« Driver-In-the-Loop Applications for New Electrified Vehicles »

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1 Driver-in-the-Loop simulation (DiL)

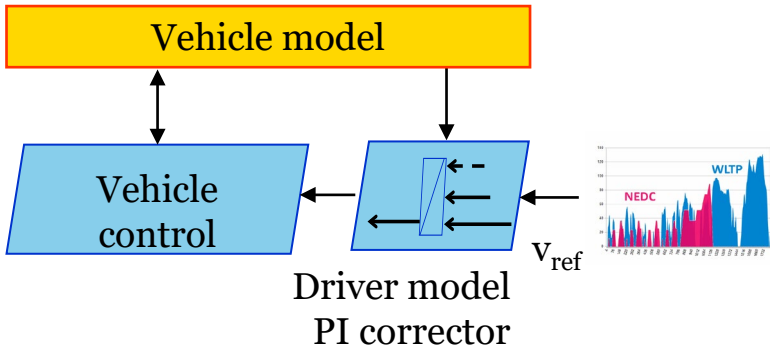
2 EMR and control of retrofitted P-HEV P0P4

3 P-HiL for battery testing including driver

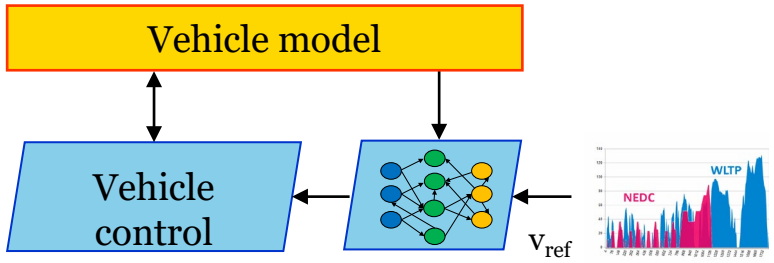
4 Conclusion & Perspective

« Driver-in-the-Loop simulation (DiL) »

