« EMR-Based simulation of A new e-locomotive»

Prof. Philippe BARRADE,

HES-SO, Switzerland

Hes·so VALAIS WALLIS

Haute Ecole d'Ingénierie
Hochschule für Ingenieurwissenschaften π

- Frame of the study
  - Tools already developed
  - Preliminary results
  - To some real-time tests

- Energetic Macroscopic Representation of a simplified network

- Implementation using Typhoon HIL tools and libraries
  - Main representation
  - Some key elements
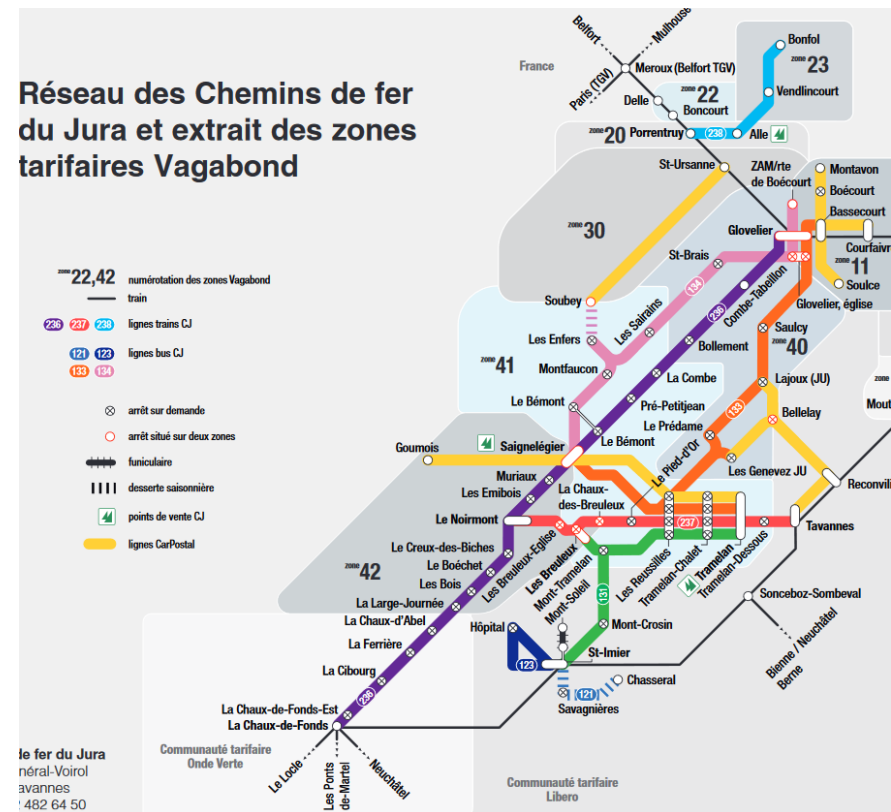 - Simulation results

