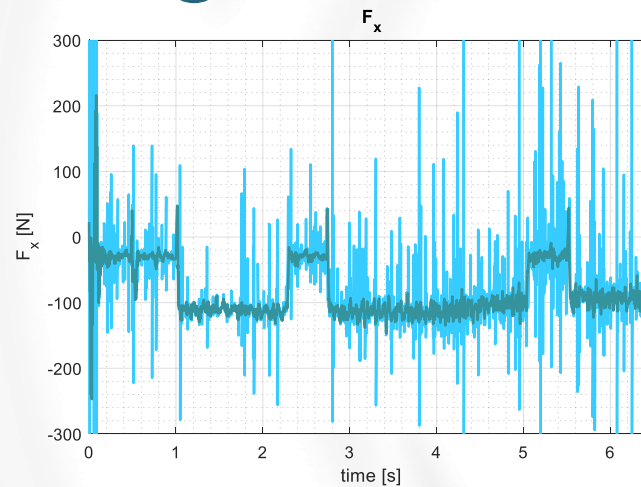


**REAL-TIME CAM SHAPE AND
CHARACTERISTICS VARIATION WITH:**

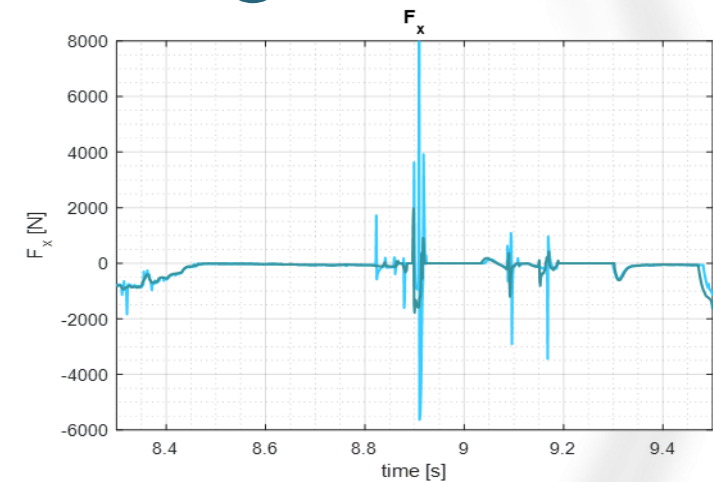
- VERTICAL LOAD
- INFLATION PRESSURE
- CAMBER ANGLE



① Uneven road

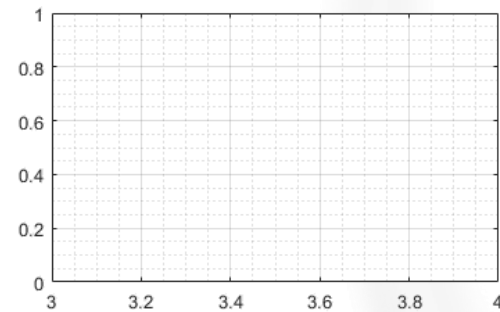
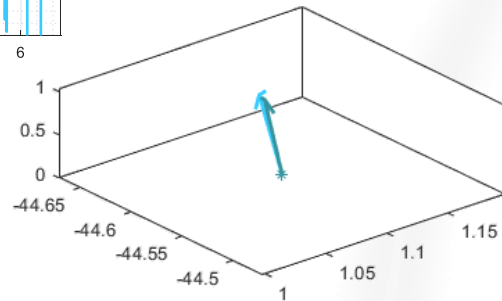
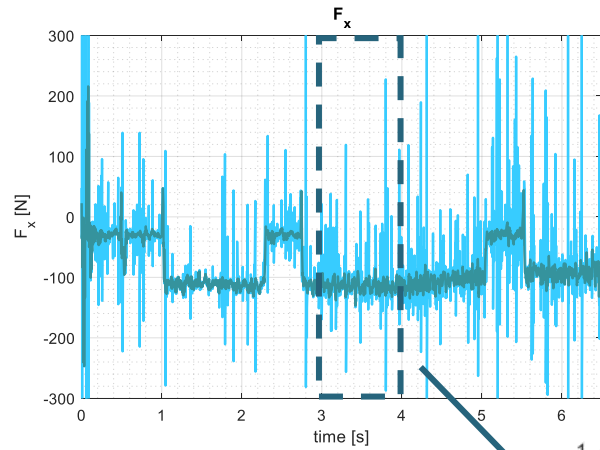


