«EMR-based Control of POwer systems for Proton Synchrotron (POPS) accelerator»

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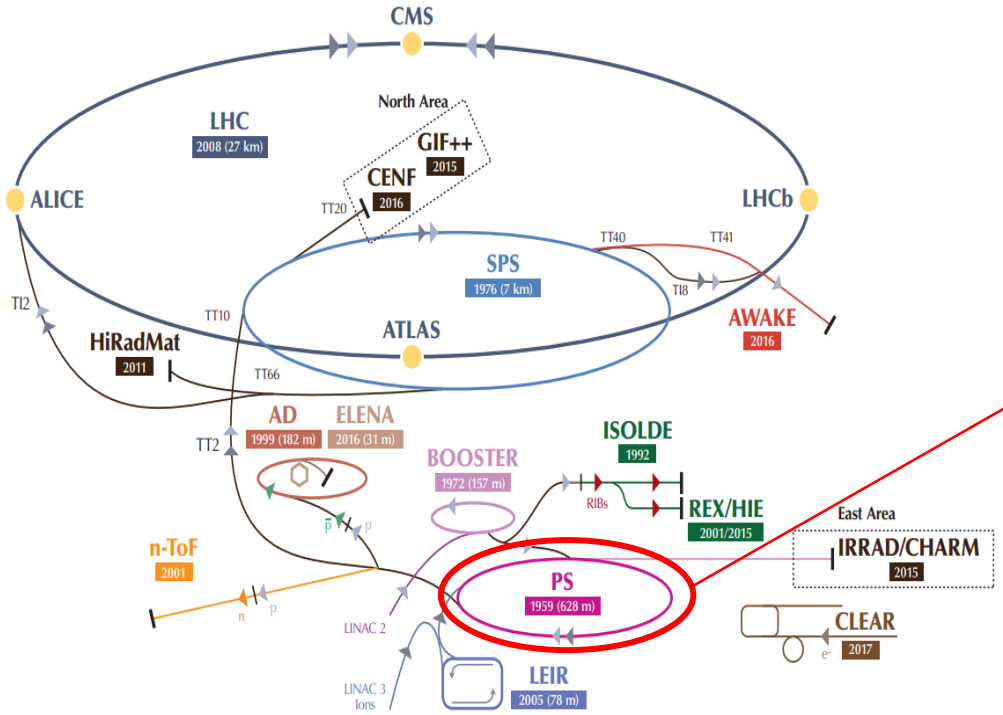
[2]CERN, European Organization for Nuclear Research.

- Outline -

1. Context and Objective
2. EMR and MCS of POPS
3. Results of the simulation
4. Results of the experimentation

« CONTEXT AND OBJECTIVE »

