EMR'22
HES-SO Sion
June 2022

EMR'22 Summer School
"Energetic Macroscopic Representation"

"From Design to HiL testing using EMR"

Dr. Abdoulaye PAM, Florian TOURNEZ, Dr. Anatole DESREVEAUX,
Prof. Alain BOUSCAYROL
ViSys, L2EP – University of Lille, France

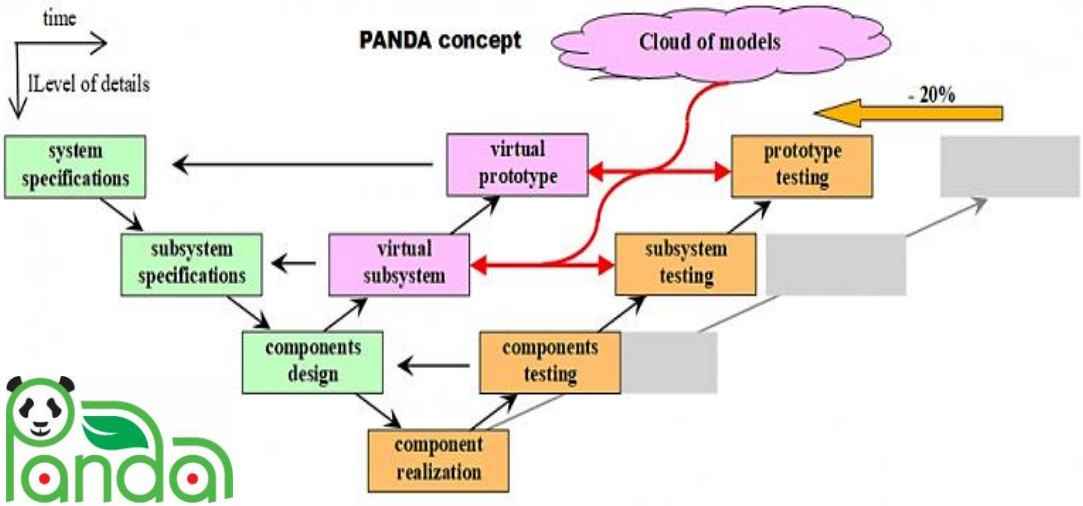
ViSys
RELIABLE VIRTUAL PROTOTYPES

Université de Lille

L2EP
Laboratoire d'électrotechnique et d'électronique de puissance de Lille

- About ViSys -

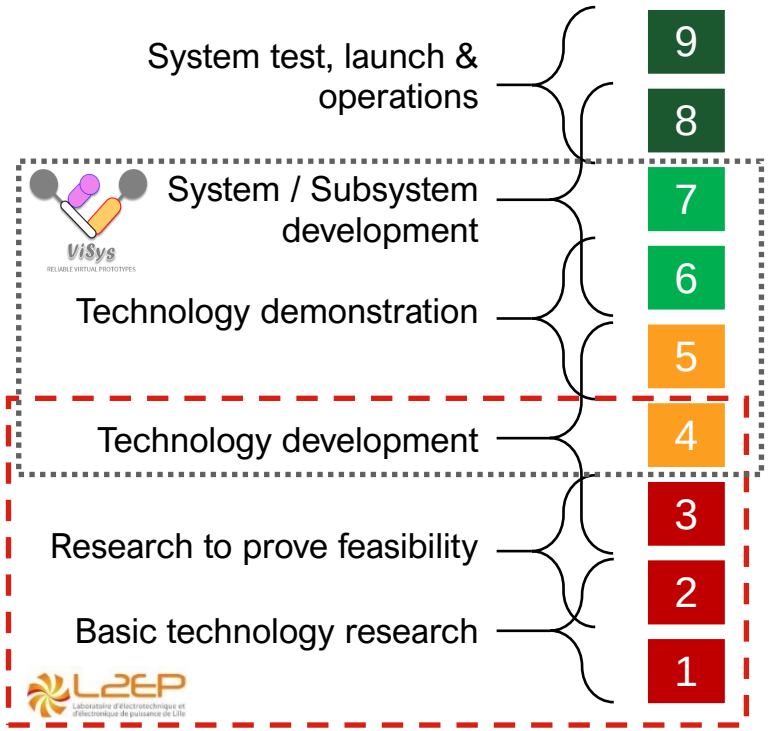
- PANDA's methodology showed a reduction of the development time by **20%**
- However, the industry needs to adjust to the methodology