② Kerb impact

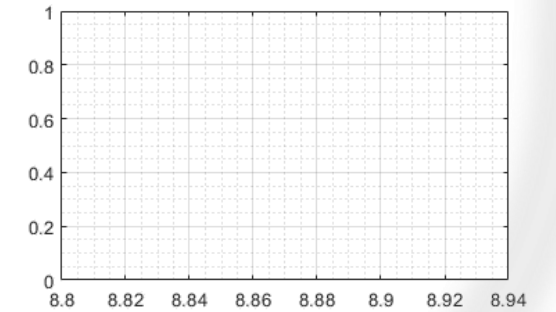
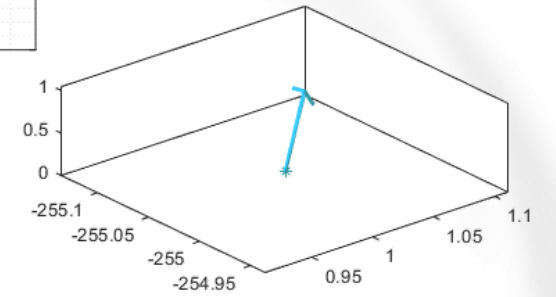
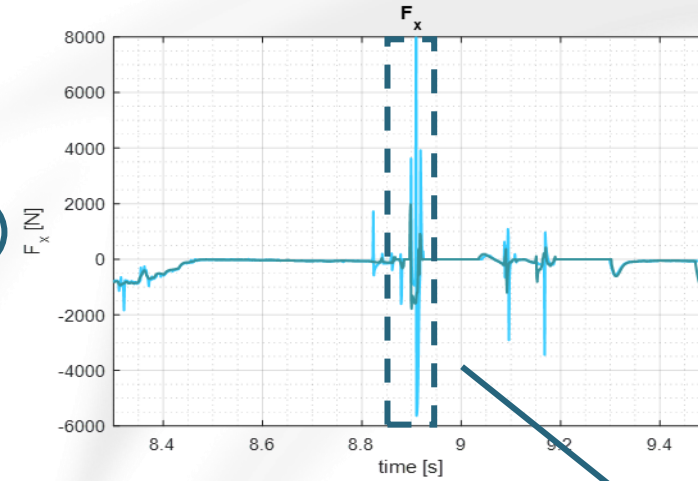


