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*June 2022*



**EMR'22 Summer School**  
**"Energetic Macroscopic Representation"**

# « EMR-based Power HIL testing for EV »

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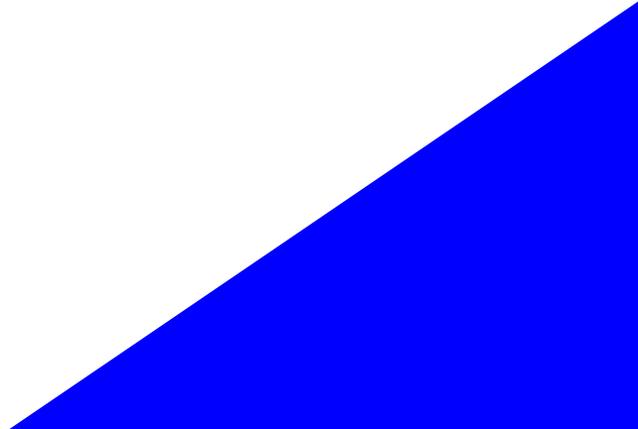


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# « Context AND Objective »



# EMR-based power HIL battery testing for EV

## Studied system

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The reference vehicle used is the Nissan Leaf



A new battery is compared to the original one



Original battery  
(Low power battery)

190 Wh/kg

40kWh

+100 kg



Substitute battery  
(Higher power battery)

134 Wh/kg

Original battery



Energy=40kWh

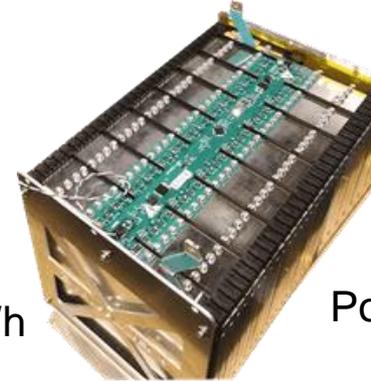
Power=110kW

Weight=303 kg

-High equivalent series resistance

- High losses
- Overheating problems

Tested battery



Energy=40kWh

Power=525kW

Weight=406 kg

-Low equivalent series resistance

- Low losses
- No cooling system needed

➔ Objective : study the consumption of the Nissan Leaf with the two batteries

# EMR-based power HIL battery testing for EV

## Consumption of the Nissan Leaf

Experimental data recording on the actual vehicle

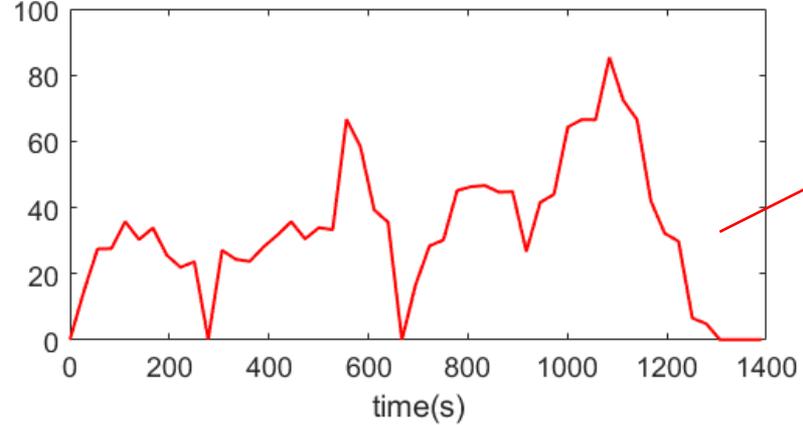
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### GPS recording



Real circuit

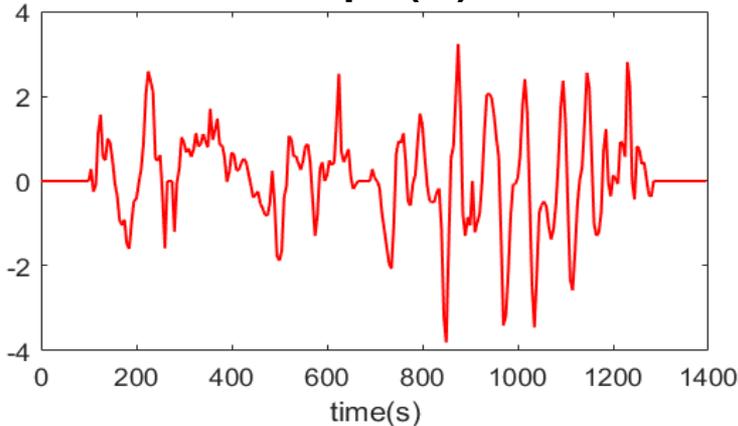
### Vehicle speed (km/h)