=> PANDA = W cycle + **EMR** + cloud of models

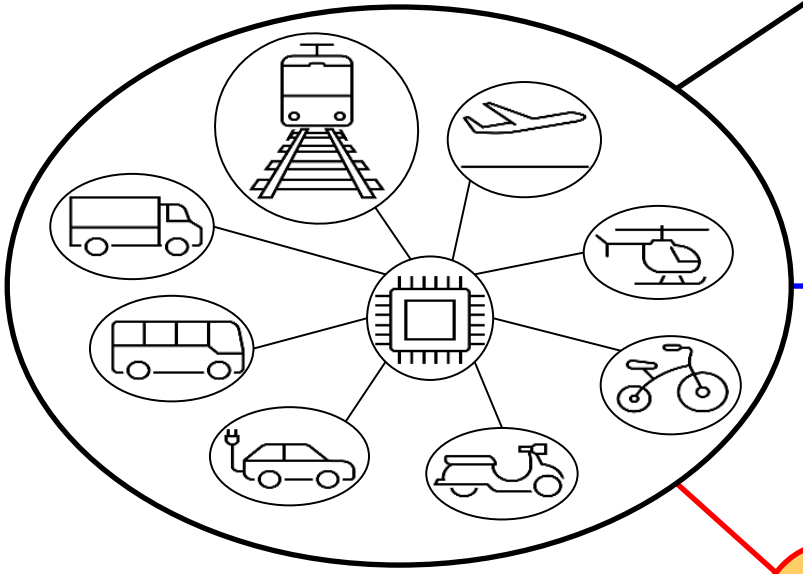
ViSys is an agile spin-off with a strong expertise in multi-level modeling, real-time control, energy management, and testing of components & subsystems of electrified vehicles (EV).

Relationship with L2EP (TRL)



- About ViSys -

A University of Lille sin-off



Sizing & Specification of EVs

- **Design models** coupled with **optimal energy management strategies**

Simulation of EVs

- **Virtual prototypes** with **real-time compatible** control algorithms

Hardware-in-the-Loop (HiL) testing

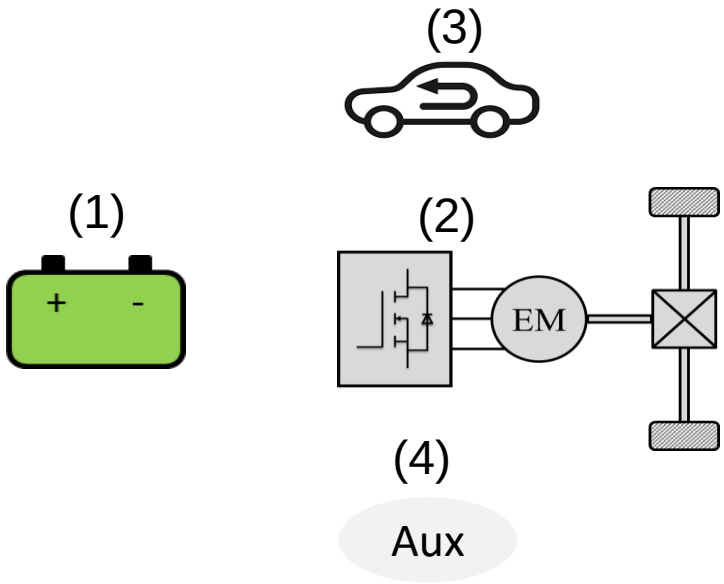
- Design and specification of **HiL test benches**
- **Multi-level experimental validation** for EVs

ViSys provides a unified method for control development & Hardware-in-the-Loop testing to reduce the time-to-market of new EV by producing reliable virtual prototypes.

