EMR'22
HES-SO Sion
June 2022

EMR'22 Summer School
"Energetic Macroscopic Representation"

EMR-based simulation of an electric subway

Ryan O. Berriel, Alain Bouscayrol, Philippe Delarue, Clément Mayet and Charles Brocart

University of Lille, France

SATIE, France

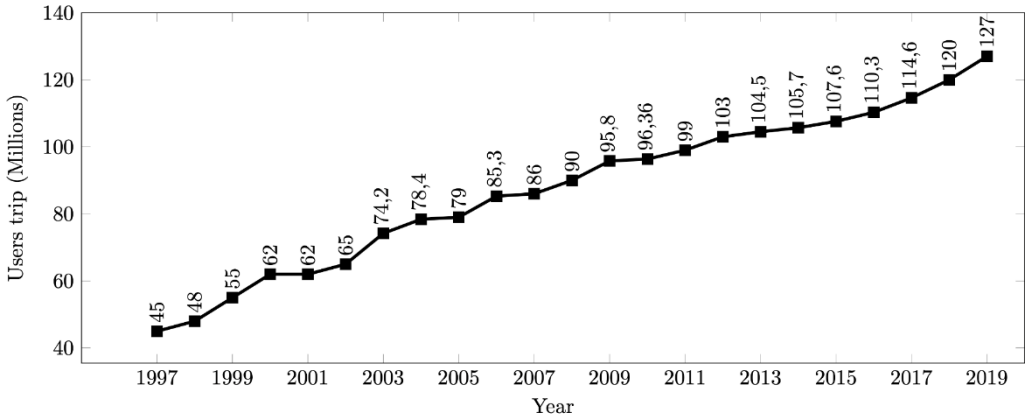
Métropole Européenne de Lille

- Outline -

1. Introduction
2. Vehicle Modeling
3. Model Validation
4. Conclusion

« Introduction »

- Consumption of 70 GWh was registered (2019)



NMR Alstom

Crescent subway utilization

Substitution of the vehicle of line 1 of Lille subway system

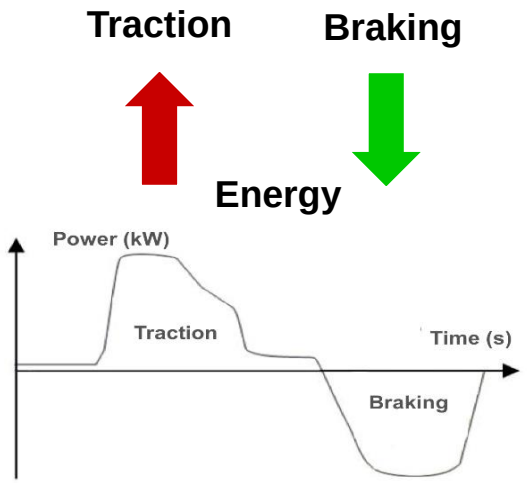
- Vehicle Alstom NMR (Nouveau Matériel Roulant)

Actual vehicle

New vehicle

Traction subsystem

- subway systems are electrified
- regenerative braking capability
- part of braking energy to next subway
- **part of braking energy wasted**



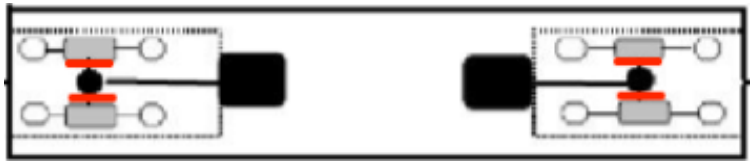
Simulation tool outputs:

- Flexible simulation tools for analysis of energy flow
- Development of innovative solutions and management
- Pre-validation on experimental platform

« Vehicle Modeling »