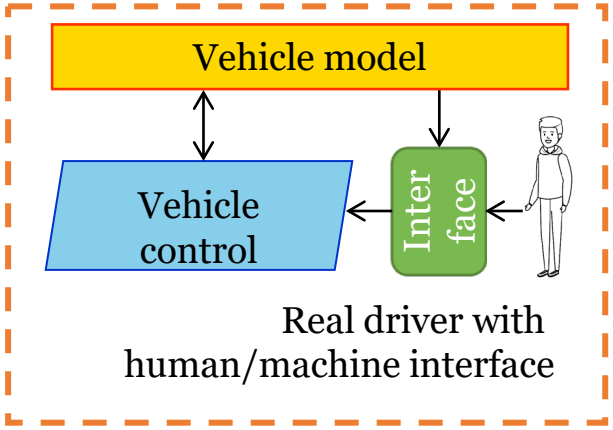
- Driver-in-the-Loop simulation (DiL) -



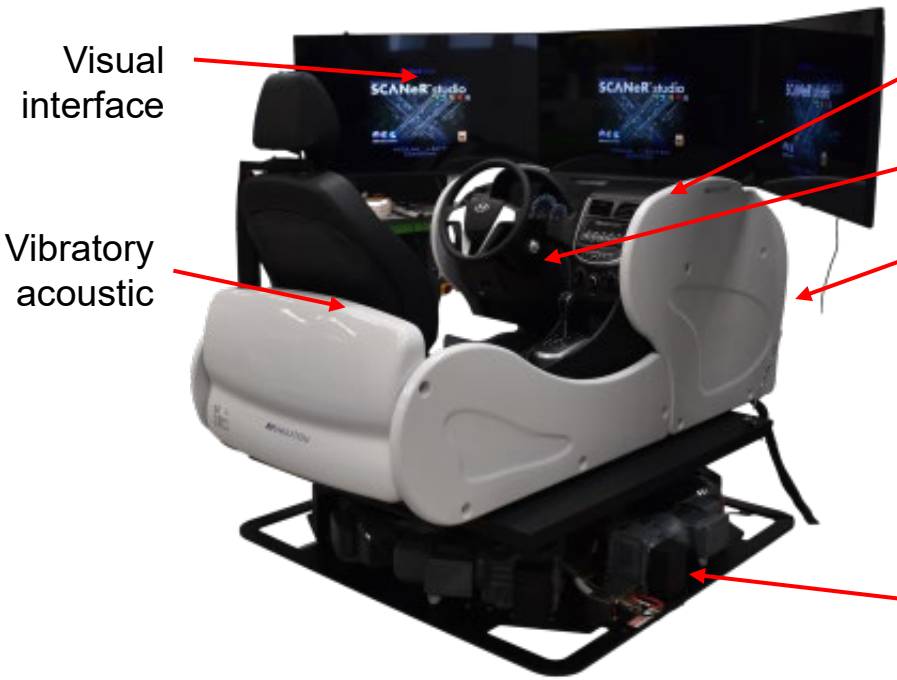
Driver model
PI corrector



Driver model
Complex method



Real driver with
human/machine interface



- **Vehicle model**
- **Set up scenario**
- **3D environnent**

Driver-In-the-Loop Applications for New electrified vehicles

- 3D environment key point based on SCANeR Software -

Simulator	Software	Engine	API	S/HiL	Co-sim
dSPACE Aurelion	Closed Source	Unreal	-	YES	-
rFpro	Closed Source	Proprietary	C++	YES	-
Morai Drive	Closed source	Unity	-	YES	-
Matlab Automotive driving Toolbox	Closed source	RadRunner Unreal	-	YES	YES
Cognata	Closed source	Unity	RESTful	YES	
SCANeR	Open Software	Unreal	Pythoon	YES	-

Limitations:

- **High Learning Curve**
- **Resource Intensive**
- **License Cost**
- **Interface bit complex**
- **3D environment**

Key Advantages:

- **Modular & Scalable**
- **Realistic Simulation** (unreal engine)
- **Integration Capabilities** (open software)
- **Compatible for HiL testing**

Silva, I., Silva, H., Botelho, F., & Pendão, C. (2024). Realistic 3D Simulators for Automotive: A Review of Main Applications and Features. Sensors, 24(18), 5880. https://doi.org/10.3390/s24185880

« EMR of retrofitted P-HEV P0P4 »

