

Physical Tire Models for Handling

Bridging Simulation and Track Improving Driver
Perception on Simulator through Physical Tire
Modeling



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2025

 PUBLIC

1. Company Profile
2. Background
3. Methodology
4. Results
5. Conclusions & Next Steps

IDIADA is an engineering partner to the automotive industry providing complete solutions for product development projects worldwide



3.356

PROFESSIONALS



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TESTING FACILITIES

OUR
ASSETS



24

COUNTRIES
59 LOCAL OFFICES



CONSTANT INNOVATION

IN NEW SERVICES
AND TECHNOLOGIES

COMPLETE SOLUTIONS FOR AUTOMOTIVE ENGINEERING



PROJECT
MANAGEMENT



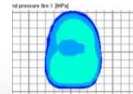
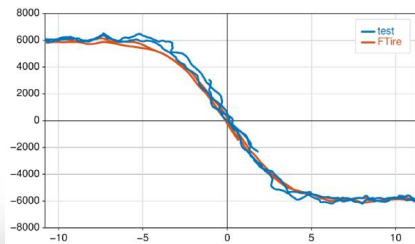
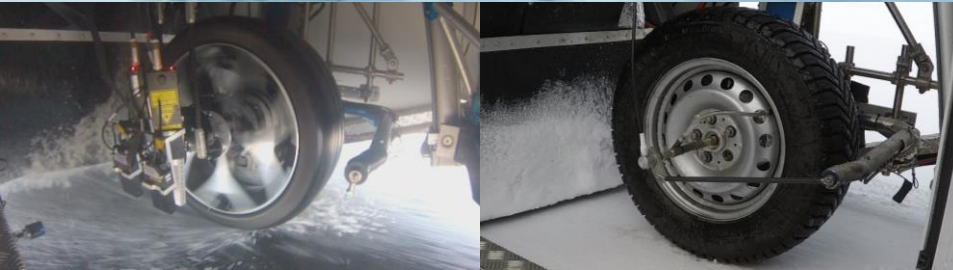
KNOW-HOW IN ALL
VEHICLE
FUNCTIONALITIES



ENGINEERING,
TESTING &
HOMOLOGATION

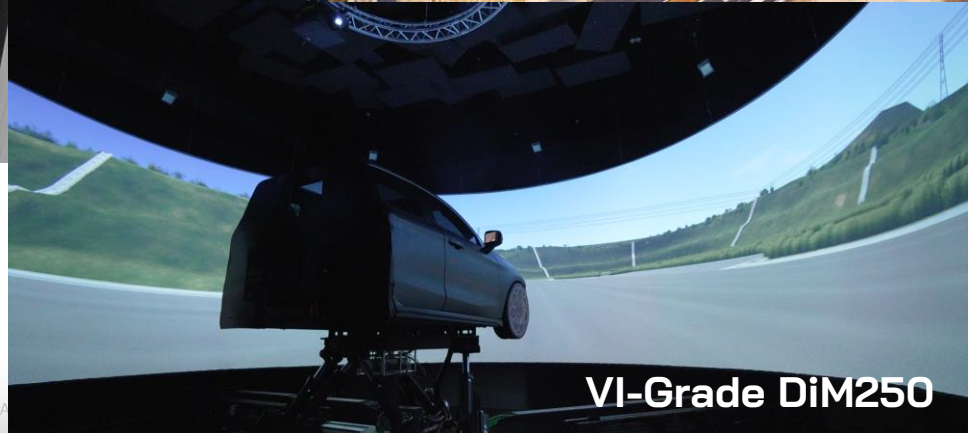


Tire Testing & Modelling



cosin

Physical and Virtual Proving Ground



VI-Grade DiM250

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TRADITIONAL MF VS. PHYSICAL TIRE MODELS

The tyre model is arguably **the most important element** for chassis development, but traditional Magic Formula models (MF) have limitations...

- ✗ Not valid for ride comfort or high-frequency applications
- ✗ Not valid beyond operating range or surface
- ✗ Limited consideration of temperature or pressure
- ✗ Some parameters not physically meaningful
- ✗ Major impact of tire testing surface in behavior

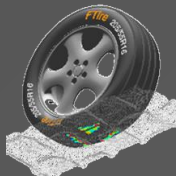
Physical tyre models advantages over traditional MF:

- ✓ High frequency response → suitable for ride
- ✓ Extrapolation is less critical → valid beyond the measurement range
- ✓ Possibility to adjust pressure and tyre temperature can be considered
- ✓ Capable to capture mu transitions

An important blocking point remains

- ✗ Often, the handling of such models is not adequate

IDIADA & Cosin have developed an exclusive process to generate FTire models with high accuracy for handling applications

