



Using a DiM250 to subjectively assess Virtual Tyre Methodologies

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May 16, 2024



MIRA Technology Park





- Ride and Handling Circuit
- Ride Features
- City Circuit
- Wet Handling Circuit
- Ride Route (coming soon)



Project Scope



BMW 1 Series
Digital Twin – MIRA



Tire Models – Giti



Giti – Introduction



Giti Tire is a Singapore-Based **Global Tire Company** offering a **complete range of quality tires and services**. The company provides tires to more than 130 countries and is ranked among the **world's largest tire companies**



Revenue 2021:
2.582 Billion USD



11 Offices in Singapore, China, Indonesia, U.S., Canada, UK, Germany, France, Dubai, Malaysia and Brazil



5 R&D + Testing Centers, around the globe

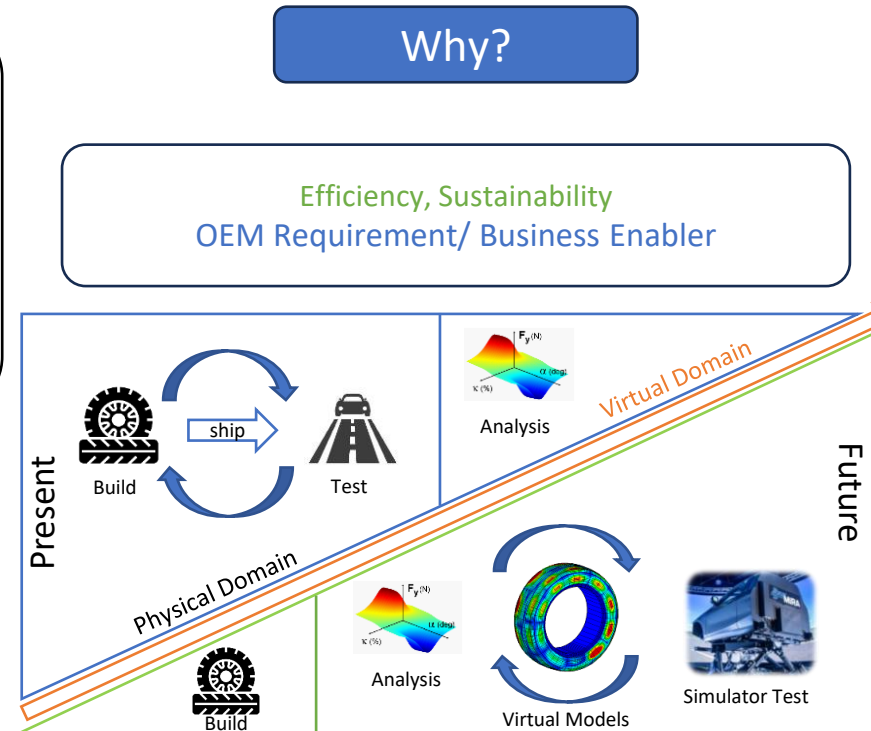
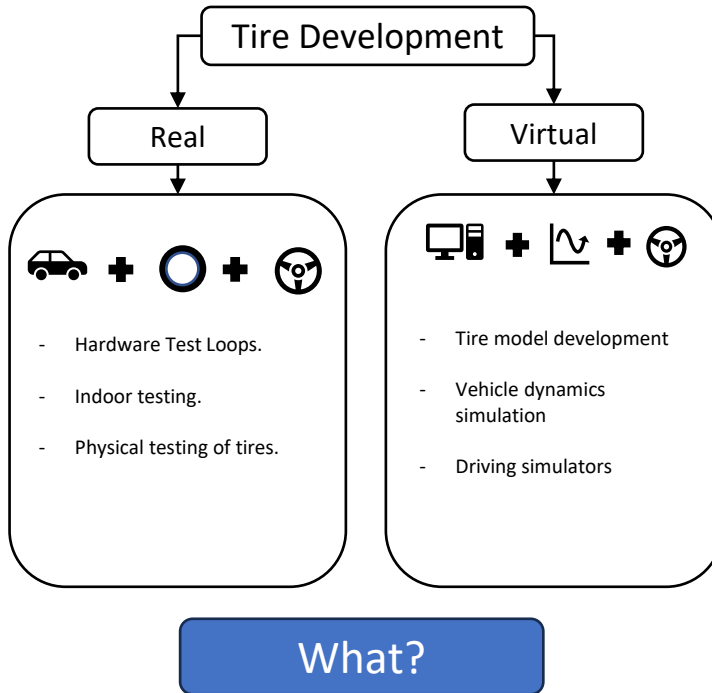


6 Manufacturing Plants 4 in China, 1 in Indonesia and 1 in the U.S.

Virtual Tire Development



What, Why and How?



