



TameTire 3.0



- //// *The model : an overview***
- //// *Model validation***
- //// *TameTire 3.0 : novelties***
- //// *Michelin's vision for TameTire***

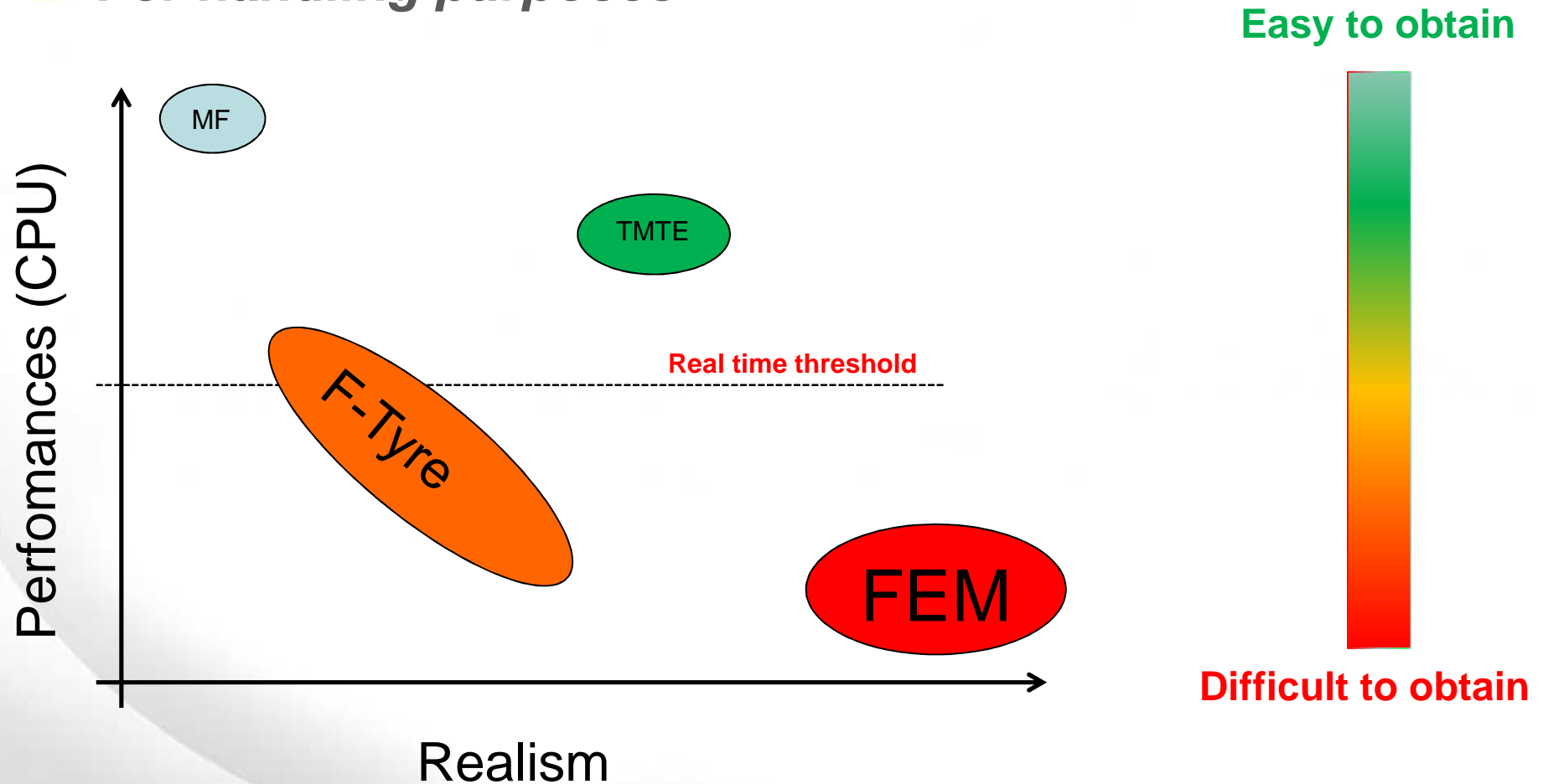


TameTire : an overview