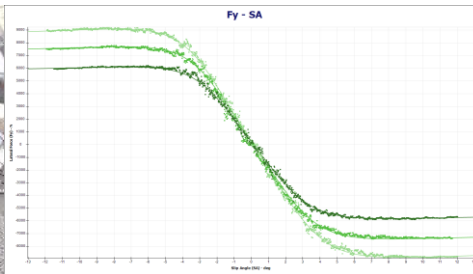


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METHODOLOGY

PROJECT WORKFLOW



1.
**Tire Testing in
Skid Trailer and
Laboratory**

2.
**Tire Modelling
and Fitting**

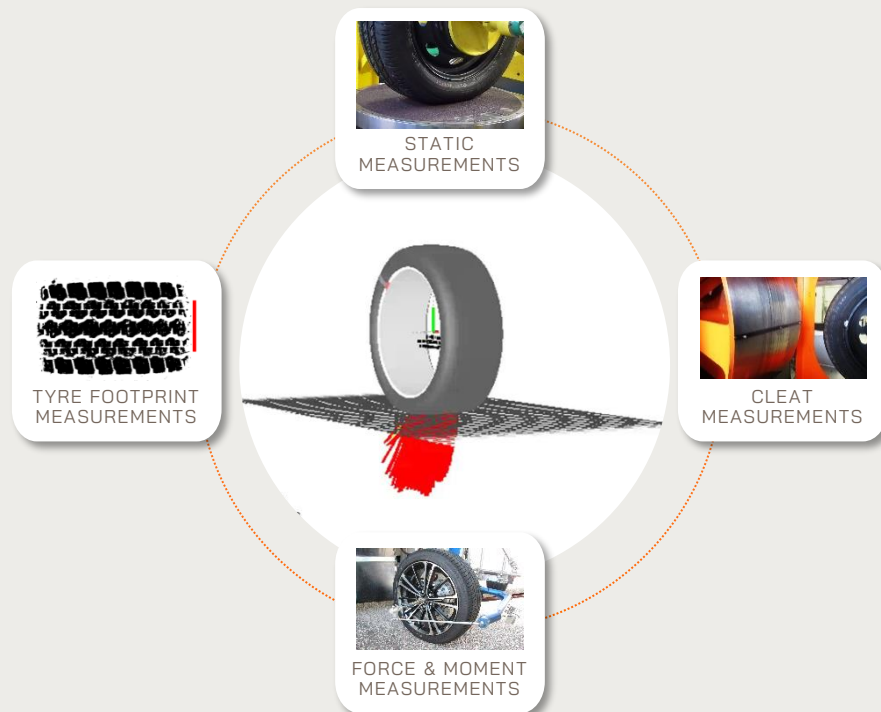
**3. Physical
Proving Ground
Tire Evaluation**

**4. Subjective
Comparison
and Correlation
in DiM250**

Key elements for tire testing at IDIADA with 9+ years of testing experience:

- ✓ Both quasi-static and Force & Moments tests are obtained on **realistic surfaces**
- ✓ **Strict control** of test actuation speed, operating temperatures and pressure during all testing activities
- ✓ **Proprietary fitting methodology**, focusing on tyre footprint shape and pressure distribution

F-TIRE MODEL GENERATION



Key elements for tire testing at IDIADA with 9+ years of testing experience:

- ✓ Both quasi-static and Force & Moments tests are obtained on **realistic surfaces**
- ✓ **Strict control** of test actuation speed, operating temperatures and pressure during all testing
- ✓ **Proprietary fitting methodology**, focusing on tyre footprint shape and pressure distribution