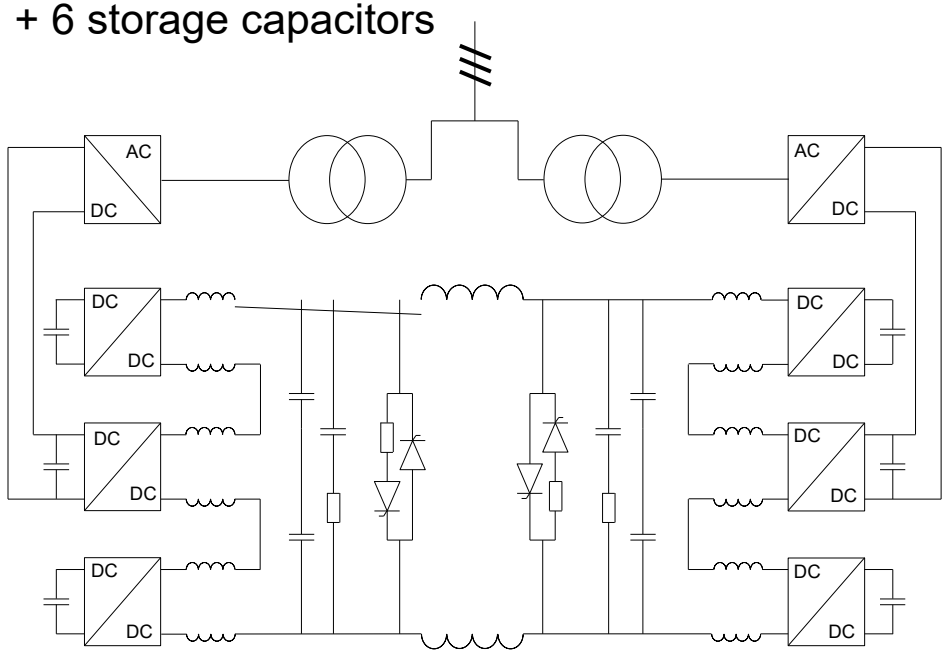
CERN accelerator complex



Proton Synchrotron

101 series magnets all along the accelerator
+ 6 storage capacitors

Centralized supply system for the magnet



EMR-based Control of POPS

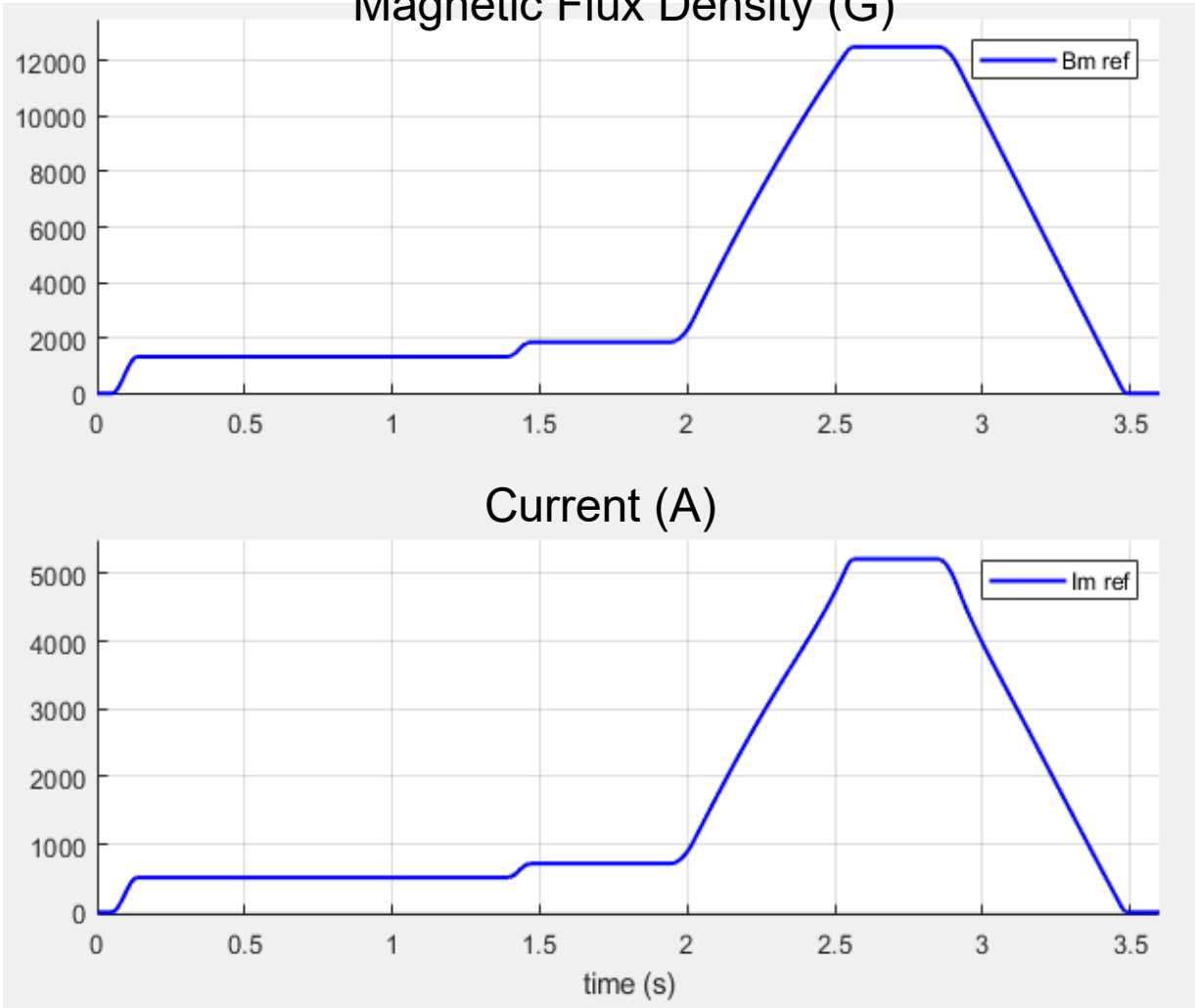
- Context -

Magnets control requirements:

- Complex supply system
- Injection phase
- Trapezoidal wave with a 12.5 kG Flat top
- Maximal current of 5.2 kA
- Maximal voltage of 10 kV
- 3.2s period
- Repetition every 3.4s 24h/24h
- Instantaneous error of 0.6 Gauss,
- 50 ppm during flat top

Other Requirements:

- Redundancy
- Energy savings

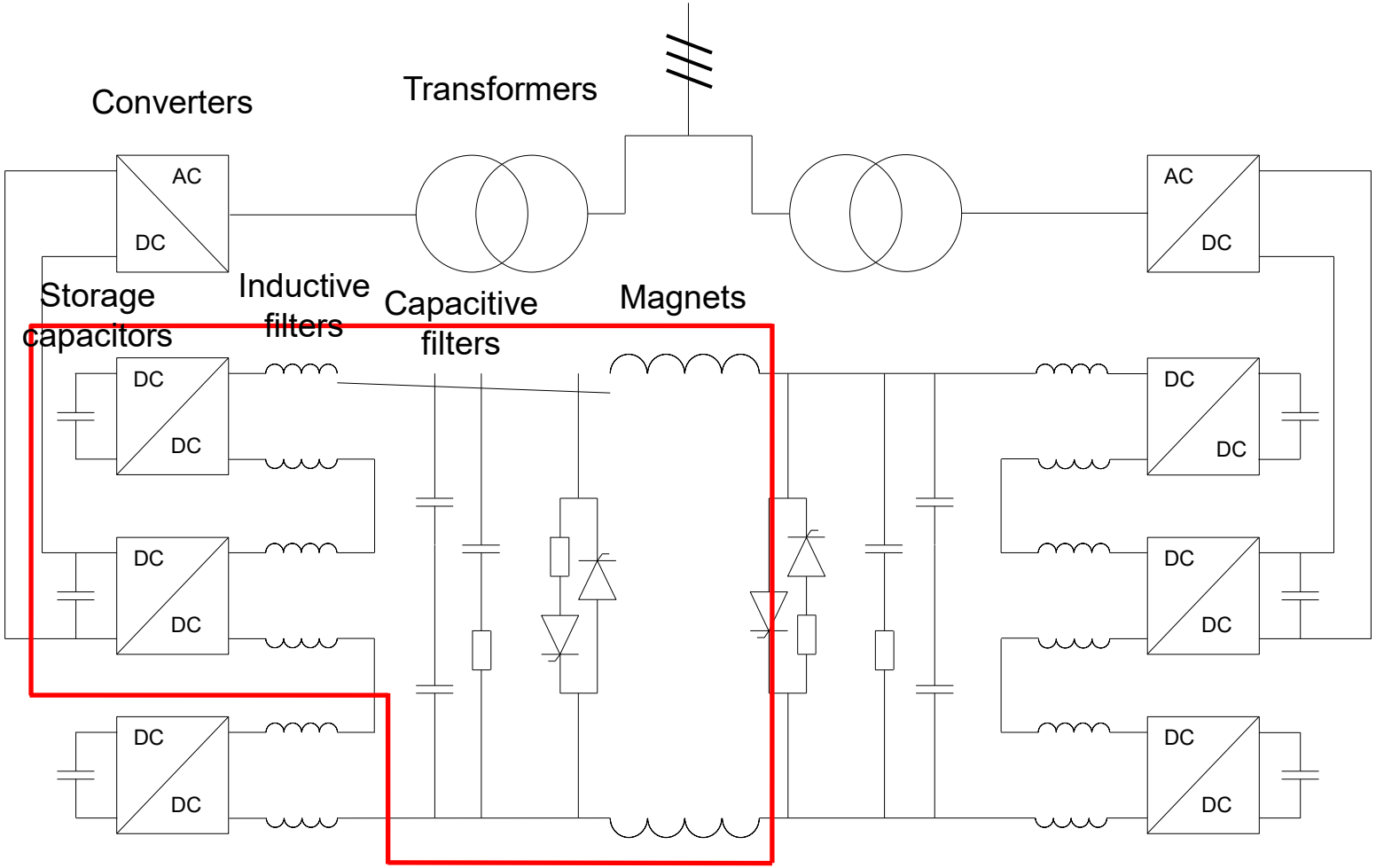


High current / slow dynamics
Ultra-high accuracy

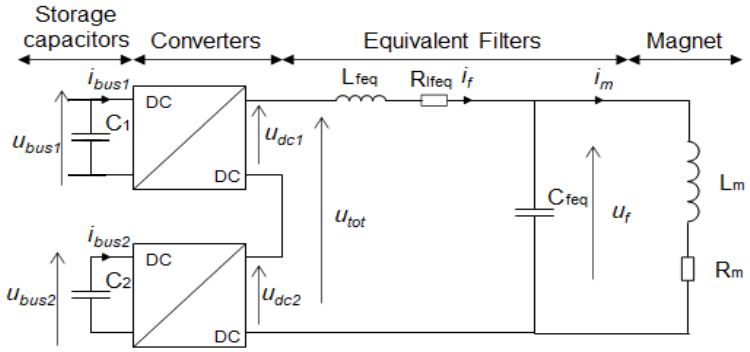
« EMR AND MCS OF POPS »