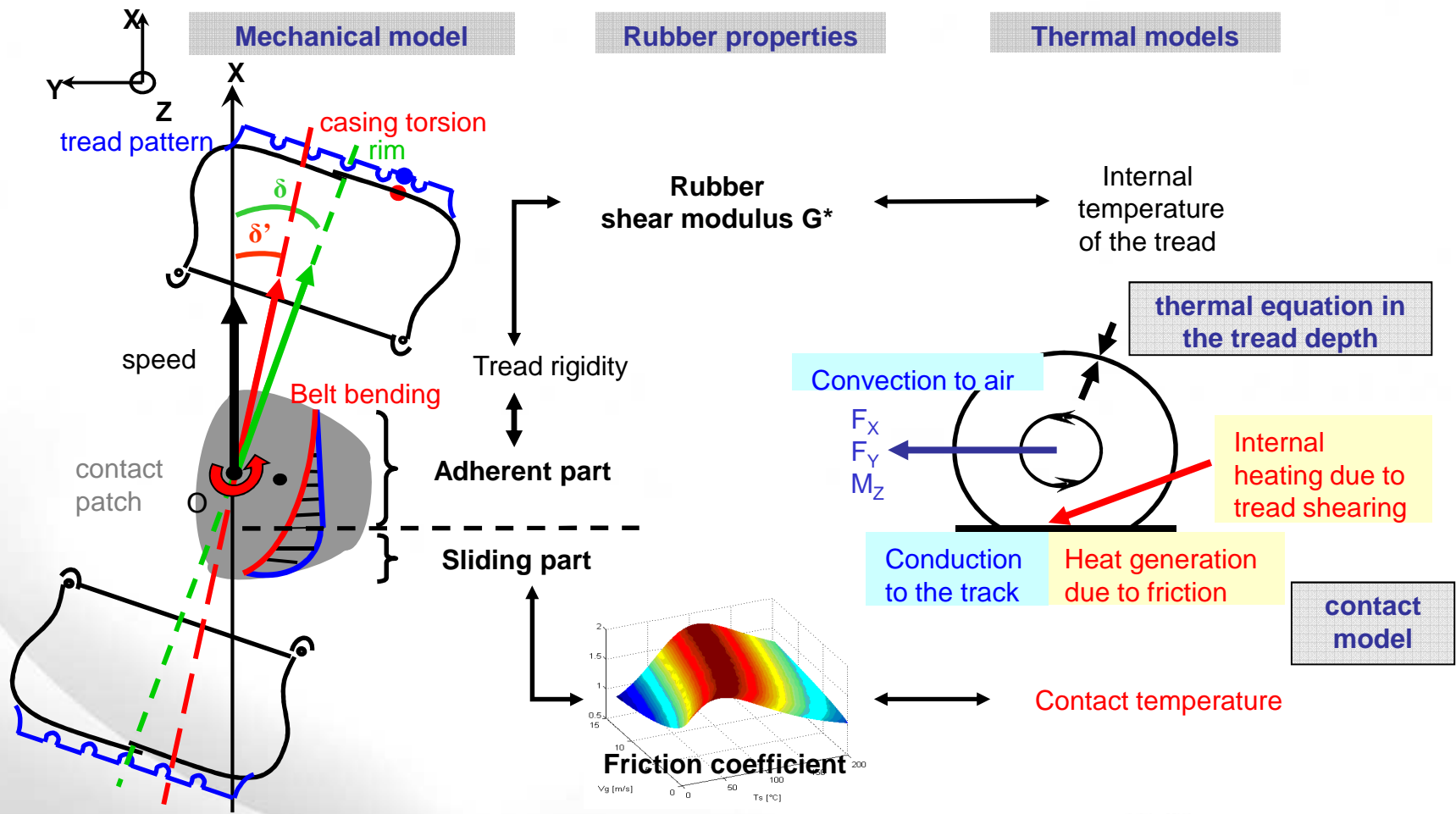


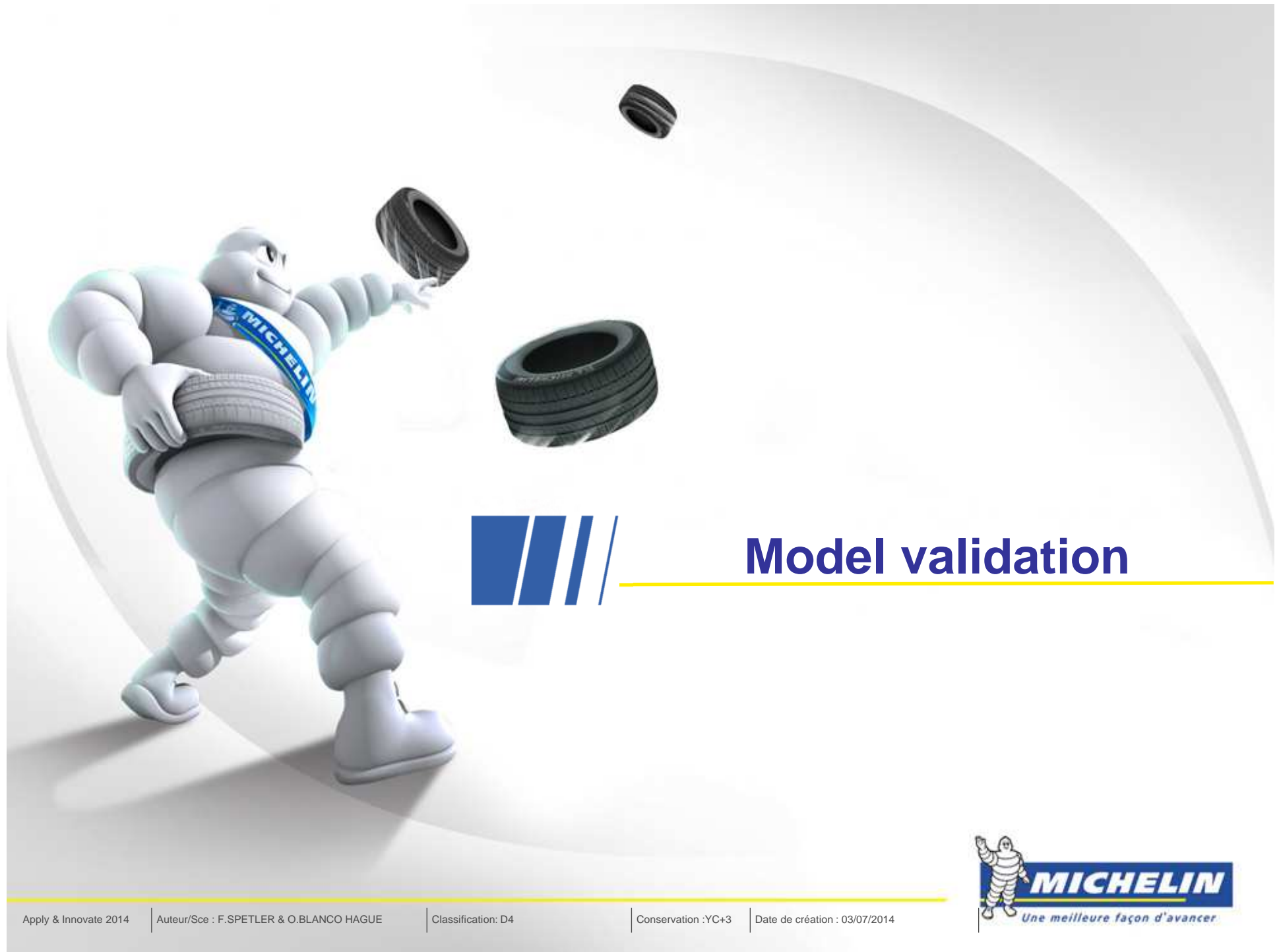
TameTire : an overview

For handling purposes



TameTire: the model





Model validation



Model validation

/// Application of the following procedure to validate our model:

- **1. Verify that the TameTire testing procedure can be applied successfully on a third party machine**
- **2. On vehicle testing:**
 - Steady state
 - Braking

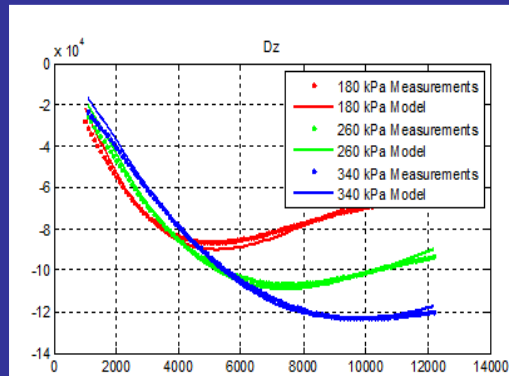
/// Visit to NTRC (USA) to perform the TameTire testing procedure on several passenger car tyres (Michelin & competitor tyres)



Test procedure on a third party machine

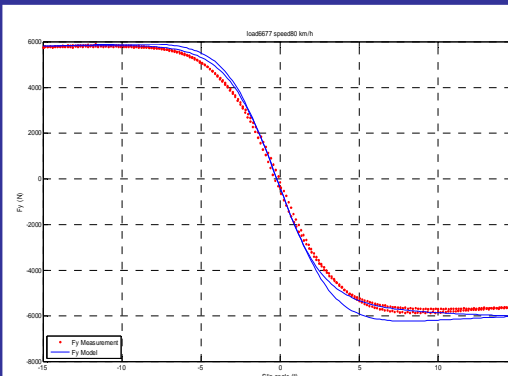
Results at the NTRC:

Cornering Stiffness at cold temperatures

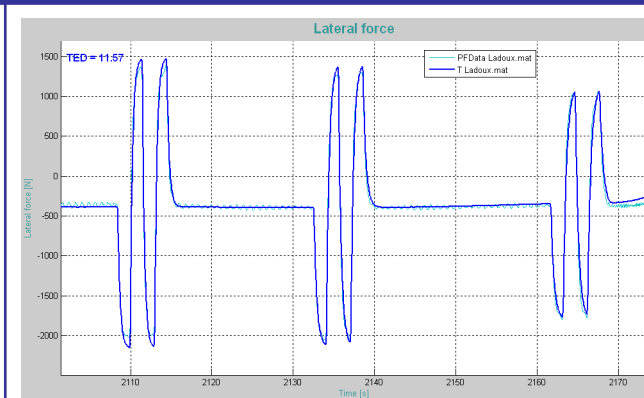


@ Michelin

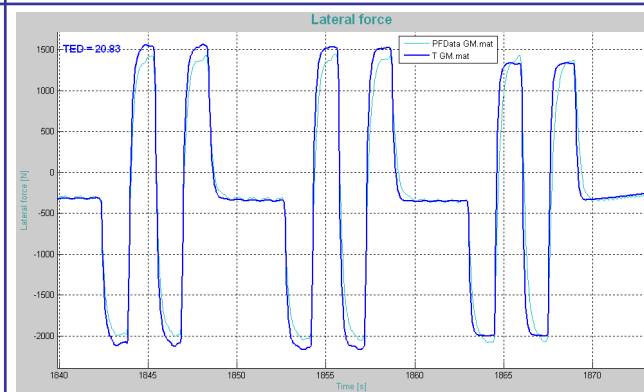
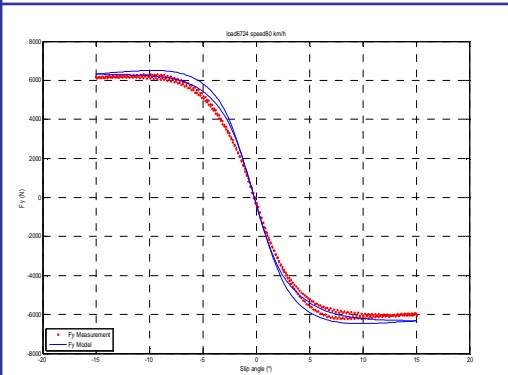
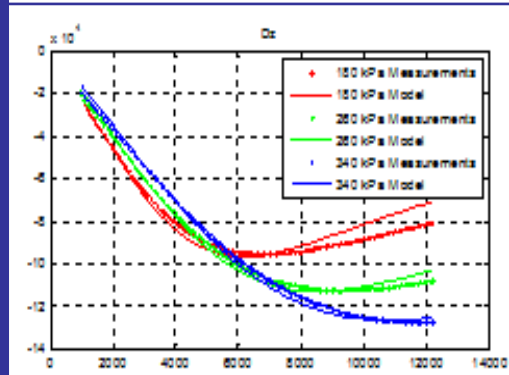
Fy @ 80kph & Z=6700N at intermediate temperatures



Transient @ 10kph at hot temperatures



@ NTRC



TameTire vs Michelin's measurement == TameTire vs NTRC measurement !/!



