MEGARIDE
APPLIED VEHICLE RESEARCH

powered by

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

# PHYSICAL MODELLING FOR REAL-TIME SIMULATIONS AND ONBOARD ADVANCED ALGORITHMS

# WHO WE ARE – THE SCIENTIFIC BACKGROUND

## Vehicle Dynamics research group

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

# 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

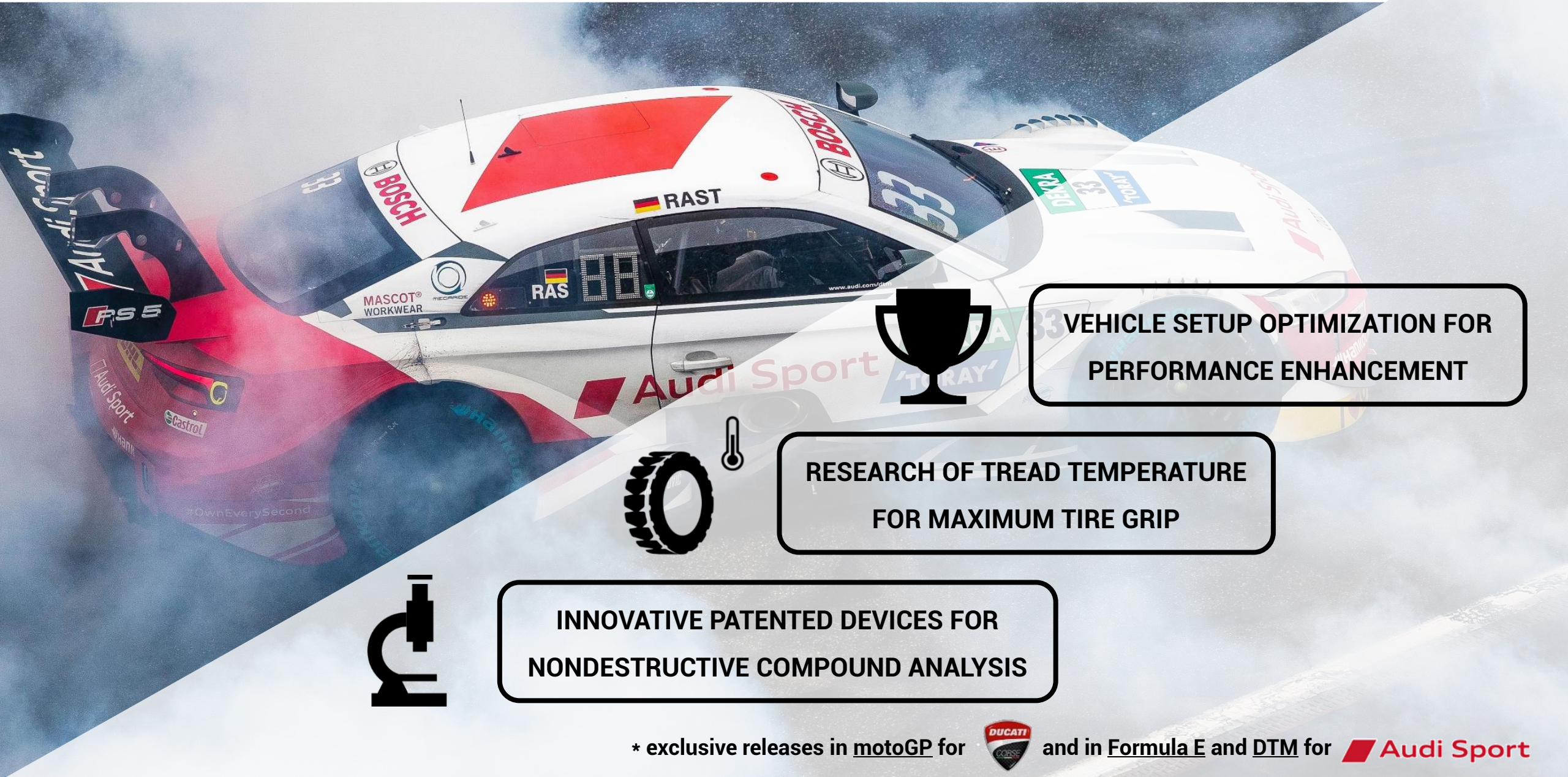
# WHAT WE DO - IN REALTIME SIMULATIONS

FEEL TIRE GRIP & ROAD ROUGHNESS VARIATIONS IN DRIVING SESSIONS

PREDITIVE METHODOLOGIES AND PHYSICAL CHARACTERIZATIONS

HIGHLY RELIABLE & REALISTIC VIRTUAL TIRES

# WHAT WE DO - FOR MOTORSPORT



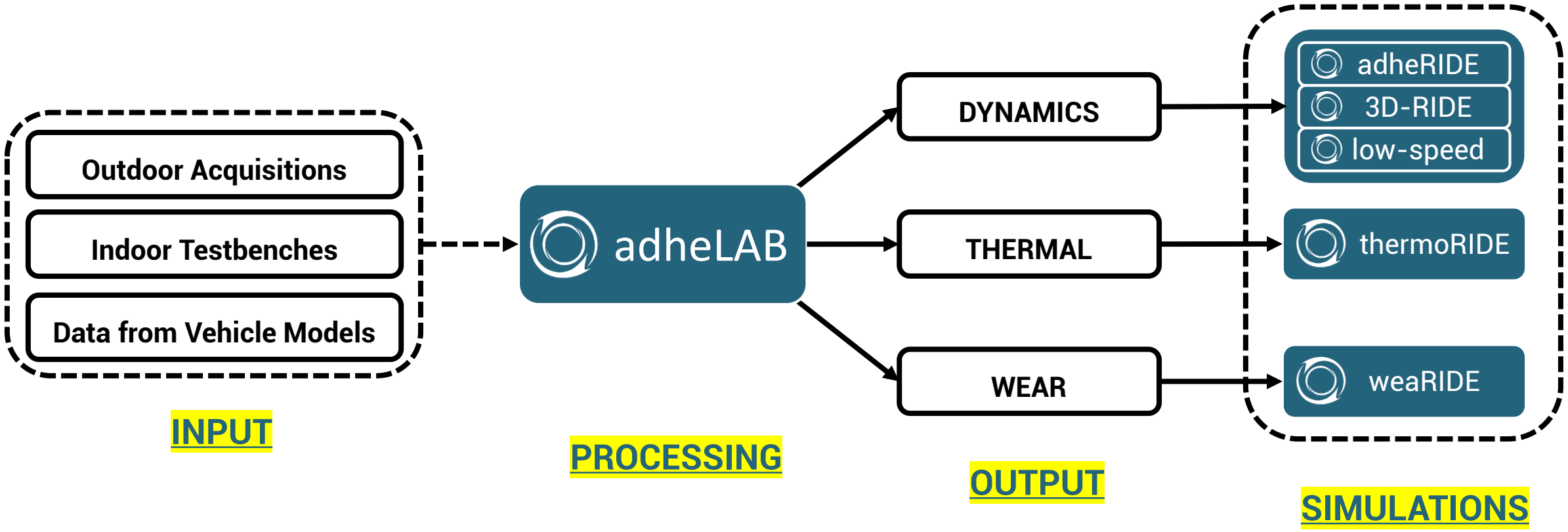

**VEHICLE SETUP OPTIMIZATION FOR PERFORMANCE ENHANCEMENT**

**RESEARCH OF TREAD TEMPERATURE FOR MAXIMUM TIRE GRIP**

**INNOVATIVE PATENTED DEVICES FOR NONDESTRUCTIVE COMPOUND ANALYSIS**

* exclusive releases in motoGP for DUCATI CORSE and in Formula E and DTM for Audi Sport