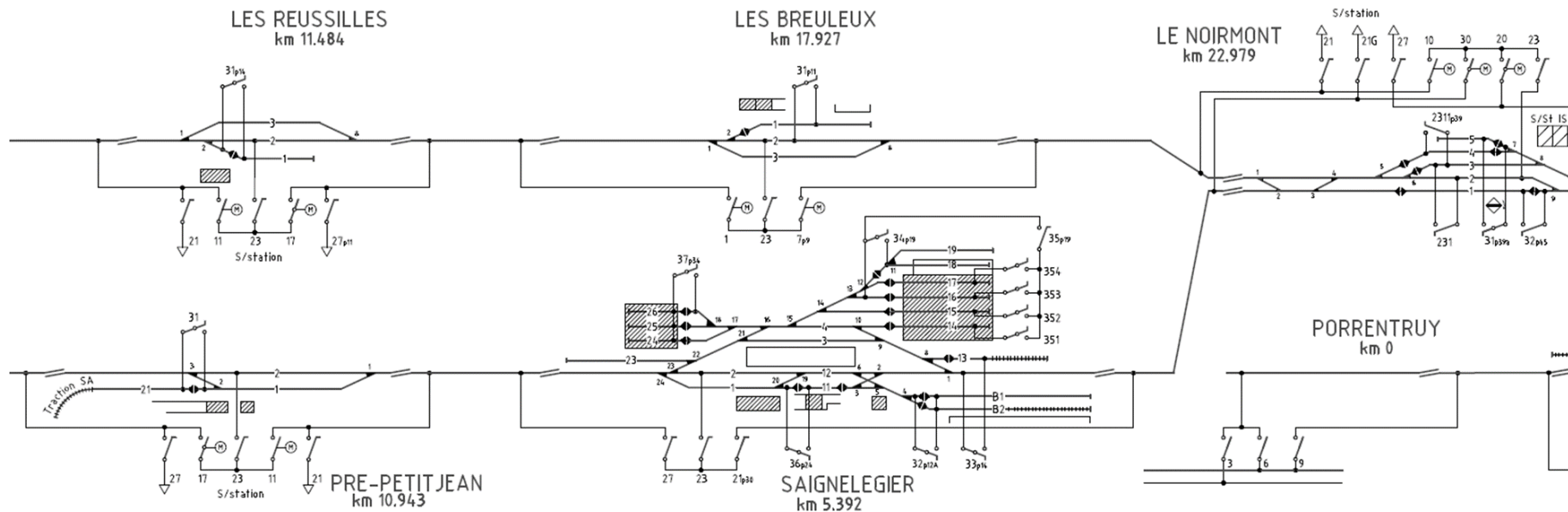# « **Frame of the study**»

Les Chemins de Fer du Jura – Jura canton – Switzerland

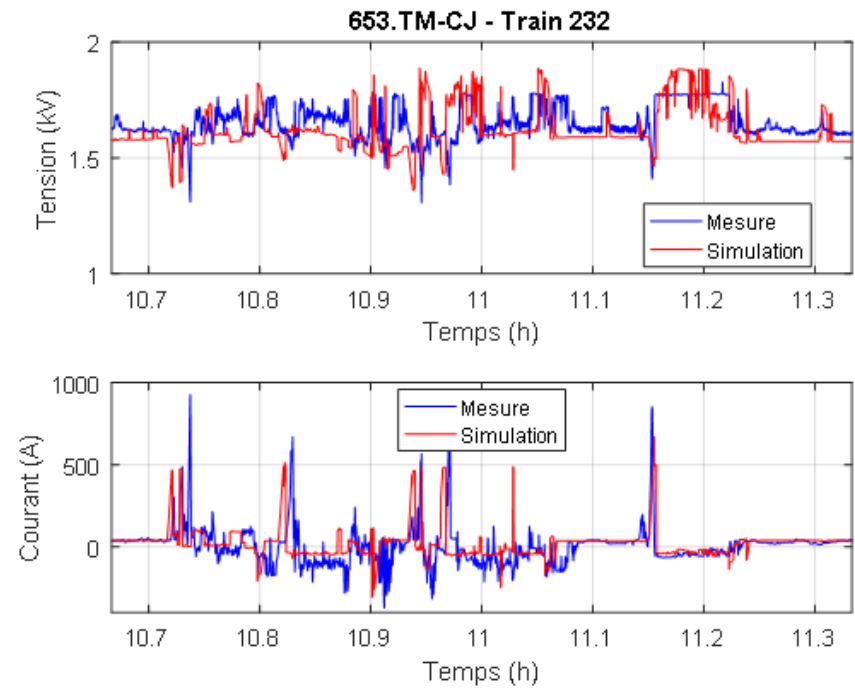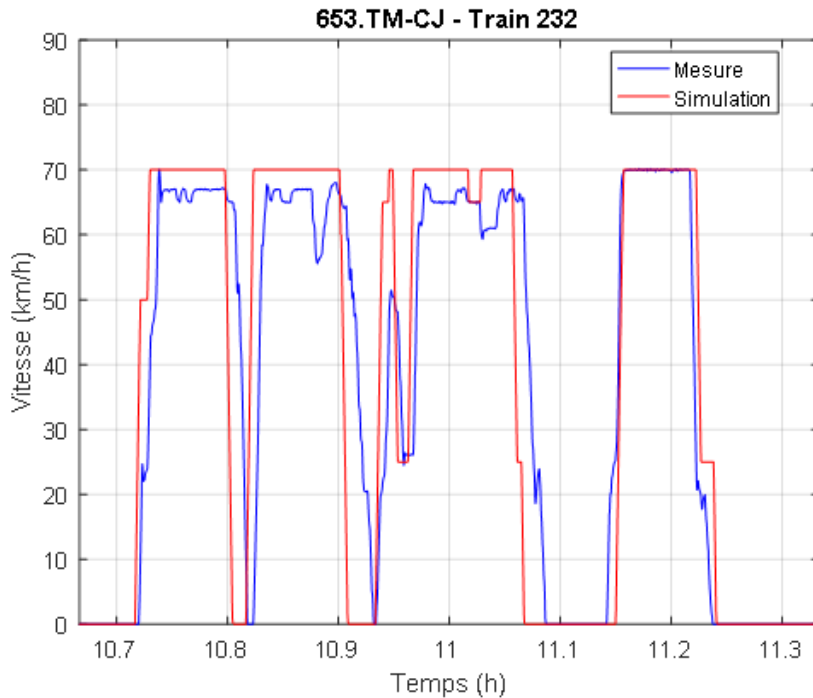Line "La Chaux-de-Fond" -> "Tavannes"