✓ Conventional vehicle converted to Plug-in Hybrid Electrical Vehicle

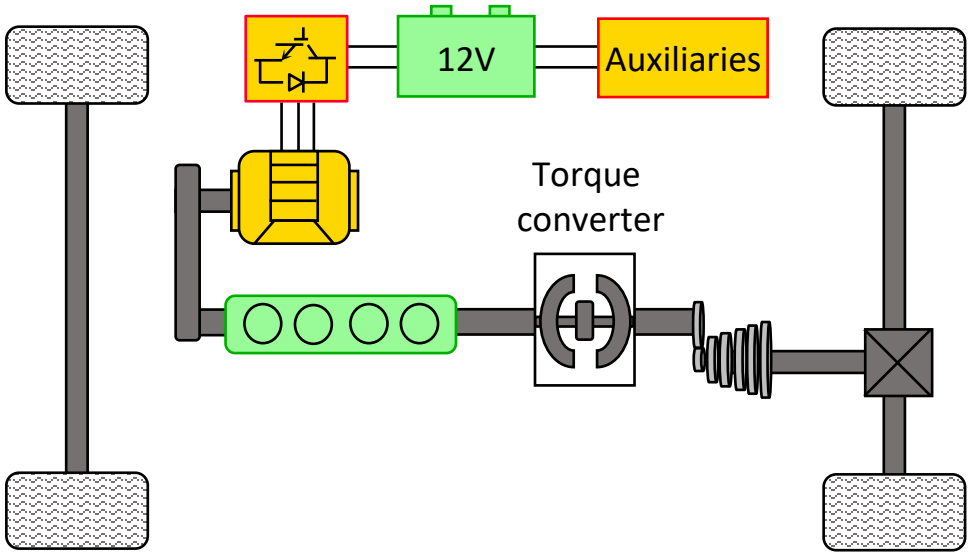


Figure: Vehicle structural scheme before retrofit

Conventional Thermal Vehicle

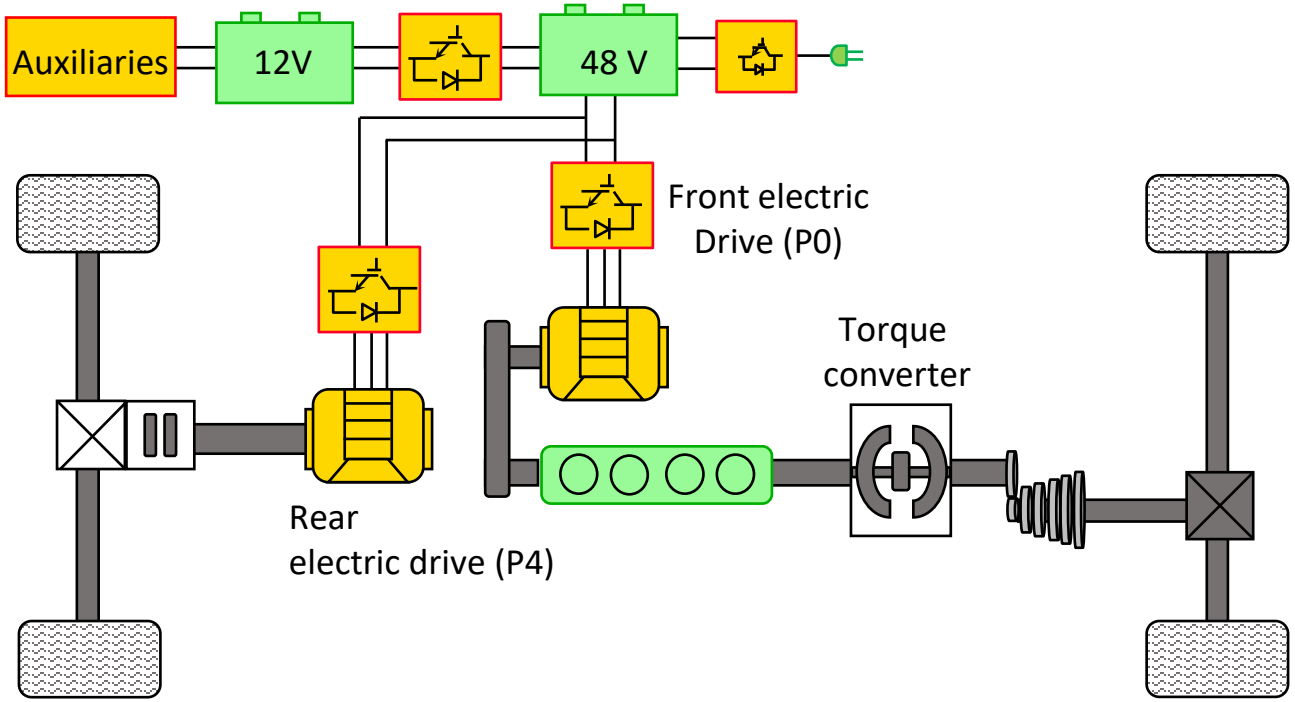
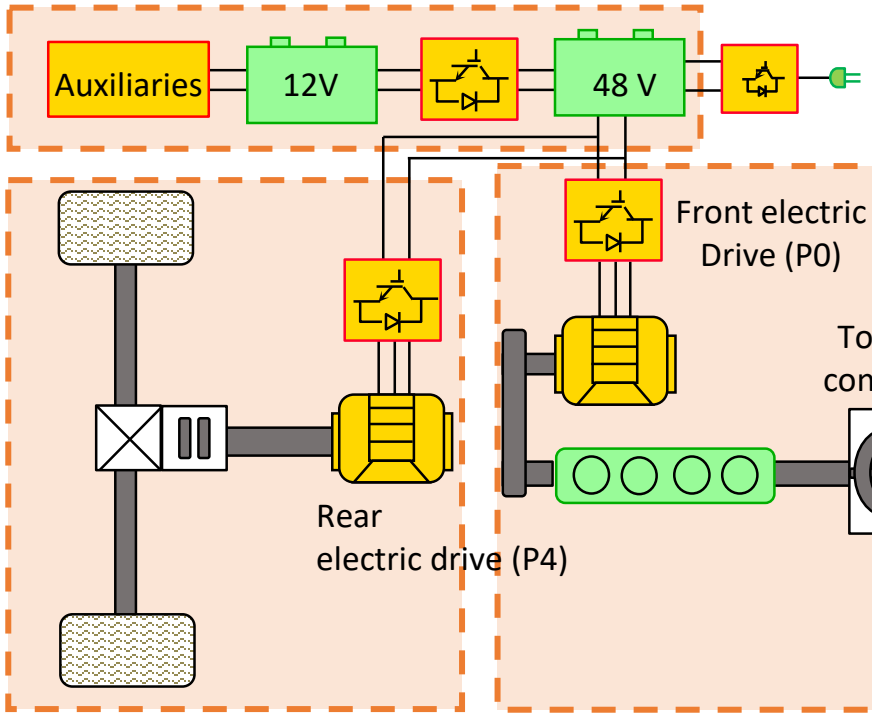