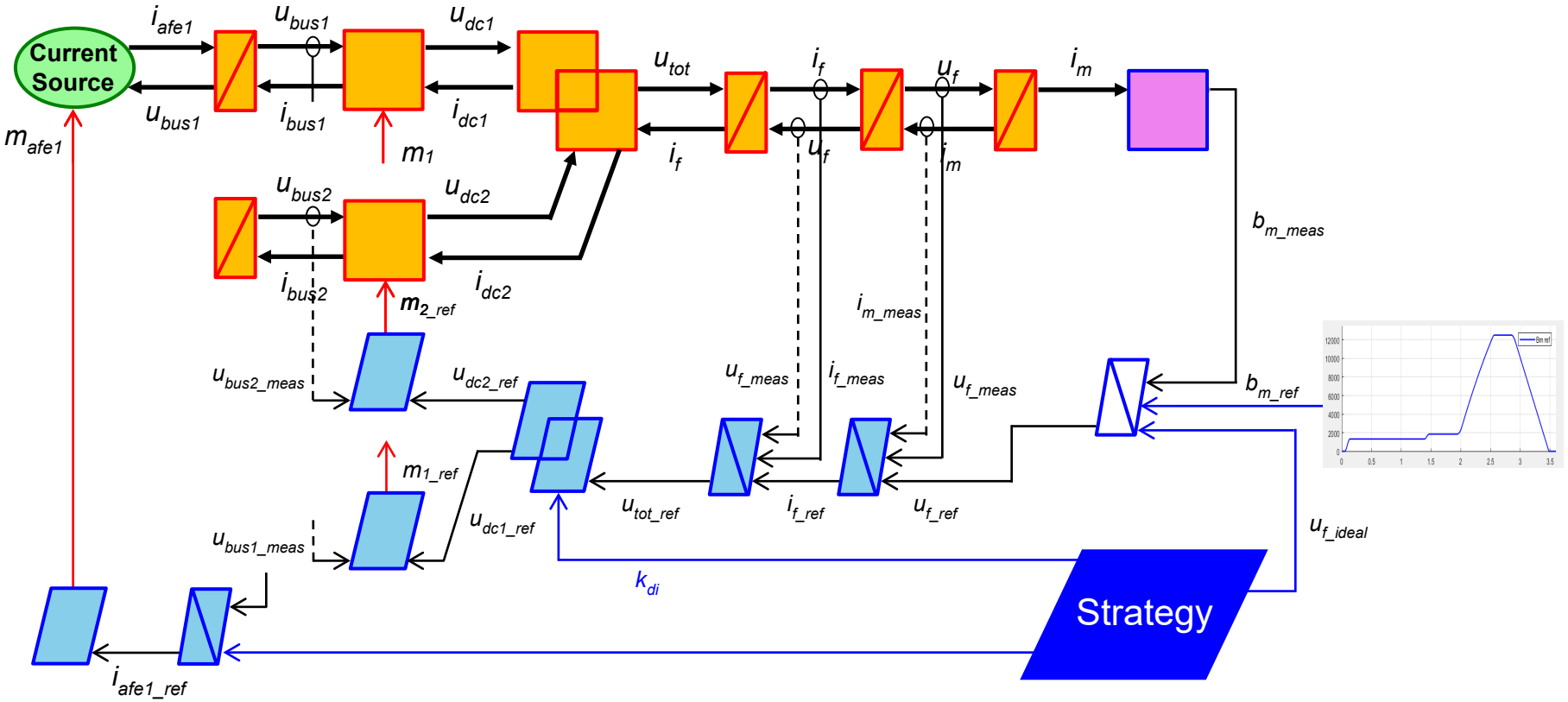
Mutual inductances are neglected

The converters are simplified