Line "Le Noirmont" -> "Glovelier"

- Integration of new locomotives and renewable feeding

  - Focus on existing feeding stations (adaptation to reversible front-end).
  - Insertion of PV plants with direct injection of energy to overhead-line.

- Full model of the line (8 trains, 5 non-reversible feeding stations)
  - Comparison with measures

653.TM-CJ - Train 232

# «Energetic Macroscopic Representation of a simplified network»

- Test of EMR library developed par Typhoon HIL in the context of PANDA

- Identification of main issues to implement and solve models
  - Using elements provided by Typhoon HIL
  - According to EMR principle
  - Enabling real-time simulation (or faster?)

- Simplified system
  - Modelling 1 train only
  - Line "Le noirmont" to "Glovelier" modelled, isolated from the rest of the network
  - 3 Feeding stations
  - The complexity of the electrical network is not considered
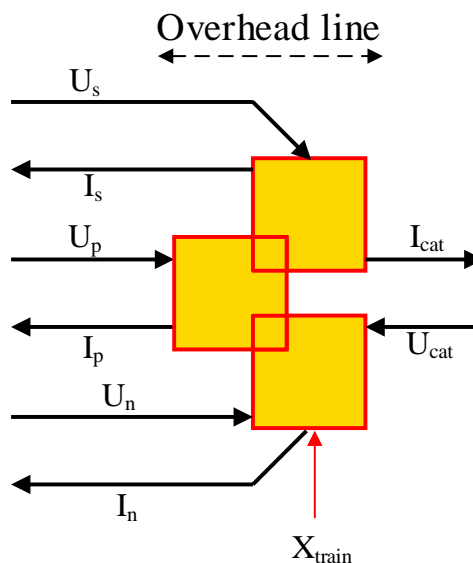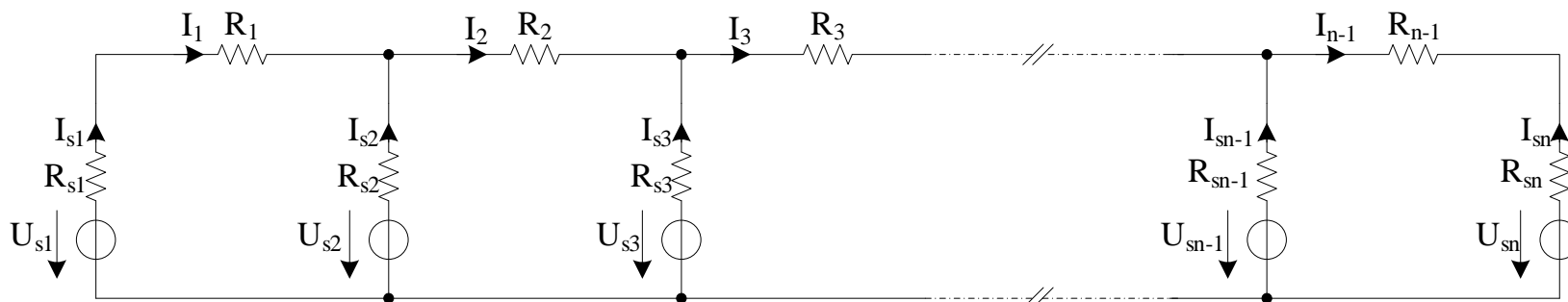   - The overhead line is one cable only, with no division on sections