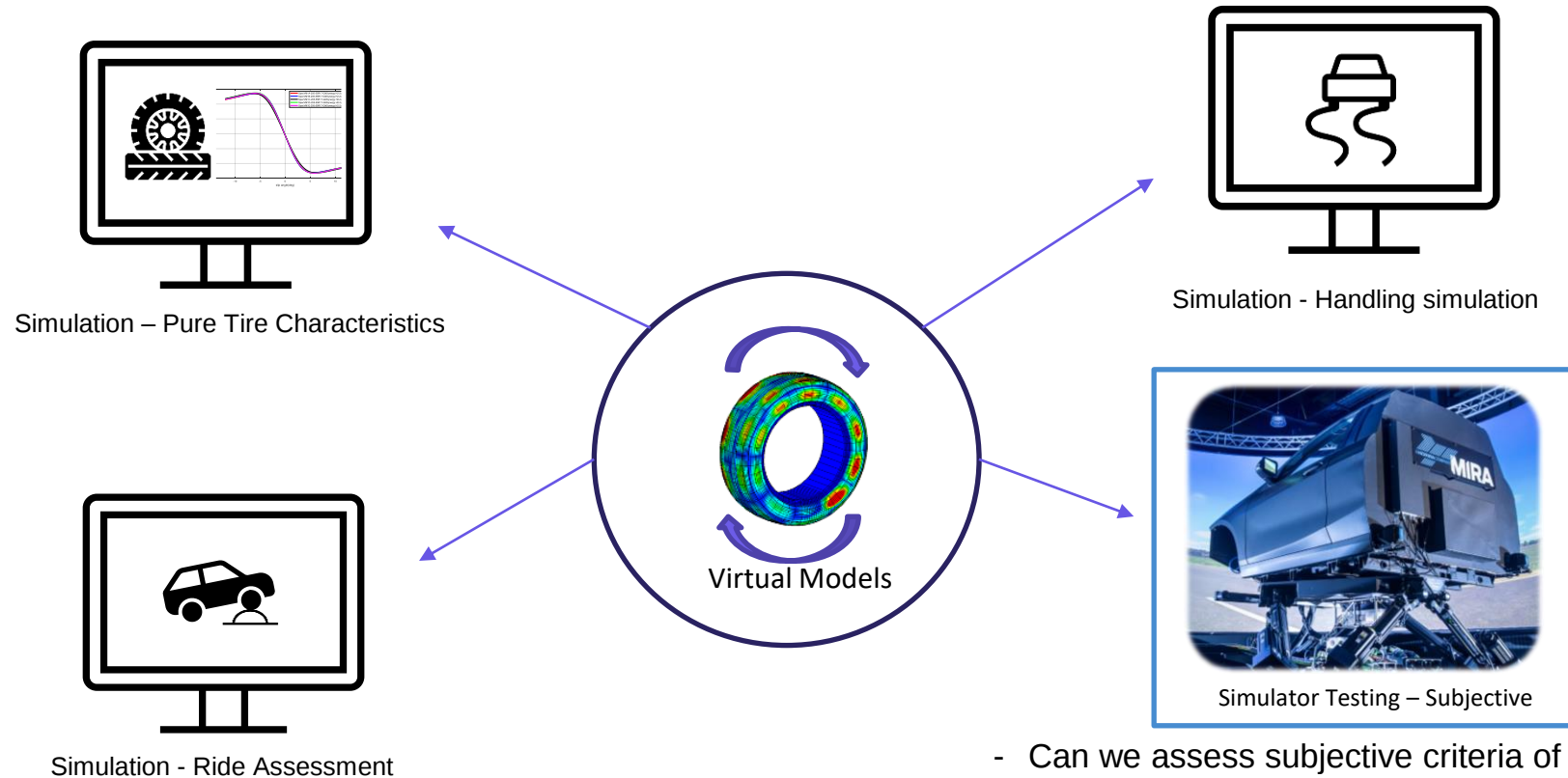
- MIRA Simulation centre : Unique opportunity of physical test track and simulation in the same site.
- State of the art simulator : VI-Grade DIM250
- Vehicle modelling facility and capability @Mira.