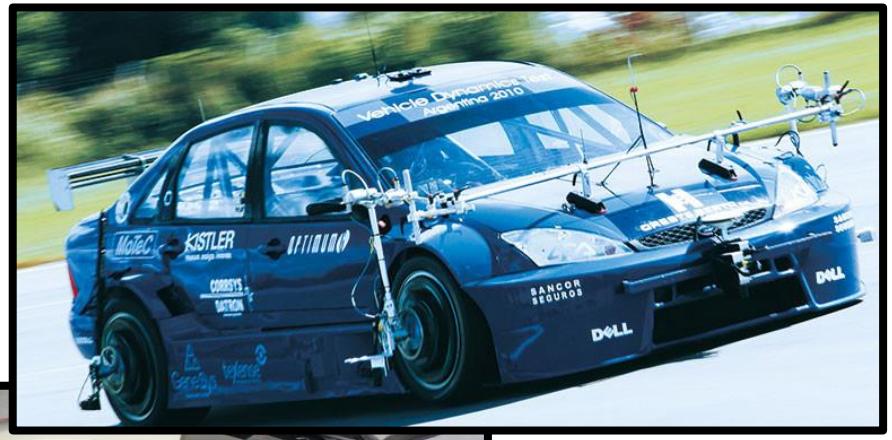
# HOW WE DO IT – WORKFLOW AND TOOLS

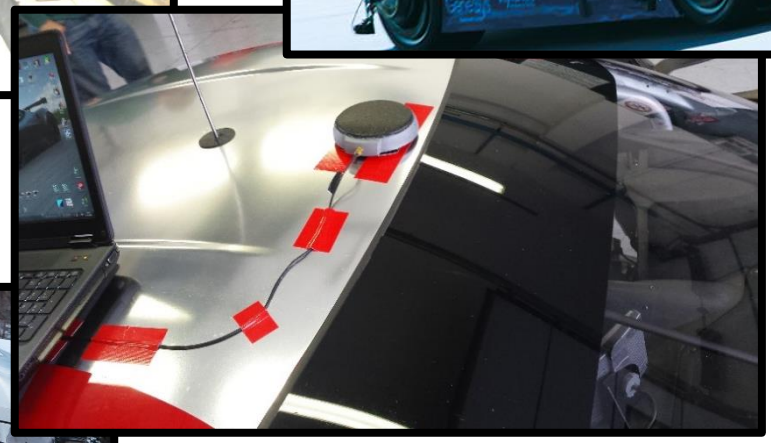


# IN DETAIL – INPUT COLLECTION

## INPUT

- **Outdoor Acquisitions**
- Indoor Testbenches
- Data from Vehicle Models



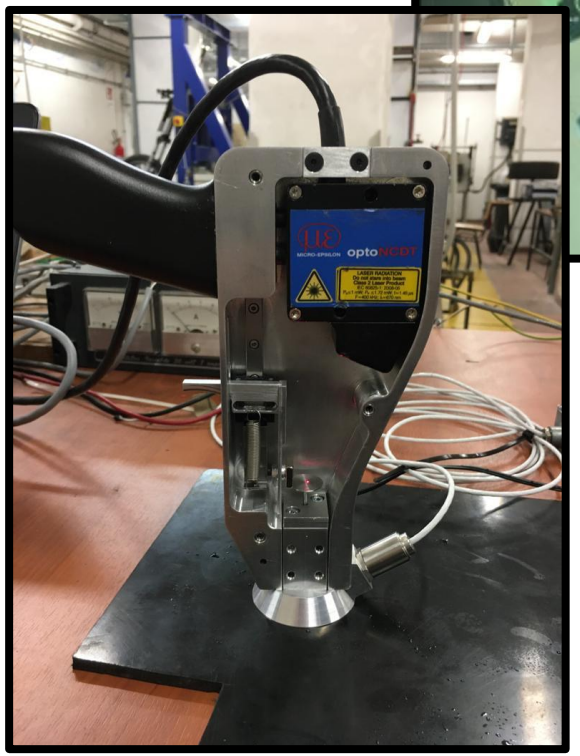


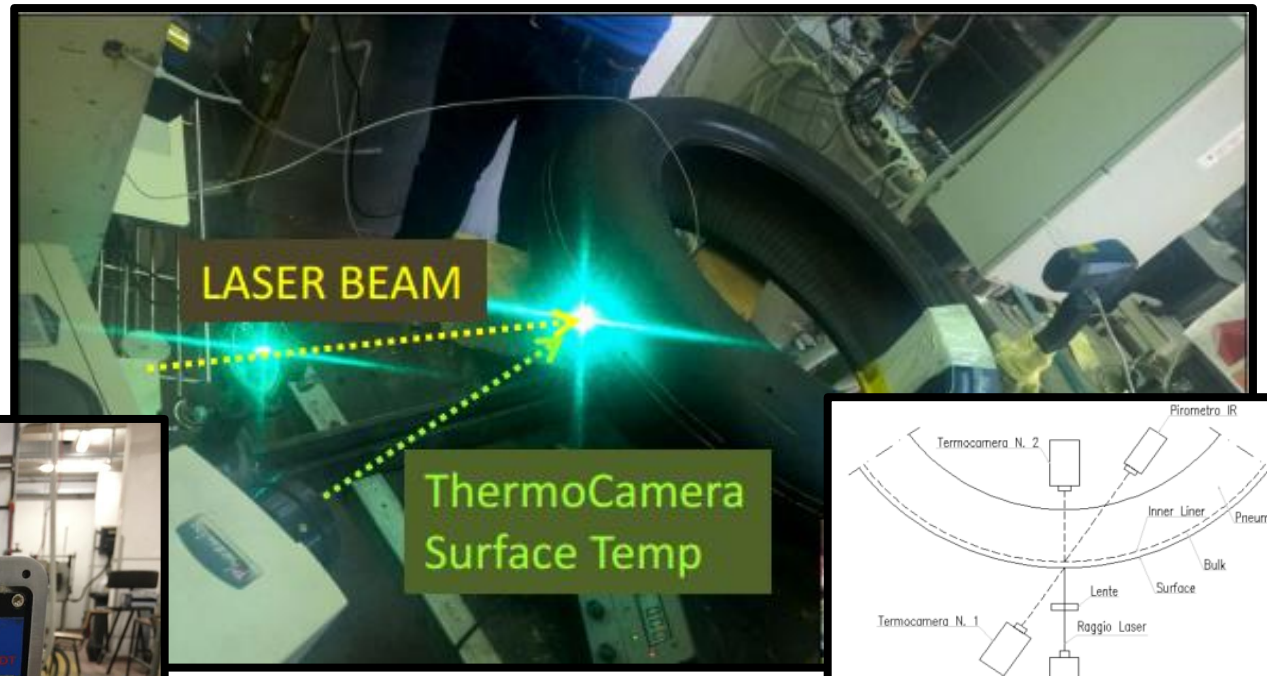
- SUPPORT "ON TRACK" FOR VEHICLE INSTRUMENTATION
- SPECIFIC MANOEUVRE ROUTINES
- COMPLIANCE TO ANY ACQUISITION SETUP

# IN DETAIL – INPUT COLLECTION

## INPUT

- Outdoor Acquisitions
- **Indoor Testbenches**
- Data from Vehicle Models







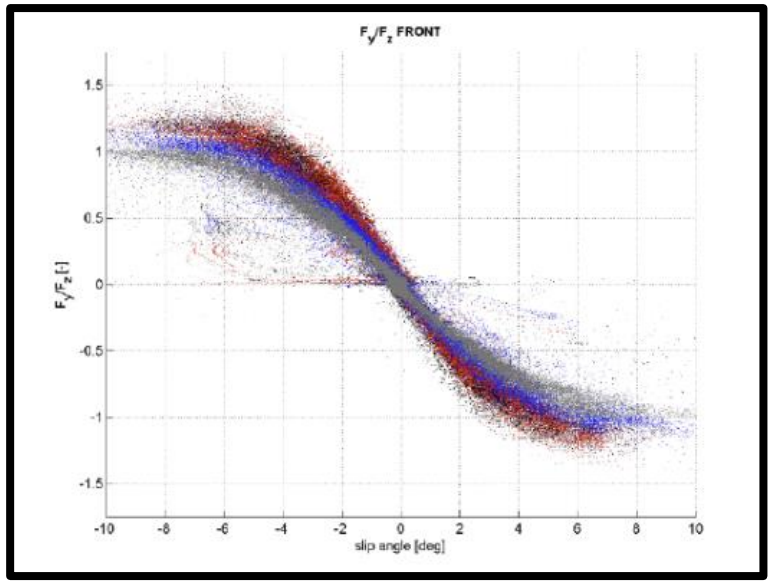
- **AVAILABILITY OF TESTING FACILITIES AT UNINA TYRE LAB**
- **NONDESTRUCTIVE METHODOLOGIES**
- **PATENTED INNOVATIVE DEVICES**

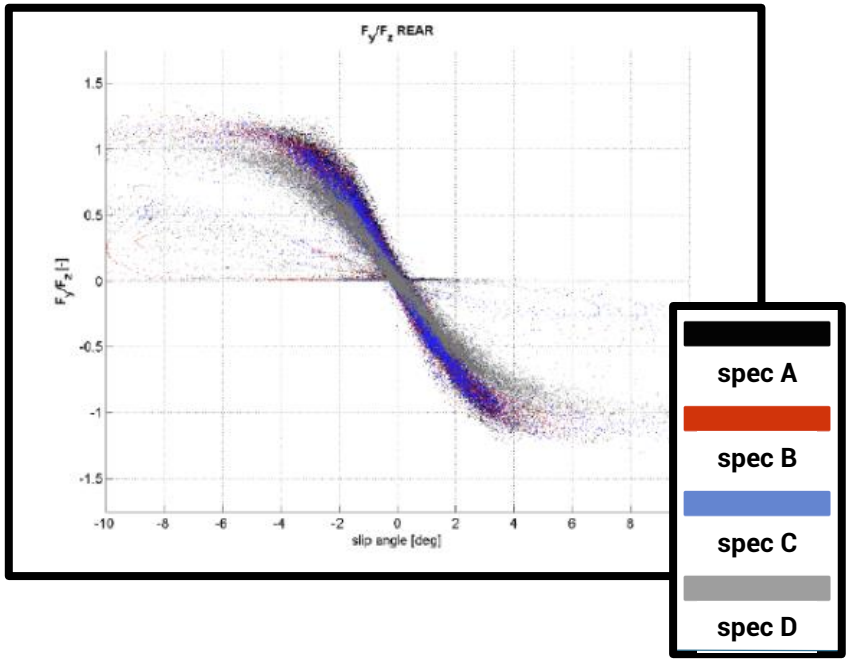
# IN DETAIL – INPUT COLLECTION

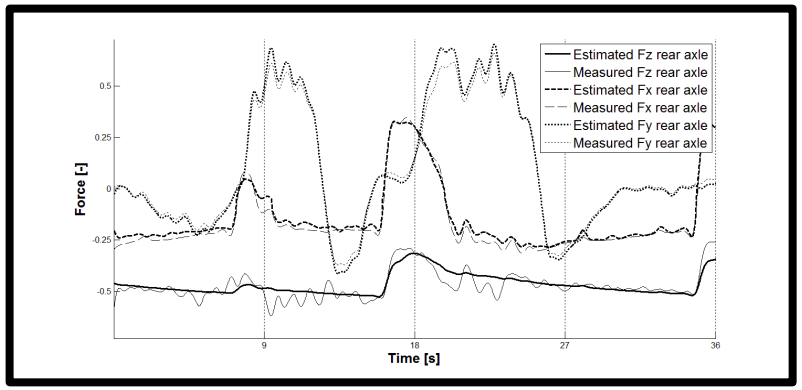
## INPUT

- Outdoor Acquisitions
- Indoor Testbenches
- Data from Vehicle Models

→ T.R.I.C.K.




- FROM ONBOARD STANDARD SENSORS TO TIRE FORCES EVALUATION
- USE THE VEHICLE AS A ''MOVING LAB''
- PHYSICAL ANALYTICAL MODEL
- REAL TIRES / REAL ROAD / REAL CONDITIONS

* 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 – FROM DATA TO MODELS: MF