- Study context and objective -

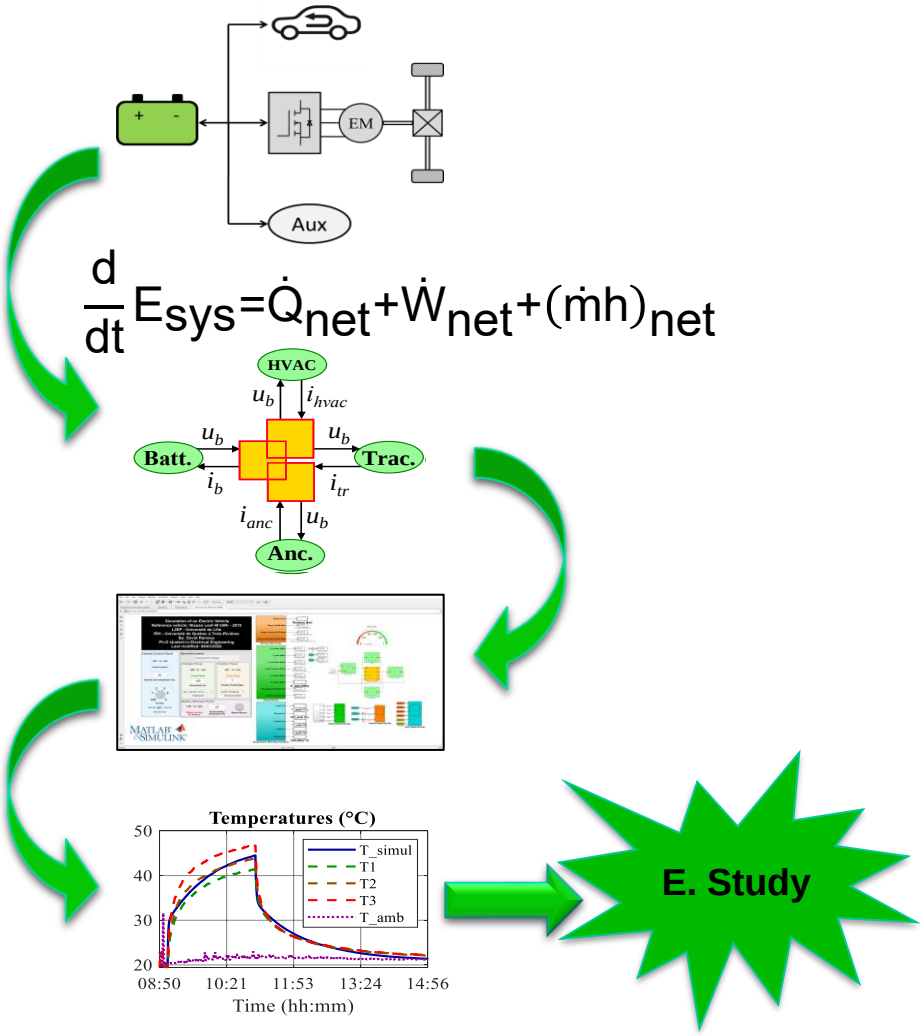
Main subsystems of an electric vehicle:

1. Battery pack
2. Traction subsystem
3. Thermal comfort subsystem
4. Rest of auxiliaries

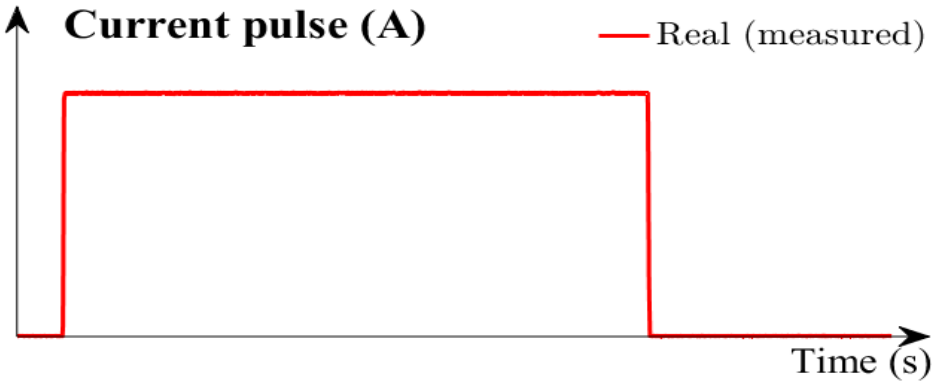


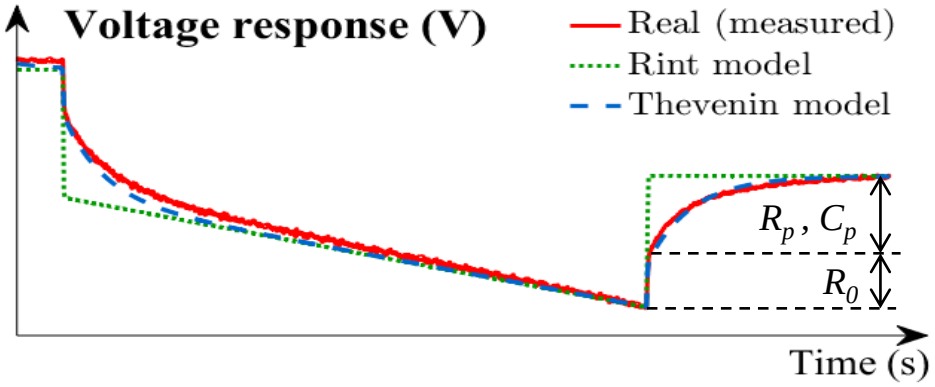
This study is focused on battery pack modelling.