How?

Virtual Tire Use Cases



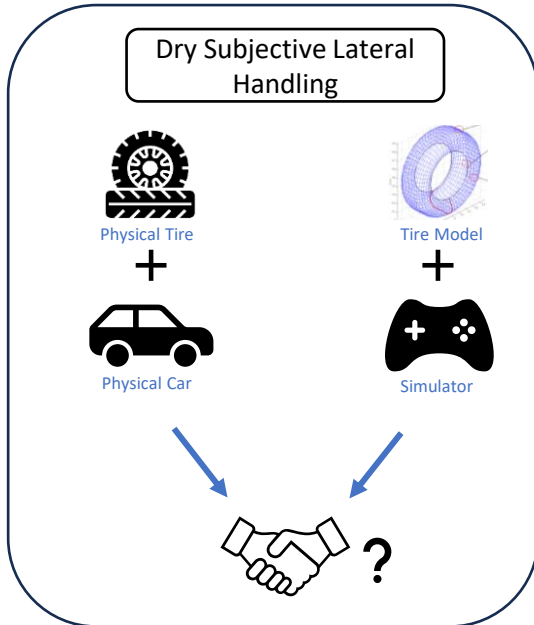
Virtual tire development and its many use cases...



- Can we assess subjective criteria of dry lateral handling assessment on the simulator?
- Can we assess virtually tuned models on the simulator?

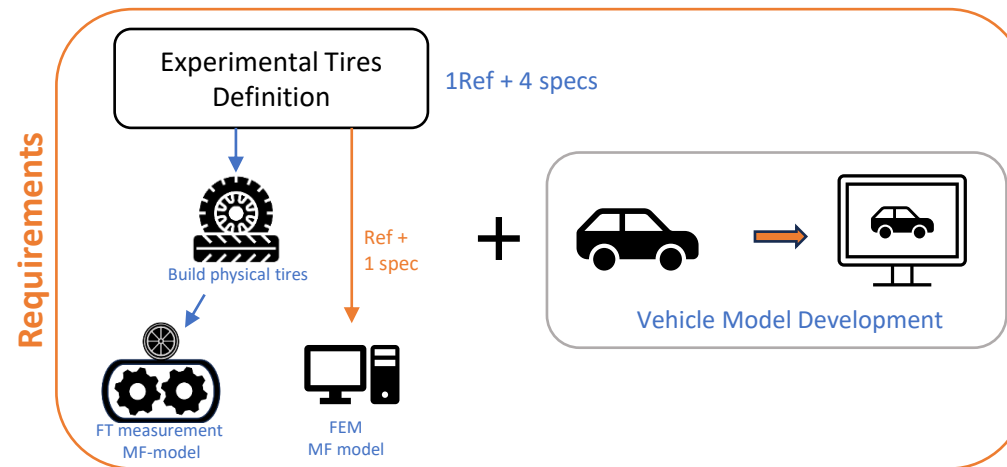


Correlation: Physical vs Simulator

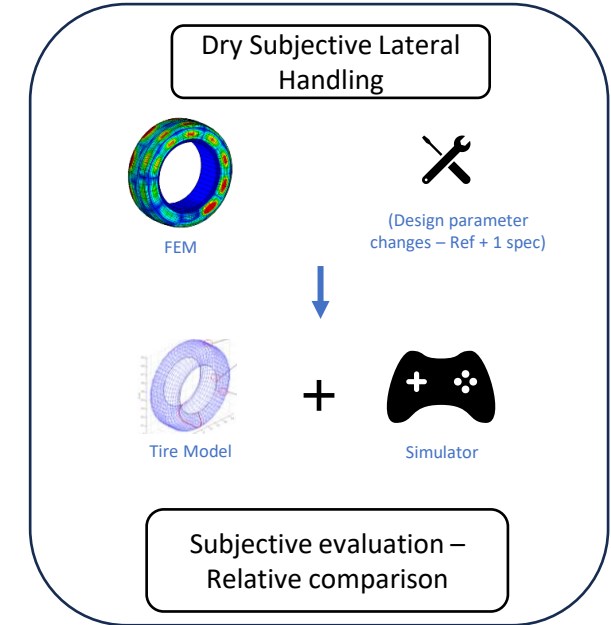


Dry Subjective Lateral Handling Criteria :