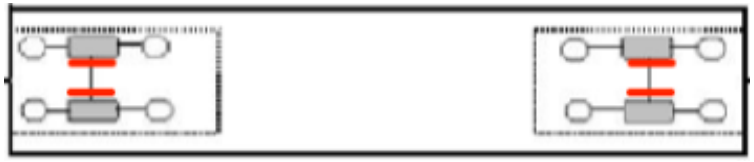
NMR Configuration

Traction car: total of 3



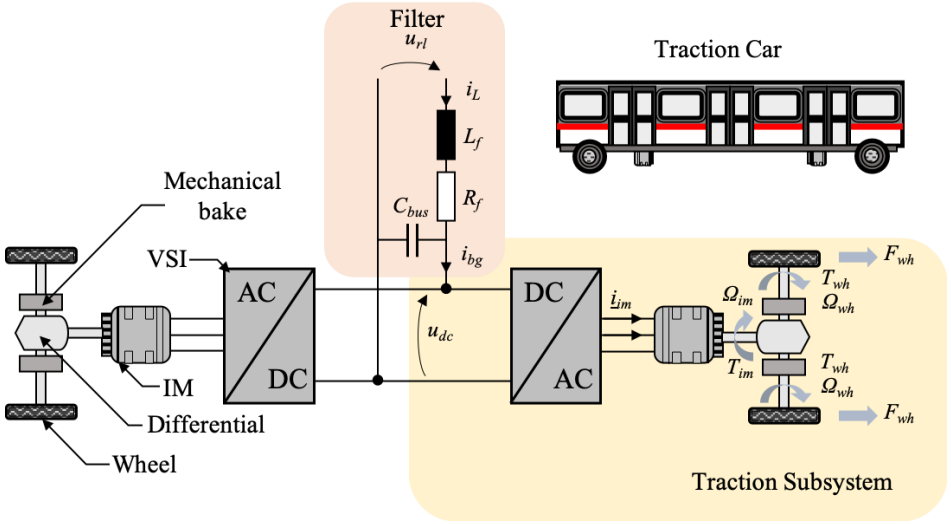
- 2 Bogies (Traction + braking)
- 2 induction machines

Non-traction car: total of 1

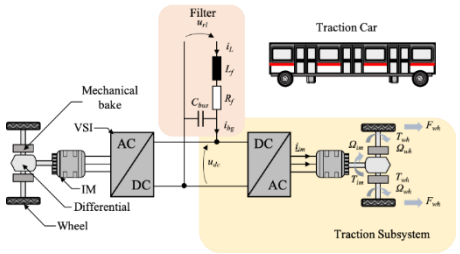


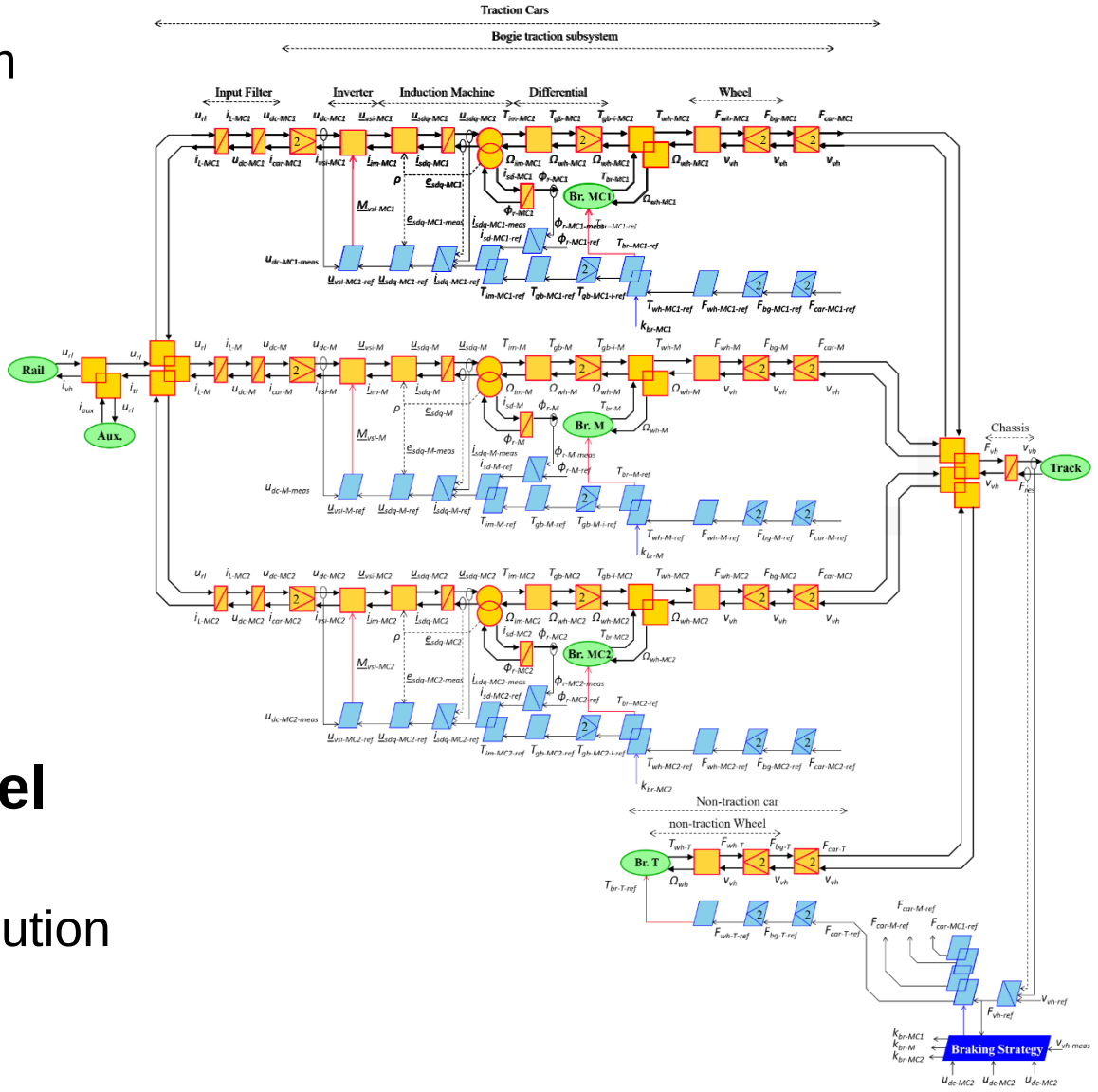
- 2 Bogies (braking)