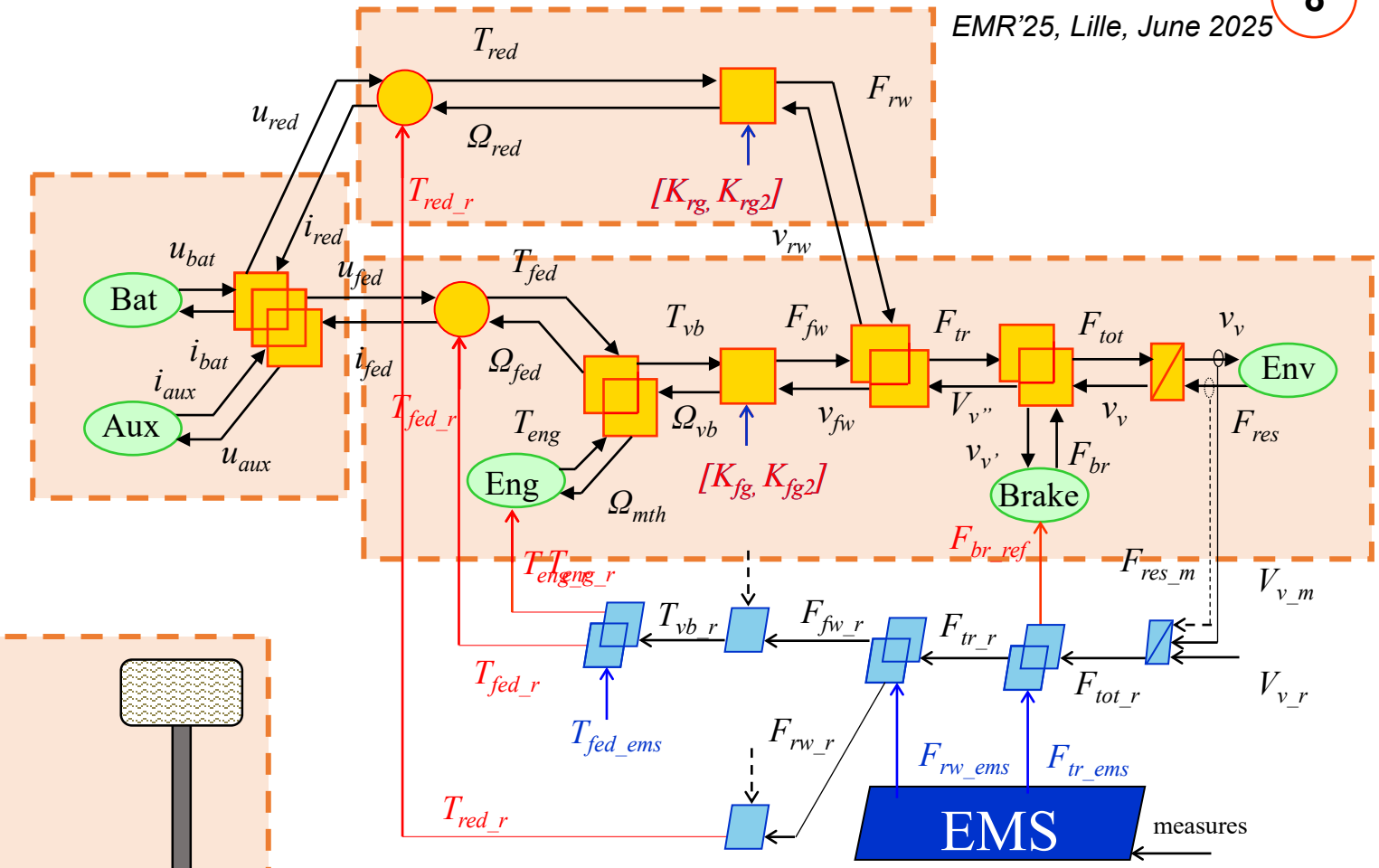
Figure: Vehicle structural schema after retrofit