- Non-Reversible feeding station

  - Can be modelled as a "non-linear" capacitor
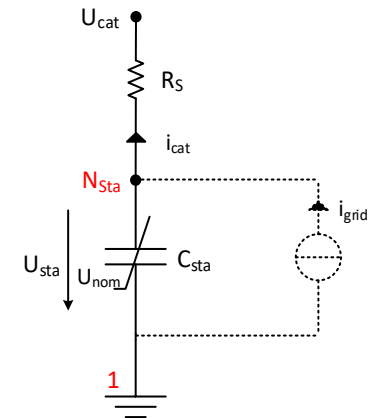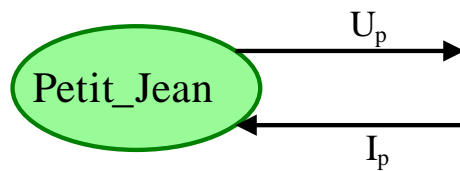
- Reversible feeding station

  - Taking into account active/reactive power injection on an industrial grid
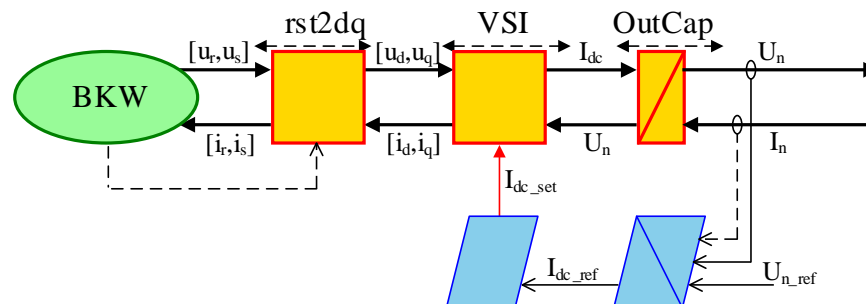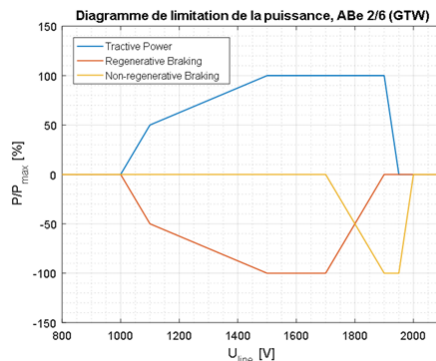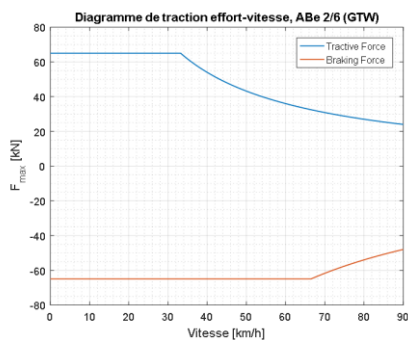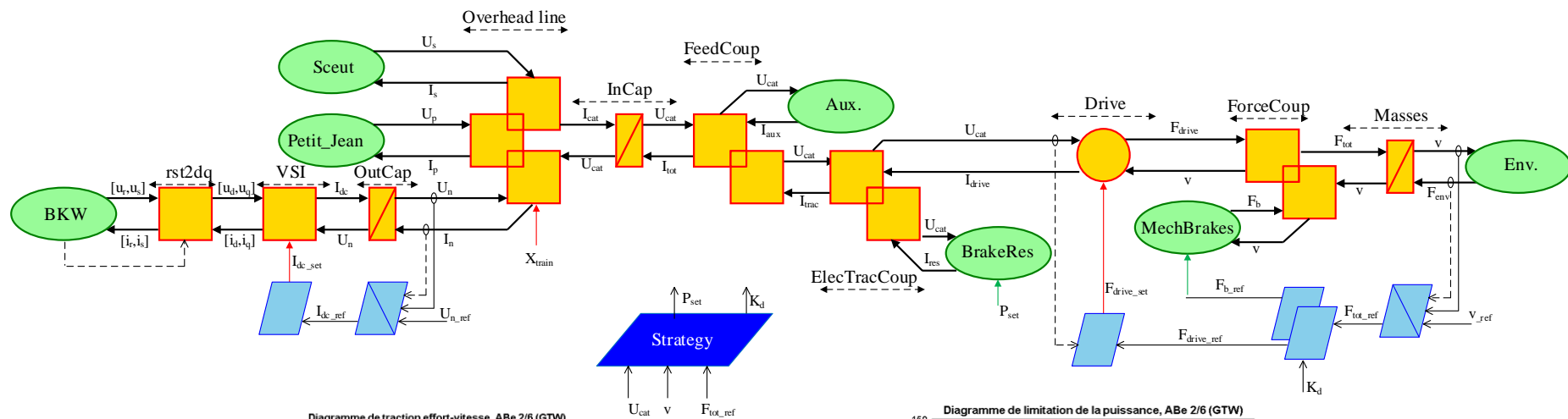
- Overhead line as a coupling element
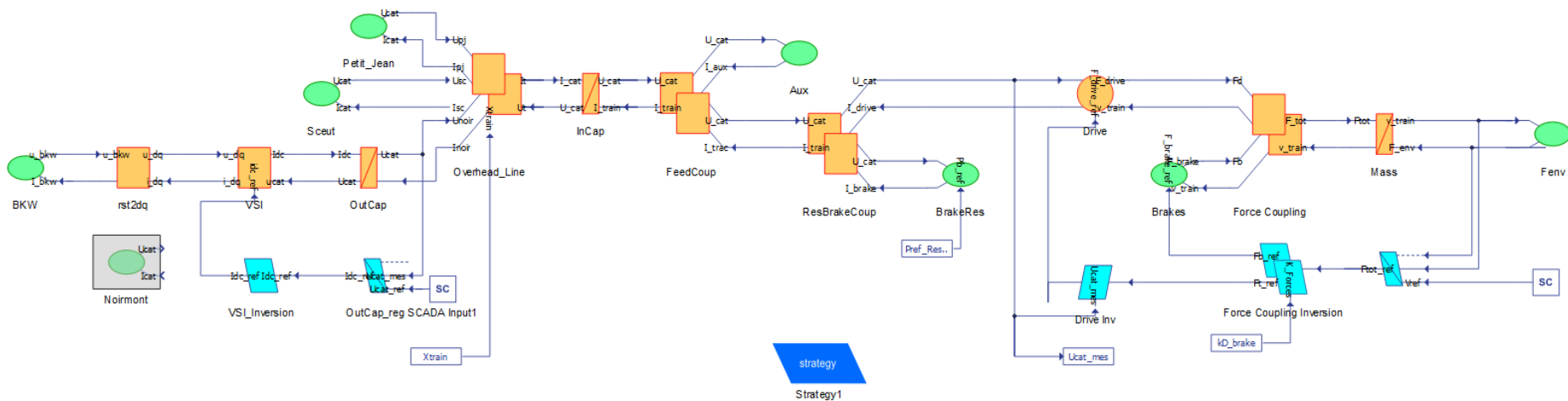 - Resolution of a resistive electrical network