- Steering response
- Steering torque
- Steering angle requirement for constant curve
- Lane change stability @ medium and high dynamics

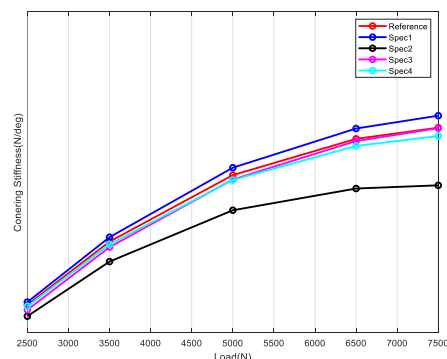
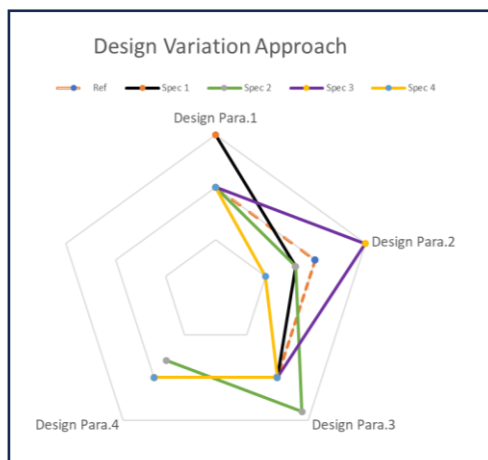


Virtual Development: Virtually developed specs

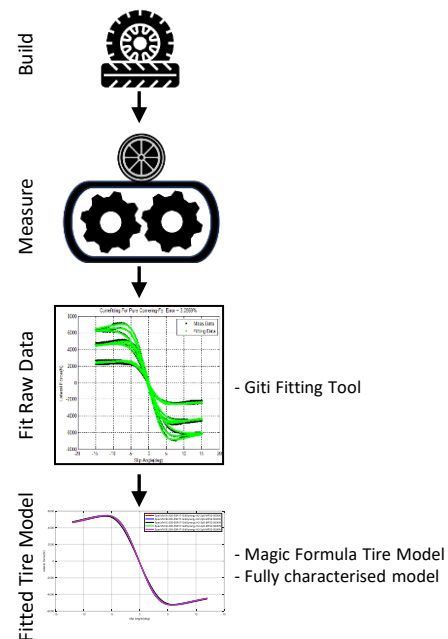


Tire Specification Definition

- 5 Specifications of a tire of a certain size were chosen for the study.

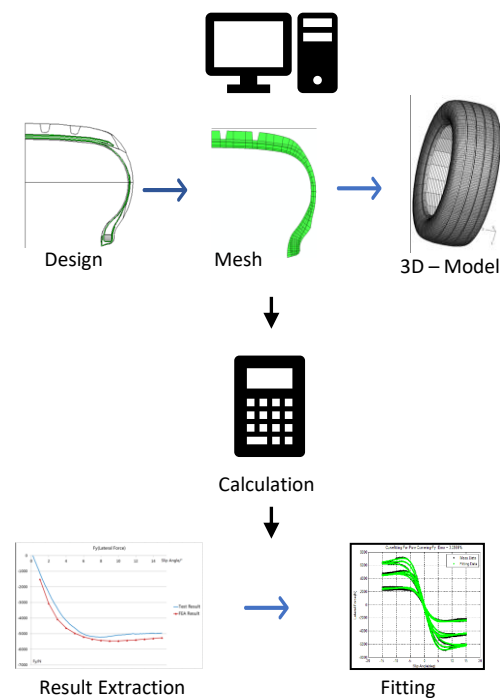


Tire Measurement / Modelling



Tire Model from Measurement:
MF 5.2 – Fully Characterised (5 specs)

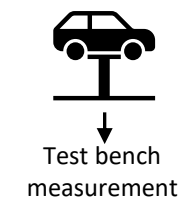
FEM



FEM Derived Tire Models :
MF 5.2 (Lateral characteristics only – 2 specs)

