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/ SYSTEMS ENGINEERING

INNOVATIVE TIRE MODELING BRICKS FOR SIMULATION BASED CHASSIS DESIGN

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Agenda

- Chassis Development Process with Virtual V-Cycle
- The classical limits to the Use of Virtual Design
- An Innovative Modeling Process to overcome those limits
 - Let's combine Measurement and Simulation
 - The Simulation Tools
 - Application on a real Use Case
- Conclusion: Collaborative Approach and Next Steps



Chassis Development Process

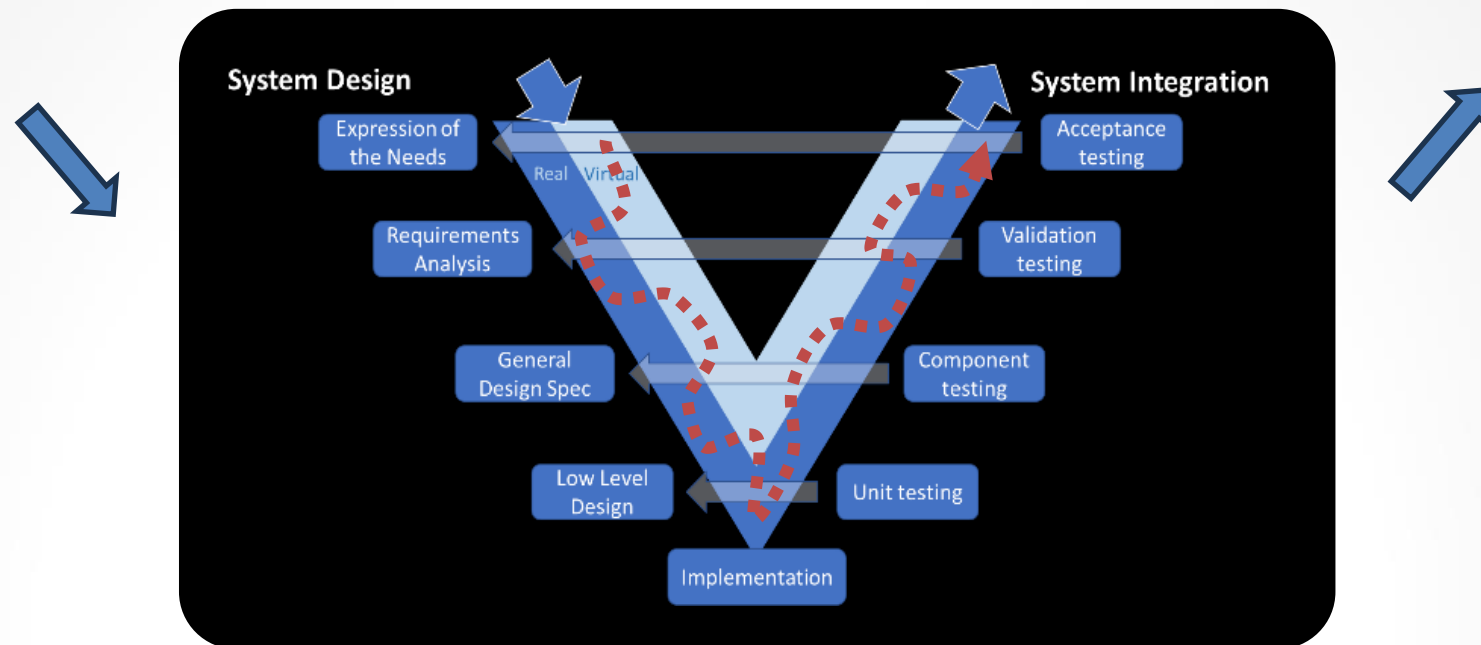
- V-Cycle is a powerful design process

Left Branch

- Start from the global targeted performance (vehicle level)
- Drill down into simpler subsystems
- Break down individual contribution and specifications for each single component