Simulations for energy consumption:



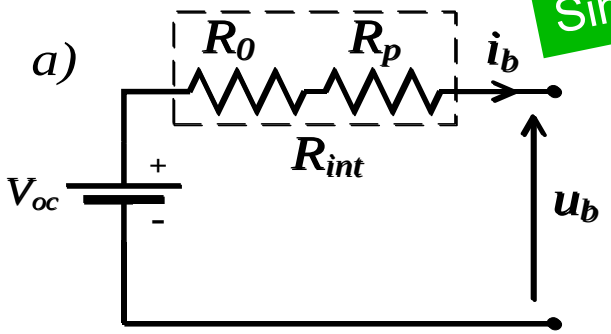
- **Battery voltage response to a current pulse**





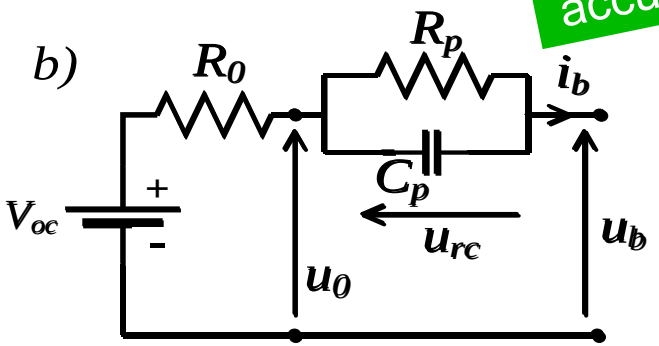
Internal resistance (Rint)

Simpler



Thevenin – 1 RC branch

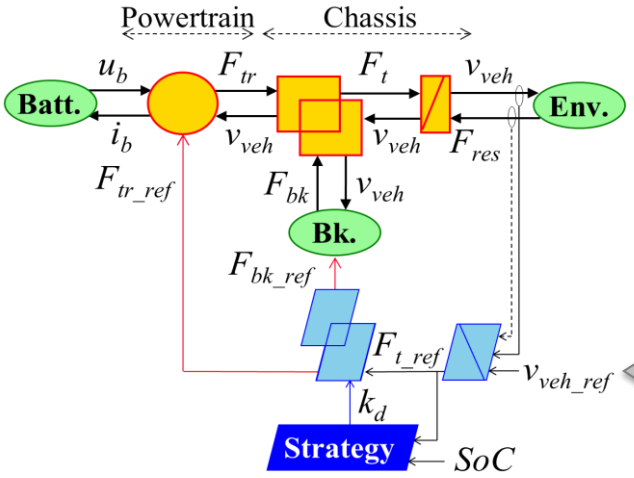
More accurate

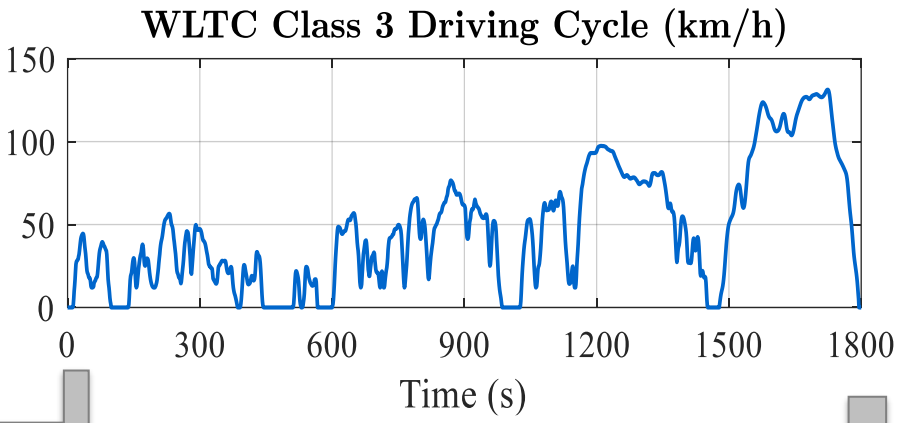


The objective of the study is to compare the accuracy of the Rint and the Thevenin models for energy consumption evaluation of electrified vehicles.