Model validation

/// Pure tyre validation → successfully achieved

/// On vehicle validation vs simulation

- **Braking:**
 - No precise braking model at our disposal → braking with a trailer
- **Steady state:**
 - On vehicle testing vs total vehicle simulation on CarMaker



Braking tests with a trailer

- Braking tests performed on Michelin's test trailer on a 245 / 35 R 20 Pilot Alpin 4

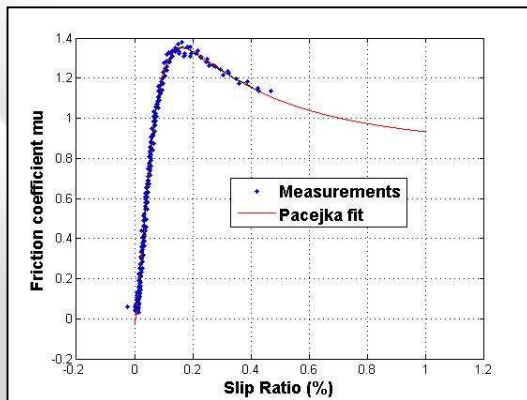
Trailer with hydraulic brake discs



Tyre being tested

- The braking force F_x is controlled until the desired maximum slip ratio (~50%) is reached

- To increase the clarity of the following graphs a Pacejka fit is performed on the experimental data

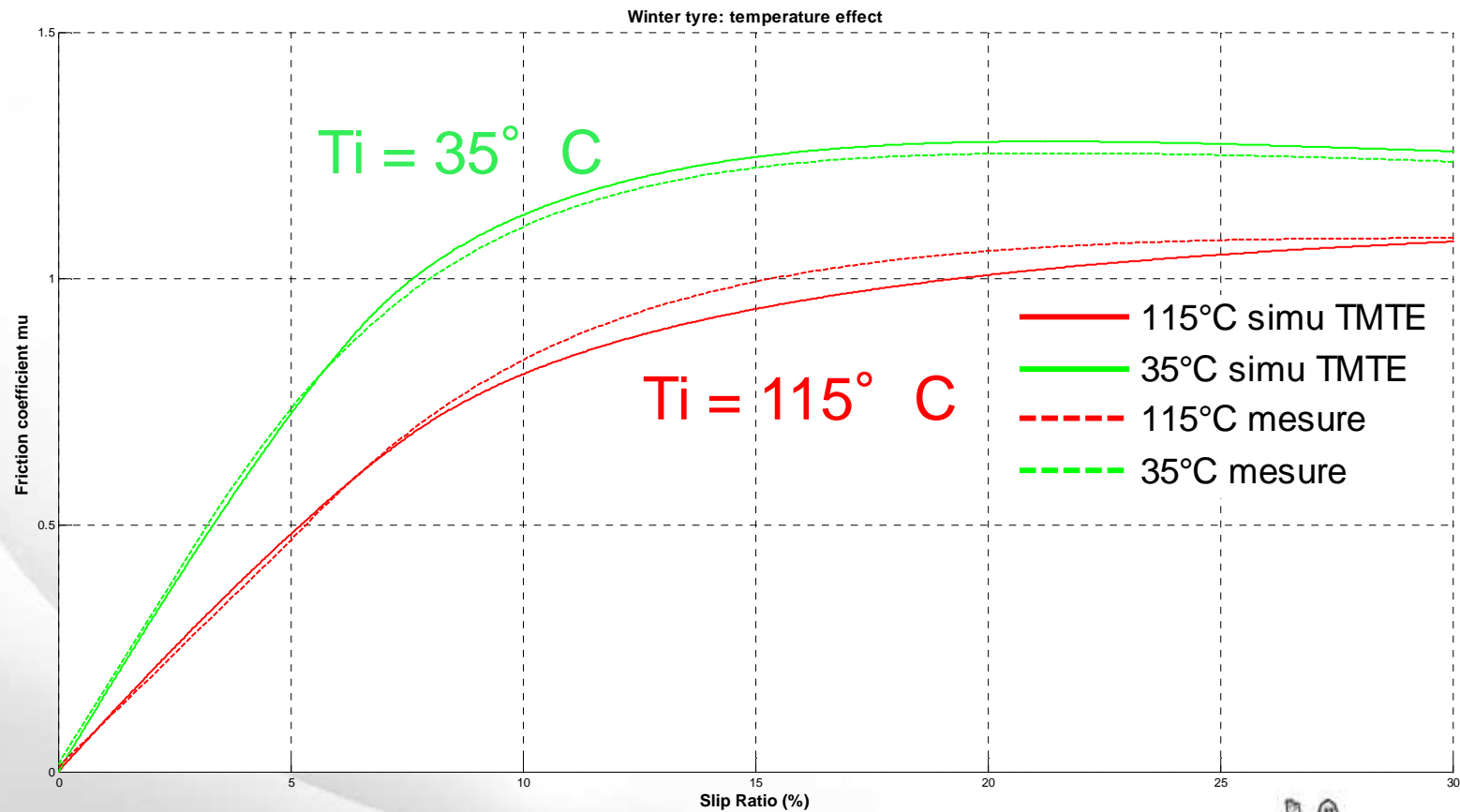


Test plan

Effect	Range
<i>Inflation pressure</i>	{1.5 ; 2.5 ; 3.5} bar
<i>Tread thickness</i>	{1.6 ; 8} mm
<i>Tyre temperature</i>	30 -> 125 ° C