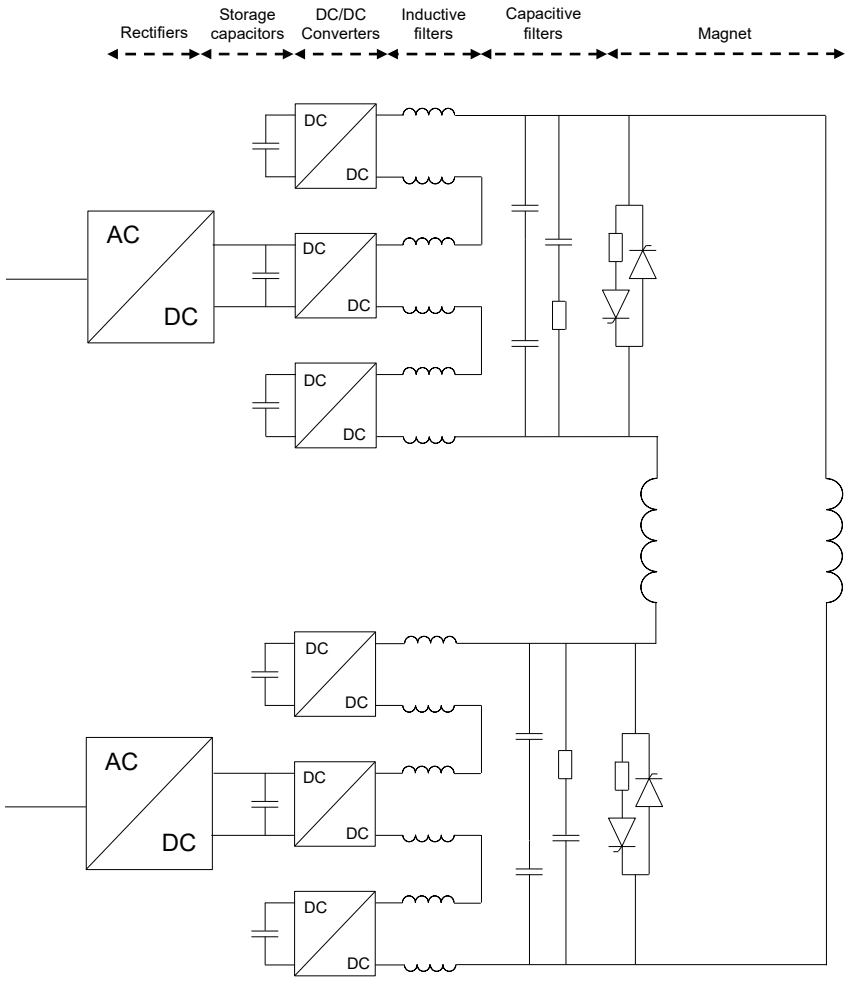
- EMR of the System -





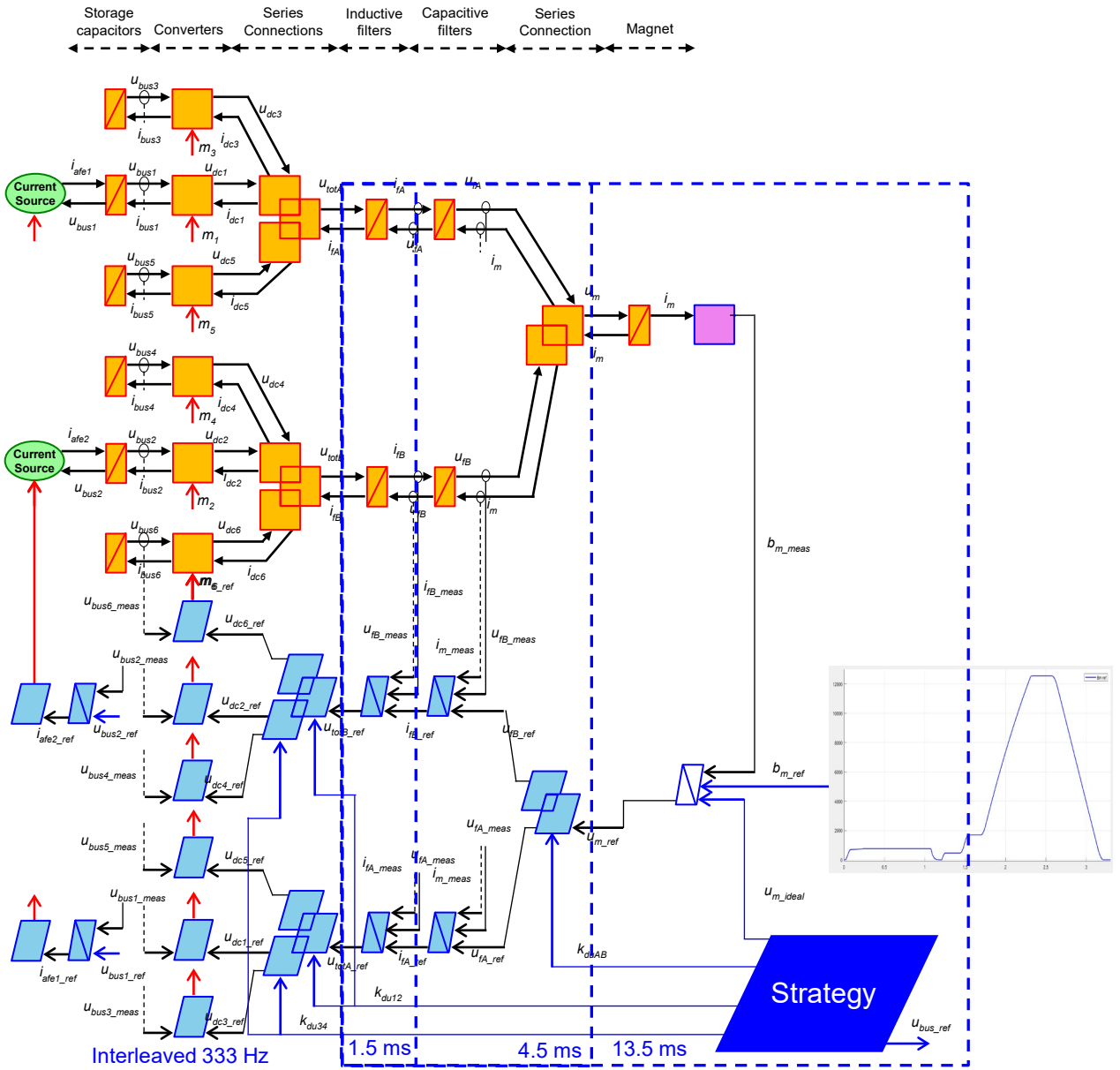
EMR-based Control of POPS