Vehicle Measurement / Modelling

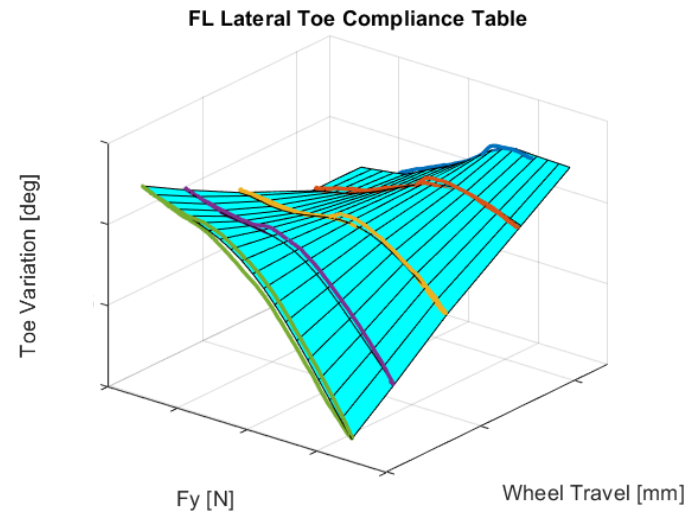
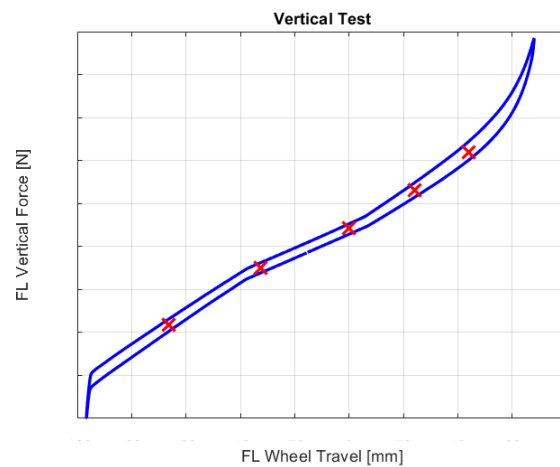
- Vehicle Definition : **BMW 118i**
- Same vehicle bug used in the MIRA-Simulator



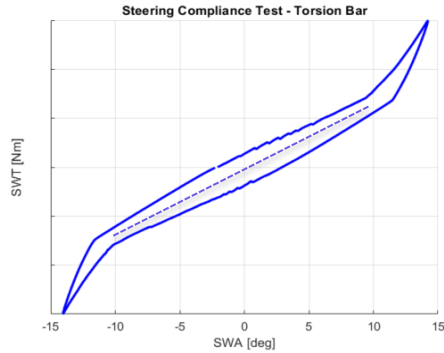
Digital Twin



- In-house K&C characterization at different ride heights
- Automated population of the VI-Grade K&C Wizard
- In-house MOI measurements
- In-house Damper characterization

