



Advanced Modeling for High-Performance Tire Simulations

a roadmap of the implementation stages of MegaRide technologies



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

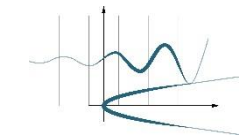
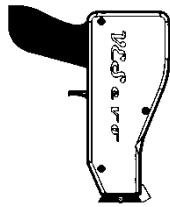
weaRIDE
tire wear model



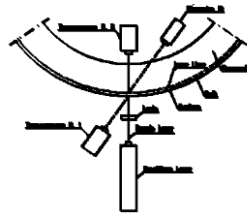


SMARTIFYING TIRE PARAMETERIZATION

1 INNOVATIVE DEVICE + TESTBENCHES

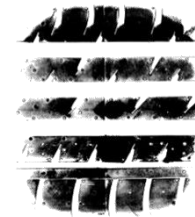


VESevo
nondestructive tread
compound analyzer



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
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4 PHYSICAL MODELS (RIDEsuite)



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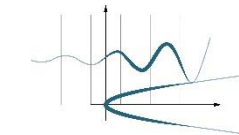
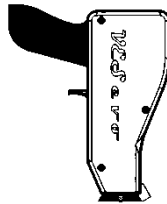


threedeeRIDE
multicontact model

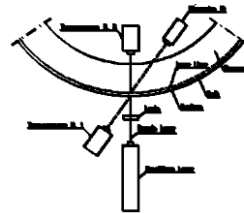
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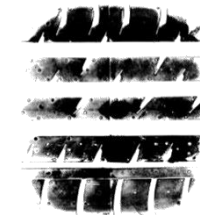


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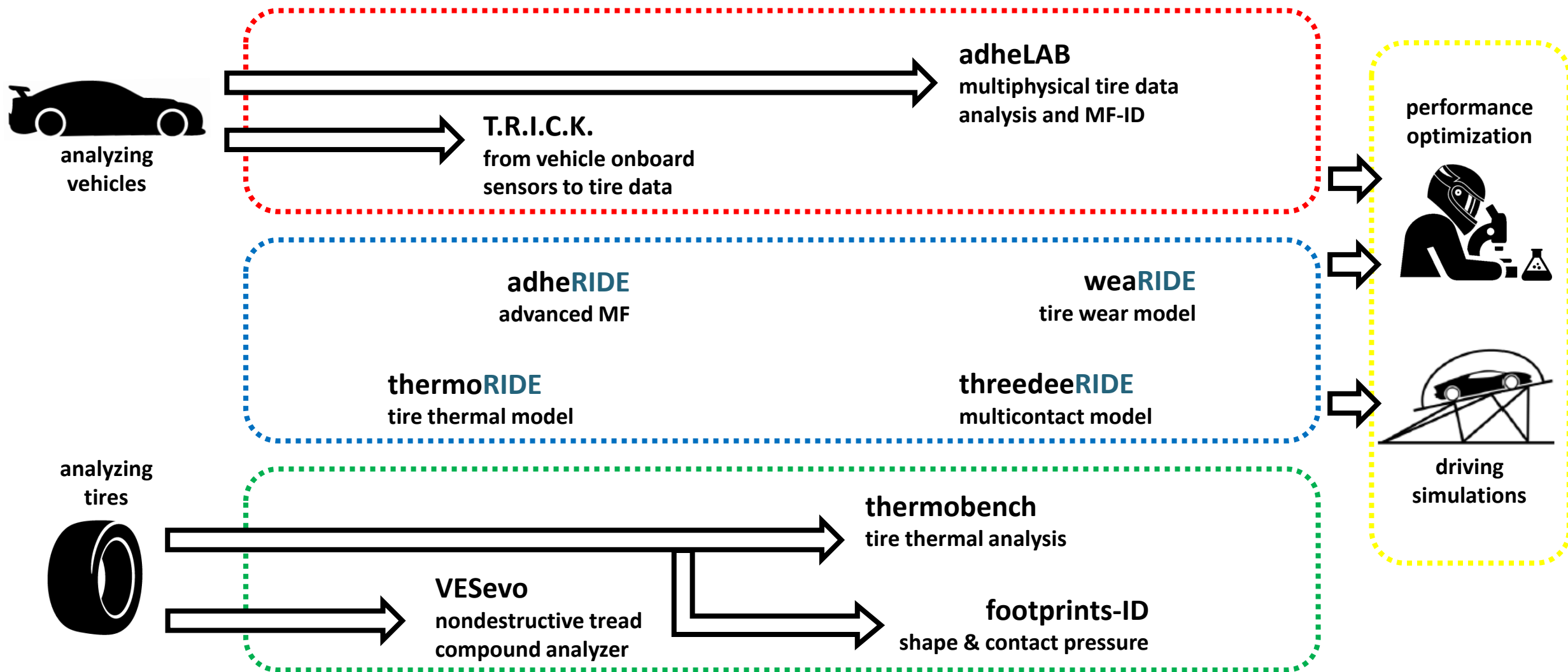
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INPUT & OUTPUT