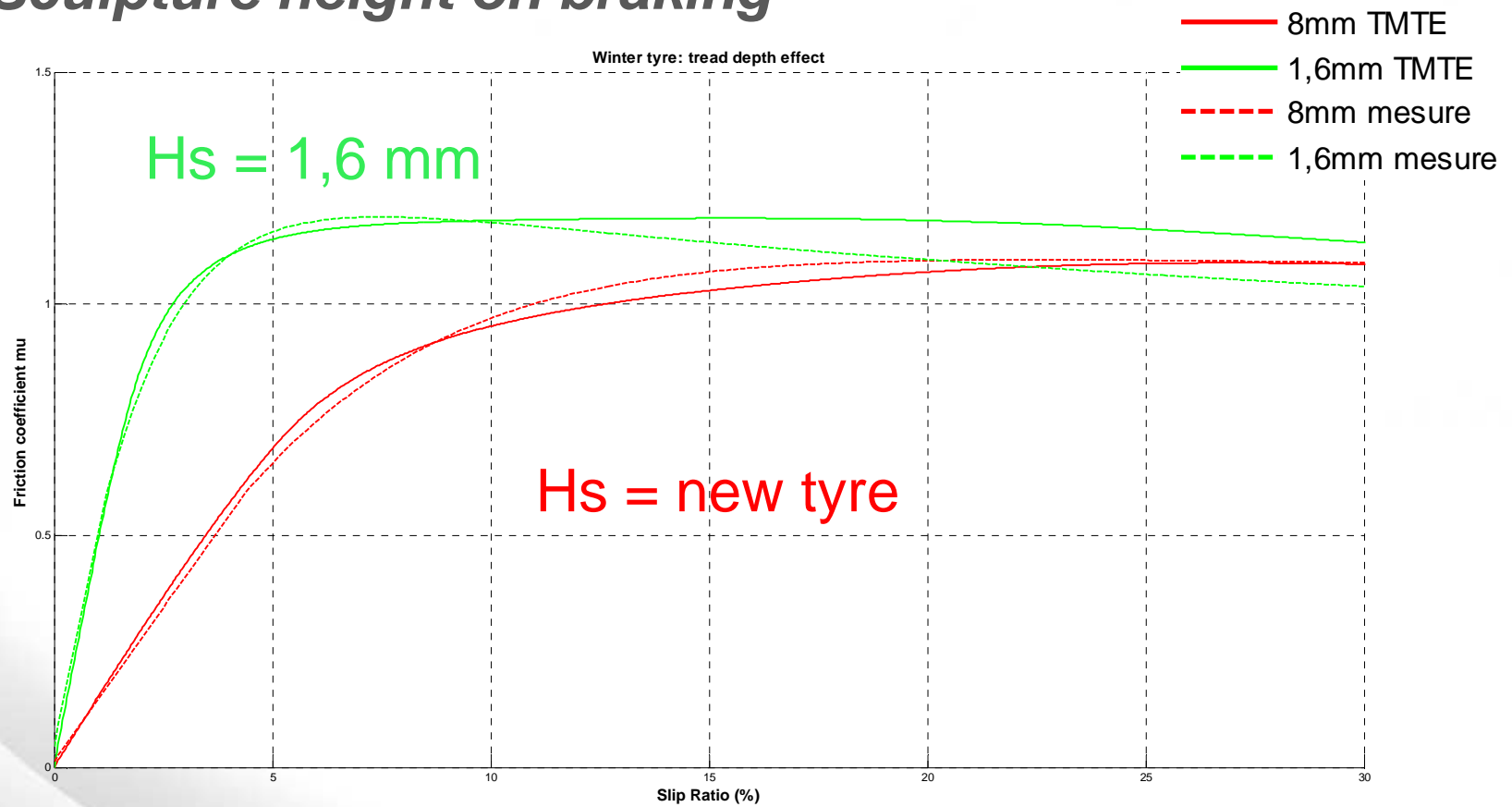
Braking with TameTire

Temperature effect on braking



Braking with TameTire

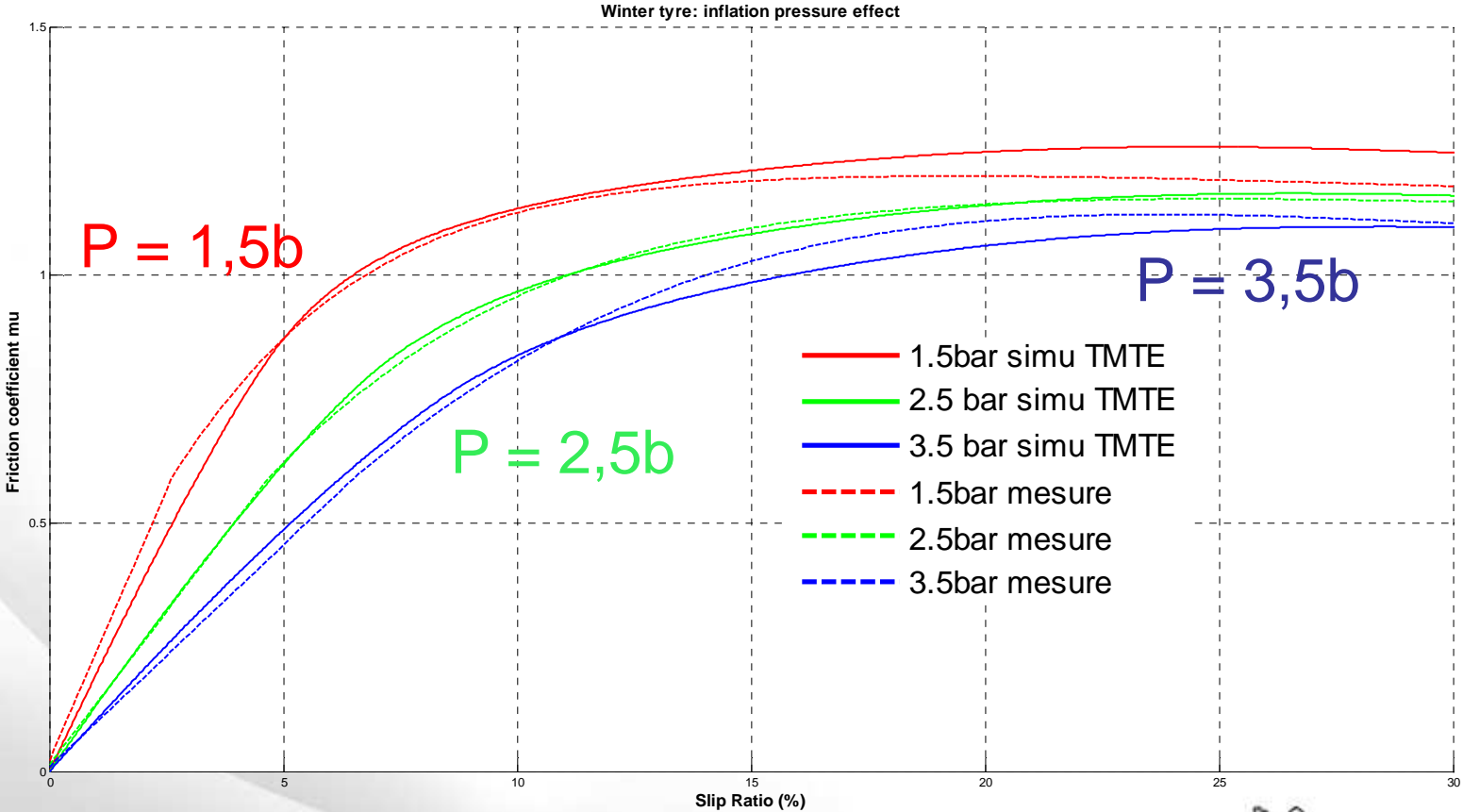
Sculpture height on braking





Braking with TameTire

Pressure effect on braking

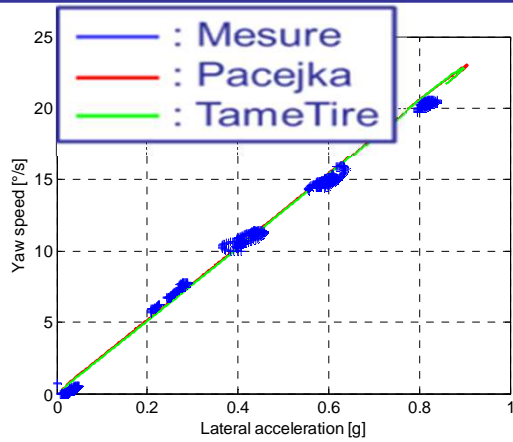


On vehicle results versus TameTire simulations on CarMaker