Plug-in Hybrid Electrical Vehicle P0P4

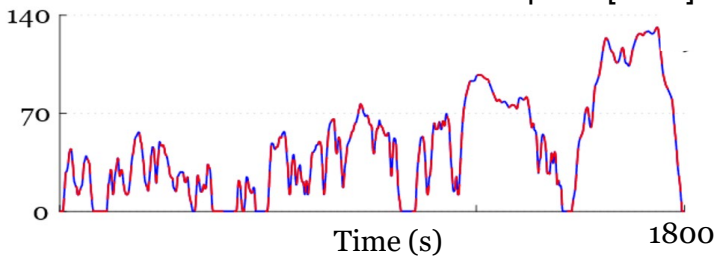
Simplifying assumptions

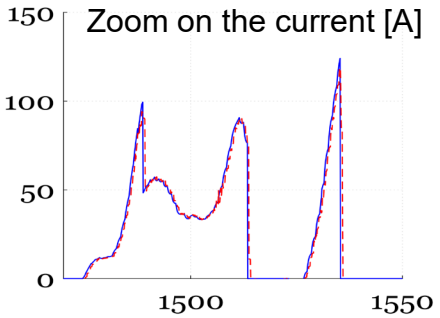
- ✓ Equivalent wheel model
- ✓ Shaft inertia neglected
- ✓ Discrete gearbox
- ✓ Onboard charger neglected