Distance:  
12.7 km

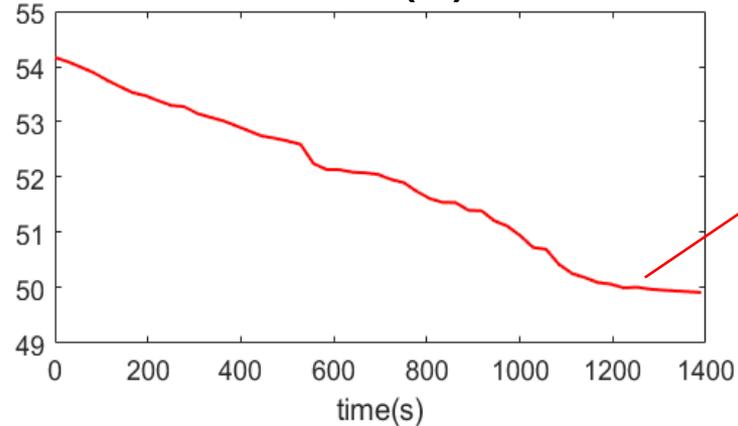
Recorded velocity

### Slope (%)



Recorded slope

### SoC (%)

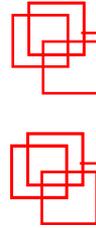


Consumption:  
1700 Wh

Recorded state of charge



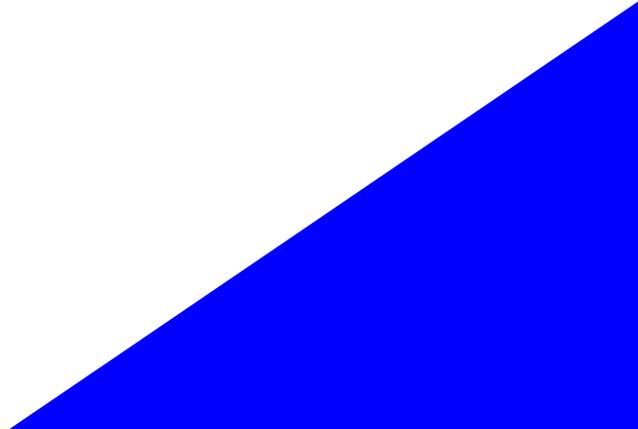
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# « **EMR AND Control of the studied vehicle** »



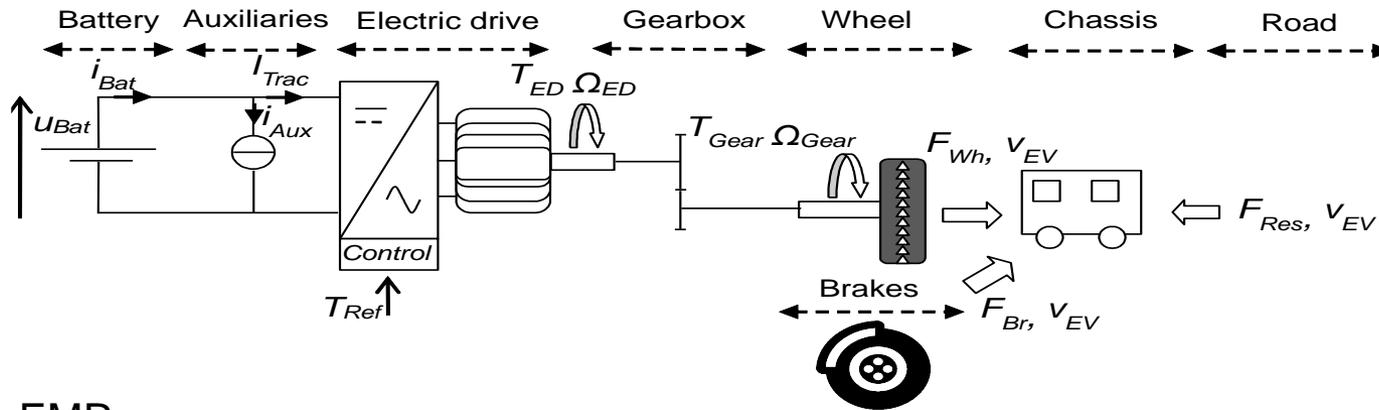
# EMR-based power HIL battery testing for EV