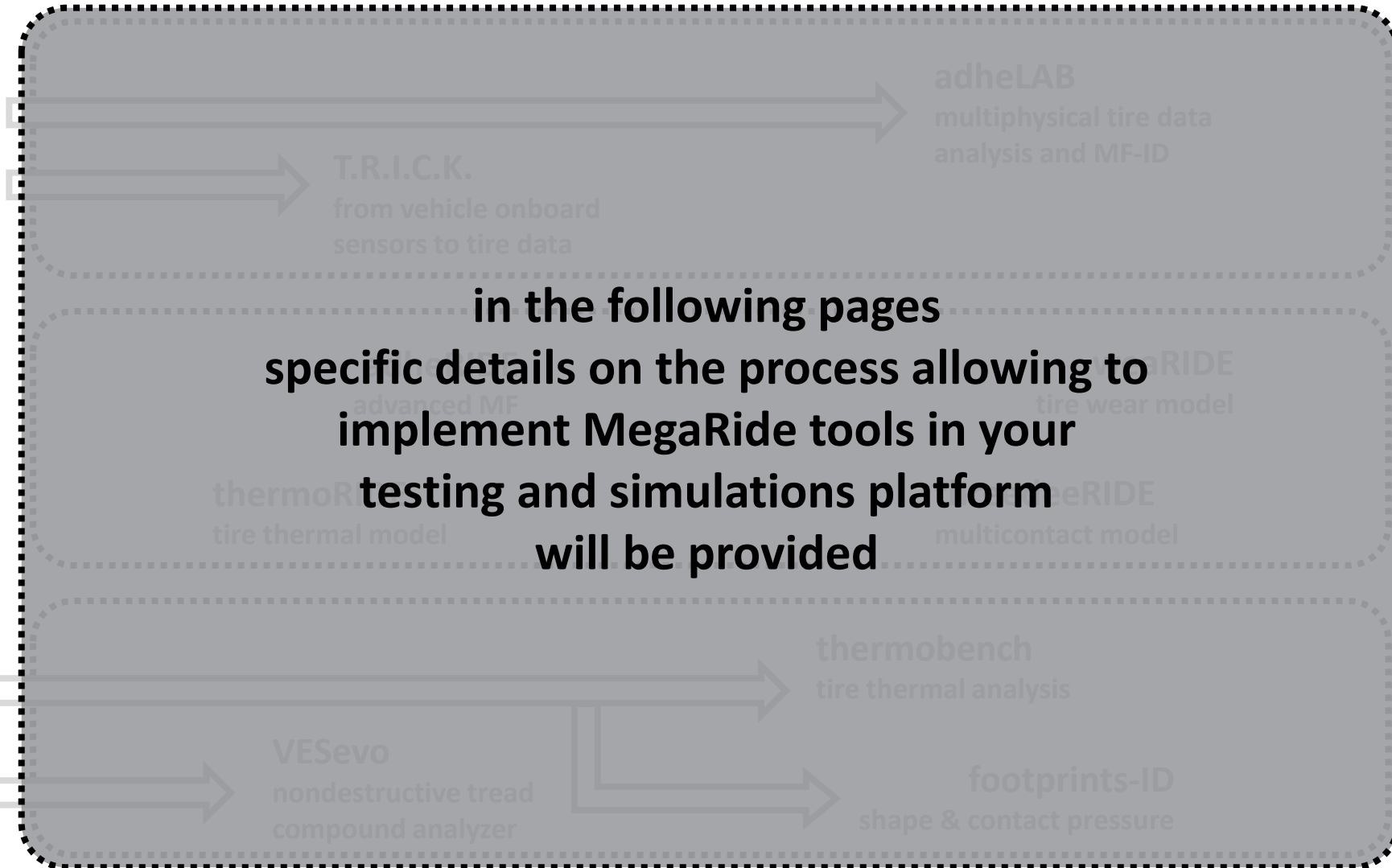




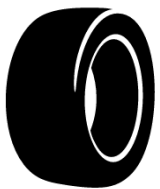
ROADMAP AND MODULES



analyzing
vehicles



analyzing
tires



performance
optimization

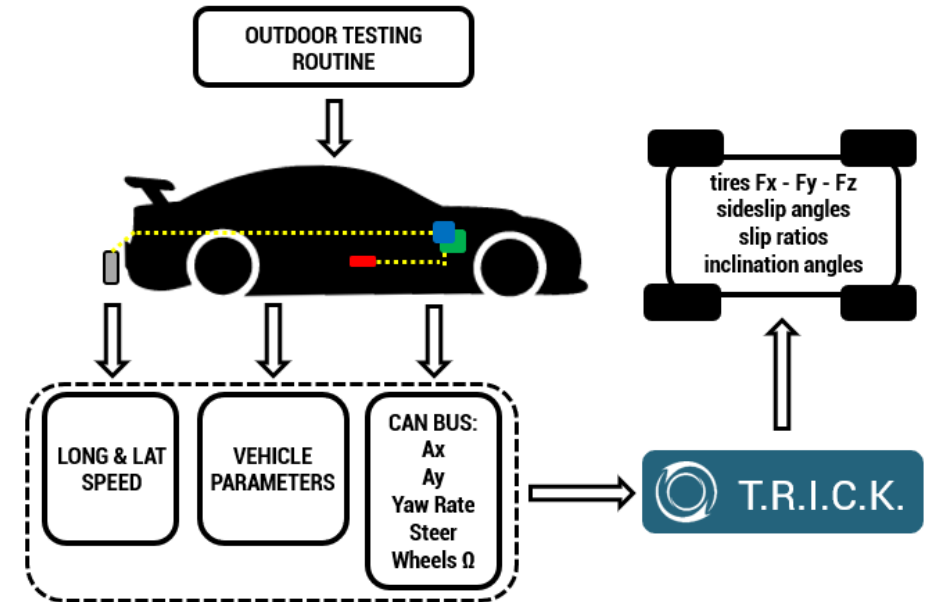
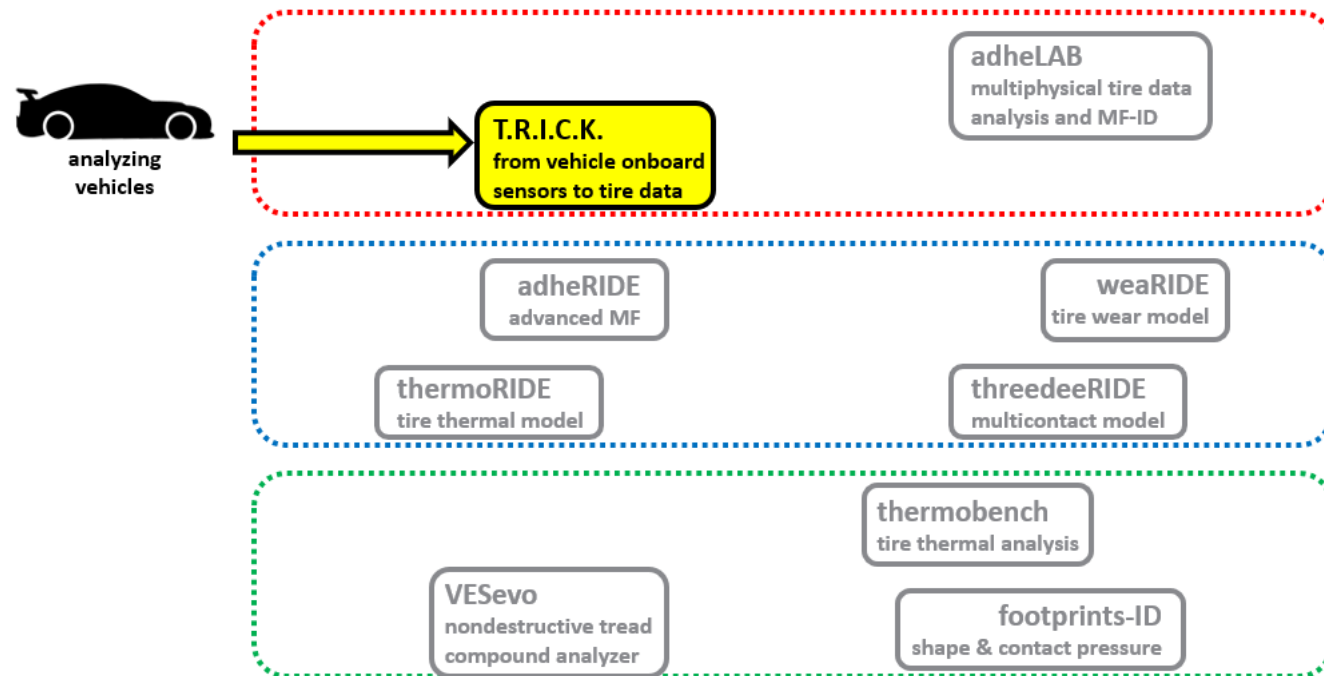


driving
simulations



stage 1 – TRICK tool

In case technologies for tire interaction forces evaluation are not already available in the partner's routines, the first step will concern the implementation of **TRICK** tool, able to "convert" vehicle sensors data in tire data, useful to analyze performance and calibrate, validate and feed the tire physical models