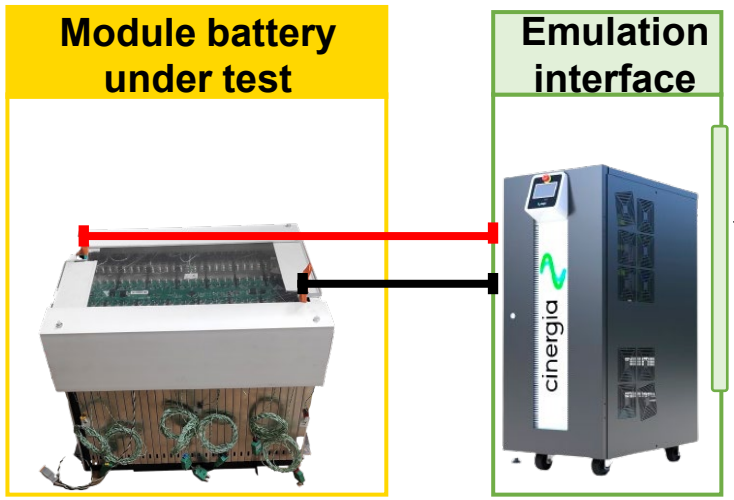




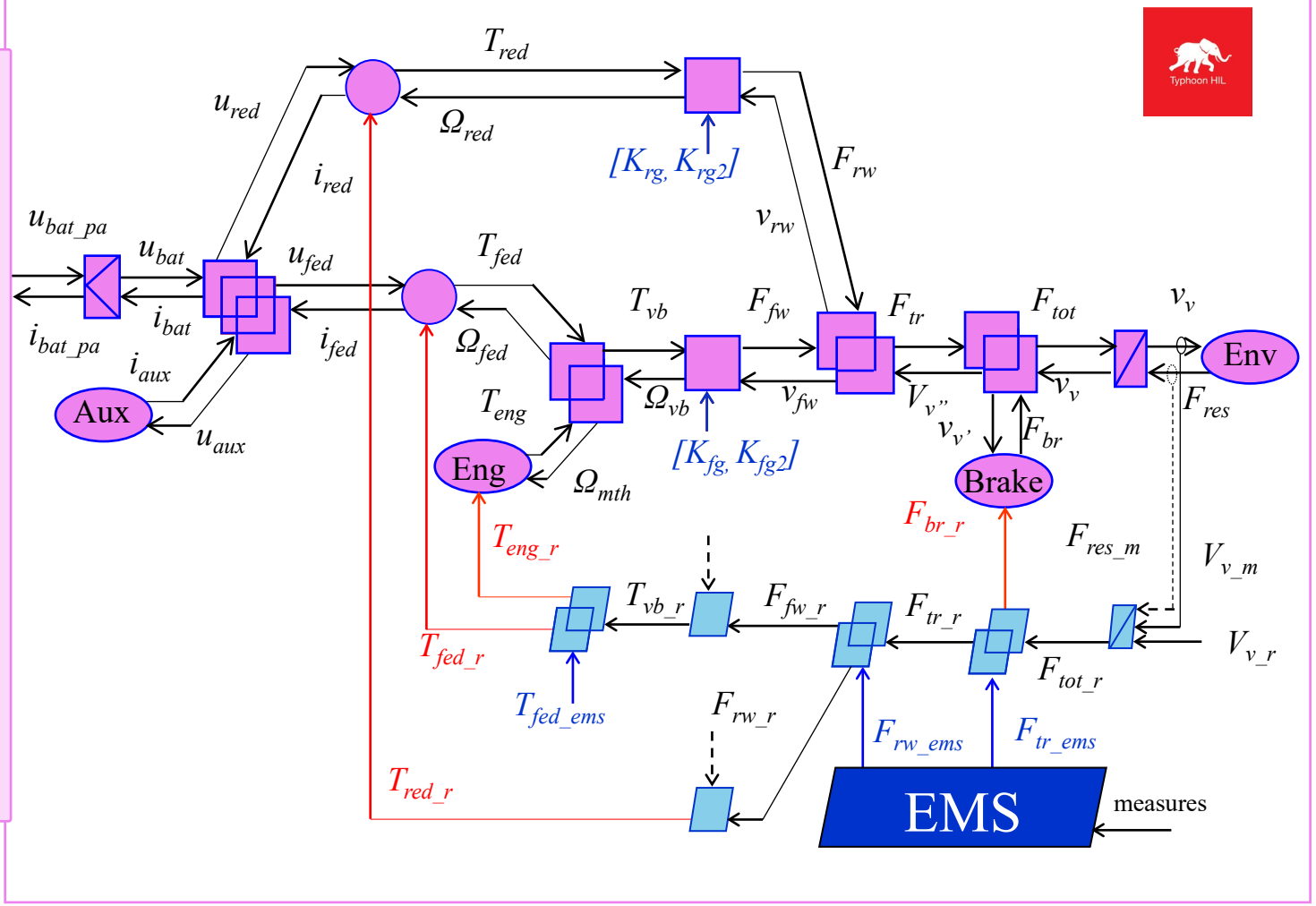
Reference and simulated vehicle speed [km/h]