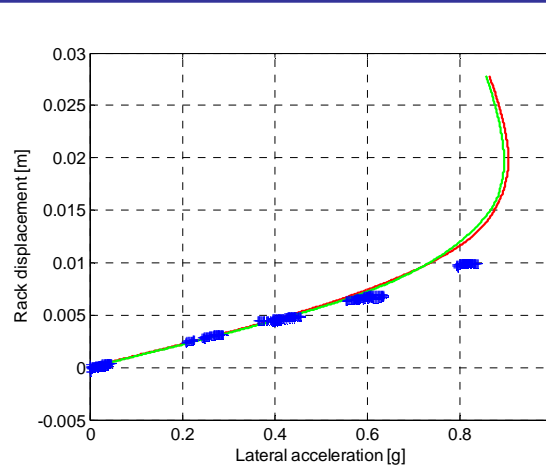
Speed : 80 kph (Steady State)

ContiSportContact

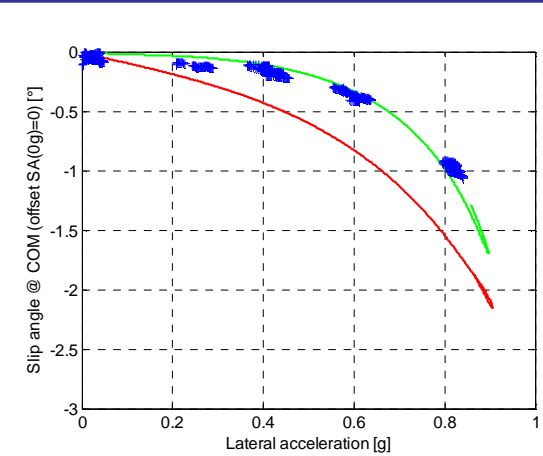
Yaw speed [°/s]



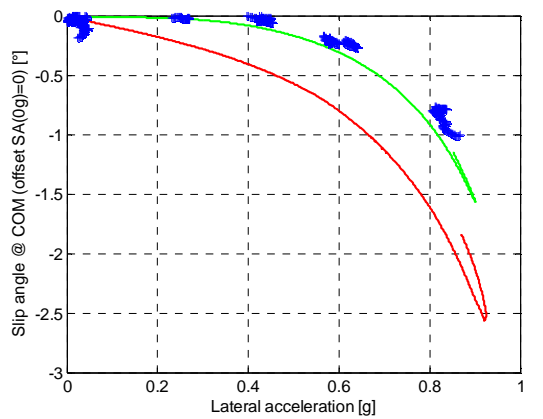
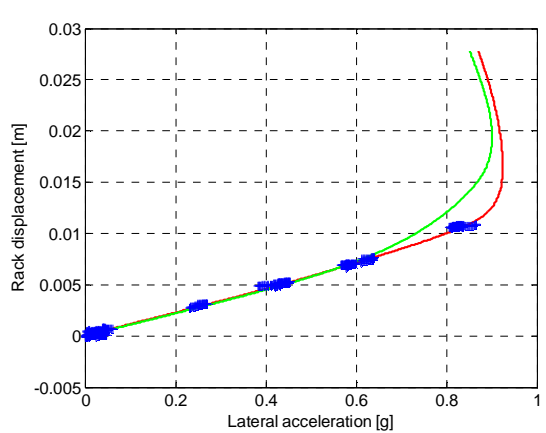
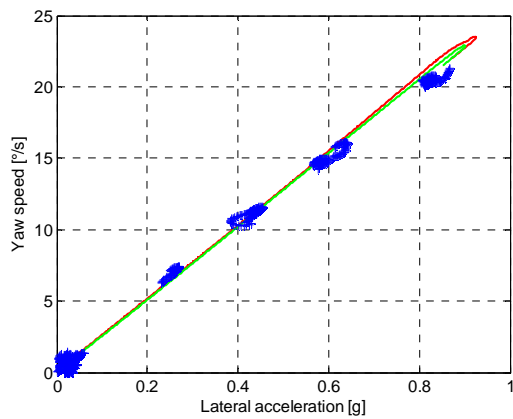
Rack displacement [mm]