## EMR of the studied system

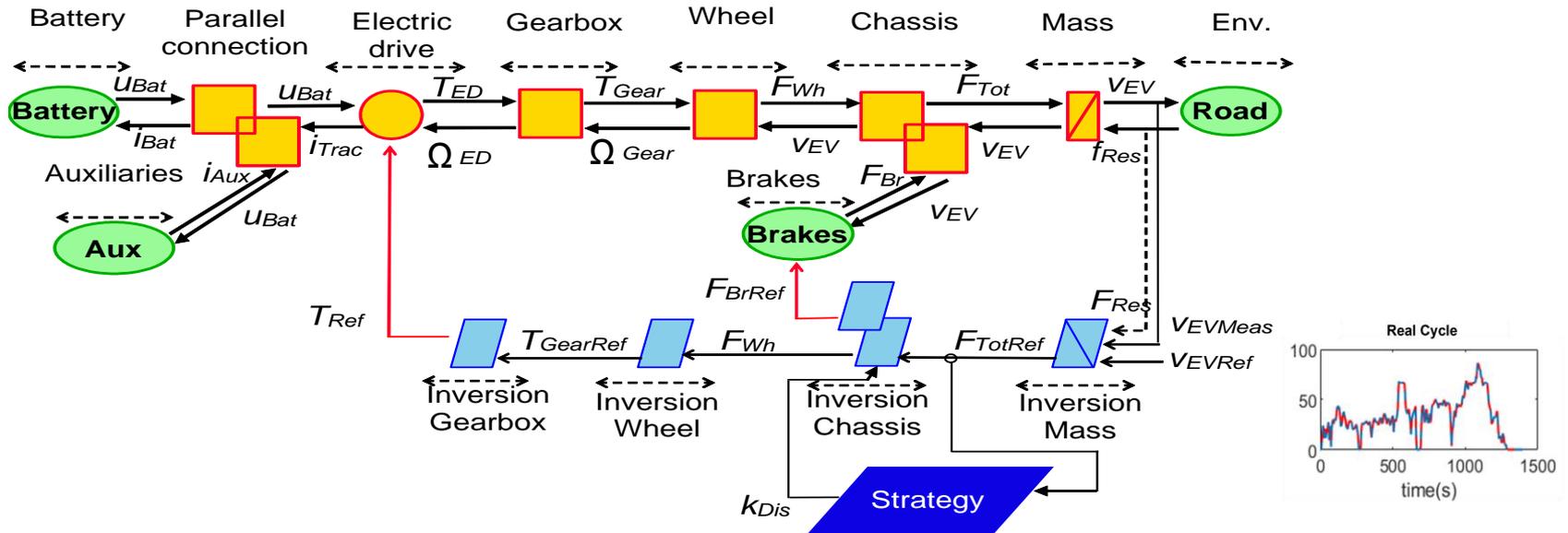
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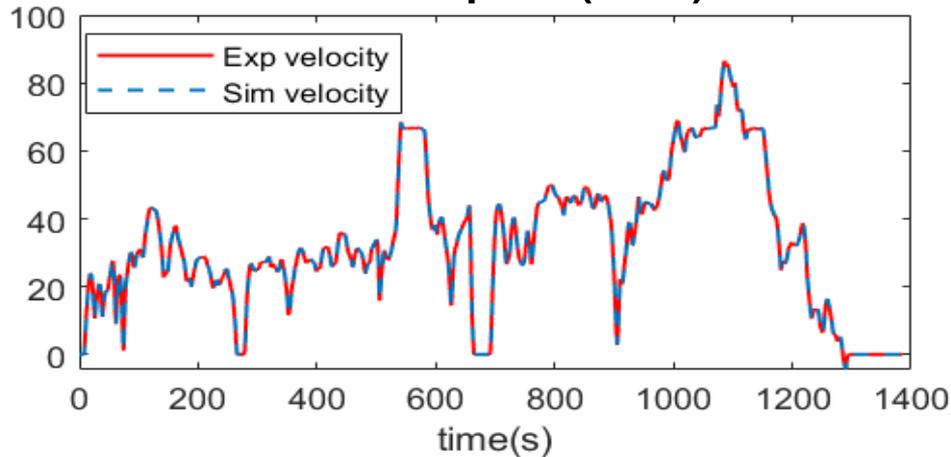
- Structural scheme