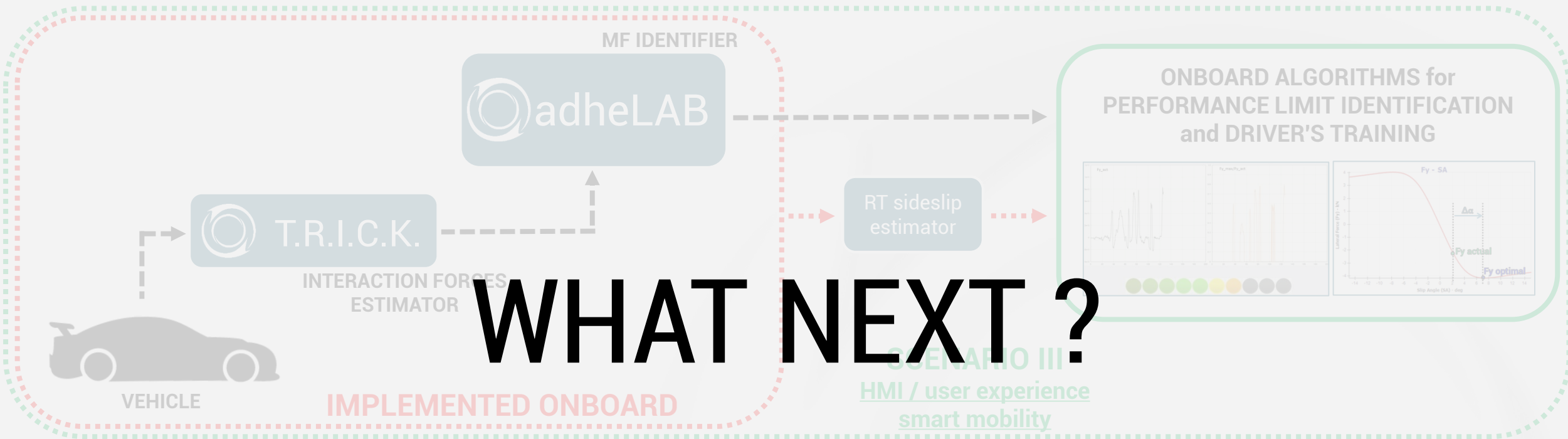
Newborn Model: threedeeRIDE

1



2



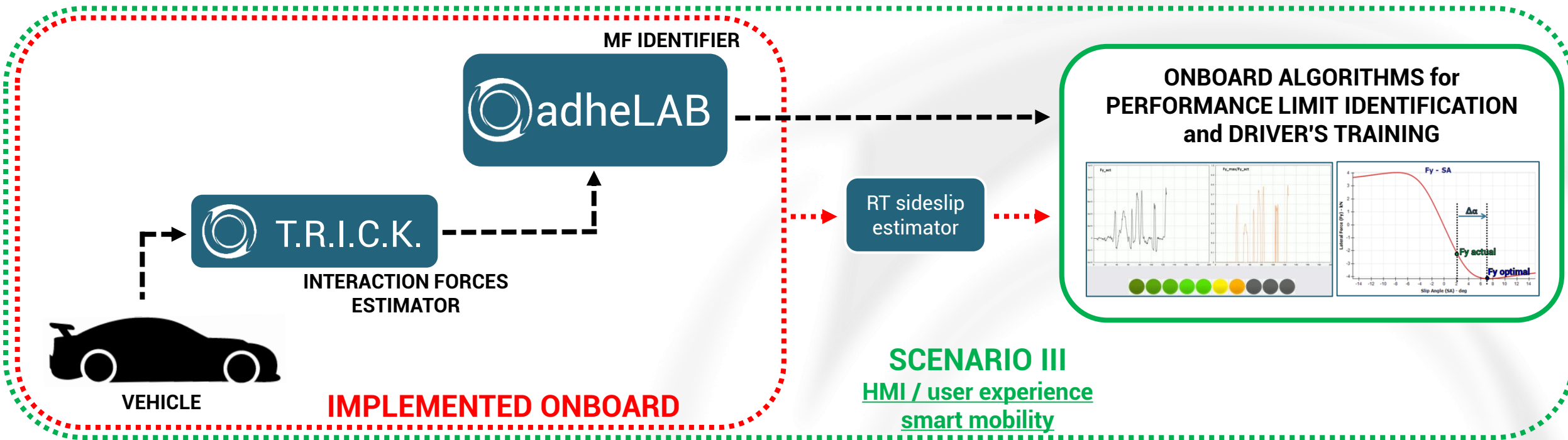


▪ RACING & MOTORSPORT:

- evaluation of tire/road available friction for drivers' training activities and driving style optimization (definition of target slip ratio and sideslip angle for performance optimization and info to the user)

▪ SMART MOBILITY:

- evaluation of tire/road effective friction for V2V AND V2I applications (tread and soil wear estimation, asphalt predictive maintenance, physical-based safety control algorithms, ...)



■ RACING & MOTORSPORT:

- evaluation of tire/road available friction for drivers' training activities and driving style optimization (definition of target slip ratio and sideslip angle for performance optimization and info to the user)