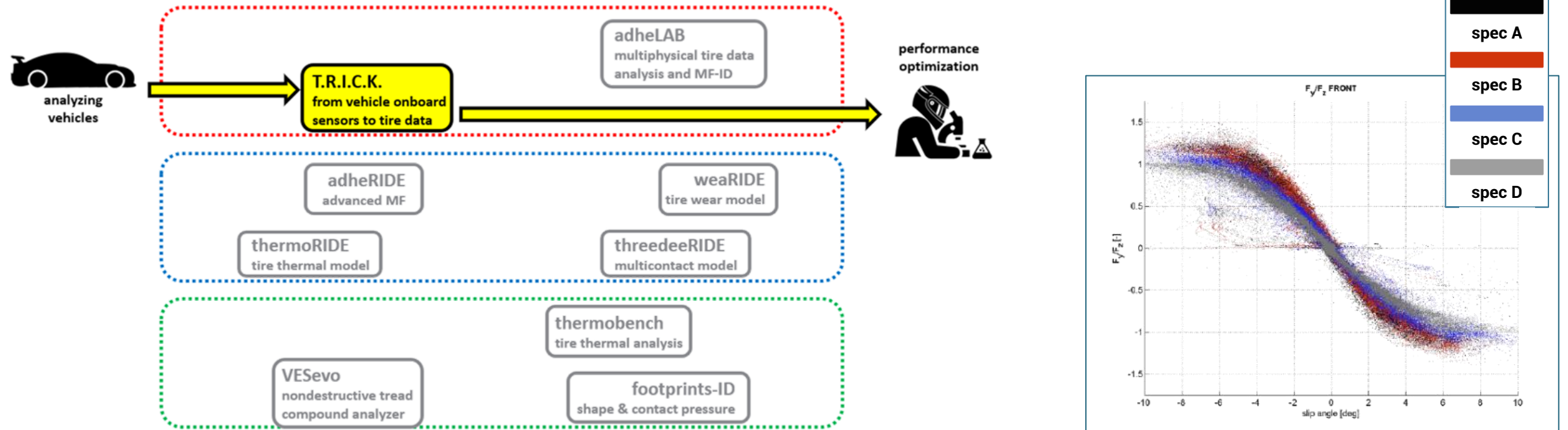
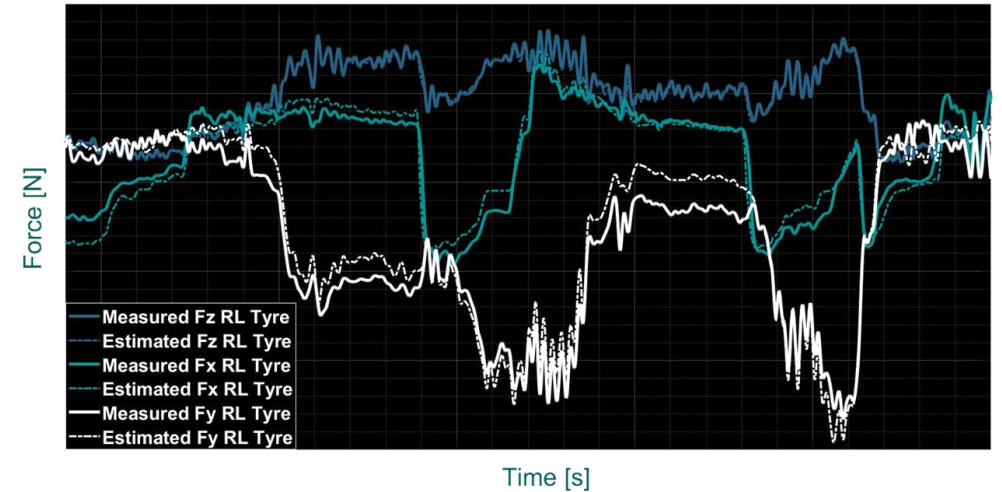


- PHYSICAL VEHICLE MODEL
- FROM ONBOARD STANDARD SENSORS TO TIRE FORCES EVALUATION
- SPECIFIC OUTDOOR TESTING PROCEDURE
- REAL TIRES / REAL ROAD / REAL CONDITIONS