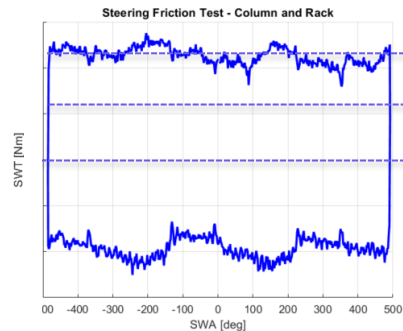


Digital Twin - Steering



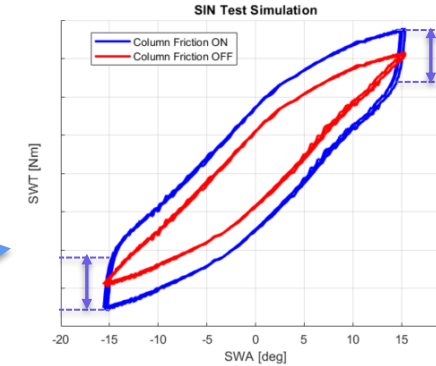
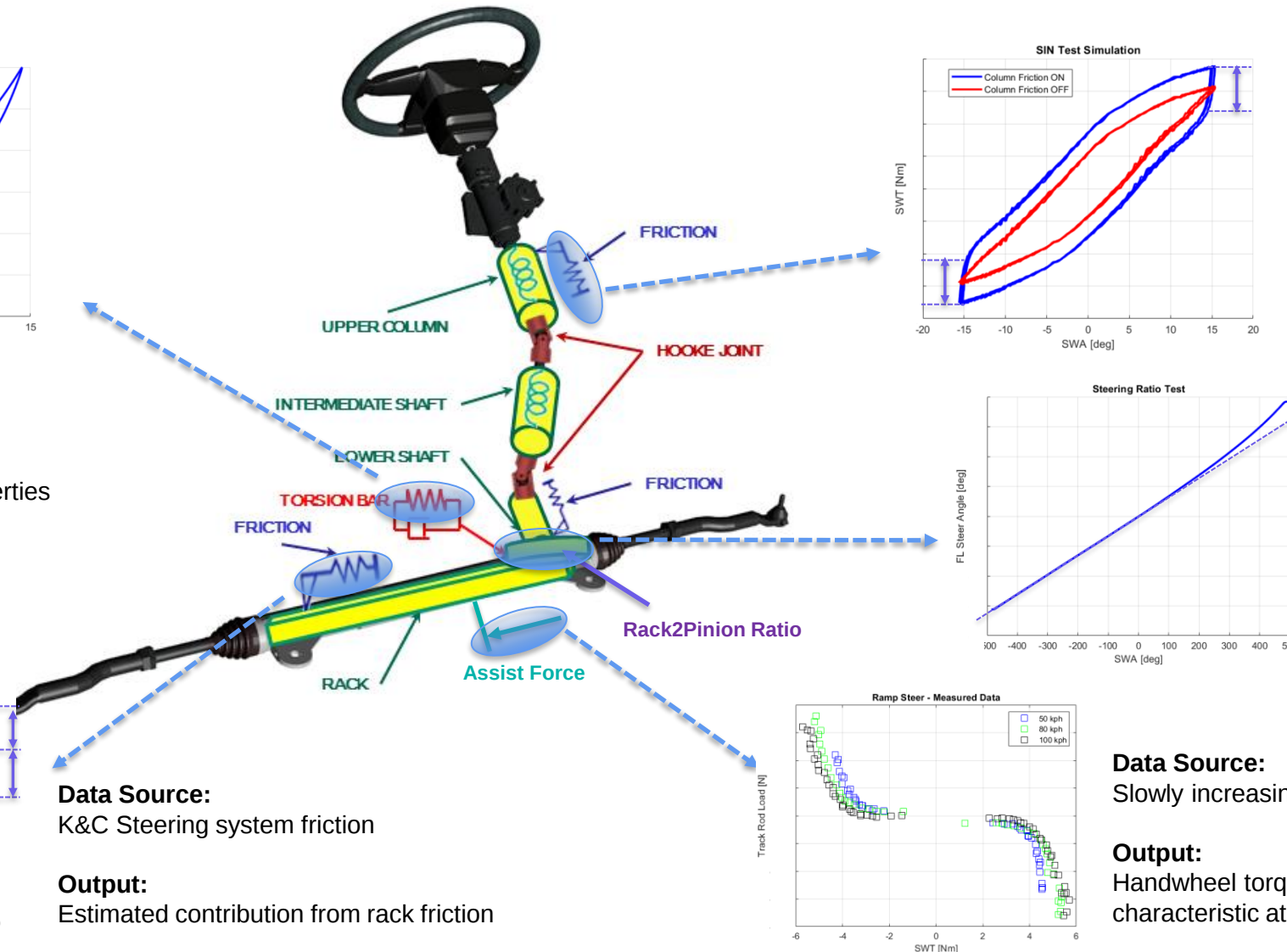
Data Source:
K&C Steering Compliance

Output:
Torsion bar stiffness properties



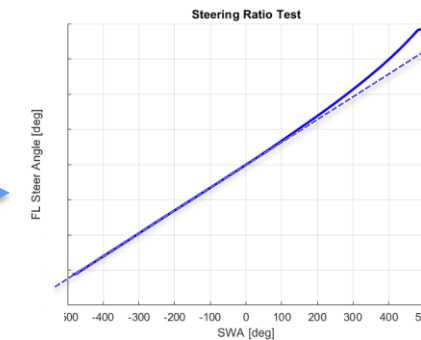
Data Source:
K&C Steering system friction