Outdoor Acquisitions

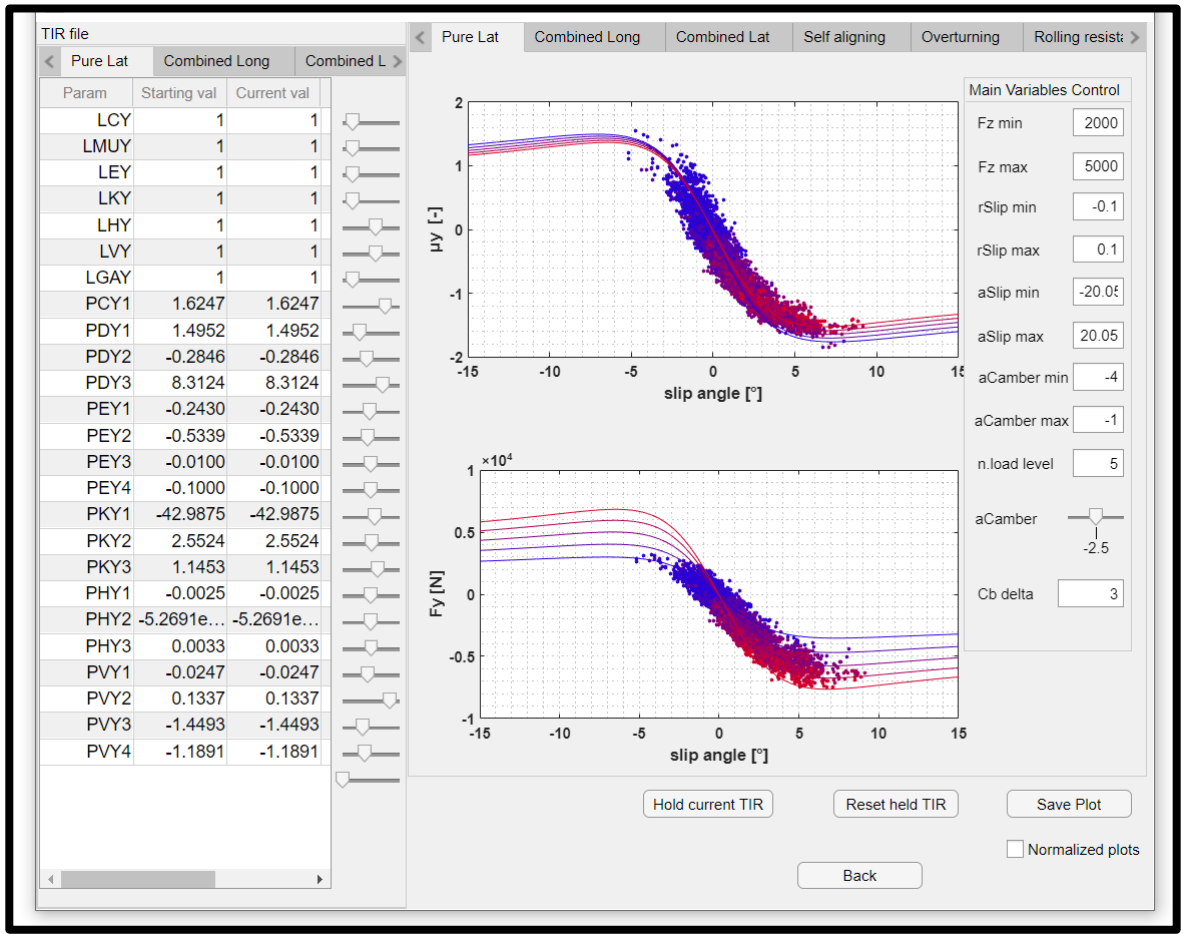
Indoor Testbenches

Data from Vehicle Models

adheLAB

DYNAMICS

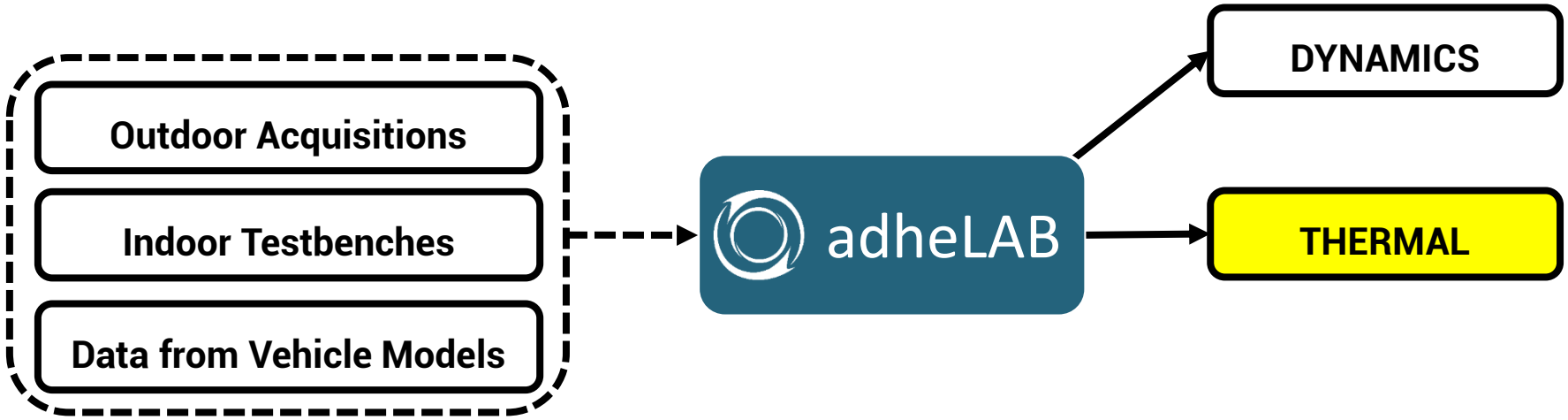
ID of Pacejka's MF



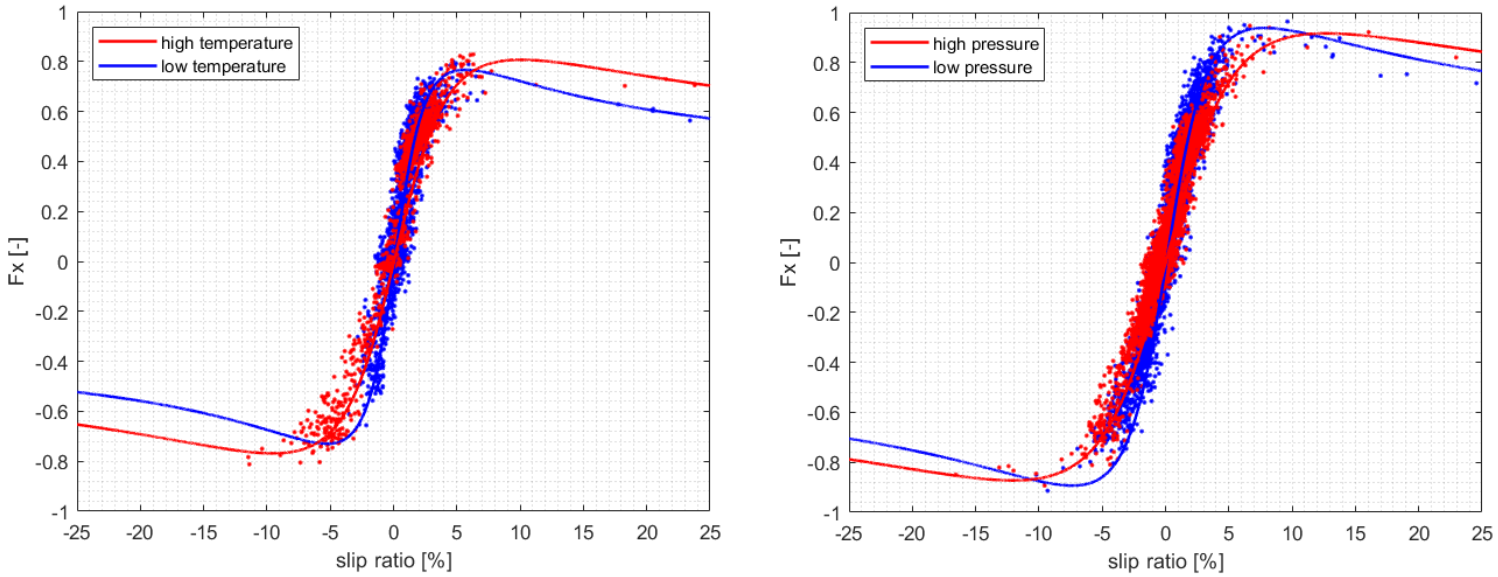

**KEY FEATURES:**

- **COMPLIANCE TO PARTNERS' PROPRIETARY ID ALGORITHMS THANKS TO FLEXIBLE MODULARITY**
- **ROBUST IDENTIFICATION OF THE MODEL PARAMS (RESEARCH OF ABSOLUTE MINIMA OF THE OBJECTIVE FUNCTIONS)**
- **SMART DETECTION OF THE UNPHYSICAL DATA**