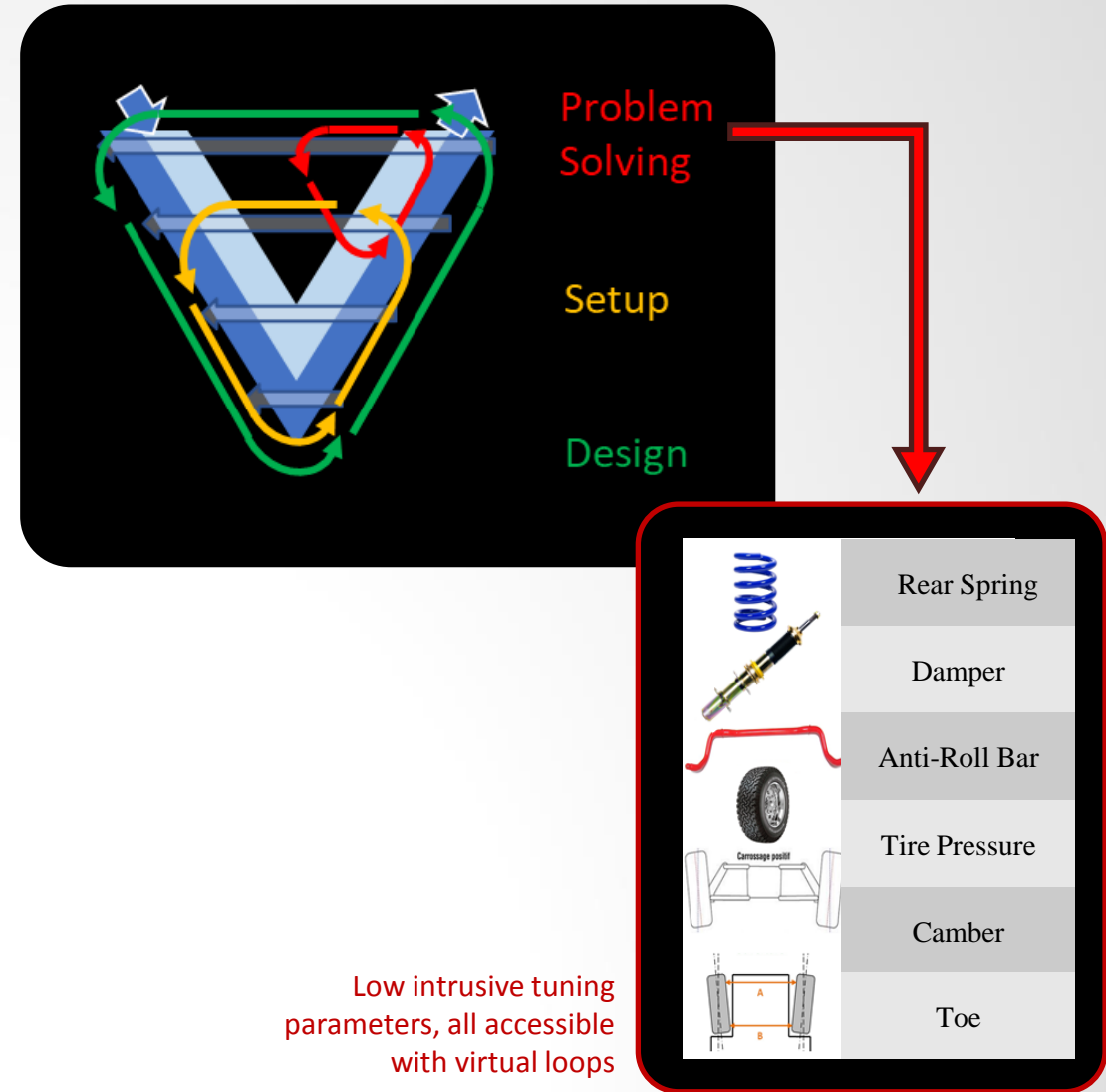
Right Branch

- Design and assemble Components, then Subsystem, then full vehicle Chassis
- Reloop on target achievement at each step



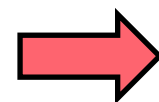
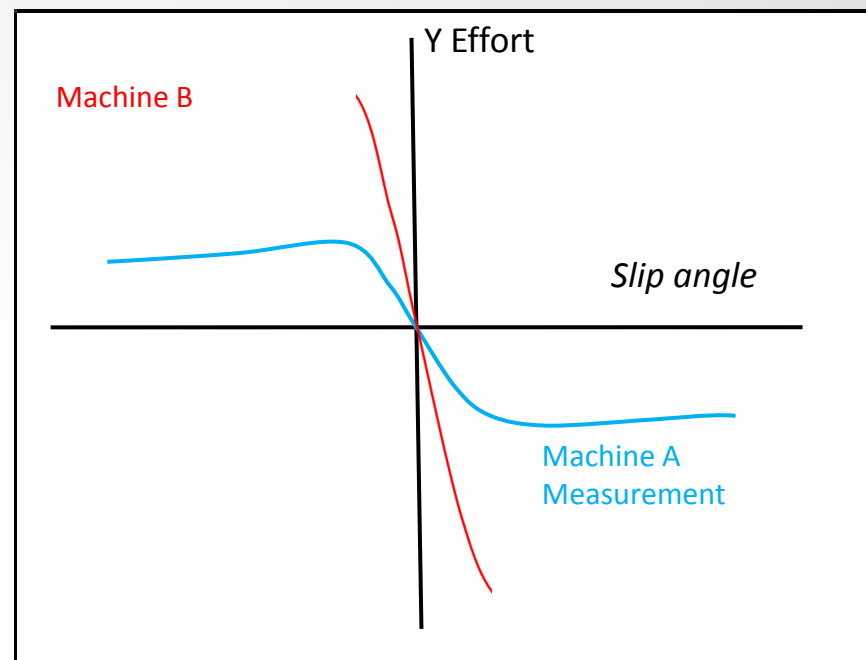
Chassis Development Process Optimization