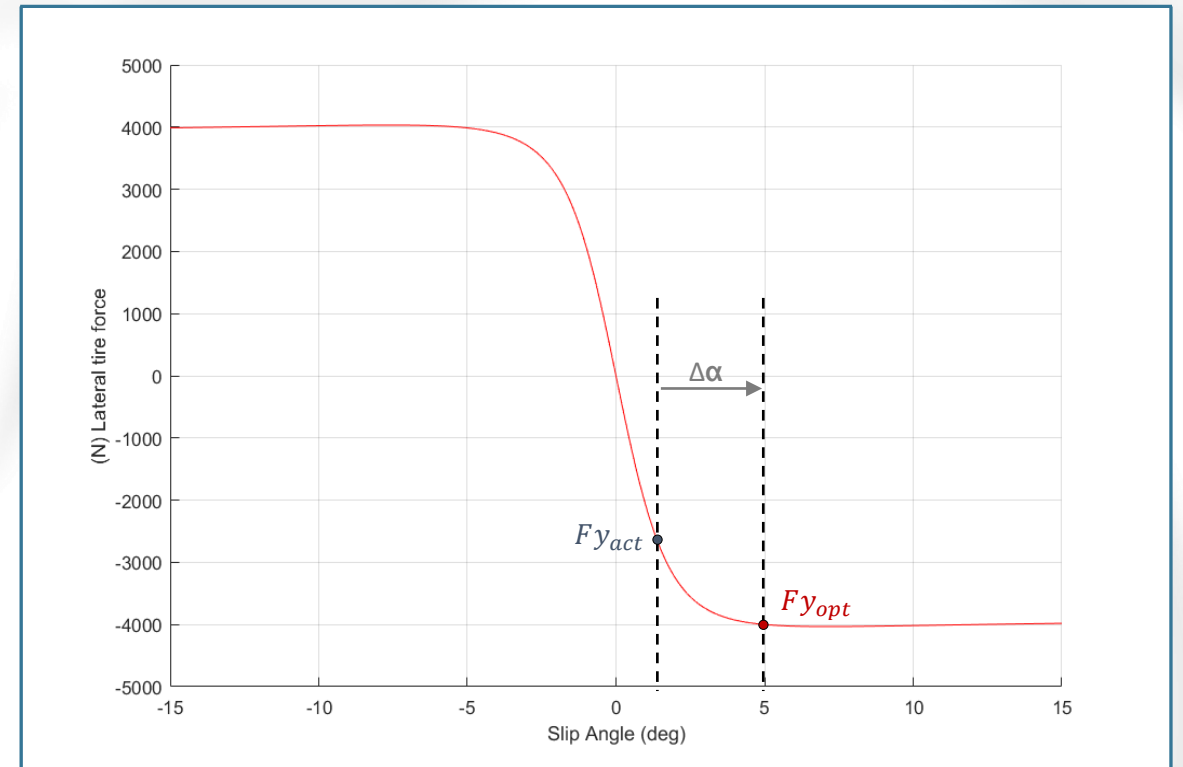
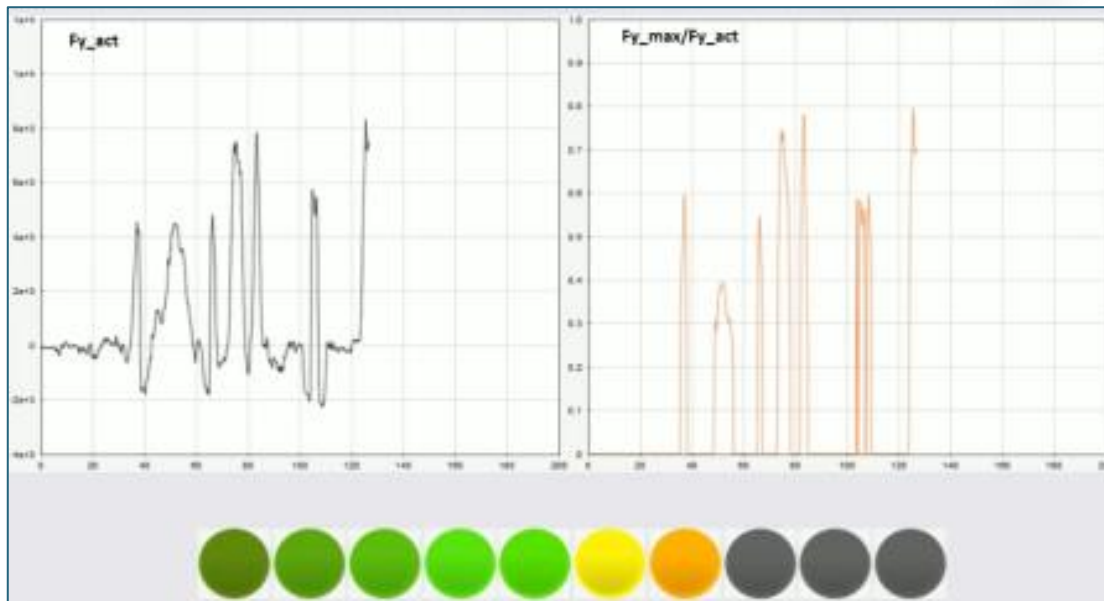
■ SMART MOBILITY:

- evaluation of tire/road effective friction for V2V AND V2I applications (tread and soil wear estimation, asphalt predictive maintenance, physical-based safety control algorithms, ...)