# adheLAB – ANALYSIS ON TIRE THERMODYNAMICS



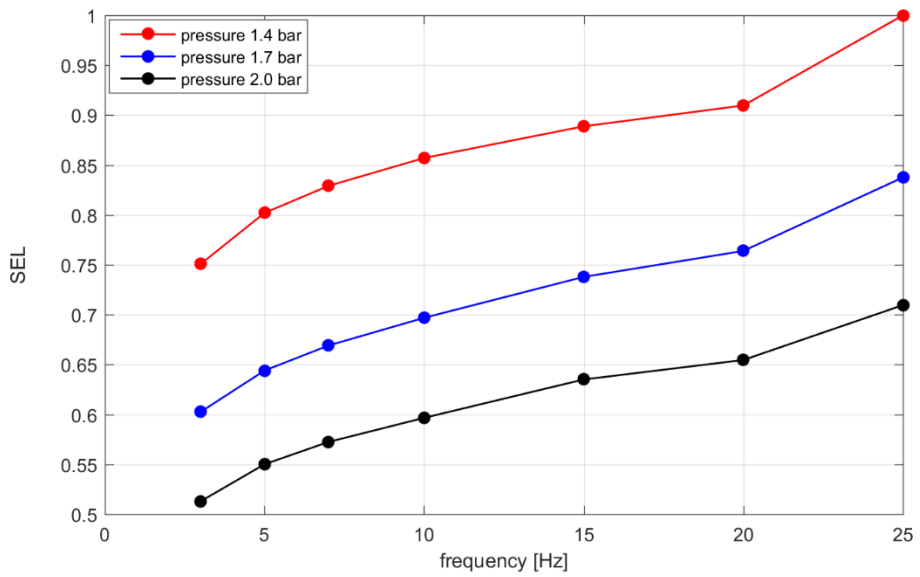

## THERMAL AND PRESSURE EFFECTS ON LONGITUDINAL INTERACTION



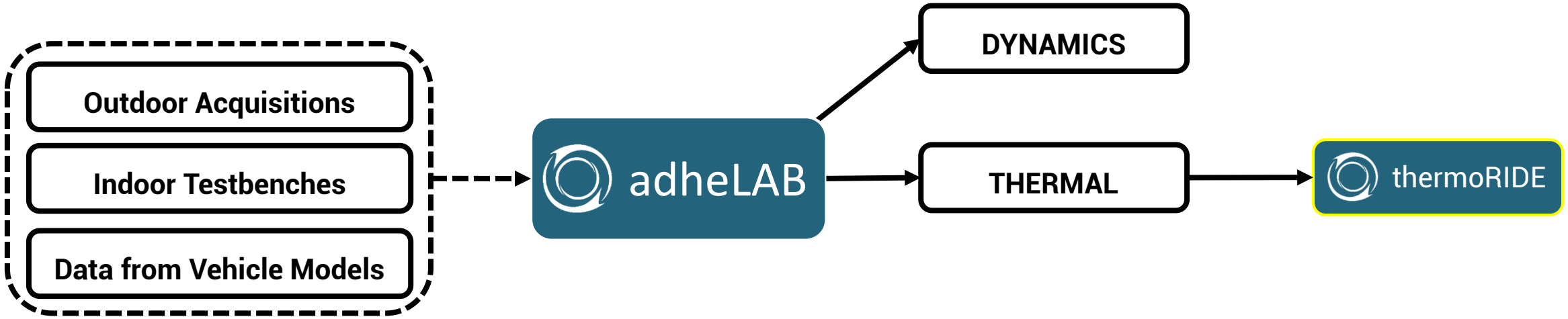


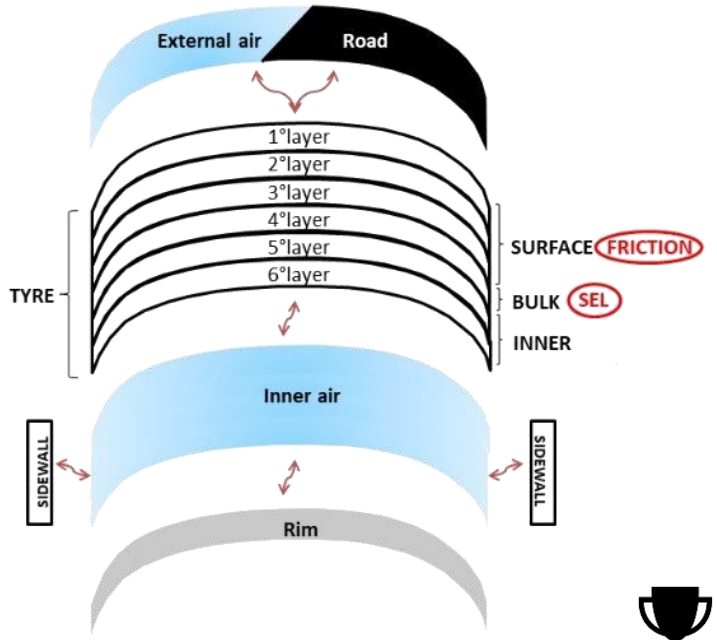


## PRESSURE EFFECTS ON S.E.L.



# adheLAB – FROM DATA TO MODELS: thermoRIDE

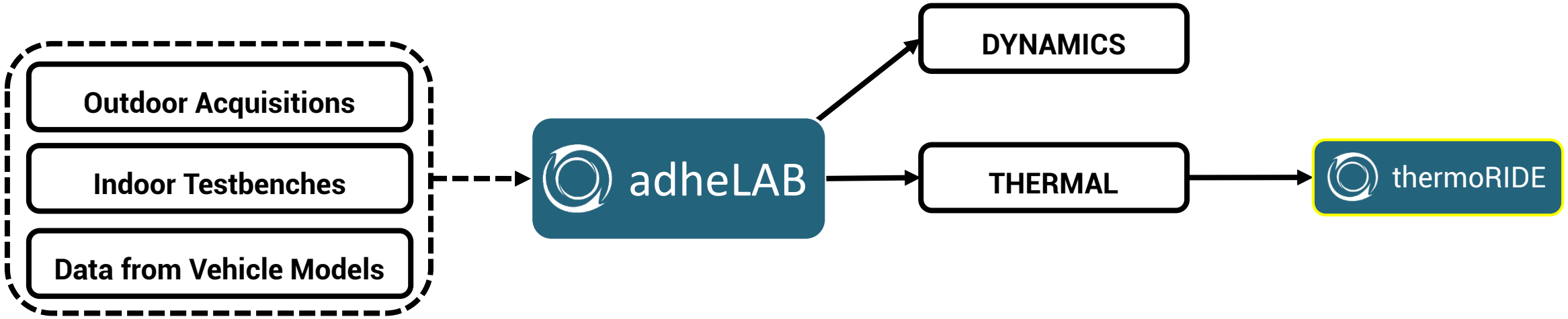


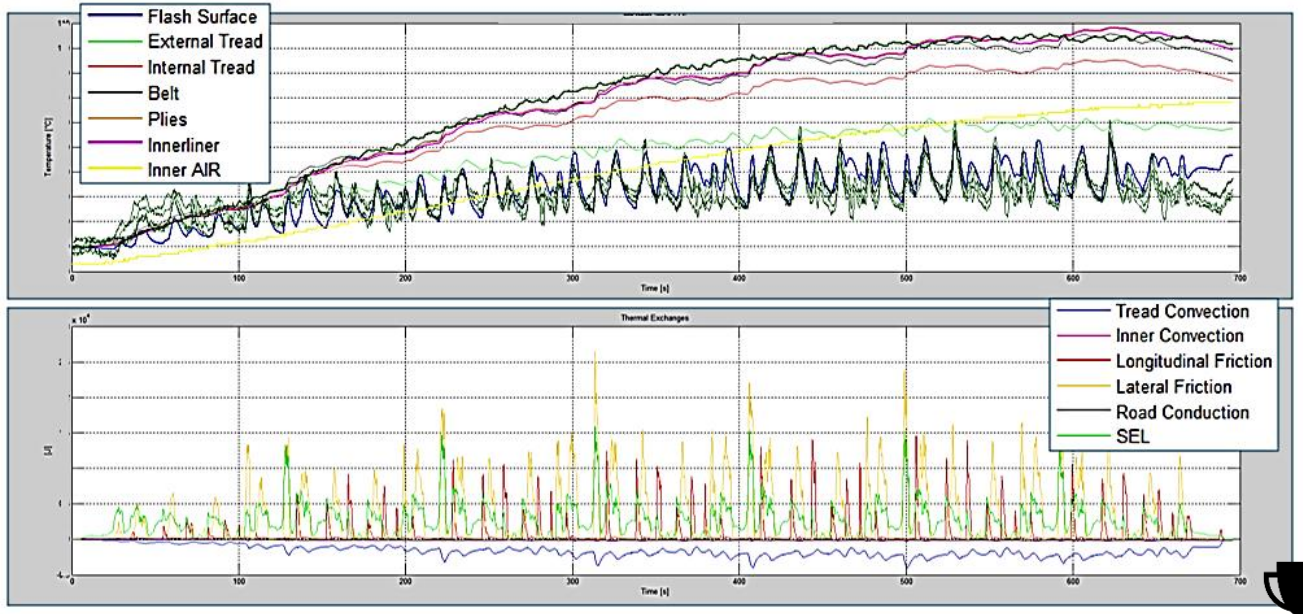




- REAL-TIME ENERGY-BASED TIRE THERMAL MODEL
- ANY TIRE SIZE AND BRAND
- UP TO 8 DIFFERENT LAYERS 16 DIFFERENT RIBS ACCOUNTING FOR INNER PRESSURE AND TREAD WEAR

Awarded as Tire Technology of the Year at TTexpo 2018

# adheLAB – FROM DATA TO MODELS: thermoRIDE

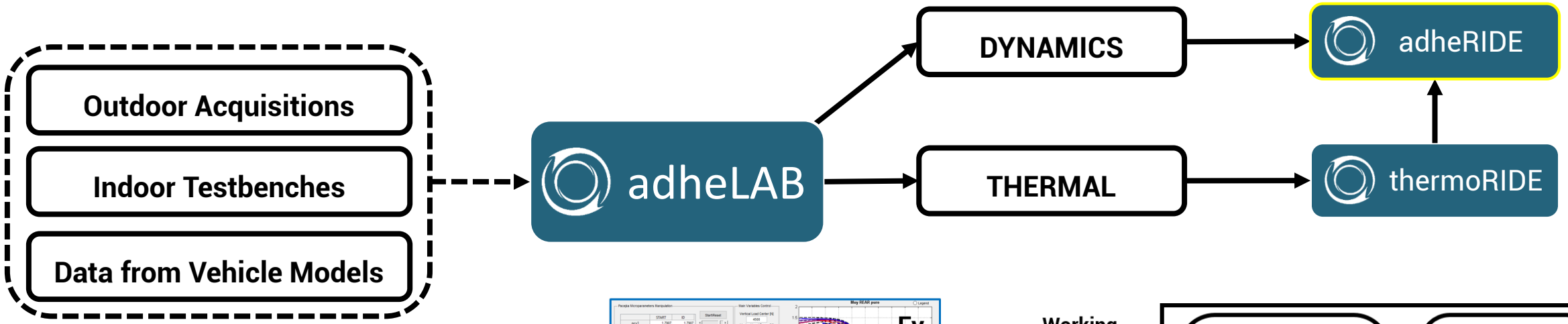


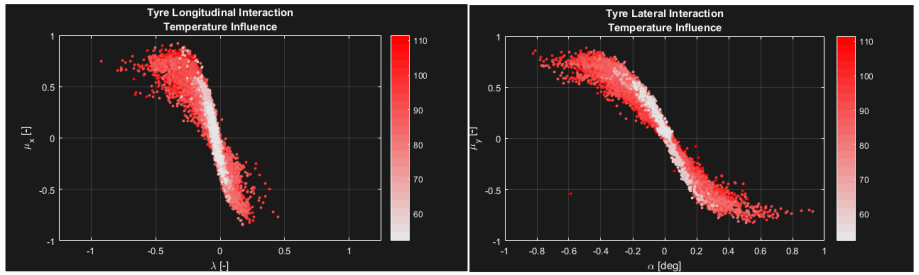



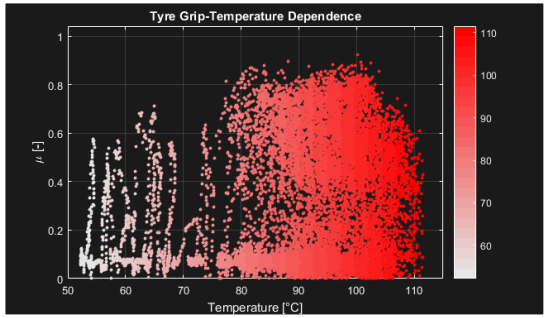

- REAL-TIME ENERGY-BASED TIRE THERMAL MODEL
- ANY TIRE SIZE AND BRAND
- UP TO 8 DIFFERENT LAYERS 16 DIFFERENT RIBS ACCOUNTING FOR INNER PRESSURE AND TREAD WEAR

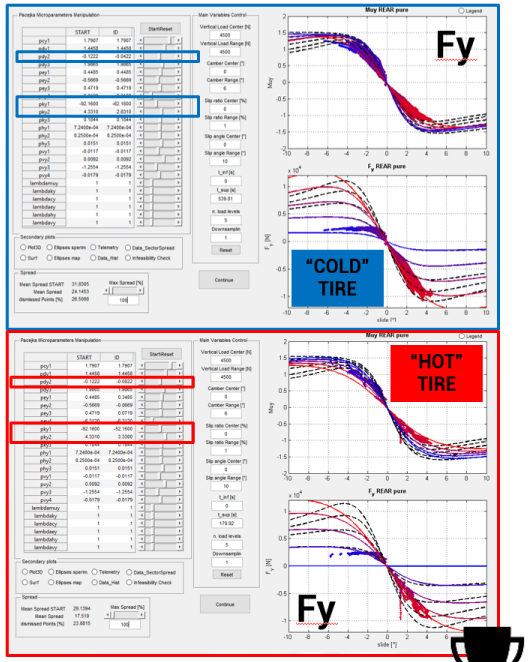
Awarded as Tire Technology of the Year at TTexpo 2018

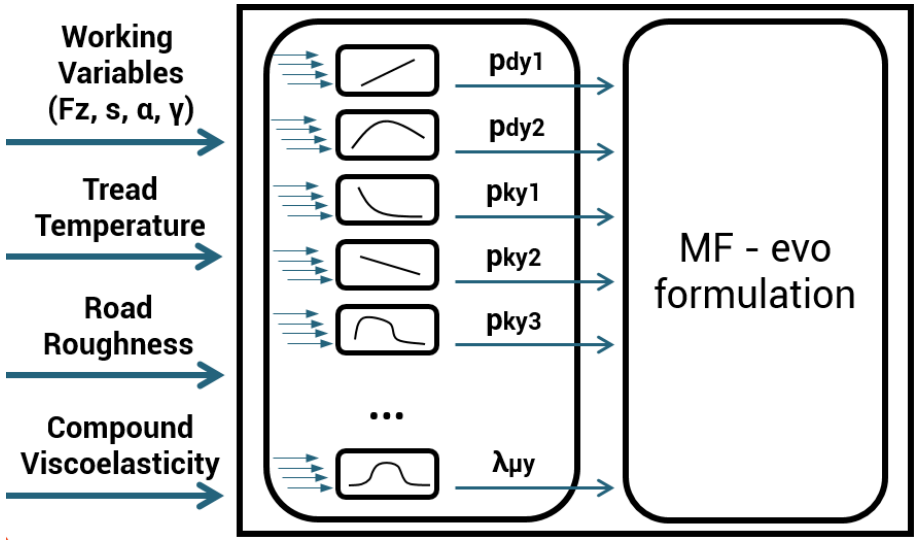
# adheLAB – FROM DATA TO MF-EVO: adheRIDE