Output:
Estimated contribution from rack friction



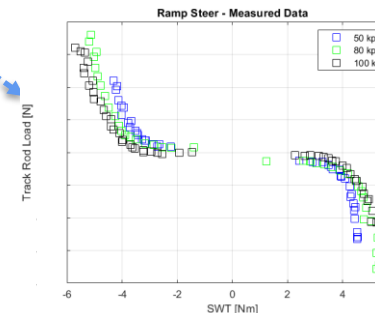
Data Source:
Sinusoidal steering tests

Output:
Hysteresis due to column friction



Data Source:
K&C Steering Test

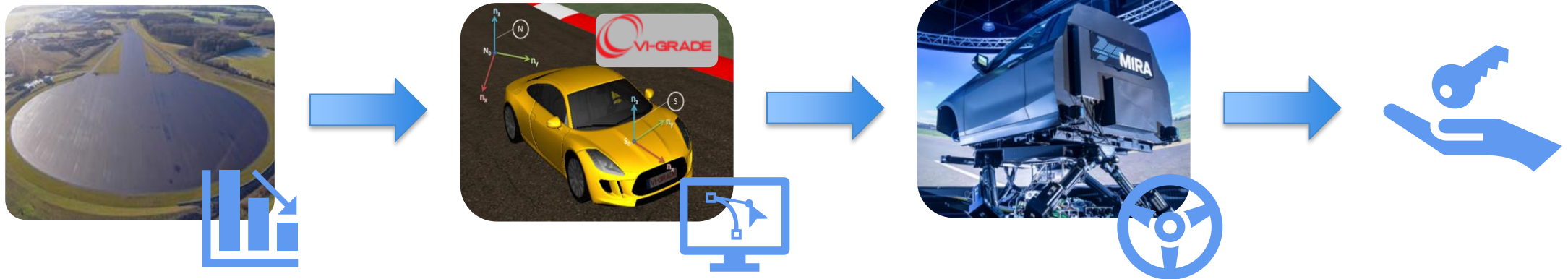
Output:
Steering ratio and rack travel



Data Source:
Slowly increasing steer tests

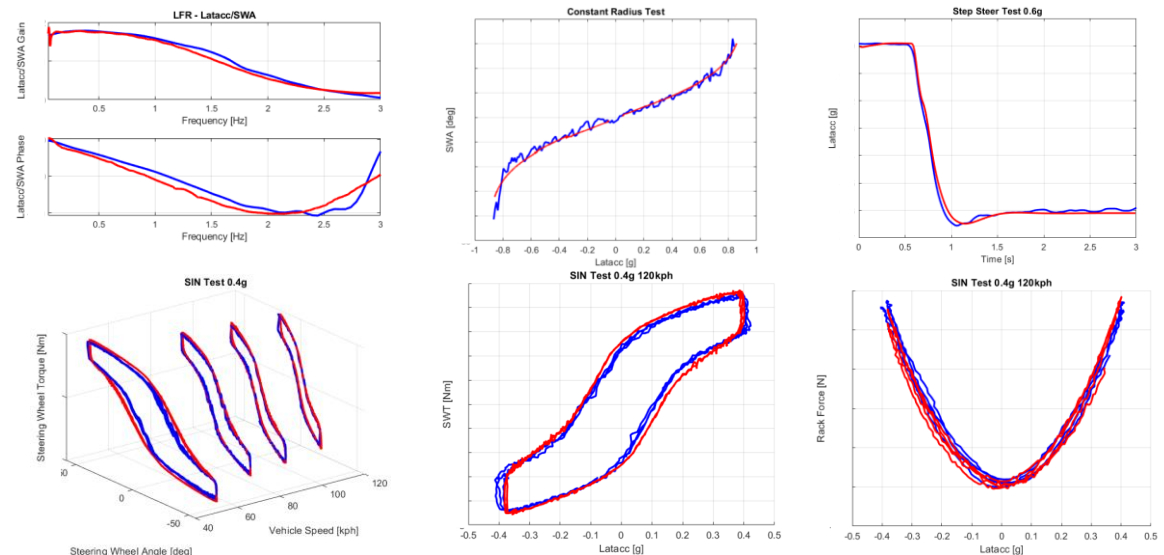
Output:
Handwheel torque vs track rod load characteristic at set vehicle speeds

Digital Twin Validation



- In-house Vehicle Dynamics Measurements
- Efficient Objective Off-Line Model Verification
- Subjective Sign-Off by MIRA Test Drivers

— Measurements
— VICRT Model



Dry Lateral Handling
As steady state as possible
3 drivers

Criteria:

- Steering response
- Steering torque
- Steering angle requirement for constant curve.
- Lane change stability @ medium and high dynamics



Physical Test on Test Track

Physical test track testing :