- **Traction car detail**



Traction Subsystem

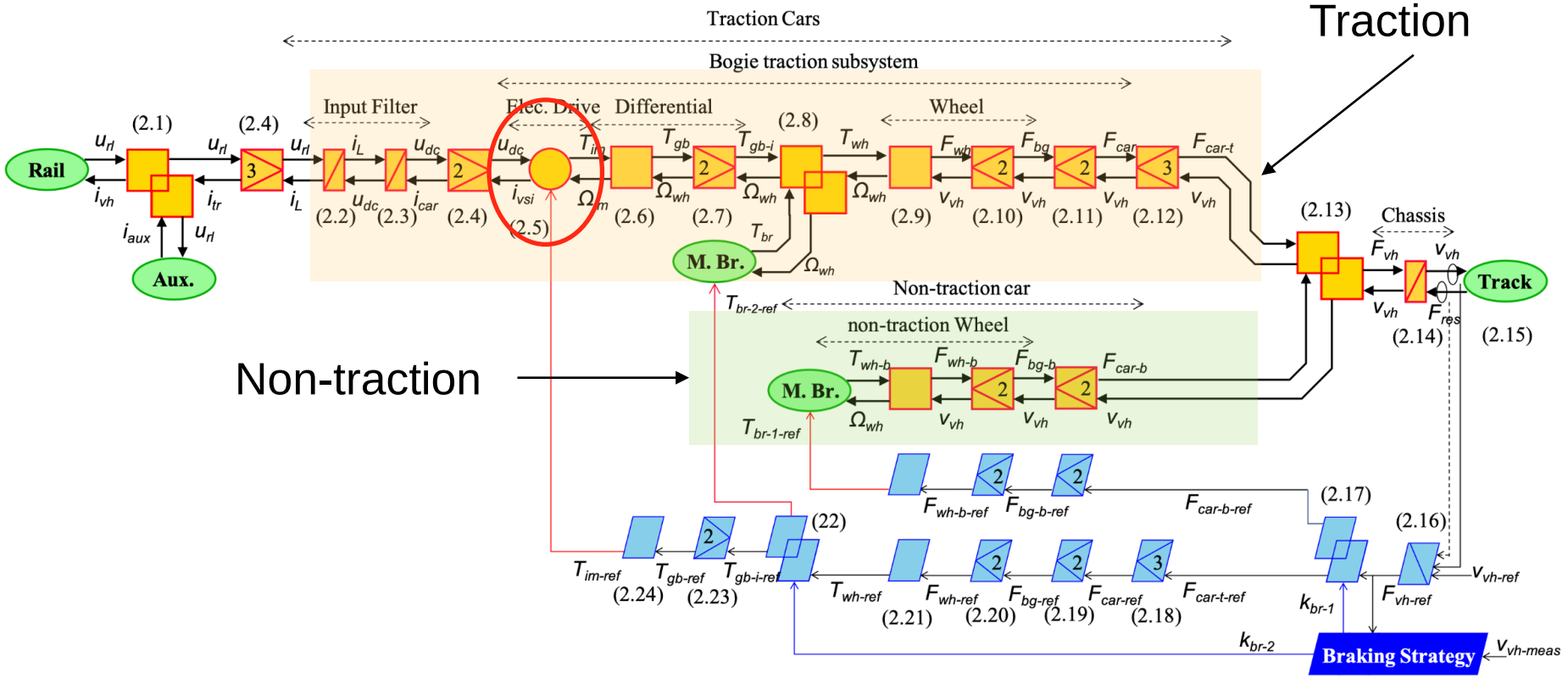




Complete Model

- More complex solution

Quasi static model



- Inverter and machine combined in a single static element