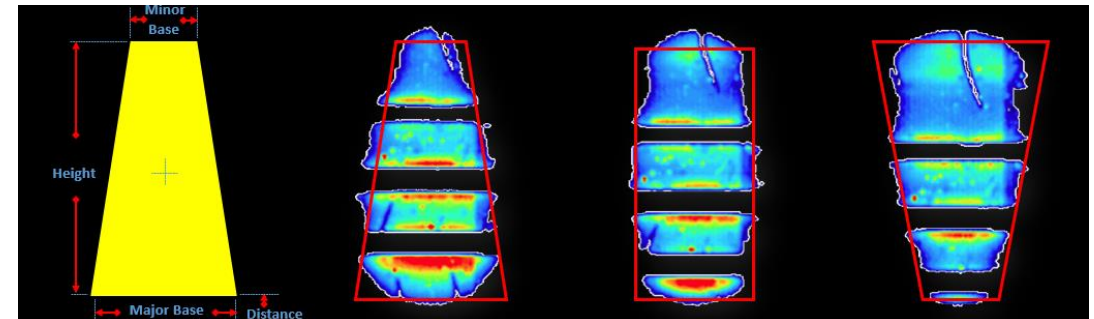
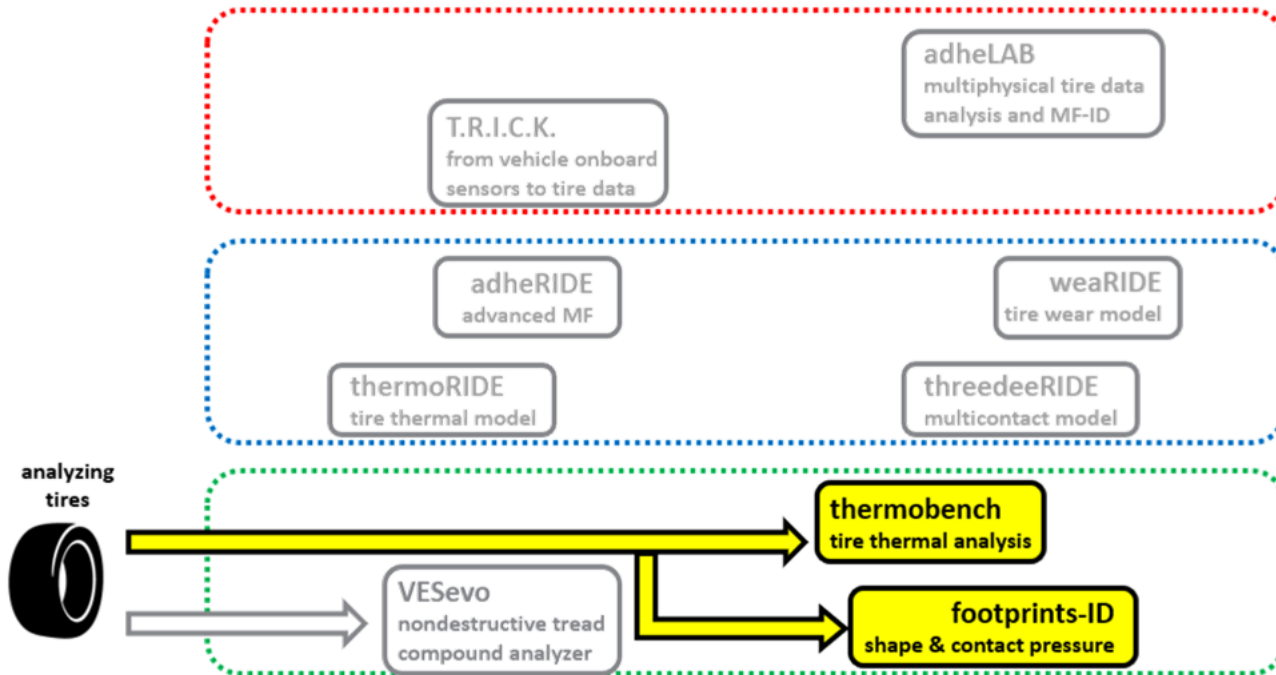
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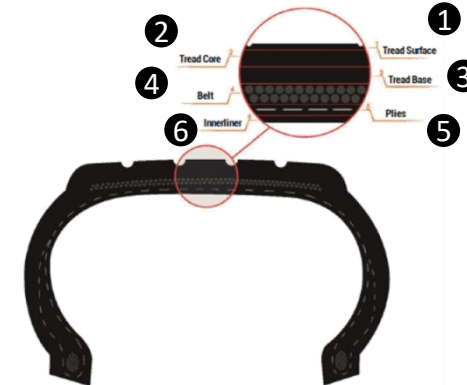
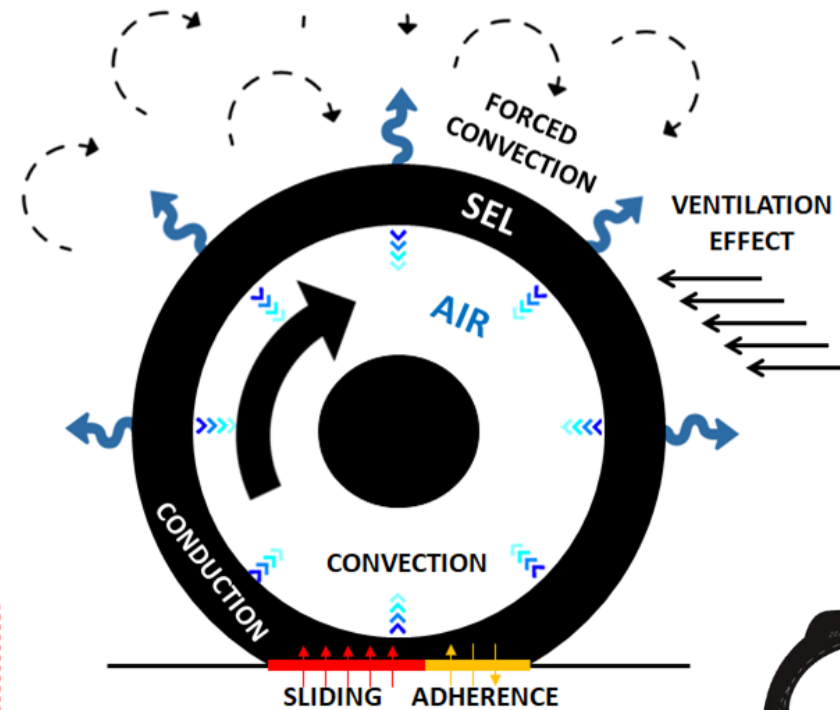
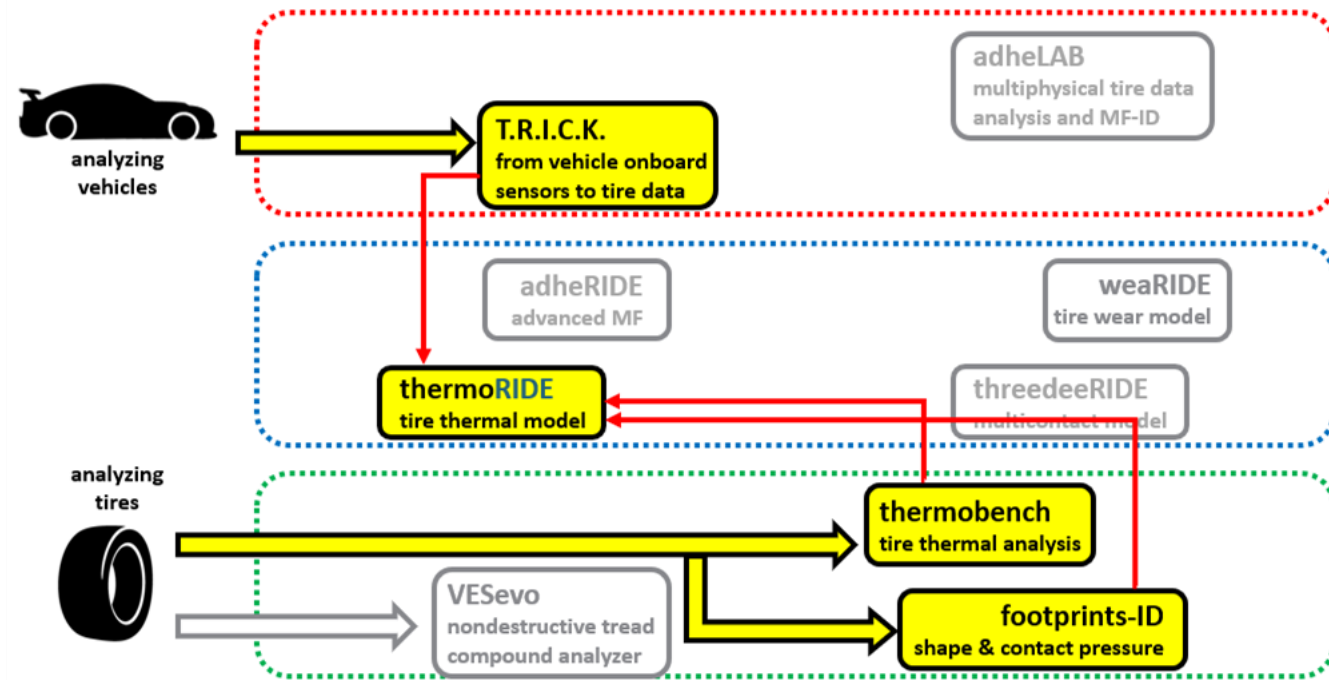
stage 2 – thermoRIDE params ID