Awarded as Tire Technology of the Year at TTexpo 2018

# adheLAB – IN PROGRESS: PHYSICAL WEAR MODEL

Outdoor Acquisitions

Indoor Testbenches

Data from Vehicle Models

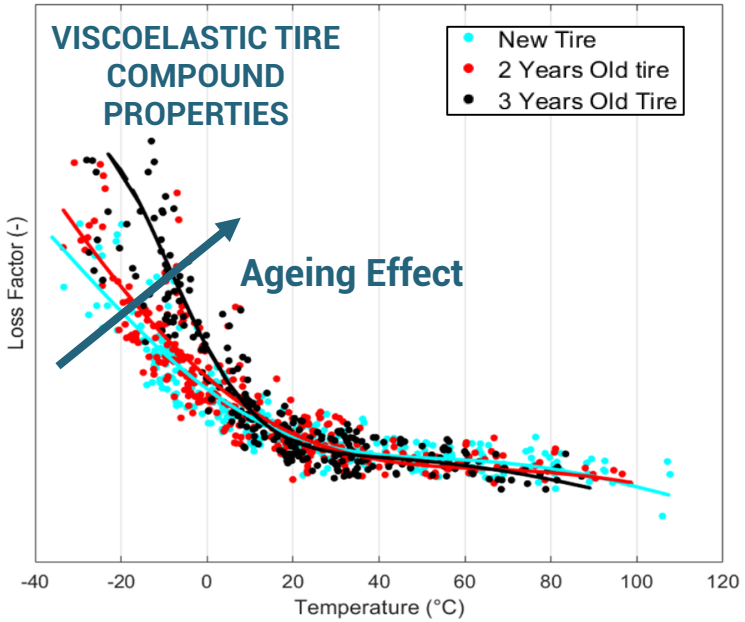
adheLAB

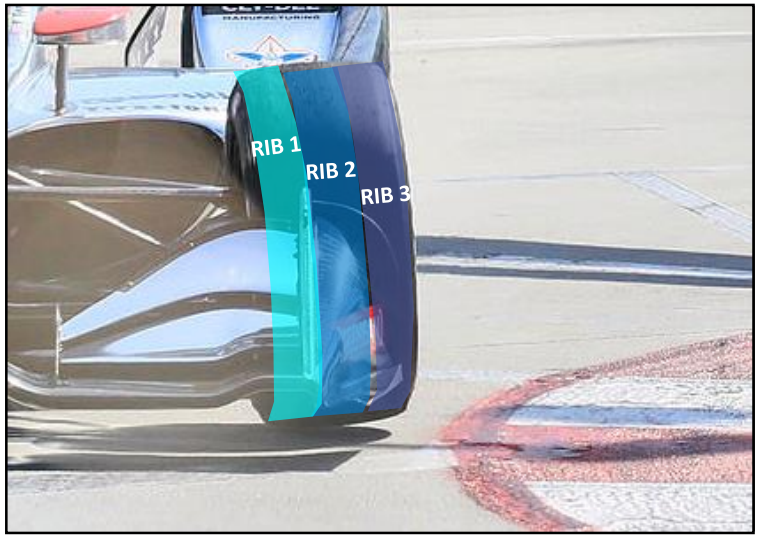
DYNAMICS

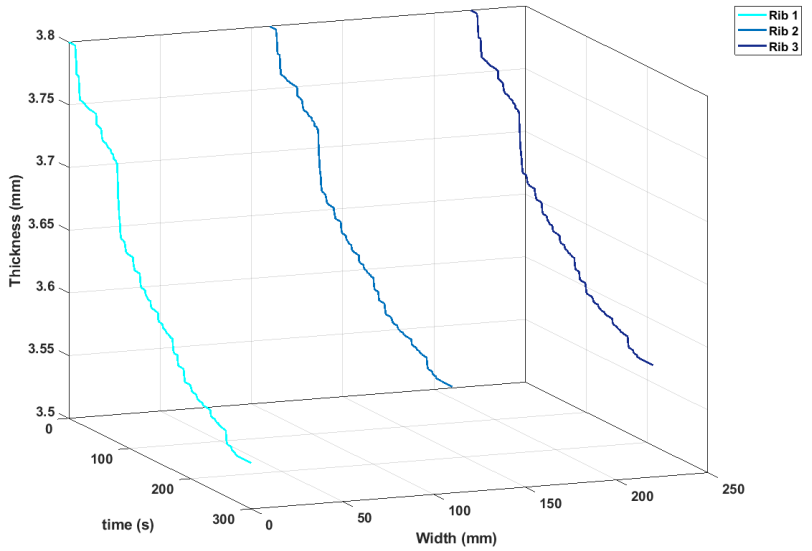
THERMAL

WEAR

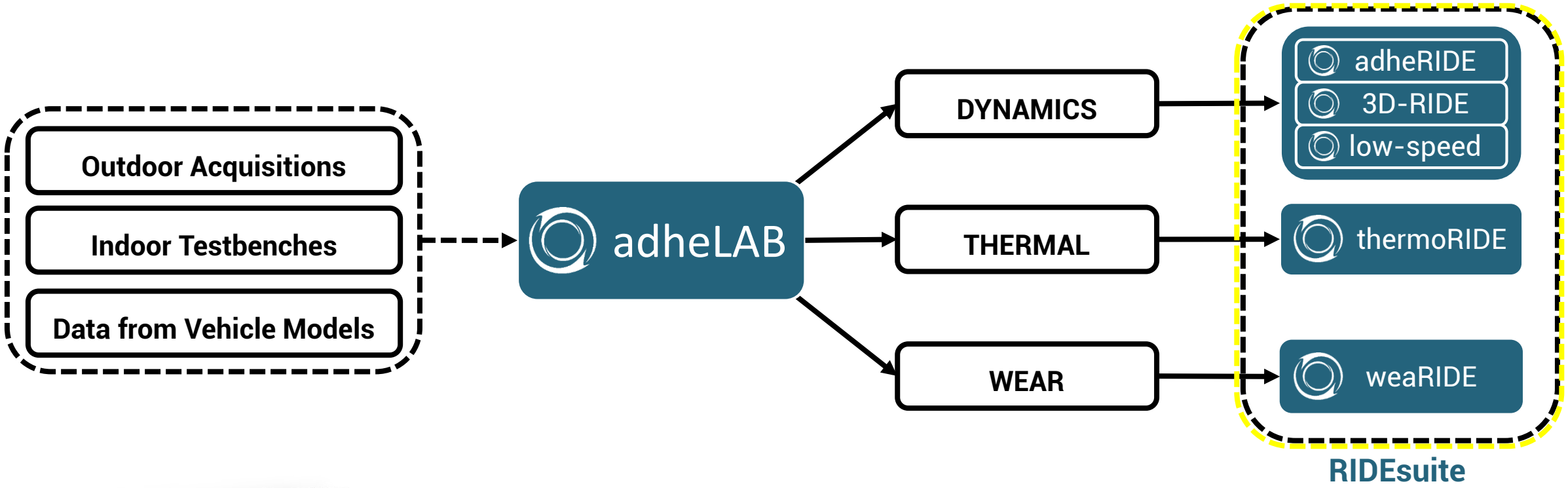
weaRIDE

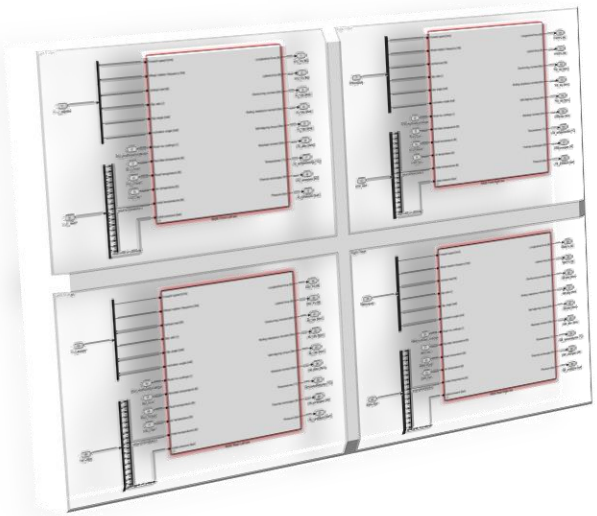


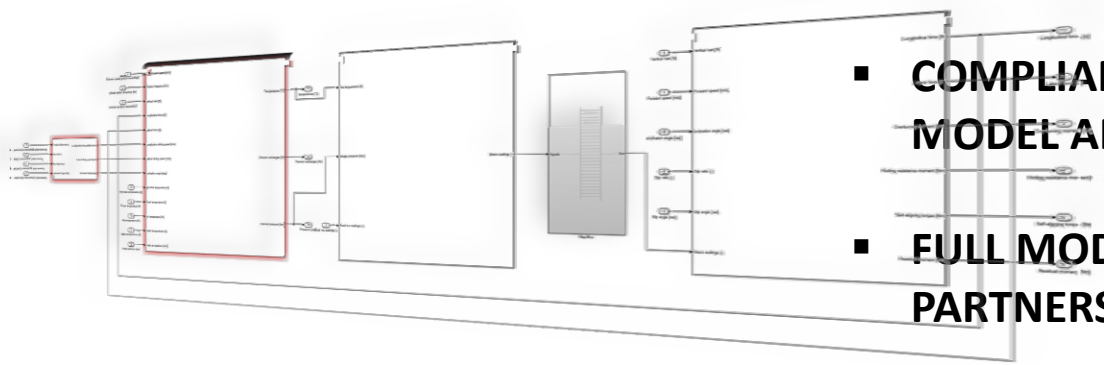



# RIDEsuite – A MULTIPHYSICS SIMULATION PLATFORM

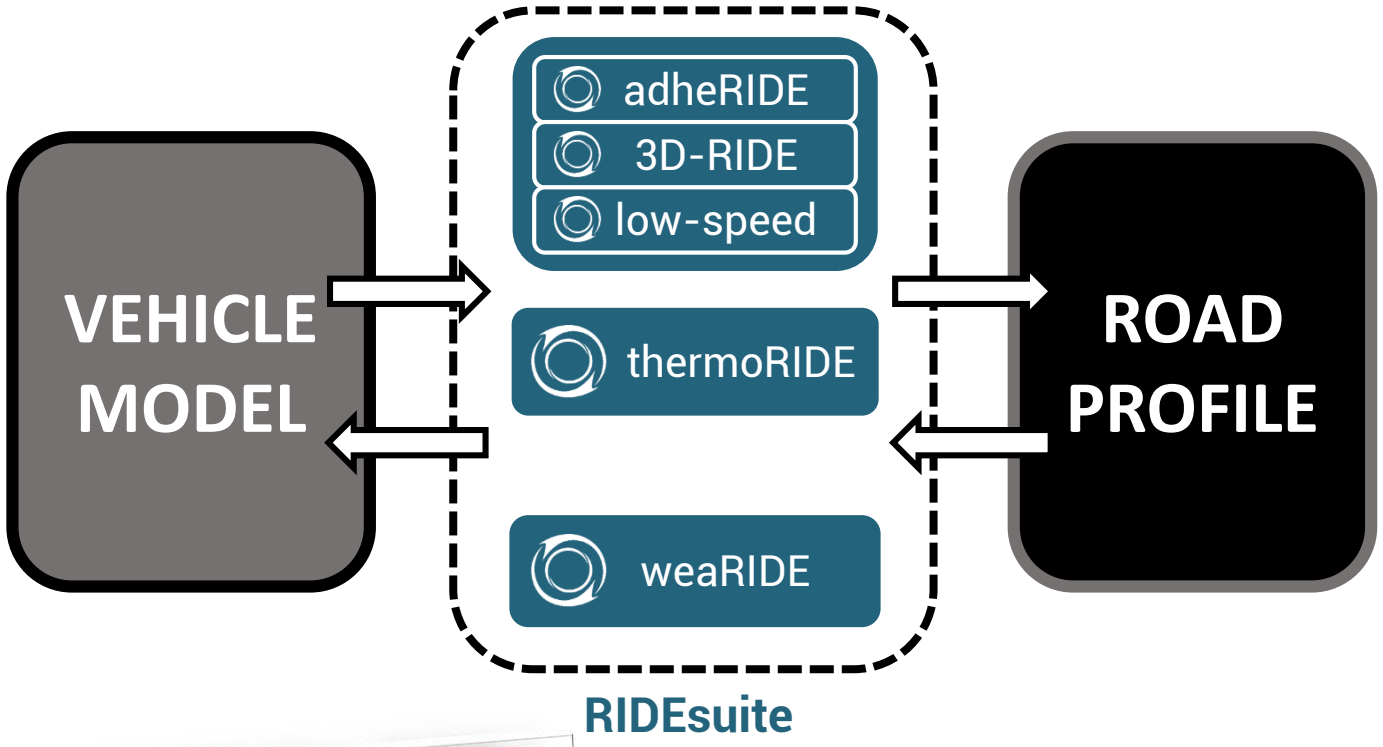


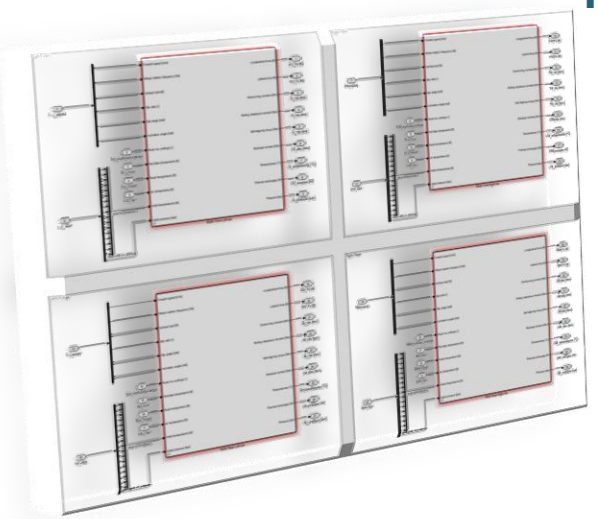