- The important question : is the **Rint model accurate enough for an energy consumption study ?**

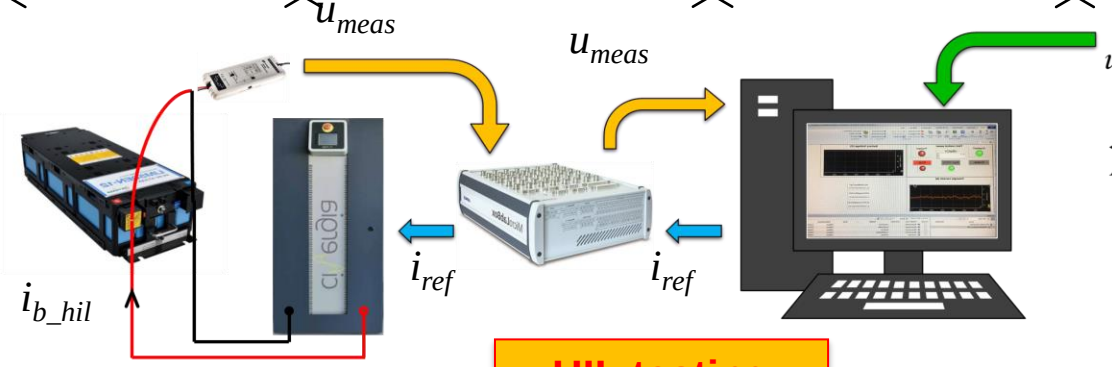
Off-line simulation



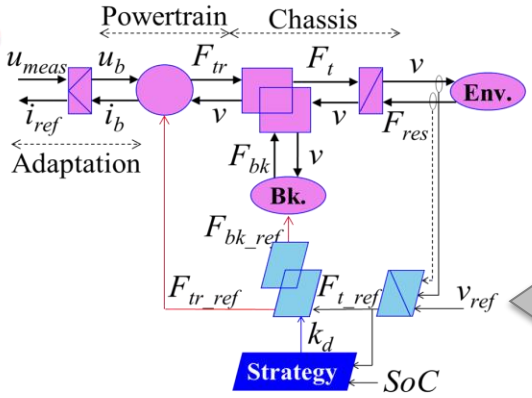


V_{ref}

Li-ion battery module | Interface + current source | Real-time simulation | BEV model