- Constant efficiency is considered
- Error of 2.0% on energy consumption

« Model Validation »

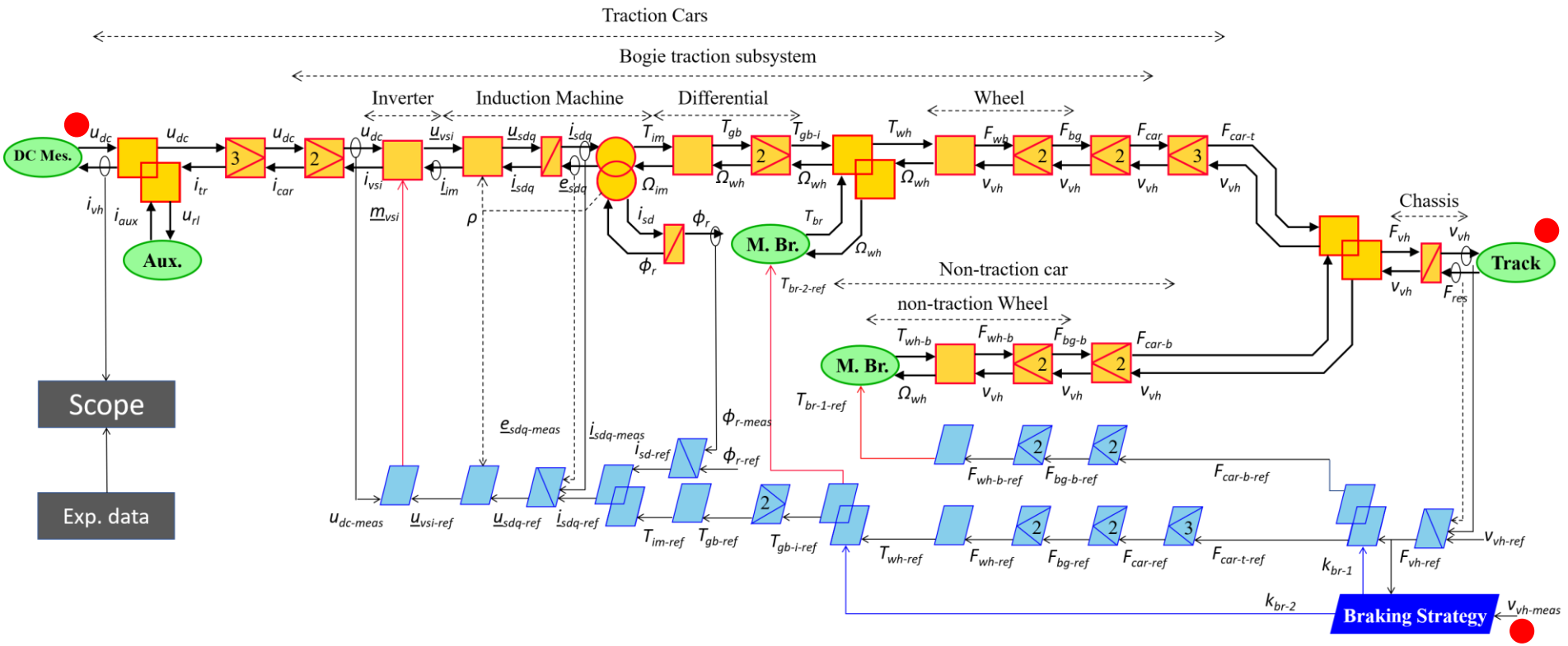
EMR-based simulation of an electric subway