In parallel with the vehicle and tire dynamic characterization from outdoor data by **TRICK**, the parameters for the tire thermal model **thermoRIDE** have to be identified, thanks to innovative nondestructive methodologies involving thermal diffusivity and footprint experimental analysis



stage 3 – thermoRIDE model calibration

Once available tire forces, slip, sideslip and camber from road data and **TRICK**, thermal model **thermoRIDE** can be calibrated. Thermal conductivities and specific heats for each tire layer, and footprint extension under various load, inflation pressure and camber conditions, are implemented



- NONDESTRUCTIVE THERMAL CHARACTERIZATION

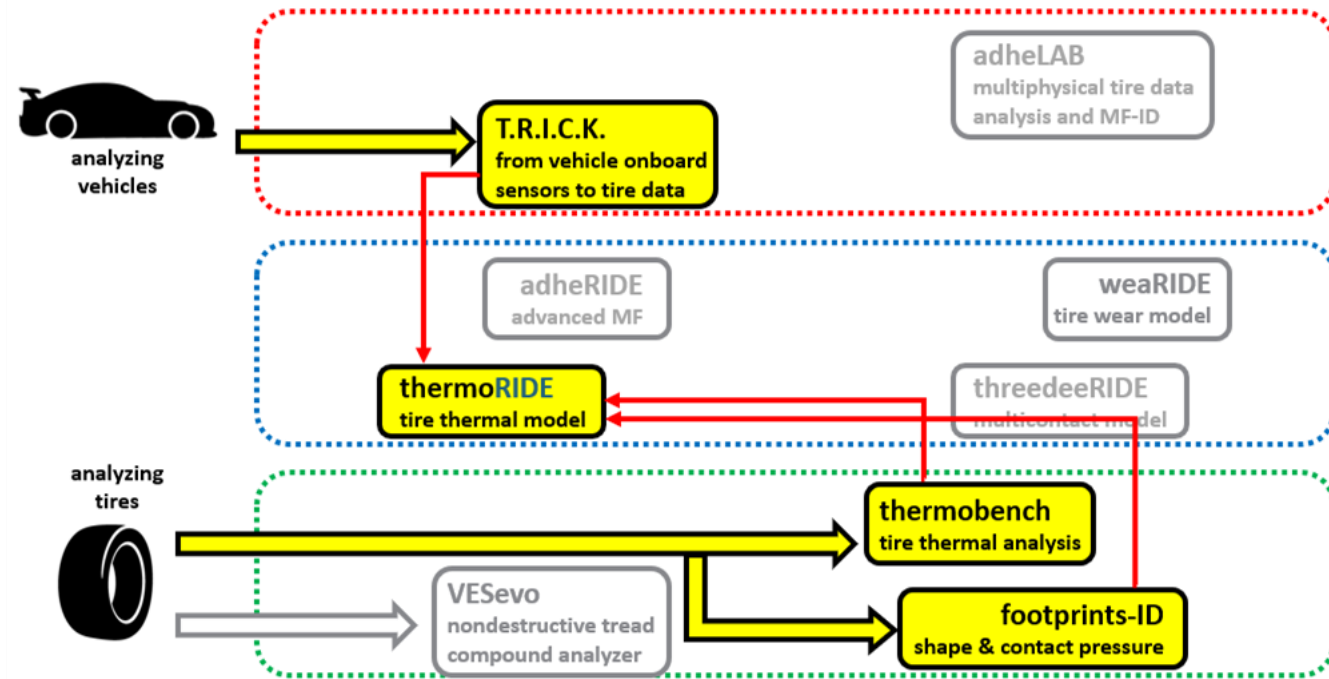
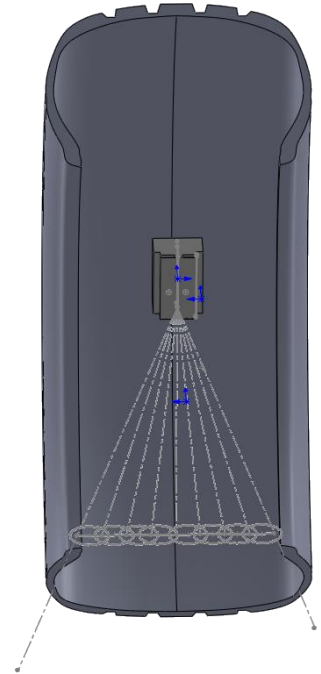
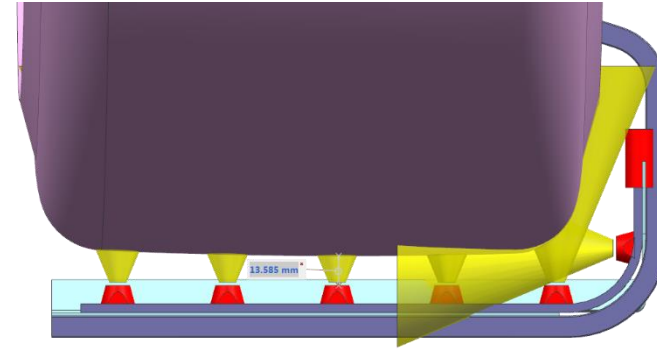
- ANY TIRE SIZE AND BRAND

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



stage 4 – thermoRIDE model validation

Once implemented thermal, footprints and geometric parameters, **thermoRIDE** model is validated by specific outdoor (or F&M bench data) testing sessions, useful to create the final thermal digital twin of the real tire to be run in simulations and performance analysis routines