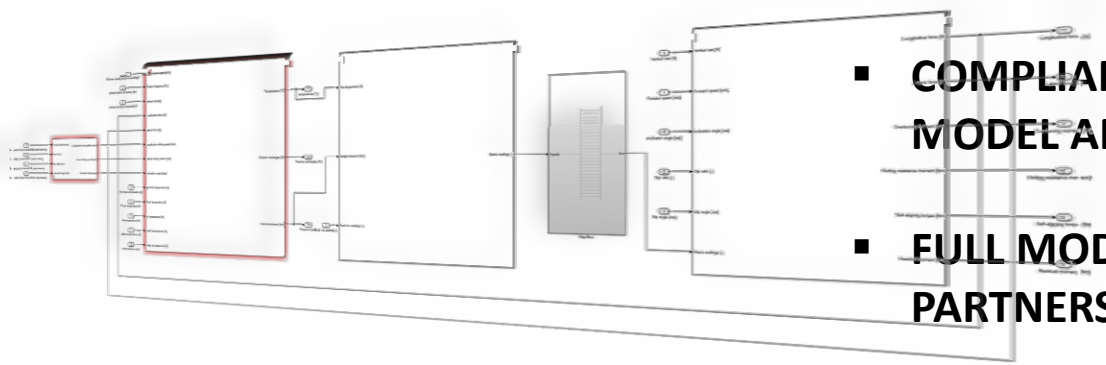
- COMPLIANCE TO ANY TIRE INTERACTION MODEL AND SIM ENVIRONMENT
- FULL MODULARITY DEPENDING ON PARTNERS' REQUIREMENTS AND NEEDS

# RIDEsuite – A SIM LAYER BETWEEN VEHICLE & ROAD



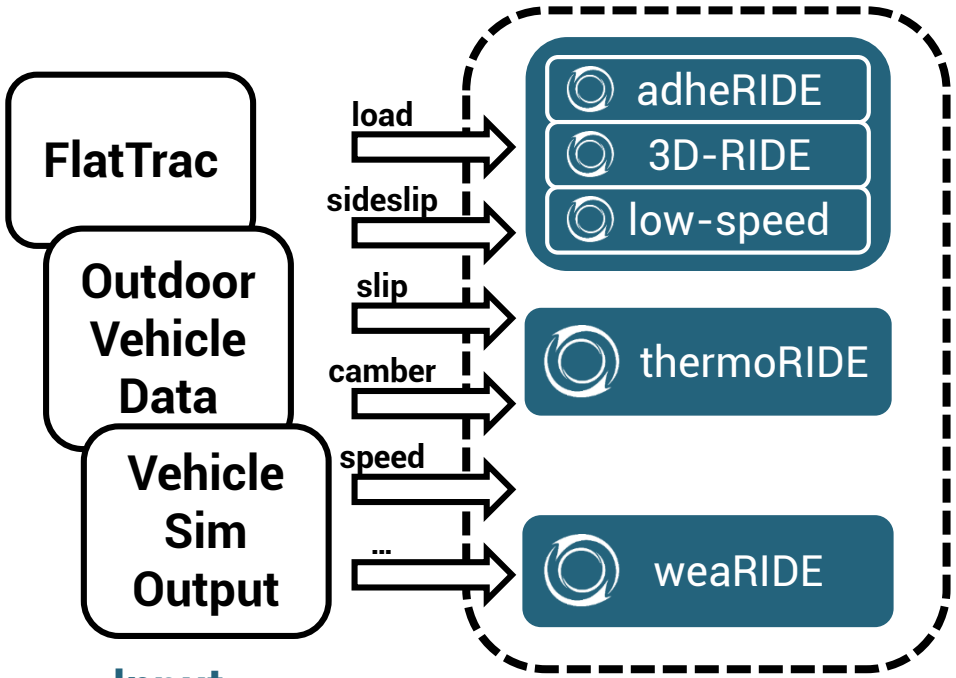


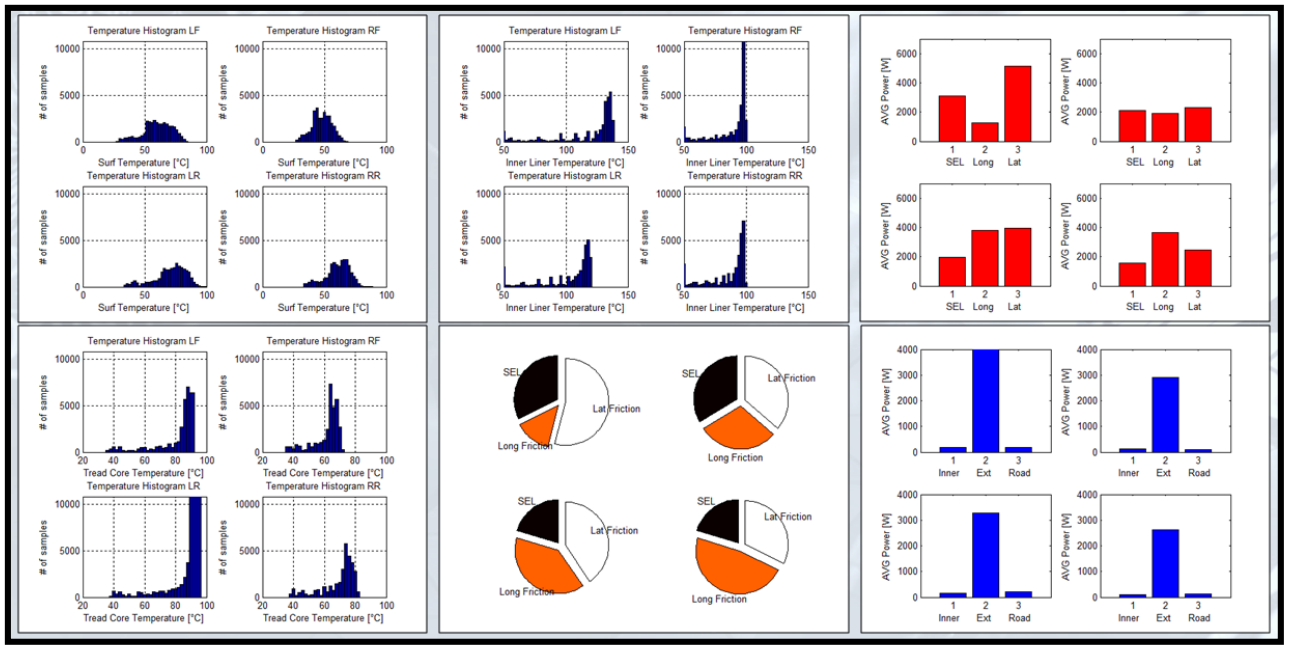




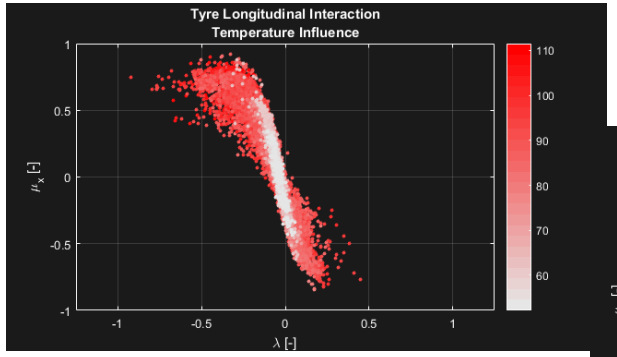
- COMPLIANCE TO ANY TIRE INTERACTION MODEL AND SIM ENVIRONMENT
- FULL MODULARITY DEPENDING ON PARTNERS' REQUIREMENTS AND NEEDS

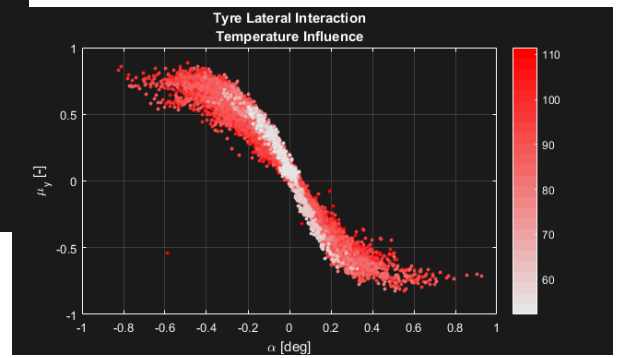
# RIDEsuite – APPLICATIONS: ADVANCED ANALYSIS