- Model Validation -

- Experimental data validation

- Impose experimental average voltage measurement
- Compare current

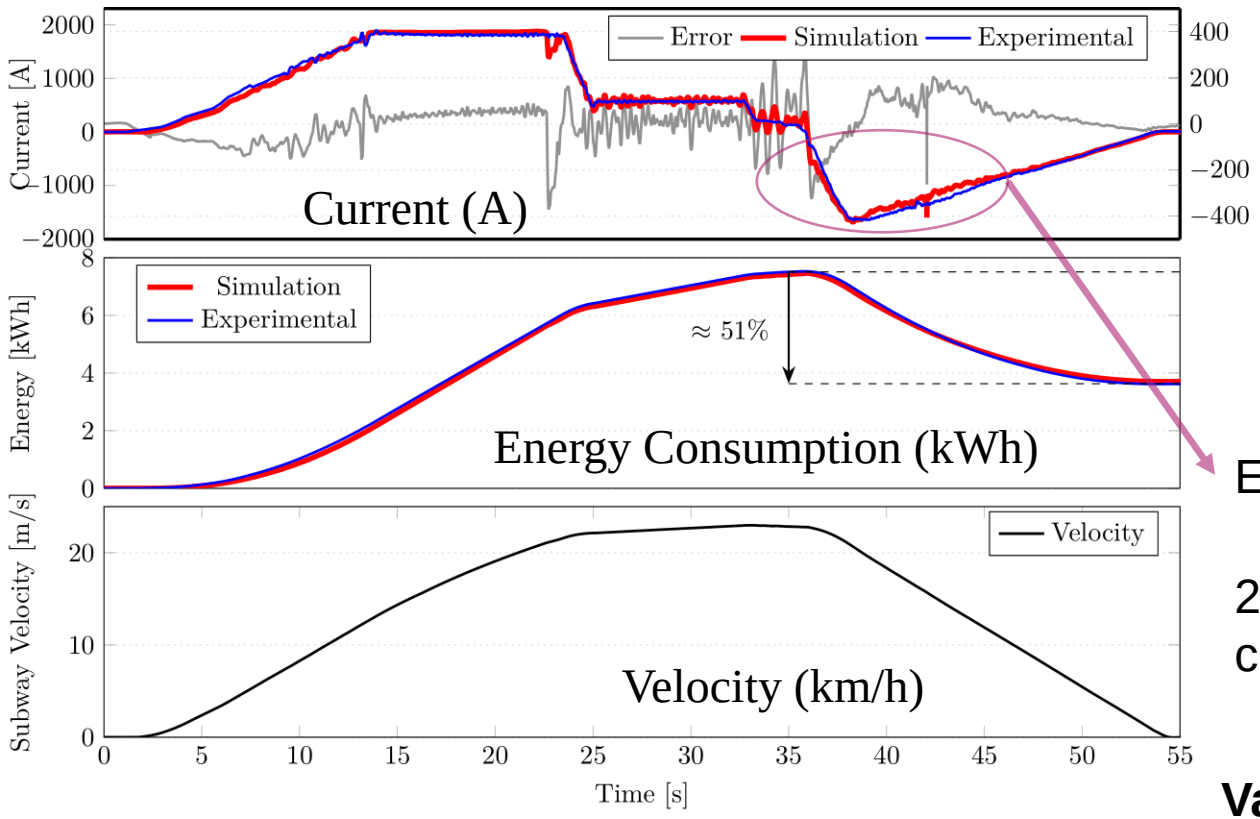
- Inputs
- DC Bus voltage
- Velocity
- Initial position
- Track topology

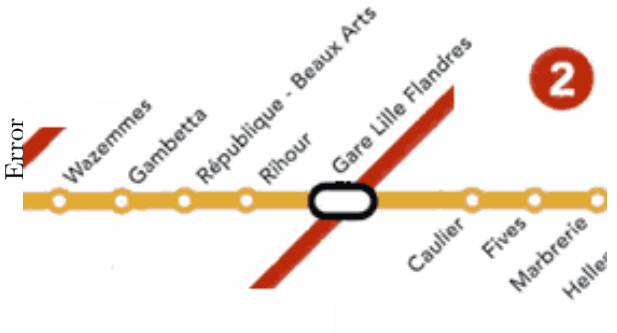


EMR-based simulation of an electric subway

- Model Validation -

Experimental
Simulation





NMR Test

Energy recovery phase

2.1% difference in energy consumption

Validation of the simulation tool

« Conclusion »

- Conclusion -

- Traction system has been modeled
- Magnitude and profile of simulation current match
- Model validation with energy consumption error of 2.1%
- Error of 2.0% on energy consumption with quasi-static simplification