- EMR

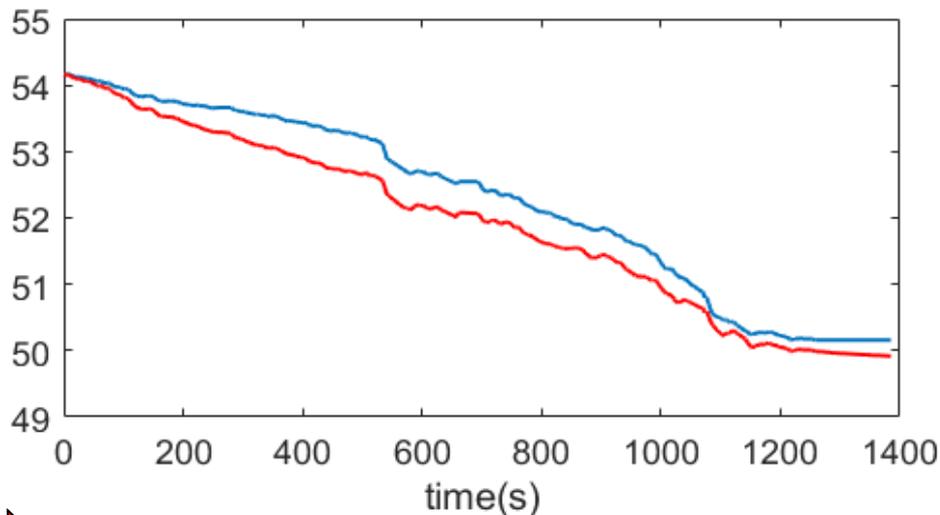


### Vehicle speed (km/h)



➔ The simulated velocity follows the experimental speed. The control of the velocity is achieved.

### State of charge (%)



➔ The error between the simulation and the experimental results is 2.7%

➔ The model is validated and can be used for HiL power testing.

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# « HiL power testing »