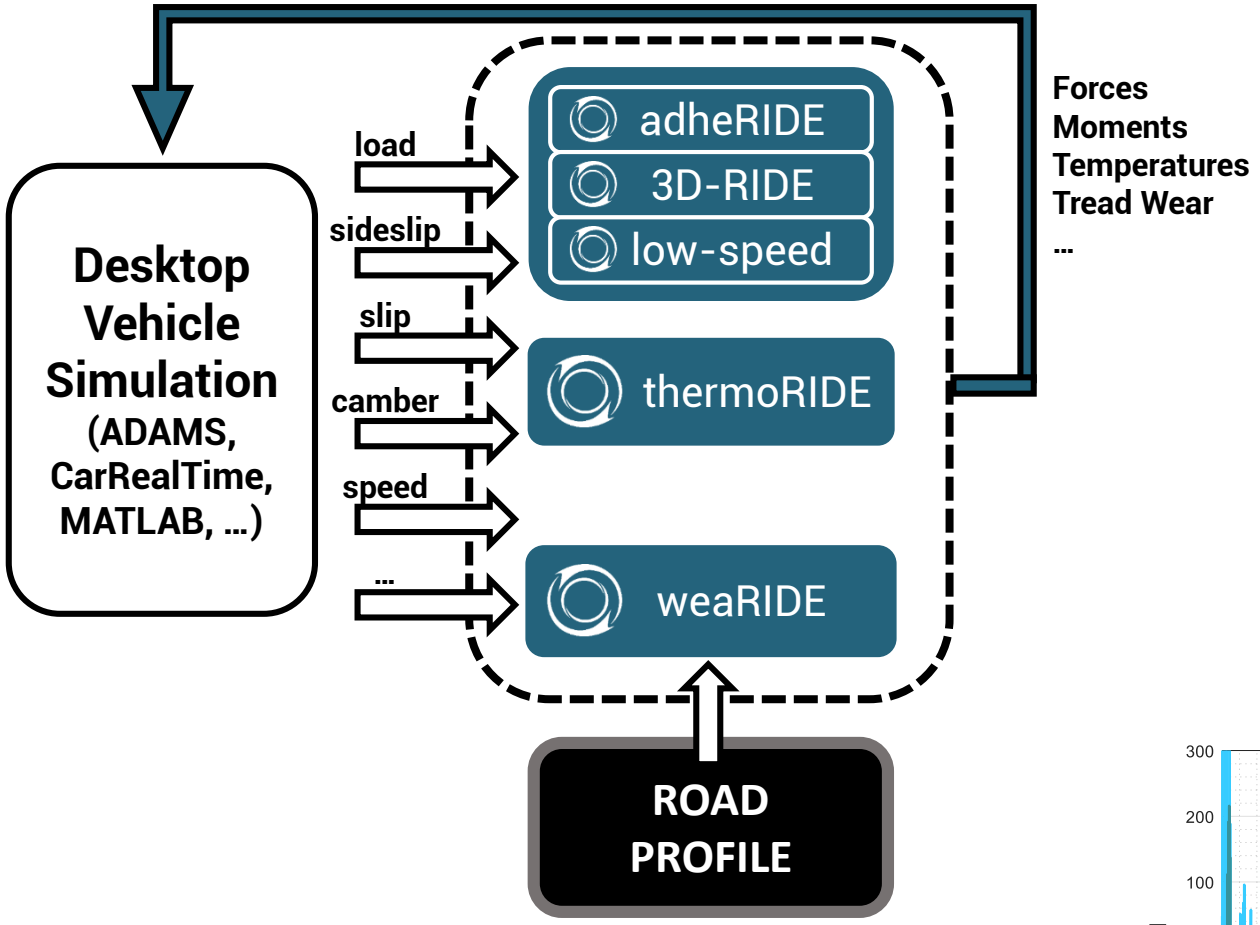

WARM-UP / HEAT EXCHANGE / THERMODYNAMIC OPTIMIZATION ANALYSIS

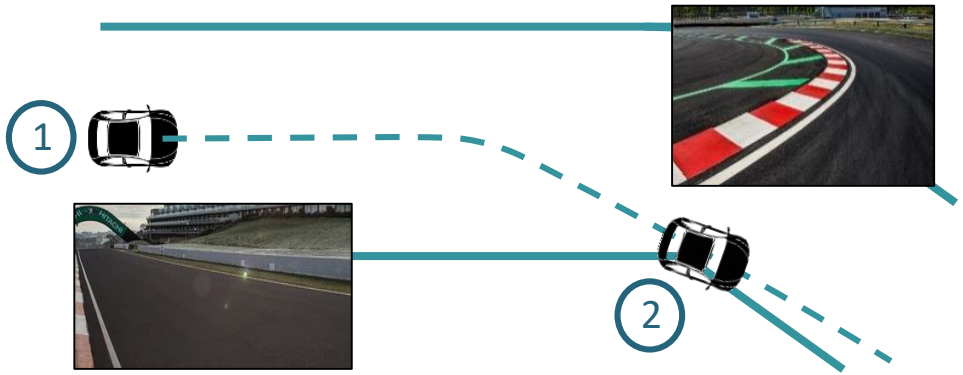


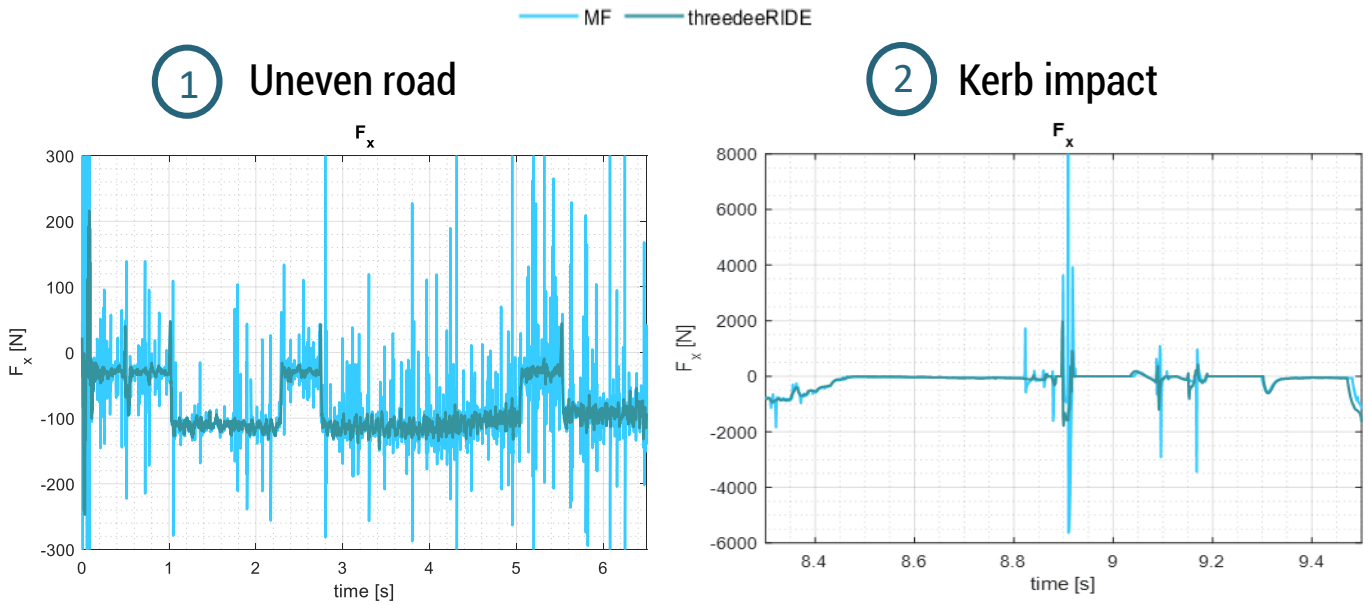




ANALYSIS ON TIRE DEPENDENCIES FROM TEMPERATURE / WEAR / ROAD ROUGHNESS / TREAD VISCOELASTICITY

# RIDEsuite – APPLICATIONS: "OFFLINE" SIMULATIONS

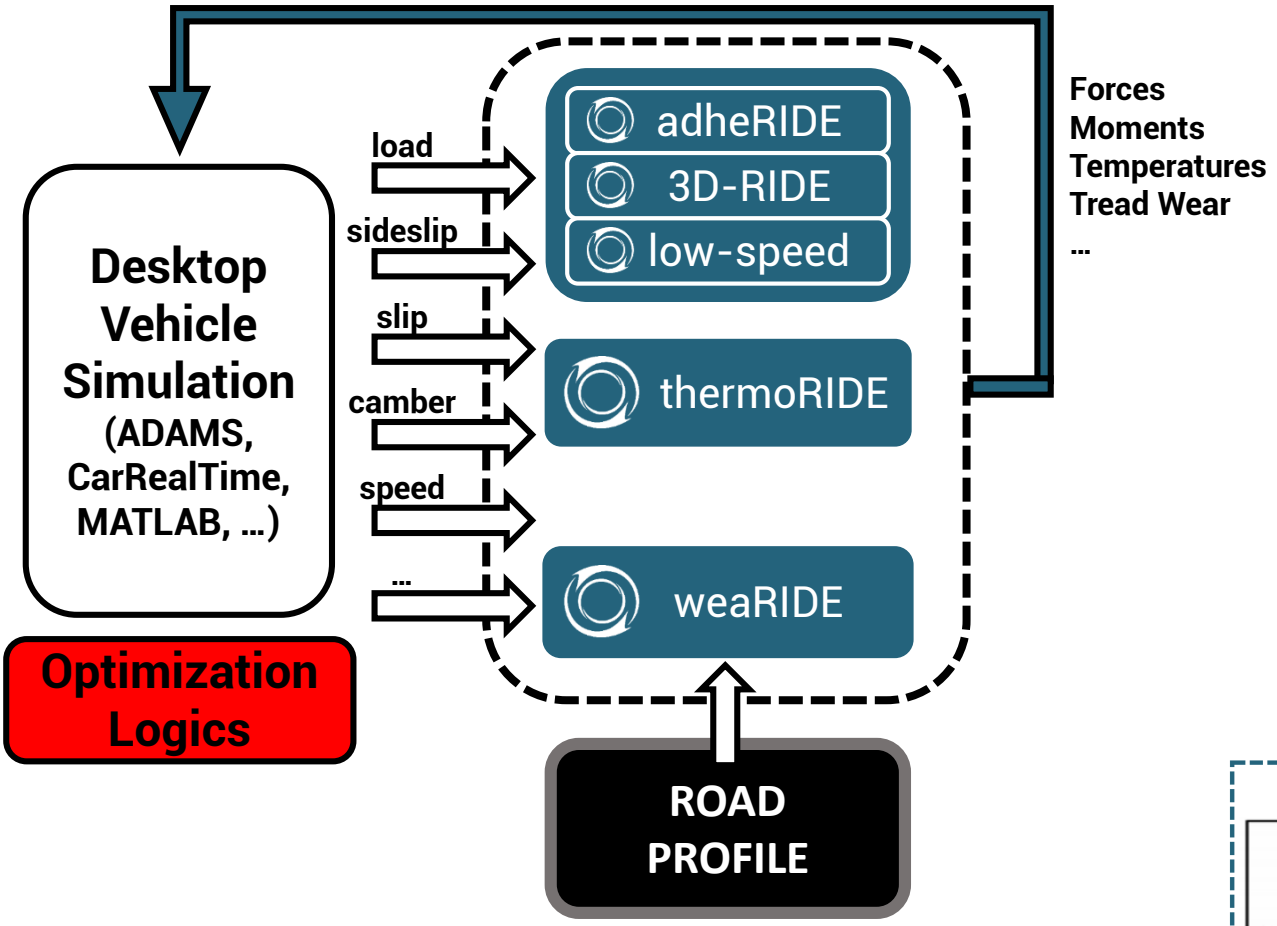


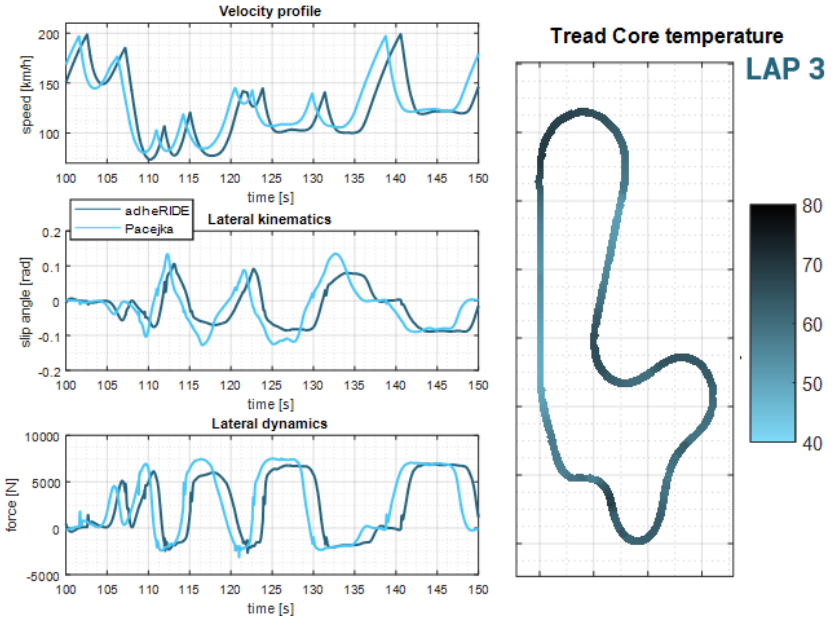



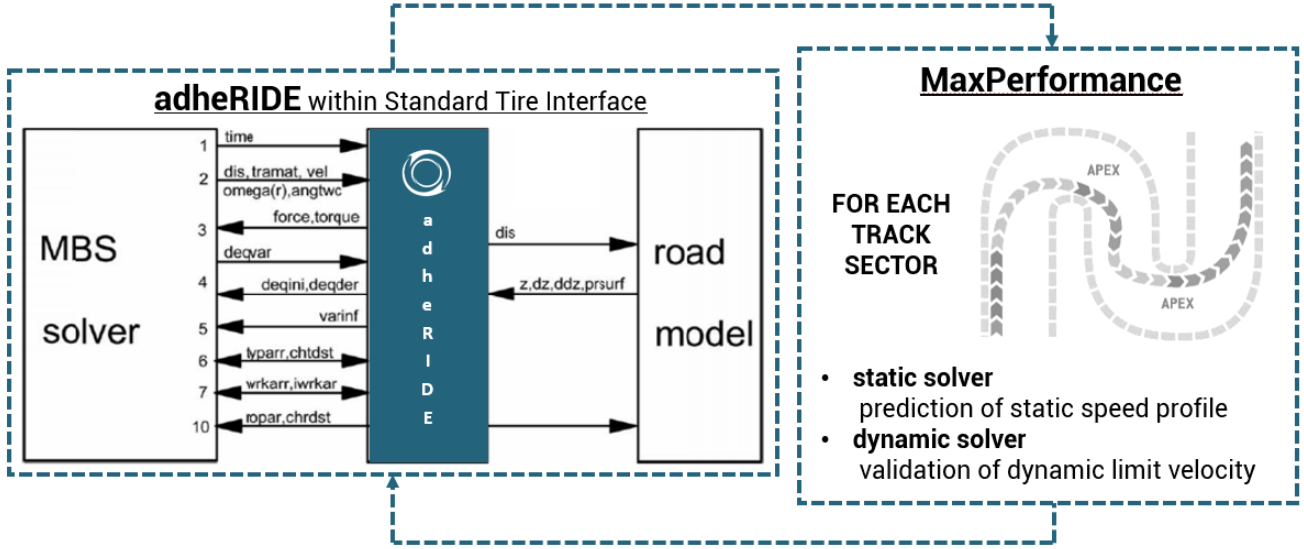




- DYNAMIC SIMULATIONS FOR CAR / BIKE / TRUCK
- TIRES IN THE SIMULATION LOOP ACCOUNTING FOR THERMAL / WEAR / ROAD MESH / SPEED PHENOMENA

# RIDEsuite – APPLICATIONS: "OFFLINE" LAPTIME OPT.

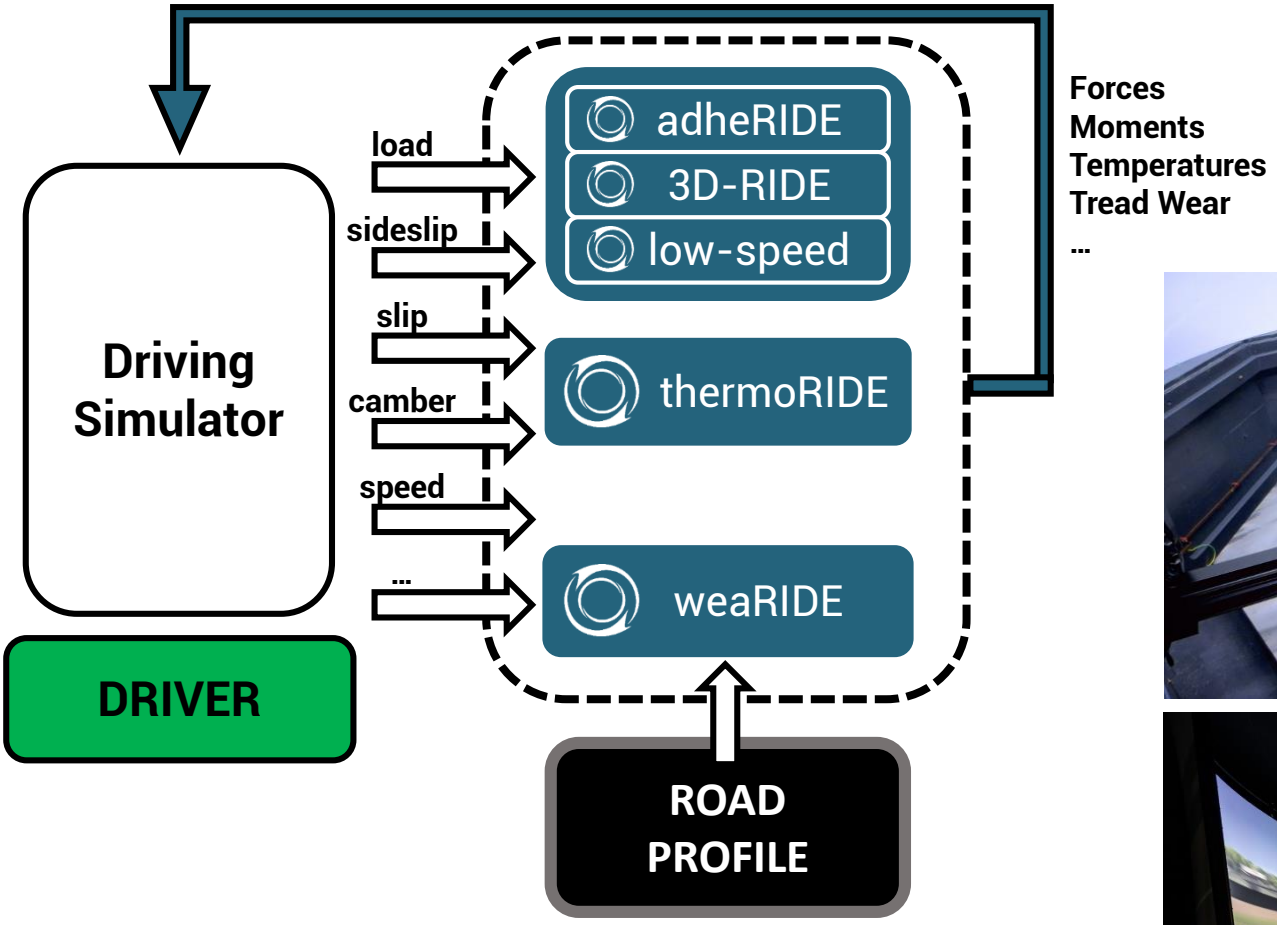


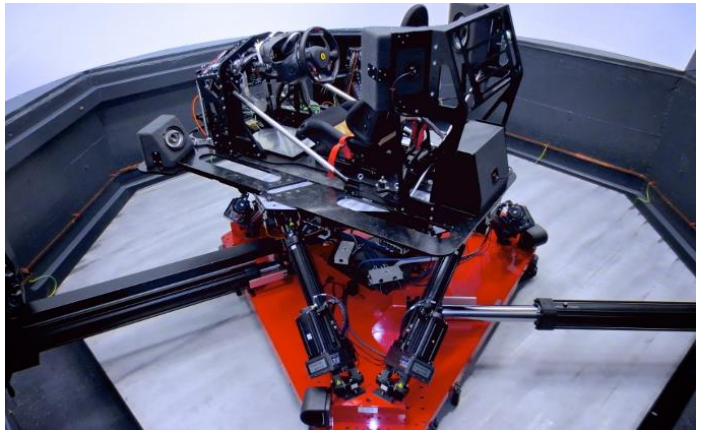

- **ADVANCED SETUP OPTIMIZATION (INFLATION PRESSURE / BLANKETS TEMPERATURE / … )**
- **GRIP&STIFFNESS VARIATIONS WITH TEMPERATURE IN THE ITERATIVE OPTIMIZATION ALGORITHMS**

# RIDEsuite – APPLICATIONS: REALTIME SIMULATIONS

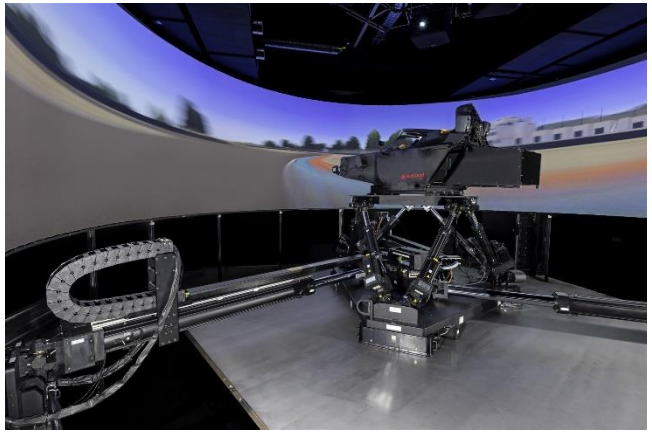



**some of the platforms adopting RIDEsuite…**

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

# REFERENCES


- Farroni F., Sakhnevych A., Timpone F. - DEVELOPMENT OF A GRIP AND THERMODYNAMICS SENSITIVE PROCEDURE FOR THE DETERMINATION OF TYRE/ROAD INTERACTION CURVES BASED ON OUTDOOR TEST SESSIONS - Proceedings of the 4th International Tyre Colloquium: tyre models for vehicle dynamics analysis, pp. 20-21, 2015.

- Farroni F., Sakhnevych A., Timpone F. - AN EVOLVED VERSION OF THERMO RACING TYRE FOR REAL TIME APPLICATIONS - Lecture Notes in Engineering and Computer Science, 2218, pp. 1159-1164, 2015.

- Farroni F., Russo M., Sakhnevych A., Timpone F. – TRT EVO: ADVANCES IN REAL-TIME THERMODYNAMIC TIRE MODELING FOR VEHICLE DYNAMICS SIMULATIONS – Proceeding of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering, 2018.