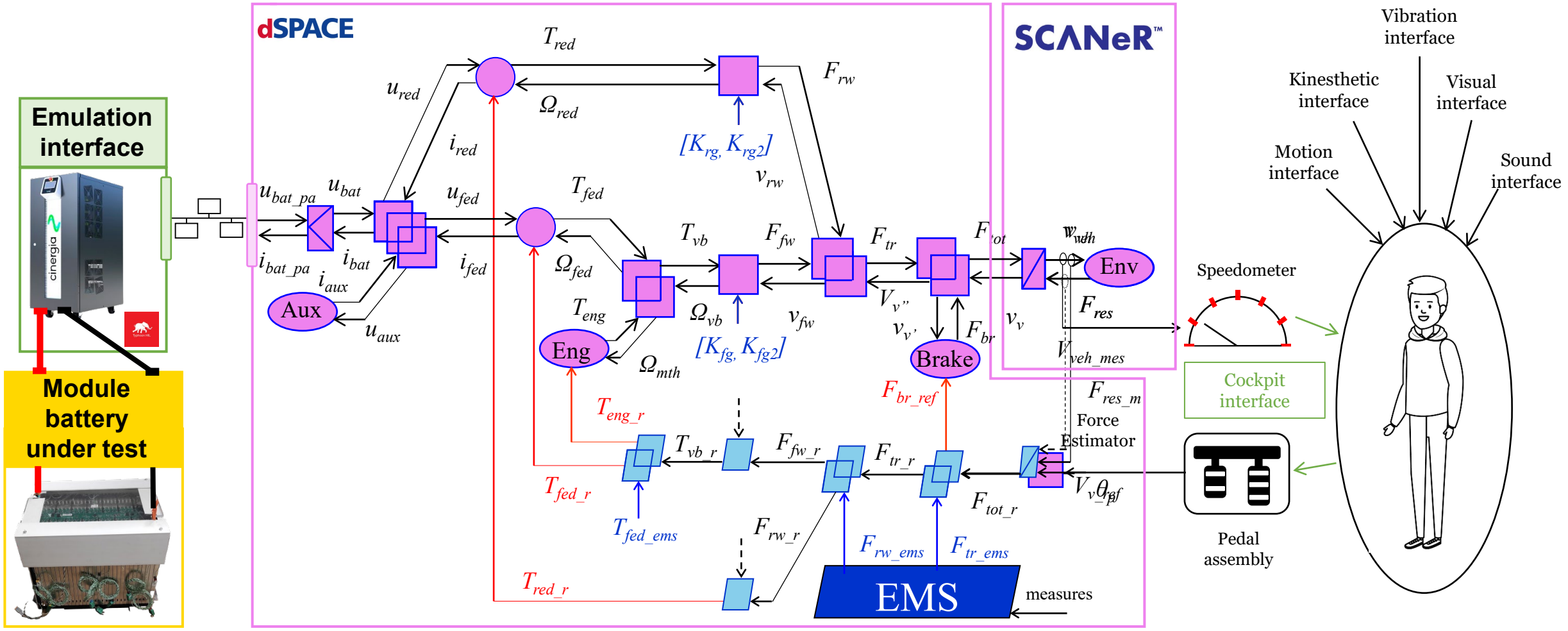




Real-time simulation (Typhoon HIL)



How introduce the driver through the cockpit interface?



Technical supervision platform

- 1 supervisor for battery testing through Typhoon HiL
- 1 supervisor for Scanerio and driving simulator management
- 1 supervisor for dSPACE management model

Real time platform

- Open at all platform trough Standard CAN communication
- Update with thermal chamber for battery testing