# EMR-based power HiL battery testing for EV

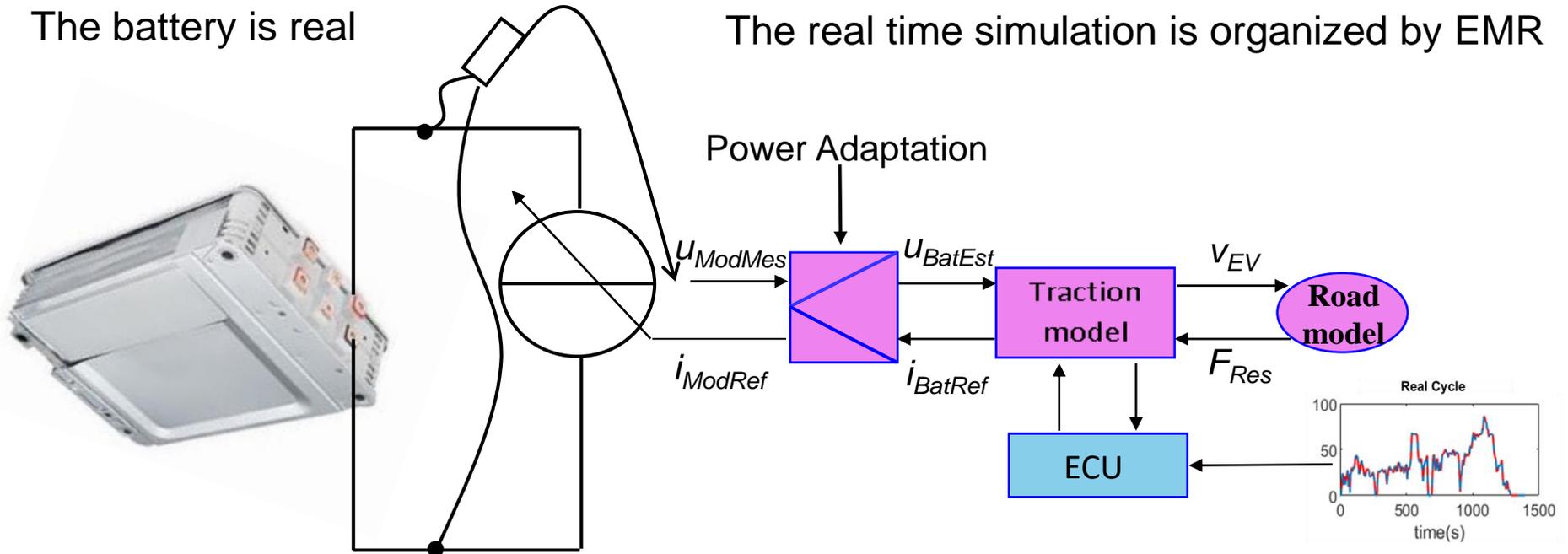
## HiL power test

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The battery is real

The real time simulation is organized by EMR



Power part

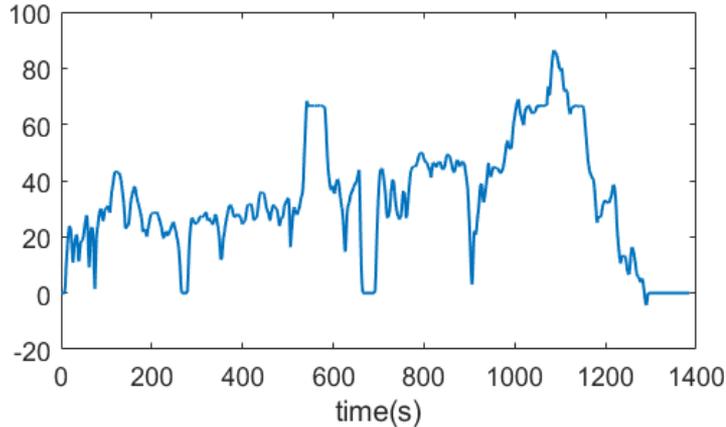
Real-time signal

# EMR-based power HiL battery testing for EV

## HiL simulation results

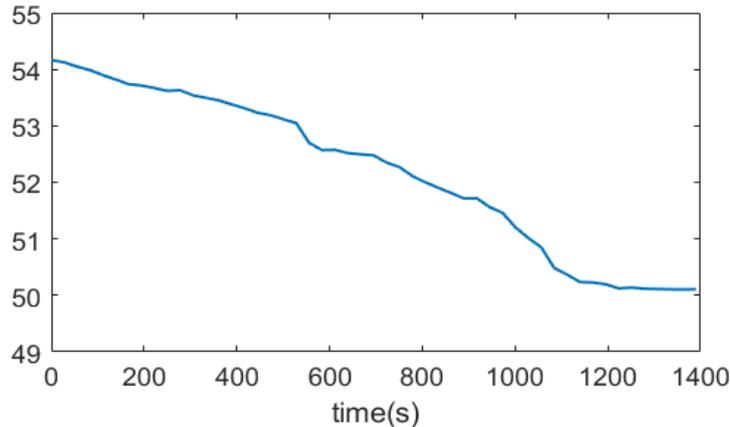
For the tested battery, we obtain:

### Vehicle speed (km/h)



➔ The same velocity cycle is used with a total distance of 12.7 km

### SoC (%)



➔ This cycle with the new battery resulted in a consumption of 1620 Wh

New battery  
1620 Wh



Original battery  
1700 Wh

**-4.7 %**

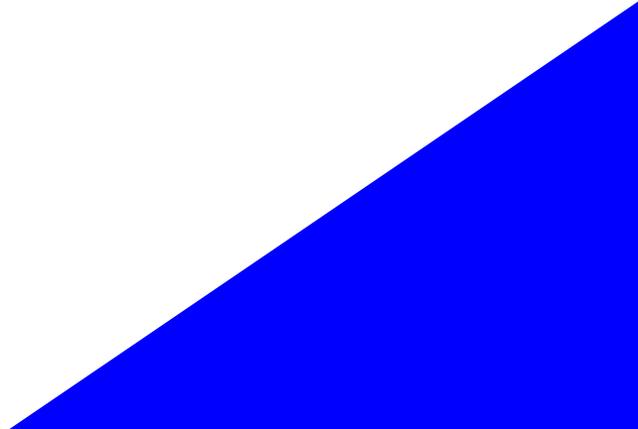


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# « Conclusion »



## Conclusion

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- Two batteries are tested for a consumption comparison
- EMR was used to organize the model of the vehicle
- The model was validated using experimental data
- EMR was used in HiL testing for the real-time signal part
- New battery consumes 4.7% less than the original one