Slip angle @ CDG [°]



Primacy 3

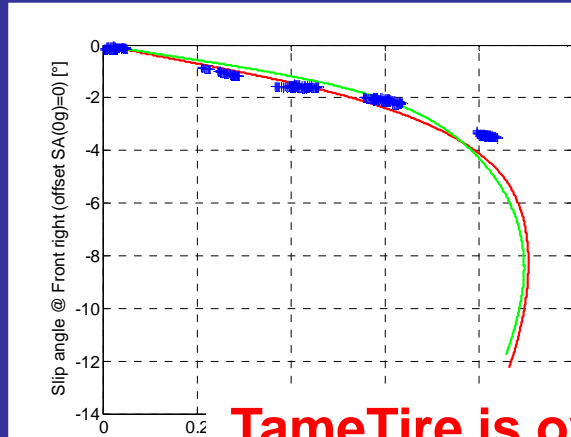


On vehicle results versus TameTire simulations on CarMaker

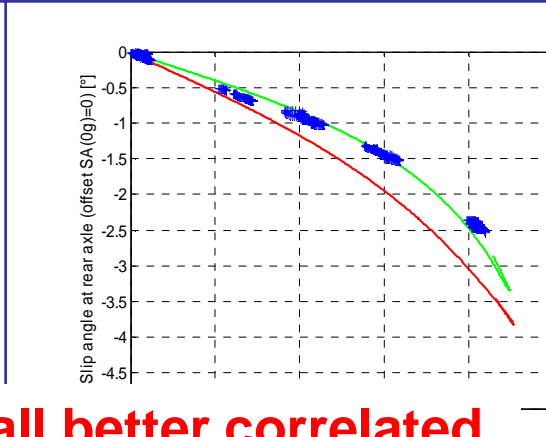
Speed : 80 kph (Steady State)

ContiSportContact

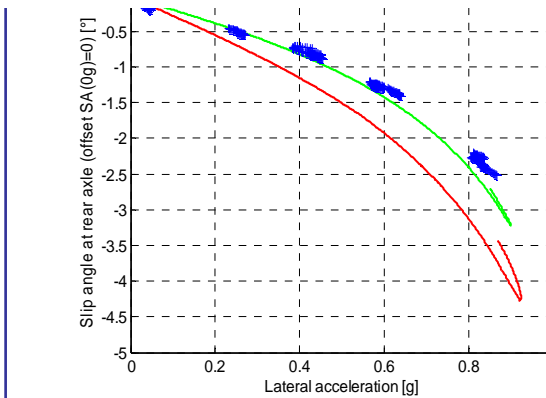
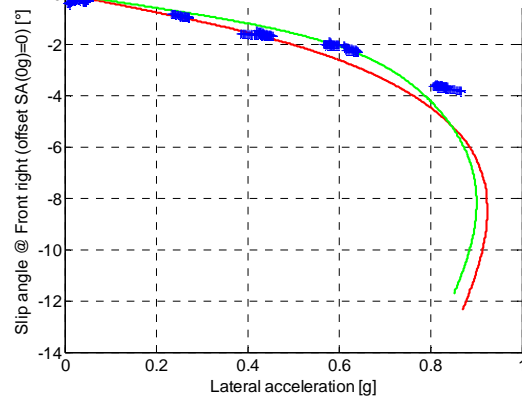
Slip angle @ Front Right [°]



Slip angle @ Rear axle [°]