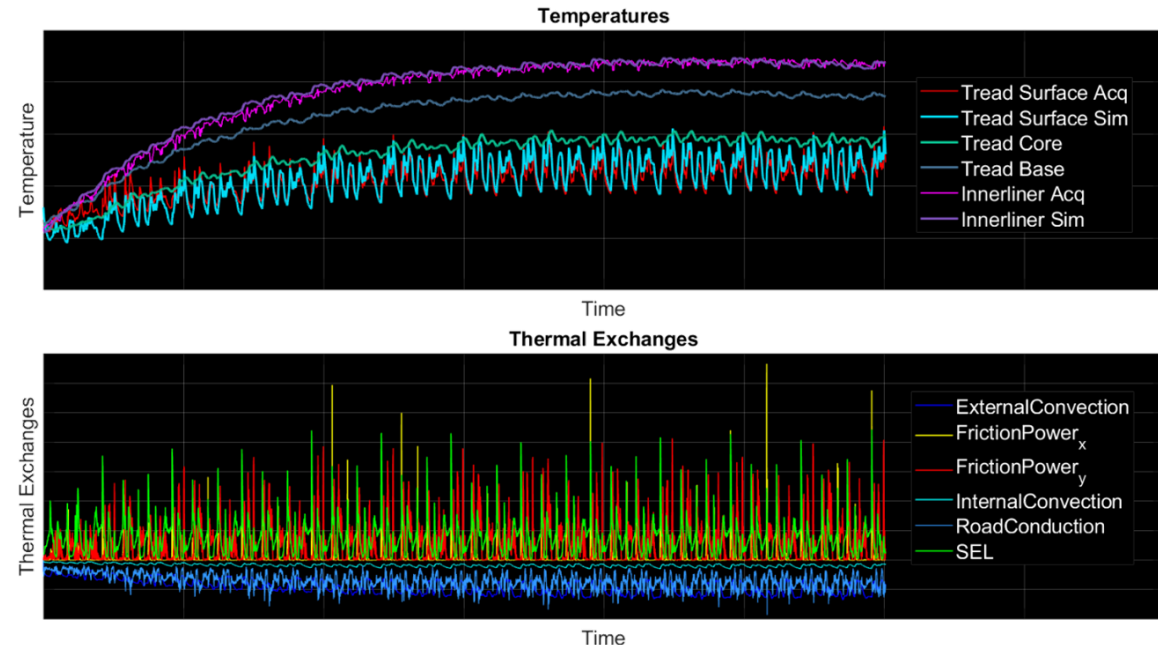
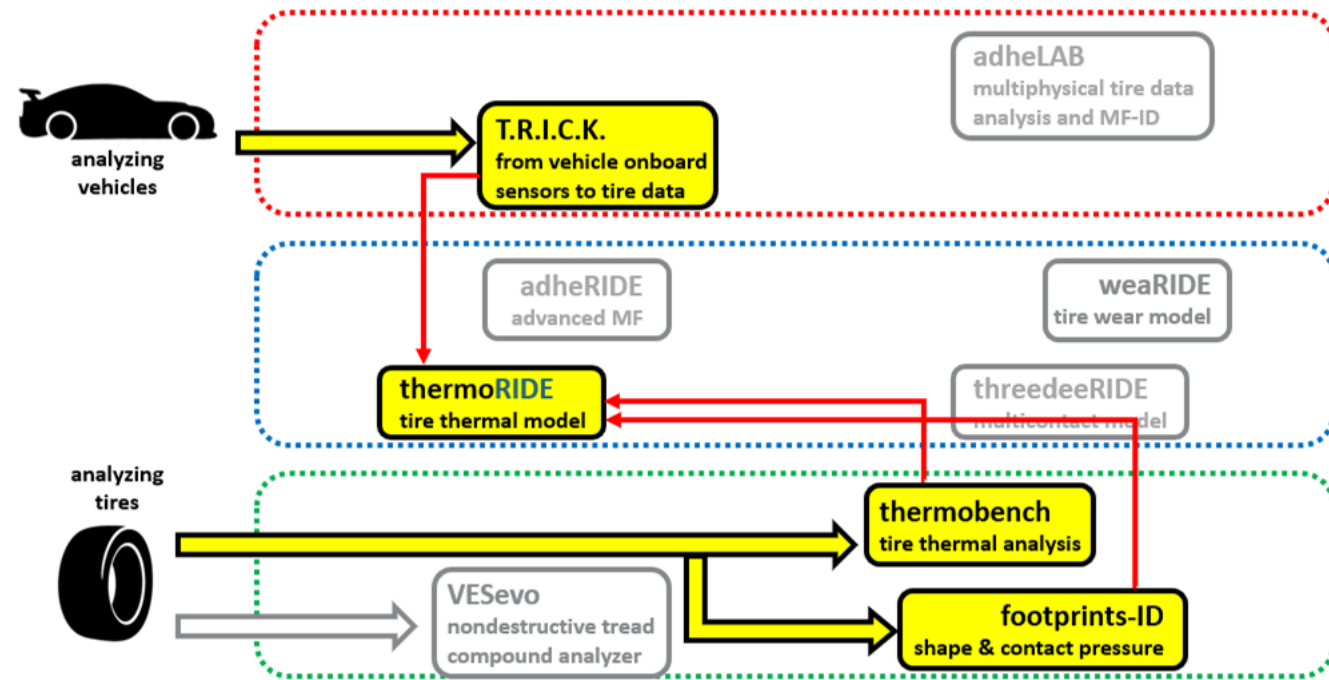
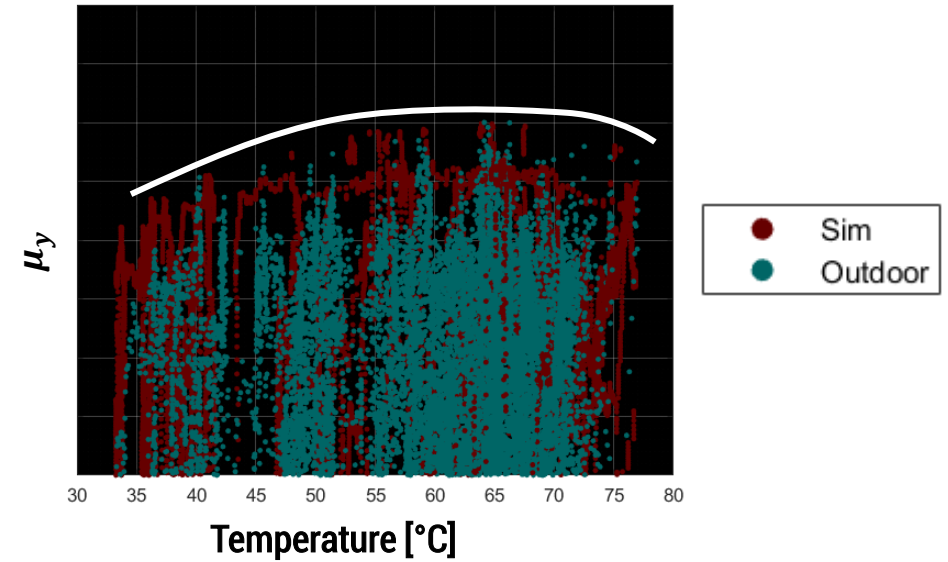
CHANNELS TO ACQUIRE:

- Longitudinal and Lateral CG Accelerations ■
- Yaw Rate ■
- Wheels Angular Speed ■
- Steering Angle ■
- X and Y Components of CG Velocity (S-motion / OXTS / ...) ■
- Temperature of External Tire Surface (IR multiarray sensors) ■
- Temperature of Inner Tire Surface (IR multiarray sensors) ■
- Temperature of Tire Inner Air (TPMS sensor) ■
- Pressure of Tire Inner Air (TPMS sensor) ■