- For 1 train

- Needs in Strategy element

  - For Inversion of some coupling elements
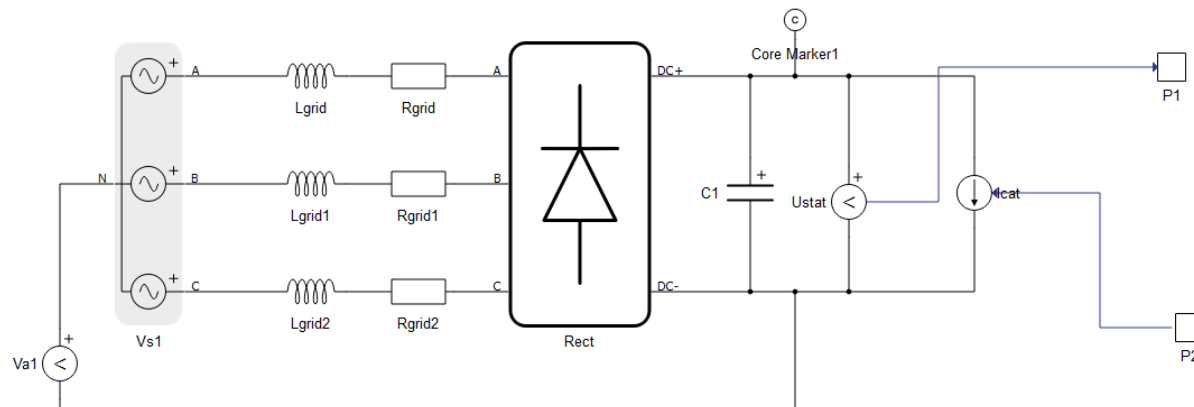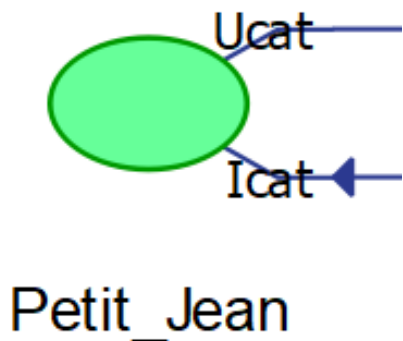
  - To define limits for traction/braking forces