New Scenarios - Onboard Control Logics

ONBOARD MF ID and real-time TRICK in motorsport

Evaluation of tire/road available friction for active controls and drivers' training activities
(definition of target slip ratio and sideslip angle for performance optimization and info to user)



curves referred to the same (s, γ, F_z) working input

$$\text{performance index} = F_{y_{act}} / F_{y_{opt}}$$

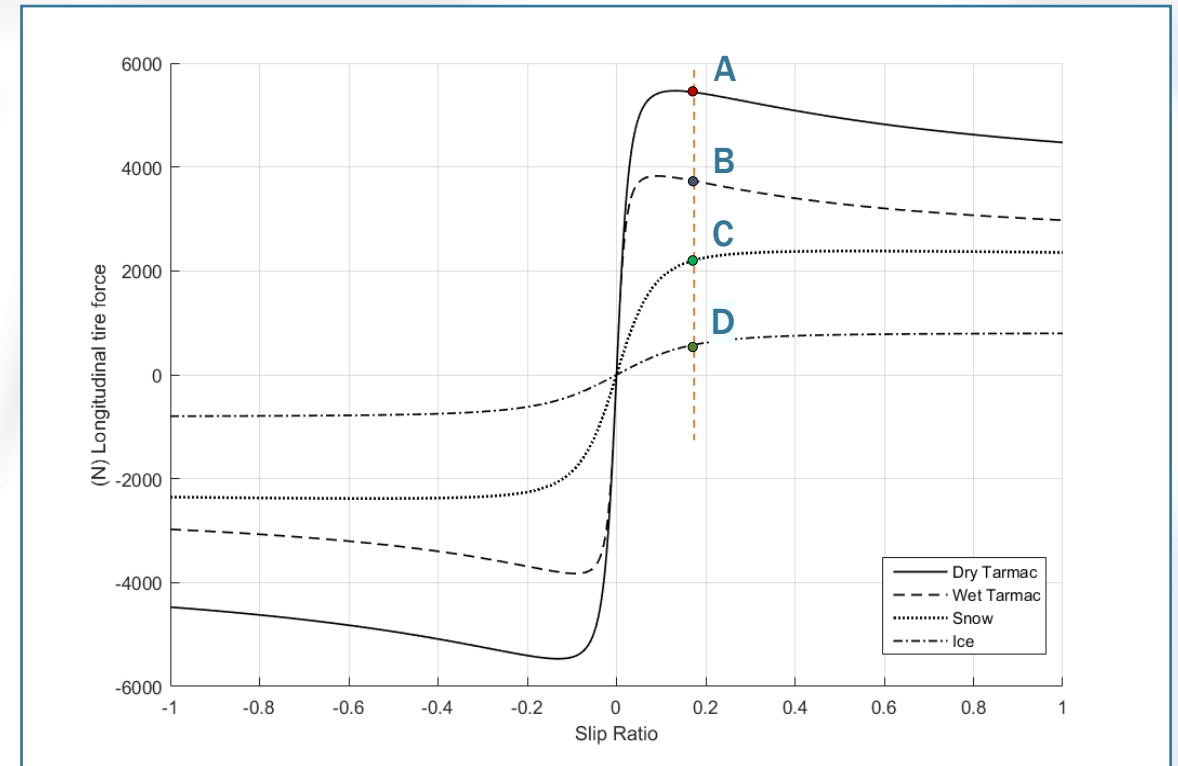
New Scenarios - Onboard Control Logics

ONBOARD MF ID and real-time TRICK in smart mobility

Evaluation of tire/road effective friction for smart mobility applications
(tread and soil wear estimation, asphalt predictive maintenance, physical-based safety control algorithms,...)

A.I., Big Data analysis & Geolocalization-examples:

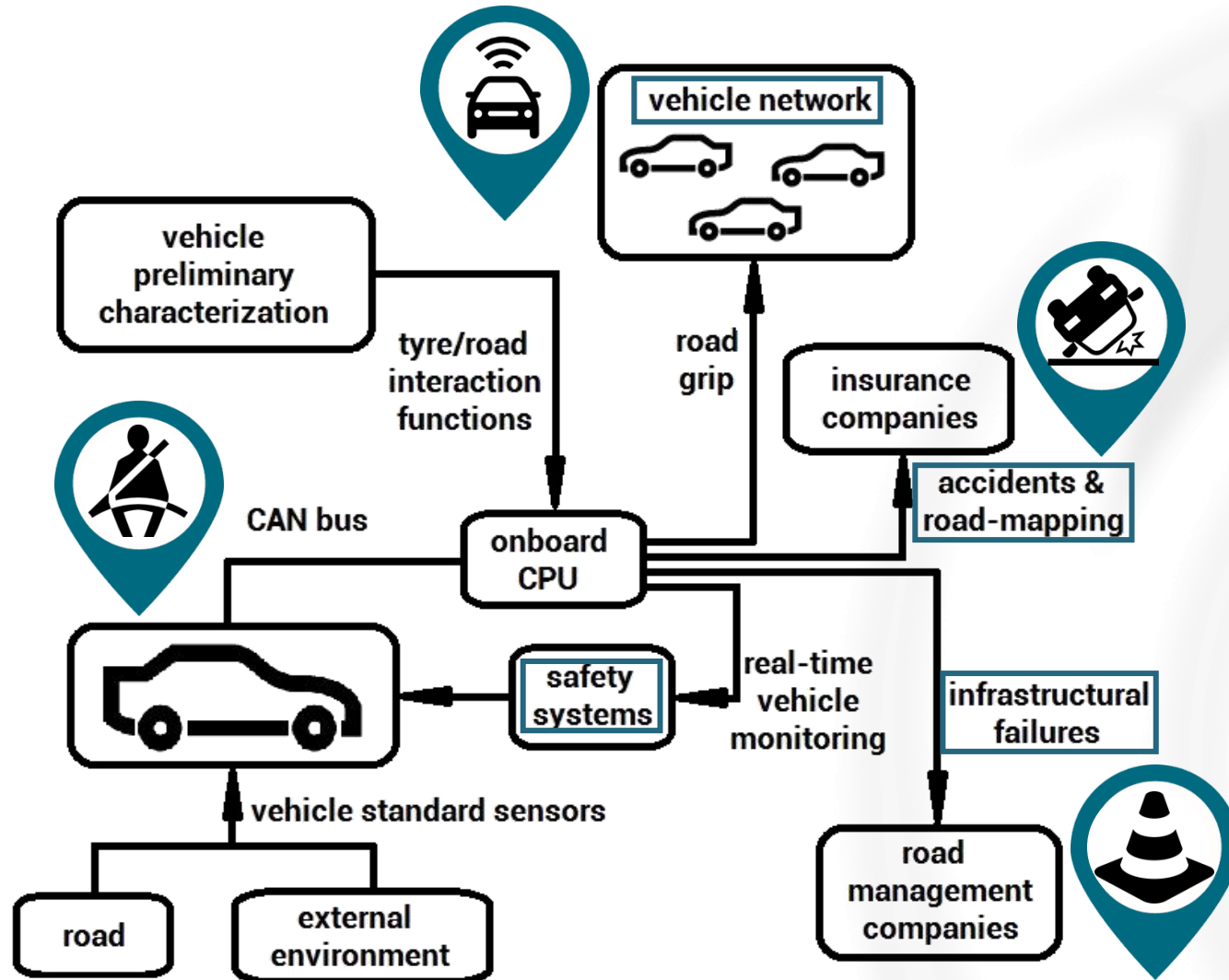
- several vehicles detected sudden and dramatic friction decrease in small area → **"oil spot" or singularity**
- single vehicles detects sudden and dramatic friction variation in small area → **accident/puncture**
- several vehicles detect progressive and significant friction decrease in medium area → **rain**
- several vehicles detect progressive and dramatic friction decrease in medium area → **ice**
- Several vehicles detect slow friction decrease in big area → **pavement wear**
- Single vehicle detects slow friction decrease in big area → **tire tread wear**



curves referred to the same (s, γ, F_z) working input

$$\text{performance index} = Fx_i / Fx_A$$

Smart Mobility Platforms



open innovation scenarios:

- UE CONSORTIUMS
- R&D PARTNERSHIPS
- TECHNOLOGICAL JVs



DEVELOPMENT TOOL OF THE YEAR

2018: VI-grade – DiM250

**2019: MegaRide –
Tire Simulation Pack**



MIT
INNOVATORS
UNDER 35
2018



TIRE
TECHNOLOGY
OF THE YEAR
2018



ECCELLENZE
D'IMPRESA
2018





info@megaride.eu
www.megaride.eu



Via Claudio 21, 80125 NAPOLI

DII – Dipartimento di Ingegneria Industriale
Università degli Studi di Napoli "Federico II"



<https://www.facebook.com/MegaRidevehicledynamics/>



https://www.instagram.com/megaride_vehicle_dynamics/