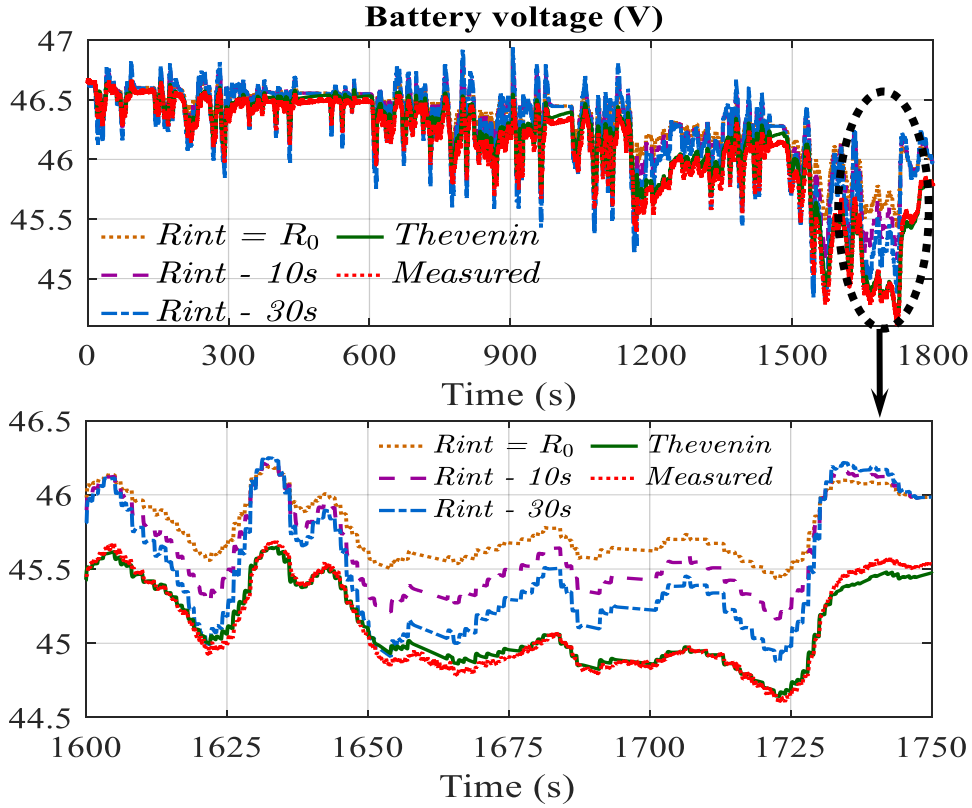
HIL testing

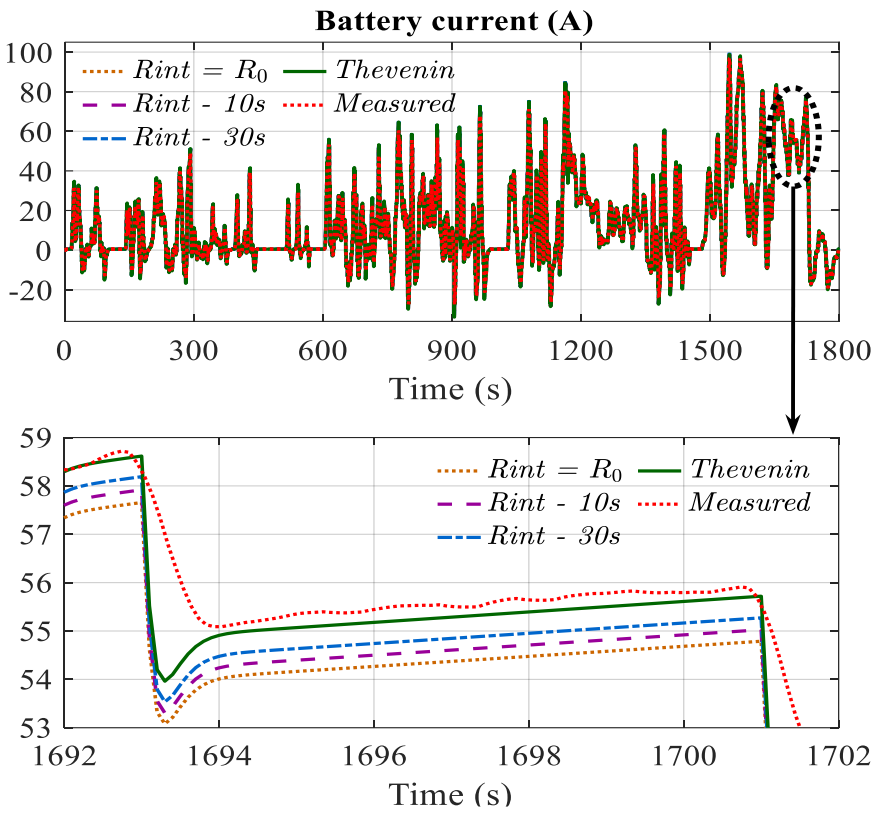


V_{ref}

From Design to HiL testing using EMR (*ViSys*)

- Comparison results -





	Mean absolute voltage error (V)	Total relative discharge error (%)
Rint = R_0	0.23	1.45
Rint–10s	0.19	1.10
Rint–30s	**0.16**	**0.75**

Both models are indeed adequate for studies on the energy consumption of electric vehicles.

- ViSys conclusions on using EMR -

CONCLUSIONS ON THIS WORK

- ✓ EMR is very helpful to go from organizing models to HiL testing
- ✓ HiL testing helped validate models and check their accuracy
- ✓ Same approach could be used to validate E-drives, etc.

EFFICIENCY OF OUR TOOLS BASED ON EMR

ViSys
RELIABLE VIRTUAL PROTOTYPES

- ✓ No need for co-simulation, systematic interconnexion of our models
- ✓ Systematic development of control structures thanks to EMR
- ✓ Smooth adaptation of simulation models for HiL testing
- ✓ Reliable simulations to help prevent, quicky identify, and solve problems

- ViSys, feel free to reach out to the leaders -

Dr. Abdoulaye PAM

PhD on HIL for HEV (ULille 2020)

R&I Engineer @ SNCF

Florian TOURNEZ

PhD on HIL for xEVs

(in progress)

Dr. Anatole DESREVEAUX

PhD on EV (ULille 2020)

Post-doc @ Univ. Paris-Saclay

Pr. Alain BOUSCAYROL

L2EP – University of Lille

Scientific Advisor

L2EP Laboratoire d'électrotechnique et d'électronique de puissance de Lille

Université de Lille

ViSys RELIABLE VIRTUAL PROTOTYPES

Feel free to reach out : contact@visys.fr