«Implementation using Typhoon HIL tools and libraries»
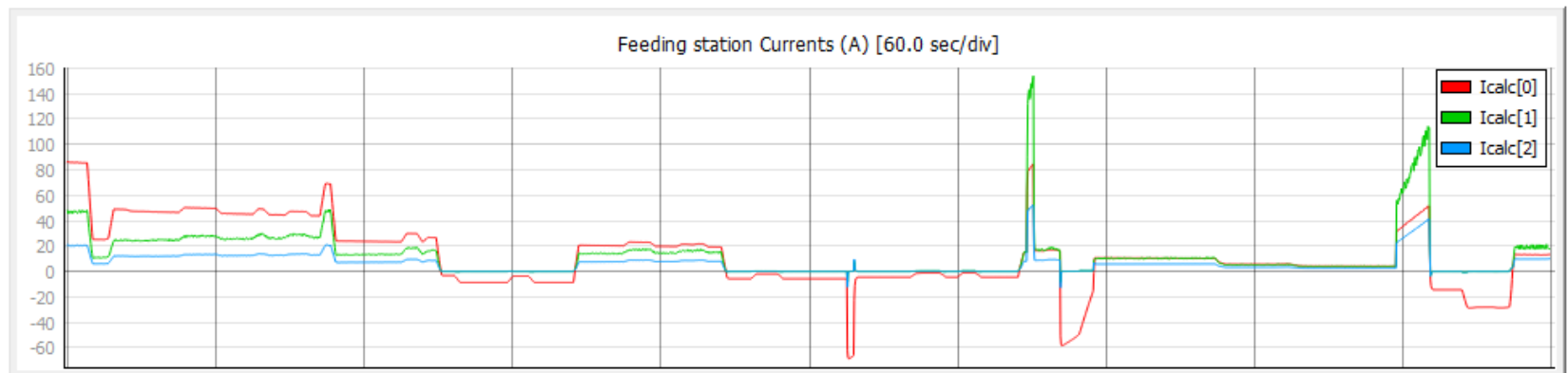
- As in original scheme

- Functional vs. Structural

- Through a user SCADA interface
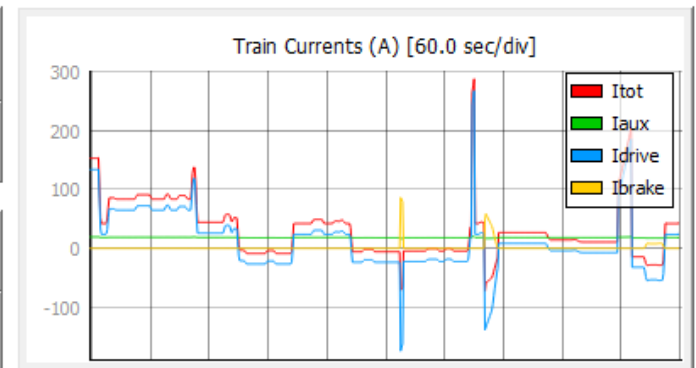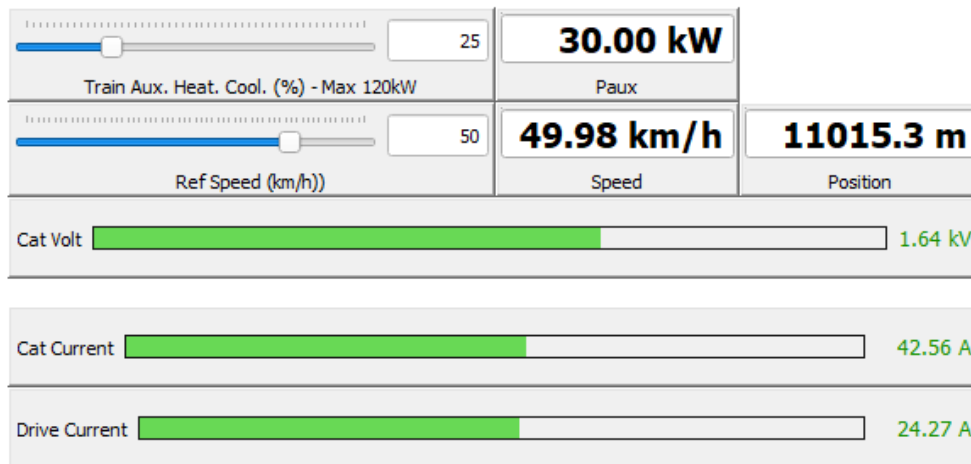
«Conclusion»

- EMR allows the correct/appropriate representation of a complex system

- According to strict respect of rules (action/reaction, causality)
  - Simulation is directly stable
  - Open-door to real-time simulation
    - 500ns sampling time for electrical
    - 50us/500us for functional elements

- Actual developments
  - Full network is modelled
  - Up to 3 train on the line

    - Simulation faster than real-time