Primacy 3



TameTire is overall better correlated to measurement than MF5.2

- : Mesure
- : Pacejka
- : TameTire





TameTire 3.0 : novelties



TameTire 3.0 : a faster version

/// TameTire 3.0 has been successfully integrated into CarMaker 4.5

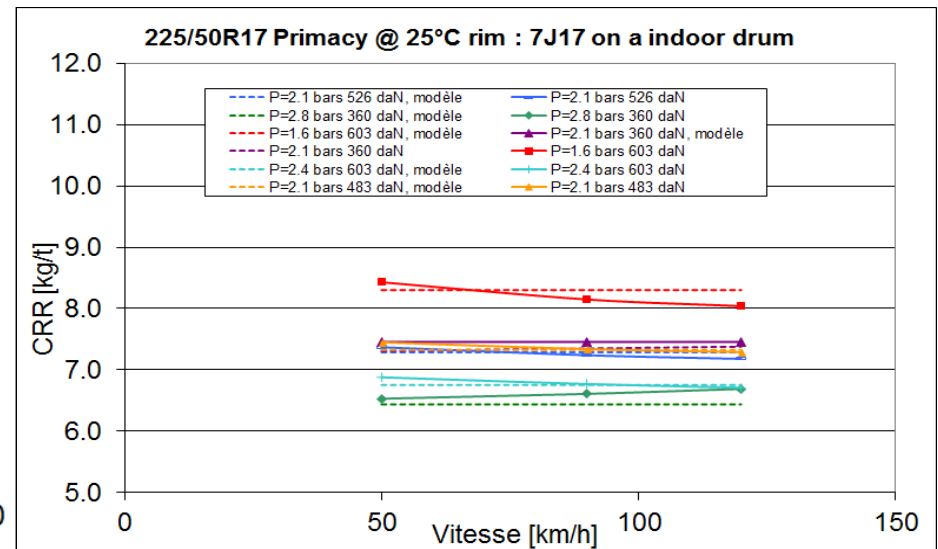
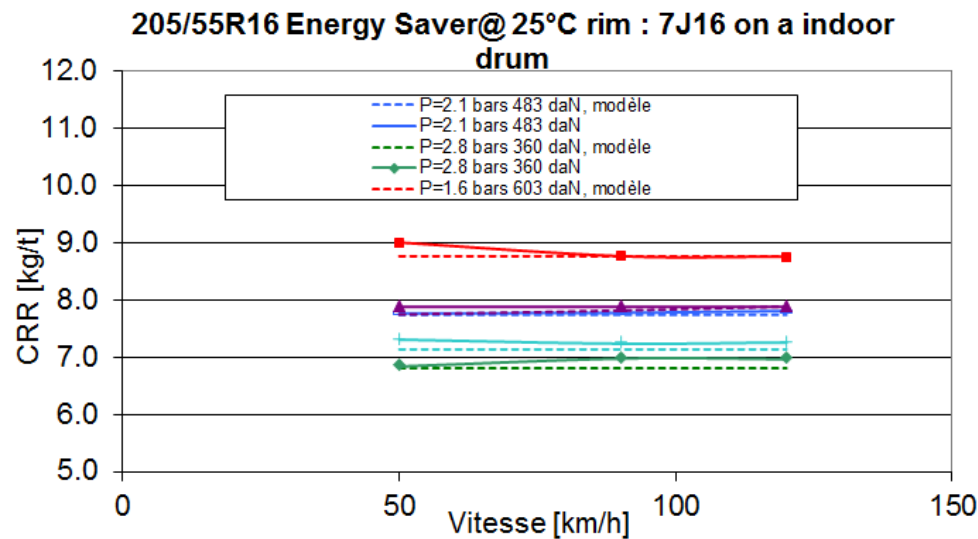
/// TameTire 3.0 is ~ 30% faster than TameTire 2.2



TameTire 3.0 : an improved RR model

Integration of a new rolling resistance model based on the ISO 28580 indoor test

$$FRR = C_{RR,ref} \cdot Z \cdot \left(\frac{P}{P_{ref}} \right)^\alpha \cdot \left(\frac{Z}{Z_{ref}} \right)^\beta$$



TameTire 3.0 : Increased database

Brand	Tyre Line	Size
Michelin	PSS	235/35 ZR19
Michelin	PSS	295/30 ZR19
Michelin	P. Sport 2	235/35 ZR19
Michelin	P. Sport 2	295/30 ZR19
Michelin	Lat. Tour HP	255/55 R18
Michelin	Lat. Sport	255/55 R18
Michelin	Lat. Alpin	255/55 R18
Michelin	Lat. Sport 3	255/55 R18

Brand	Tyre Line	Size
Michelin	P. Sport 3	225/45 R17
Michelin	P. Sport 2	225/45 R17
Michelin	P. HP	225/45 R17
BFGoodrich	G Grip*	225/45 R17
Michelin	Alpin 5	225/45 R17
Michelin	P. Alpin	225/45 R17
Michelin	Primacy 3 ST (AS)	225/45 R17
Michelin	Primacy 3 (EU)	225/45 R17
Continental	Conti Sport Contact	225/45 R17
Bridgestone	Turanza ER300	225/45 R17
Bridgestone	Potenza S001	225/45 R17

Brand	Tyre Line	Size
Michelin	Primacy HP	205/55 R16
Michelin	Energy Saver	205/55 R16
Michelin	Energy Saver+	205/55 R16
Michelin	Primacy Alpin	205/55 R16
Michelin	Alpin 5	205/55 R16
BFGoodrich	G-grip*	205/55 R16
Michelin	E. Saver	195/65 R15
Michelin	E. Saver +	195/65 R15
Michelin	Alpin 3	195/65 R15
Michelin	Alpin 5	195/65 R15
Kleber	Dynaxer HP3	195/65 R15
Michelin	E. Saver	175/65 R14
Michelin	E. Saver +	175/65 R14

Increased/upgraded database with competitor tyres





Michelin's vision for TameTire



Michelin's vision for TameTire

Our answer for Tire Modeling: TameTire

- Employed **internally by Michelin** for Tire Development
 - For passenger cars and racing tires
- Used **outside Michelin**
 - Vehicle dynamics simulations
 - Virtual chassis design and set-up, virtual development loops
 - HIL and Driving simulators (driver in the loop)
- **Key advantages**
 - **Thermal & real time** abilities
 - Representing **real tire physics**
 - Competitive Tools for **TameTire model feeding** are available
 - **Virtual Scaling Factors**
 - **Real Tire characterization process is robust**
 - **Representative tire database available**



Michelin's vision for TameTire

/// *TameTire is opened towards our customers*

- **Our Strategy = being able to support a wide deployment**
- **Efficient Customer Support**
 - Powered by the IPG + Michelin partnership
- **Customer Oriented Model**
 - Integration of customer needs for future developments
 - Measurement process for tire characterization successfully tested on external machine (NTRC)

/// *Continuous Improvement & Progress Strategy*

- **A living model, periodically updated**
- **Merging multiple tire performances models**
 - XY-Forces and Torques, steady-state and transient
 - Rolling Resistance
 - TPMS (Rolling Radius, evtl. Eigenmodes in the future...)
- **New features added regularly** (e.g. v3.0 recently released)
- **Continuously enhanced performances**
 - precision, calculation time...





**Thank you
for your attention!**