- Combining Real Prototypes and Virtual Approach along the V-cycle allows to *maximize process efficiency*
- Higher target thanks to wider tested scope + reached faster
- For different stages of the development cycle
 - Derisking and problem solving at final stages, based on low-intrusive design levers
 - Or global design with less and faster loops
- But there are *some usual limits for this virtual approach...*
... such as Accessibility of tire models



Classical Limits of Virtual Development Process

- Representative Digital Twins for Components are needed
- For Complex components, *measurement is usually required* to create the digital Twin
- Tire is a complex component
- Measurement *test benches have limits*
e.g., for large tires, at high load or slip angles, for various grip conditions, for soft soil...

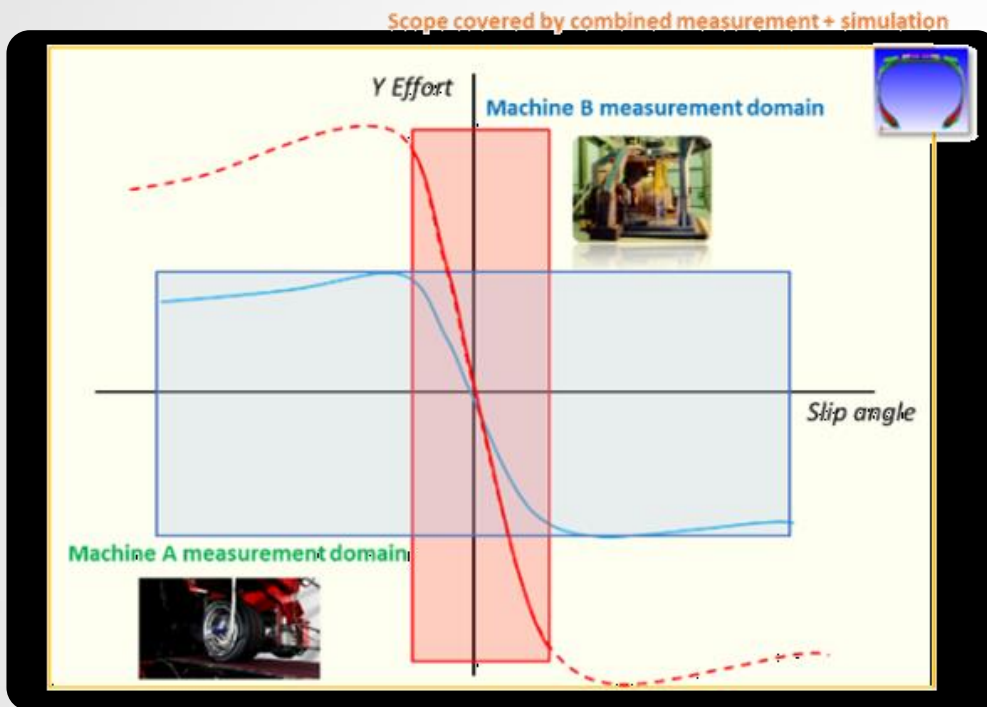
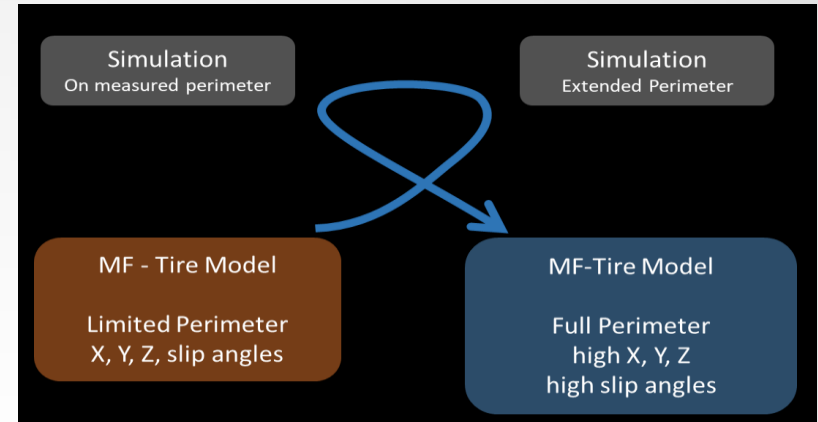