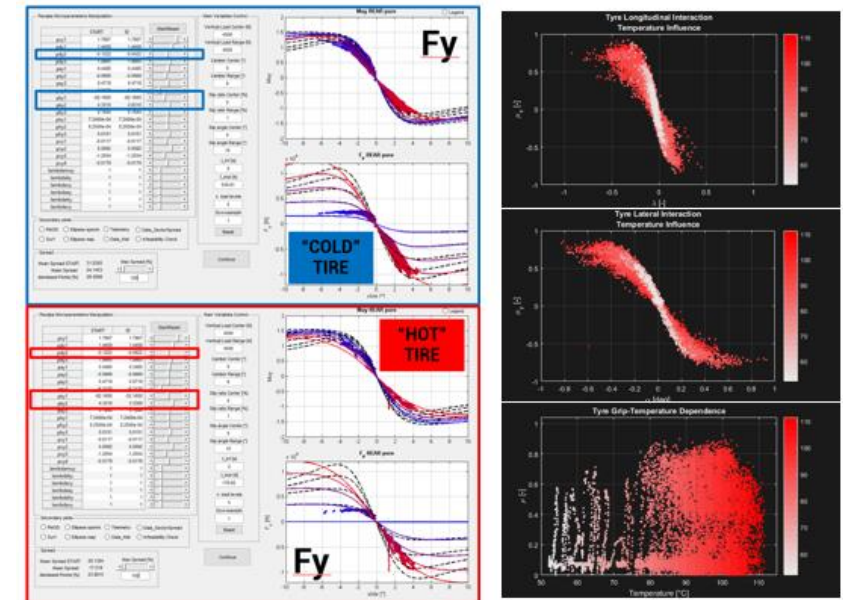
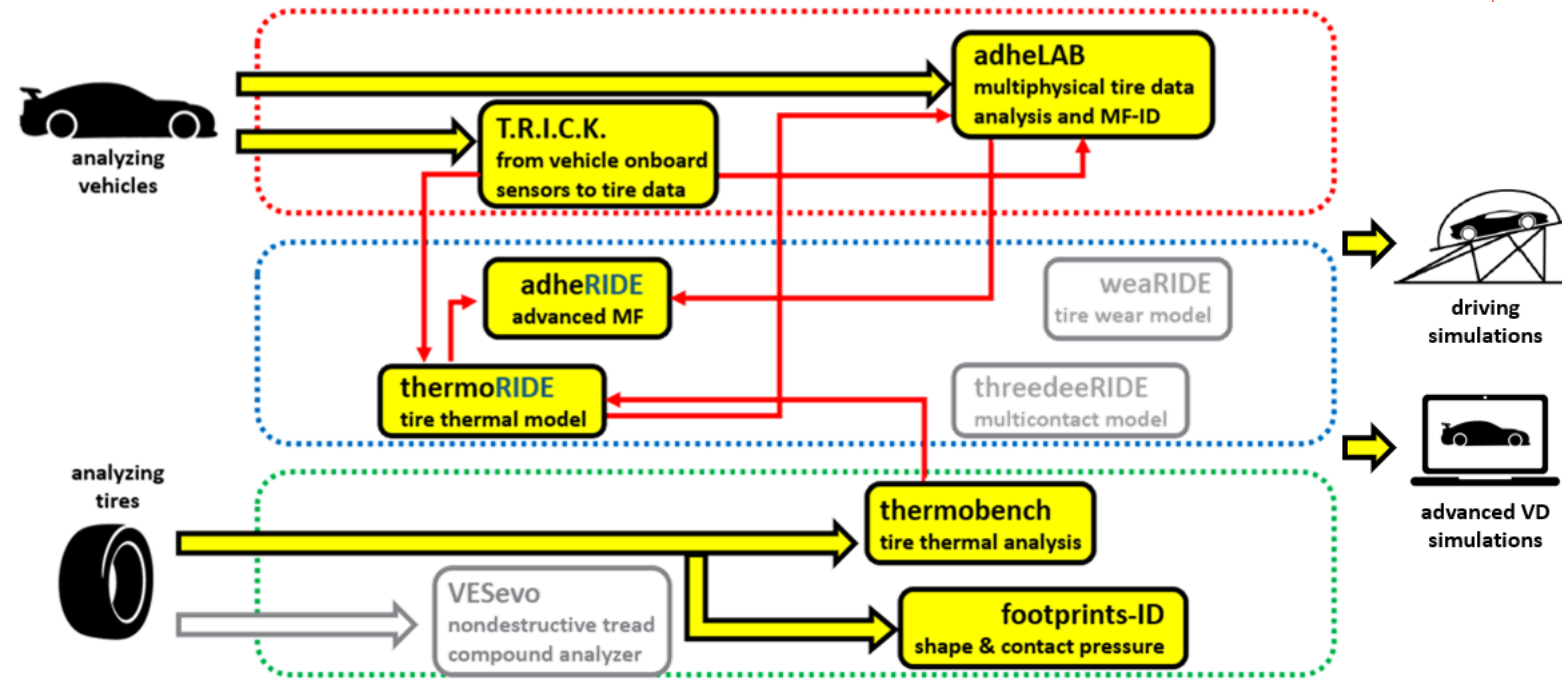
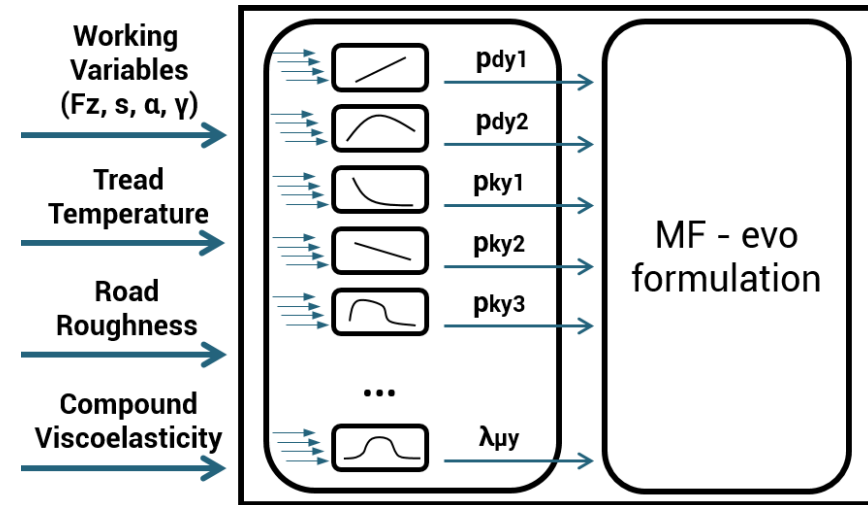
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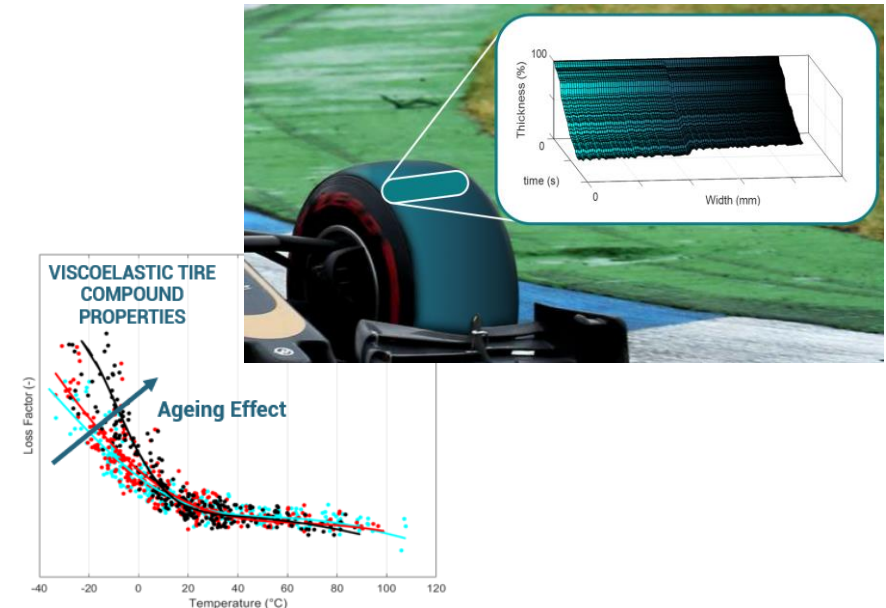
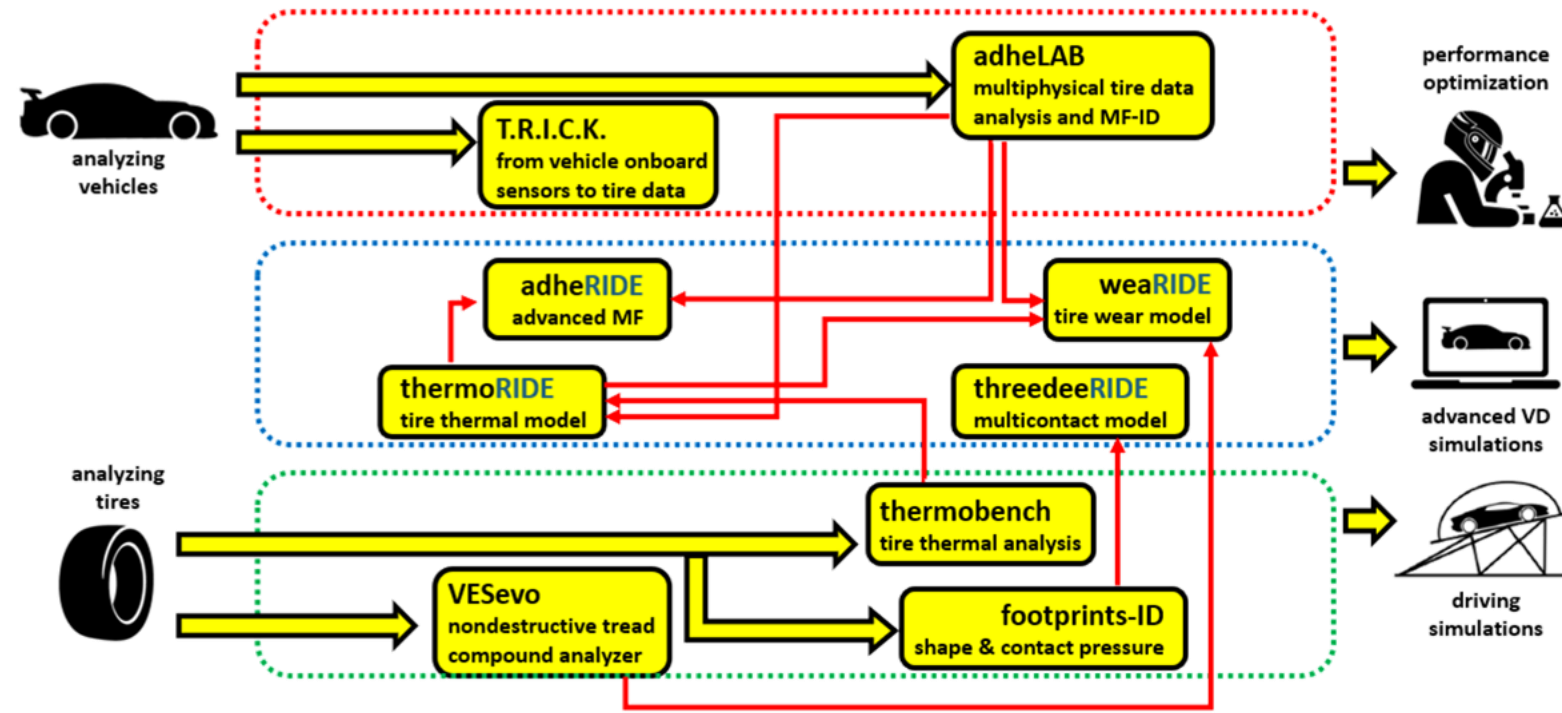
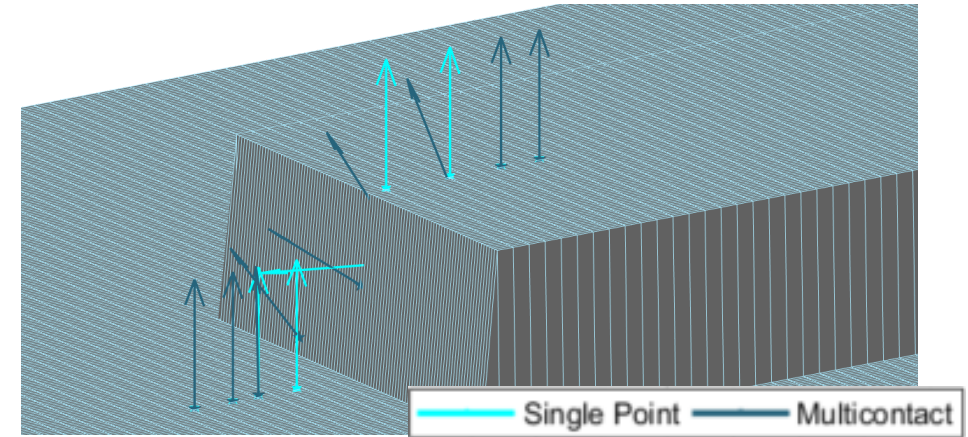
stage 5 – advanced MF model identification

With dynamic tire data available from TRICK and temperatures, pressures and energies from thermoRIDE, **adheLAB** data analyzer allows to identify the coefficients of an innovative version of Pacejka's MF, called **adheRIDE**, able to run in real-time taking into account tire multiphysics



further stages – towards multiphysics

When the basic tire analysis and simulation platform will be implemented, further activities will involve the modelling of the multicontact footprint dynamics with **threedeeRIDE**, for enhanced subjective feeling in DiL, and the reproduction of the wear and degradation effects with **weaRIDE** physical model





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APPLIED VEHICLE RESEARCH

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