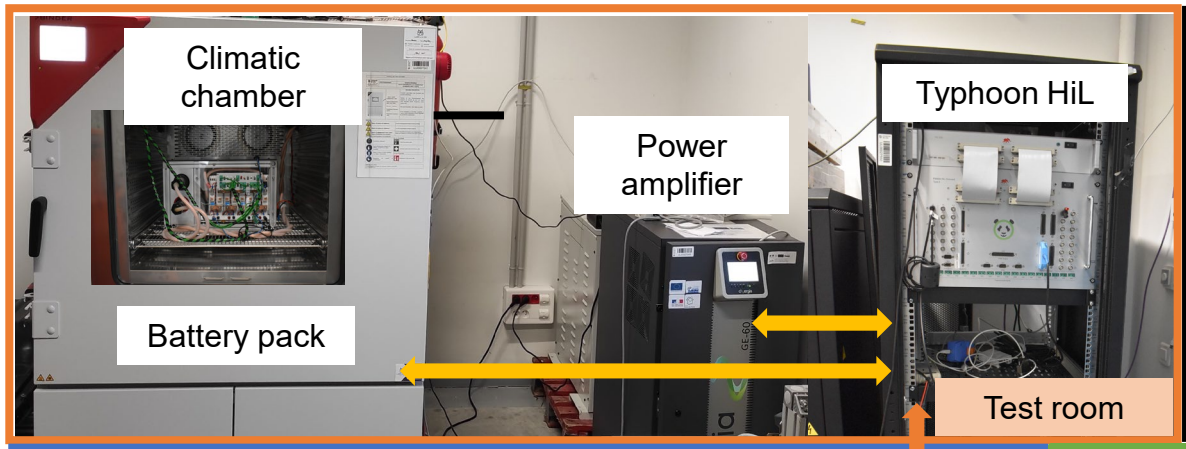
Typhoon HIL

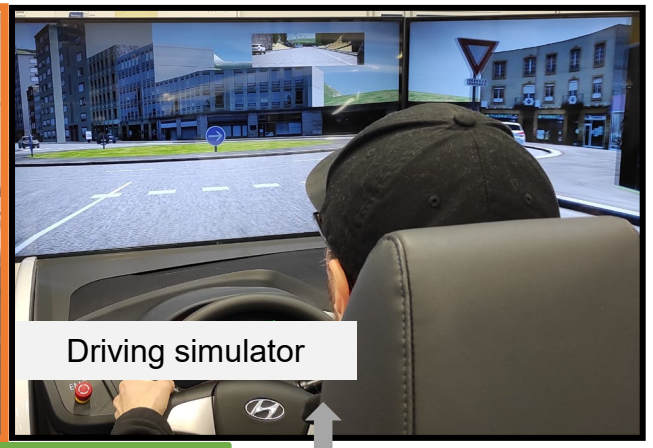
dSPACE

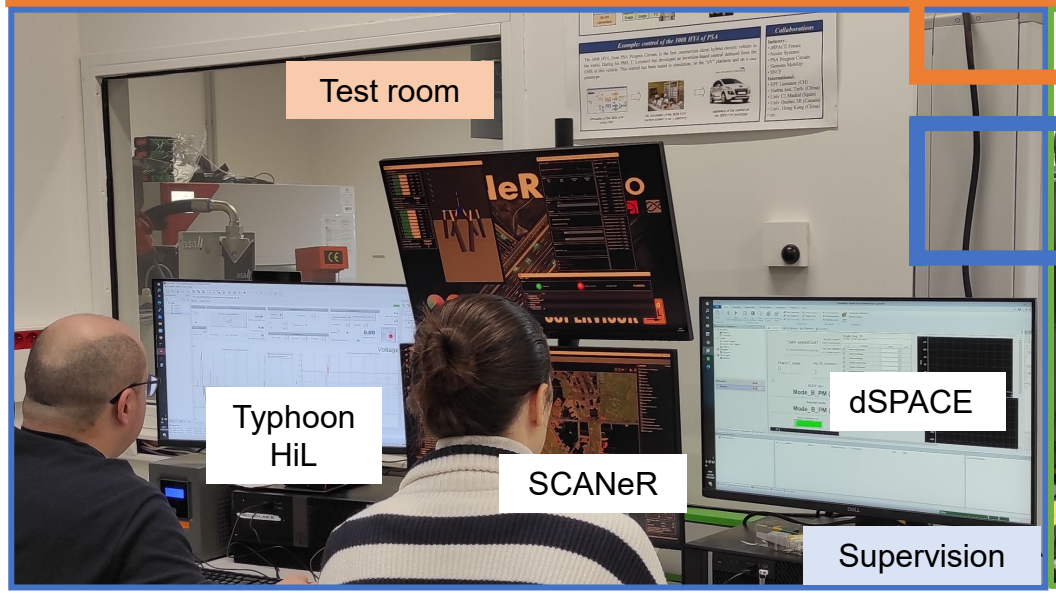
Although the setup is substantial, good organization makes it easy to use

Driver-In-the-Loop Applications for New electrified vehicles

- Demonstration -







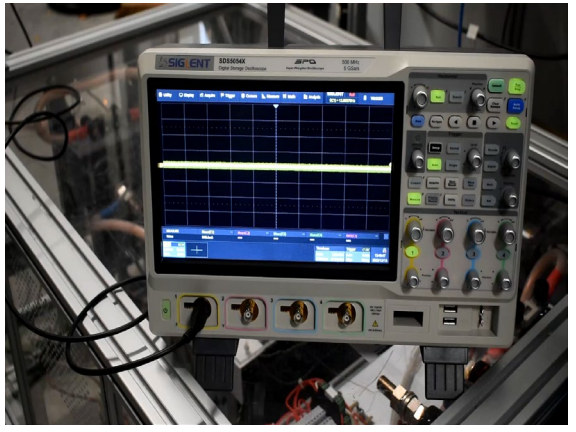
Data exchange: Typhon hiL ↔ Climatic & Power amplifier

Data exchange: Typhon hiL ↔ Scalexio dSPACE

Data exchange: SCANeR ↔ Scalexio dSPACE

Data exchange: SCANeR ↔ Driving Simulator

- Demonstration -



« Conclusion »

Conclusion

- ✓ EMR facilitates the organization of P-HIL for battery testing and driver integration
- ✓ Strong work on Sotfware interfaces
- ✓ Cockpit interface validation
- ✓ DiL and P-HiL were successfully executed together in real time

Perspectives

- Extend it on Nissan Leaf vehicle of the platform
- Validation of Nissan Leaf model (L2EP/CRITT-M2A) through Roller test bench analyse
- Extend P-HiL on battery, Electric drive and Battery + Electric drive testing