STATIC
MEASUREMENTS



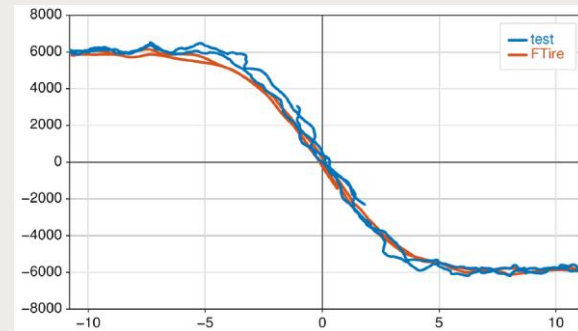
TYRE FOOTPRINT
MEASUREMENTS



CLEAT
MEASUREMENTS

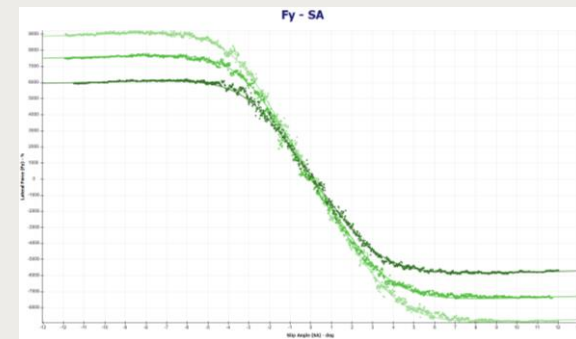


FORCE & MOMENT
MEASUREMENTS



FTire
Fy vs. SA
Low Fz

MF
Fy vs. SA



*FTire & MF show **high degree of model correlation**.*

*However, subjective **validation in DS** is necessary*

- Comparative study between PG and DS with **same virtual and physical tyres, vehicle and tracks**
- Expert driver to perform subjective blind tests on both PG and DS
- On-Site technical support from Cosin for tire model refinement

cosin

Vehicle

- BMW 320d (G20)

Tyres

- COMFORT TYRE – 225/45 R18 95Y
- SPORT TYRE – 225/45 R18 95Y

Tracks

- IDIADA Spain PG Tracks: High Speed, Dynamic Platform and Dry Handling Circuit



Vehicle Model

- IDIADA VI-CRT BMW 320d Digital Twin

Tire Models

- FTire Model: COMFORT & SPORT models
- MF Model: COMFORT and SPORT models

Virtual Surface Model

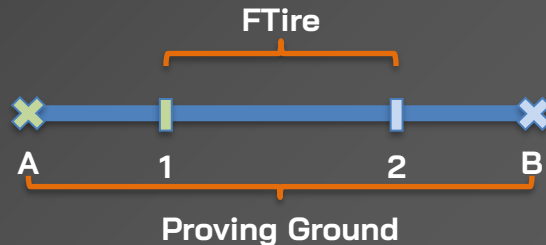
- IDIADA Spain Virtual PG Tracks: High Speed, Dynamic Platform and Dry Handling Circuit

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PROVING GROUND VS. FTIRE COMPARISON

- Driver correctly identifies tyres on PG & DS after blind tests
- Larger change perceived in the PG compared to FTire
- Realistic subjective feeling of FTire in Driving Simulator



Item	Evaluation Results
<i>Tyre Variants</i>	Driver can identify COMFORT and SPORT variants on the DS. Both virtual and physical tyres have similar blind scores , but larger change is perceived in the physical tyres
<i>Vehicle Performance</i>	Progressive Yaw rate feel , which helps to perceive and control US/OS. Vehicle reactions on lane changes at low-medium speeds feel realistic . FTire shows slightly more rear axle delay than the real vehicle, especially at high speeds rear stability decreases.
<i>Tyre Performance</i>	Tyre reactivity/sharpness and compliance are well simulated by FTire. Inflation pressure variation clearly perceived and affects US/OS balance. Realistic temperature decay in FTire in Dry Handling

MF VS. FTIRE COMPARISON

- Differences between both tyres are more noticeable on FTire than on MF-Tyre
- Vehicle reacts similarly on the linear range for FTire/MF, but performs quite different on the limit

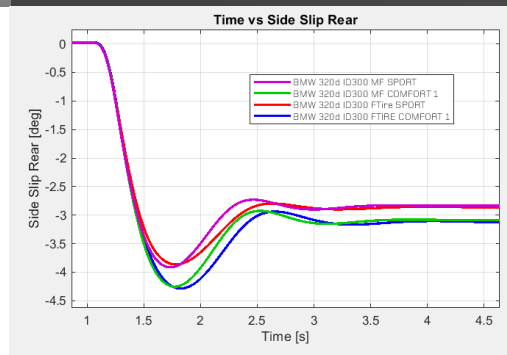
Evaluation Item	FTire	MF
<i>Steering Feel</i>	Adequate steering feel vs. Vehicle yaw response feeling	Lack of connection between steering wheel and road
<i>Limit Stability</i>	FTire behavior is more progressive and predictable	MF-Tyre retains good stability, with very severe inputs required to lose control – but the loss of control is quite sudden.
<i>Tyre Compliance</i>	Subjective compliance feeling aligned with real vehicle	More direct, “undamped” reaction

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CONCLUSIONS

- ✓ FTire model has realistic handling behavior for evaluation in the DS
- ✓ Differences between tyres are more noticeable on FTire than MF
- ✓ One tire model, all applications → cost and time reduction



NEXT STEPS

- FTire model refinement based on subjective driver's feedback
- Complete detailed correlation loop with Full Vehicle objective metrics
- Full validation for low-mu conditions





ご親切なご配慮に感謝します

THANK YOU FOR YOUR KIND ATTENTION
ANY QUESTIONS? WE CAN TALK LATER!



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