So What



Innovative Modeling Process

- Push the boundaries of measurement limitations for large tires
- *Combine Measurement* and *Simulation*



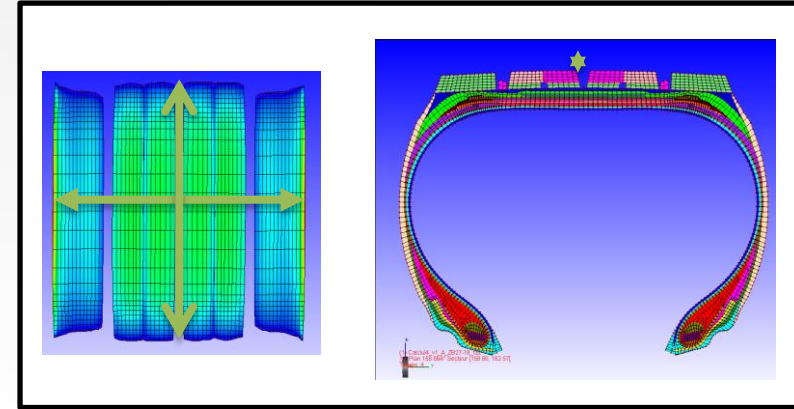
How?

- *Physics based* simulation
- Parameters calibrated on a known and measurable perimeter
- Extrapolate above (physics laws validity domain)
- Generate *Virtual Measurements*
- Fit a tire model on mixed Real + Virtual Measurements Set



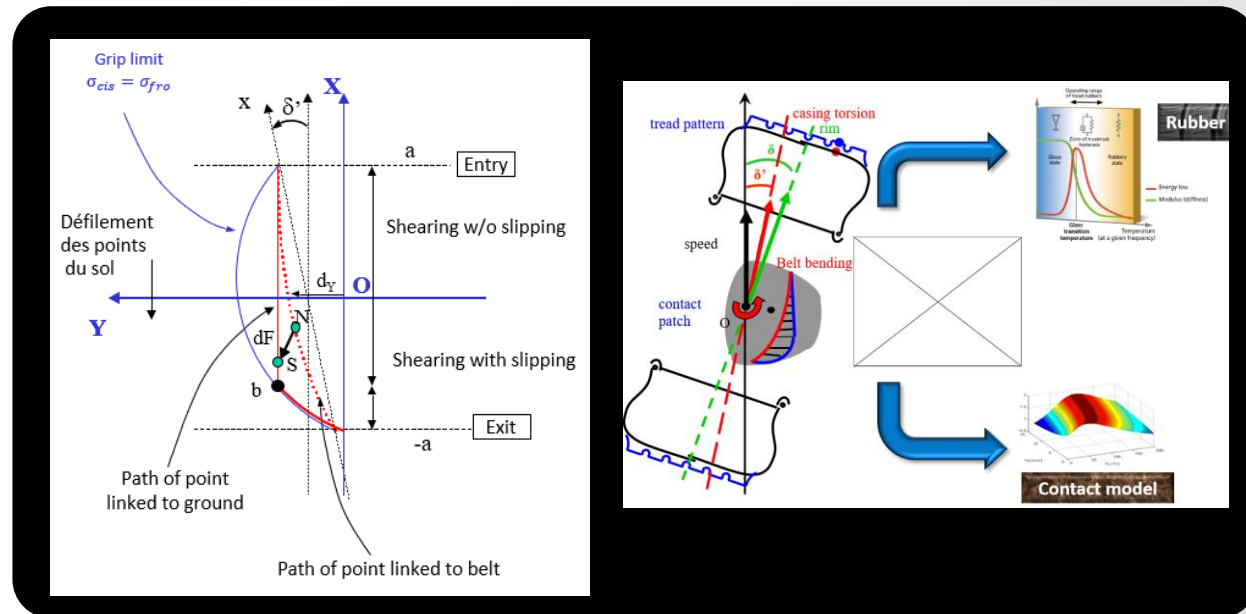
Innovative Modelization Process

- 2 Types of Simulations Tools may be used
 - Finite Elements Models (FEM)
 - Functional models



- Several Effects to be considered

- Ability to describe the internal structure of the tire is key
- Tire is a complex composite
- Rubbers are *non-linear thermal dependent* materials
- **Operating state** has a big influence on tire response (t° , stress, pressure...)