- Farroni F., Sakhnevych A., Timpone F. - PHYSICAL MODELLING OF TIRE WEAR FOR THE ANALYSIS OF THE INFLUENCE OF THERMAL AND FRICTIONAL EFFECTS ON VEHICLE PERFORMANCE - Proceedings of the Institution of Mechanical Engineers, Part L: Journal of Materials: Design and Applications, 231 (1-2), pp. 151-161, 2017

- Farroni F., Lamberti R., Mancinelli N., Timpone F., 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", Vol. 102, pp. 1-22, 2018.

- Farroni, F., Timpone, F. - A TEST RIG FOR TYRE ENVELOPE MODEL CHARACTERIZATION - Engineering Letters, 24 (3), pp. 284-289, 2016.

- Allouis, C., Farroni, F., Sakhnevych, A., Timpone, F. - TIRE THERMAL CHARACTERIZATION: TEST PROCEDURE AND MODEL PARAMETERS EVALUATION - Lecture Notes in Engineering and Computer Science, 2224, pp. 1199-1204, 2016.

- Farroni F., Russo M., Russo R., Timpone F. - A PHYSICAL ANALYTICAL MODEL FOR LOCAL GRIP ESTIMATION OF TYRE RUBBER IN SLIDING CONTACT WITH ROAD ASPERITIES - Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering - Vol. 228, n. 8, July 2014, pp. 958 - 972.

- Farroni F., Russo R., Timpone F. - EXPERIMENTAL INVESTIGATIONS ON RUBBER FRICTION COEFFICIENT DEPENDENCE ON VISCO-ELASTIC CHARACTERISTICS, TRACK ROUGHNESS, CONTACT FORCE, AND SLIDE VELOCITY - Tire Science and Technology, 45(1), pp. 3-24, 2017.

- Arricale V.M., Carputo F., Farroni F., Sakhnevych A., Timpone F. – EXPERIMENTAL INVESTIGATIONS ON TIRE/ROAD FRICTION DEPENDENCE FROM THERMAL CONDITIONS CARRIED OUT WITH REAL TREAD COMPOUNDS IN SLIDING CONTACT WITH ASPHALT SPECIMENS – Key Engineering Materials, 813, pp. 261-266

# STARTUP ECOSYSTEM

research partners

business partners

customers

and...

www.megaride.eu
info@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/