- 3 drivers
- 3 laps per driver at defined speeds
- Nr.2 Track @ MIRA

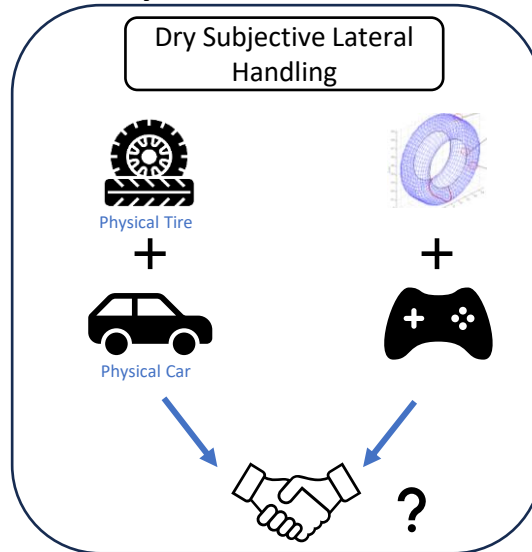


Simulator Test

Simulator testing :

- 3 drivers
- 3 lane highway with constant radius curves
- Driver adaptation + Motion cuing setup

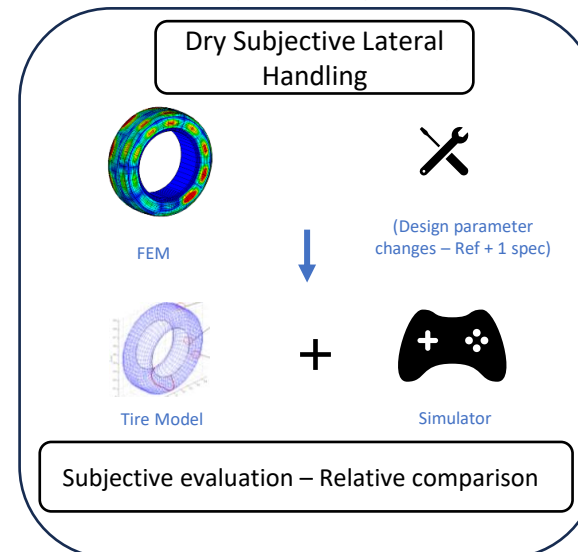
Correlation: Physical vs Simulator



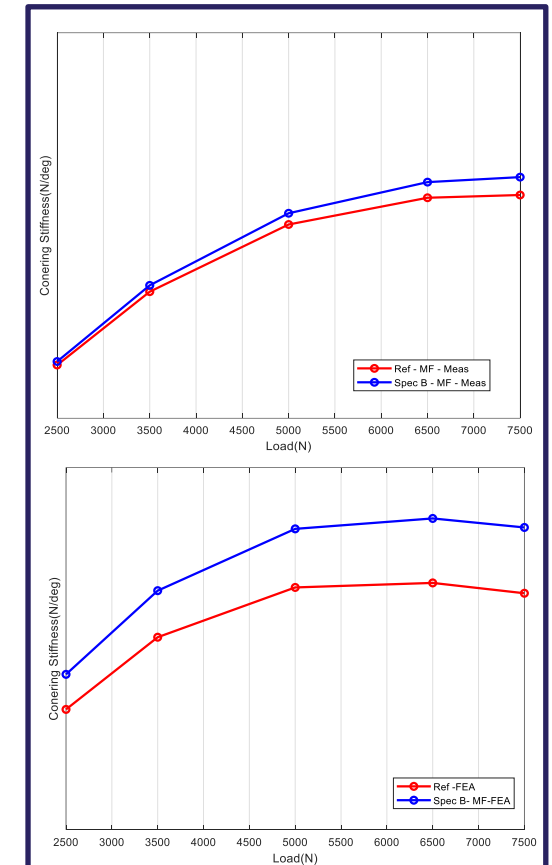
➤ Ranking based correlation between 2 domains

1. *Steering response*
2. *Steering torque*
3. *Steering angle requirement for constant curve*

Virtual Development: Virtually developed specs



- ✓ Specification change mirrored the expected tire performance characteristics
- ✓ Similar trend wise rating for the specification between the physical, semi empirical MF and FEM derived MF
- ❑ Absolute difference is to be improved



Conclusions

- Extension of the Giti-MIRA partnership to virtual tyre testing thanks to the brand-new MIRA Driving Simulator Centre
- Creation of an accurate digital twin model of Giti's test vehicle
- Positive feedback from Giti's test drivers on the DiM250 technology and its potential for virtual tyre assessment
- Good correlation between outdoor and simulator assessment of the soft-handling for multiple tyre specifications

Next Steps

- Expand assessment criteria to higher-dynamics maneuvers
- Virtual ride evaluation