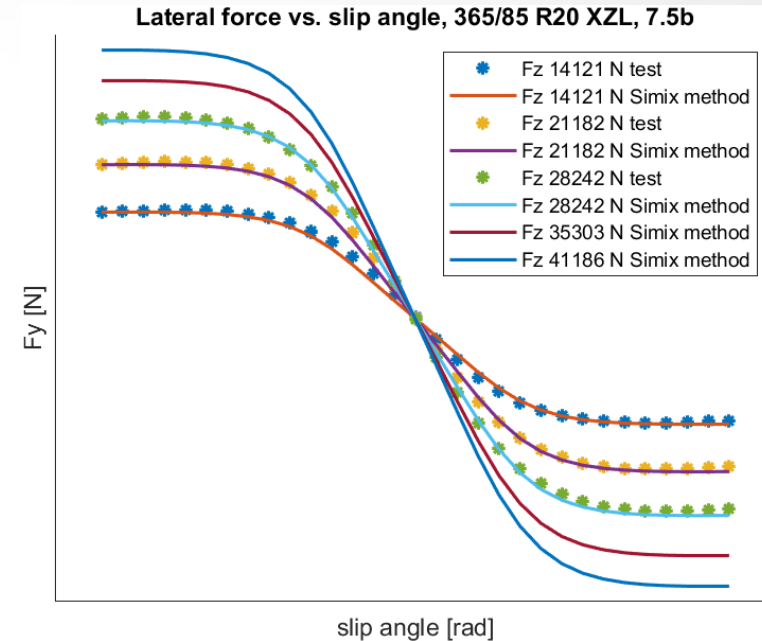
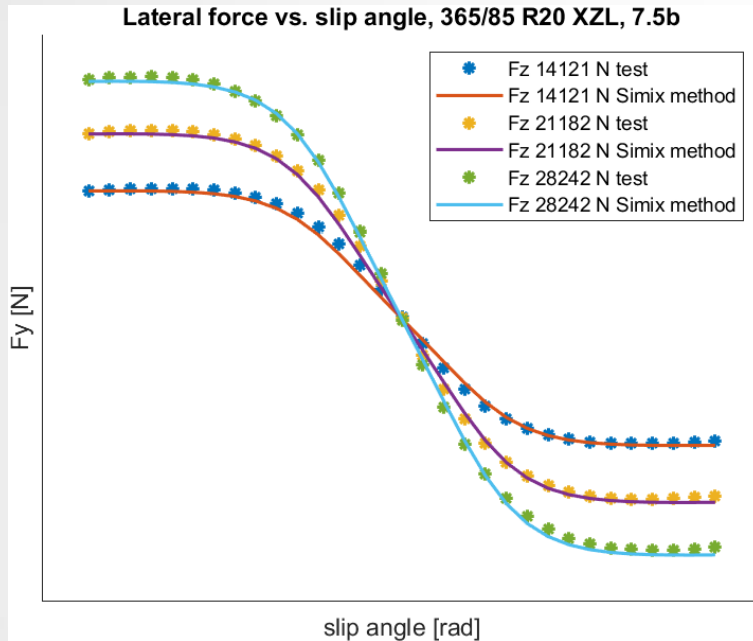
Innovative Modelization Process

Application on a real Use case

Simulation calibrated on a measurable
365/85R20 Michelin XZL Tire

Simulation Applied on an extended perimeter
(here higher loads)

+/-5% accuracy is reached



Conclusion

- The need of a *collaborative approach*, with partner labs
 - Simulation is not opposed but complementary to measurement
 - Qualitative Measurement is needed
 - Simulation extends the perimeter of what can be reached
- A platform dedicated to datasets
<https://chassis-simulation-datasets.michelin.com/>

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- Next Steps
 - Tire models for various operating conditions, *wet, soft soil (mud, sand ...)*



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Thanks for Your Attention

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