- EMR of the System -



EMR-based Control of POPS

- EMR of the System -

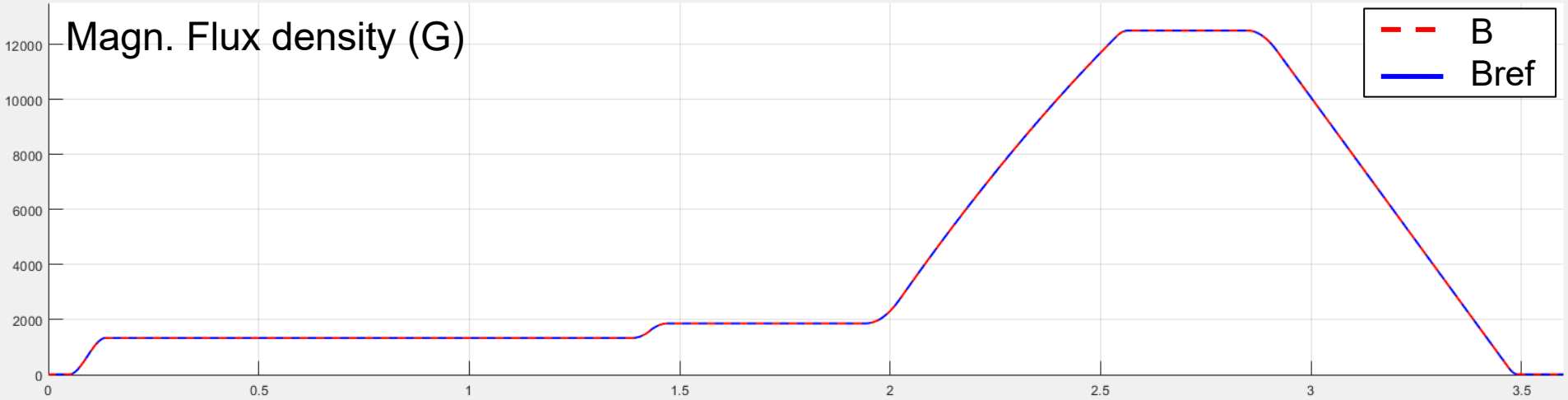


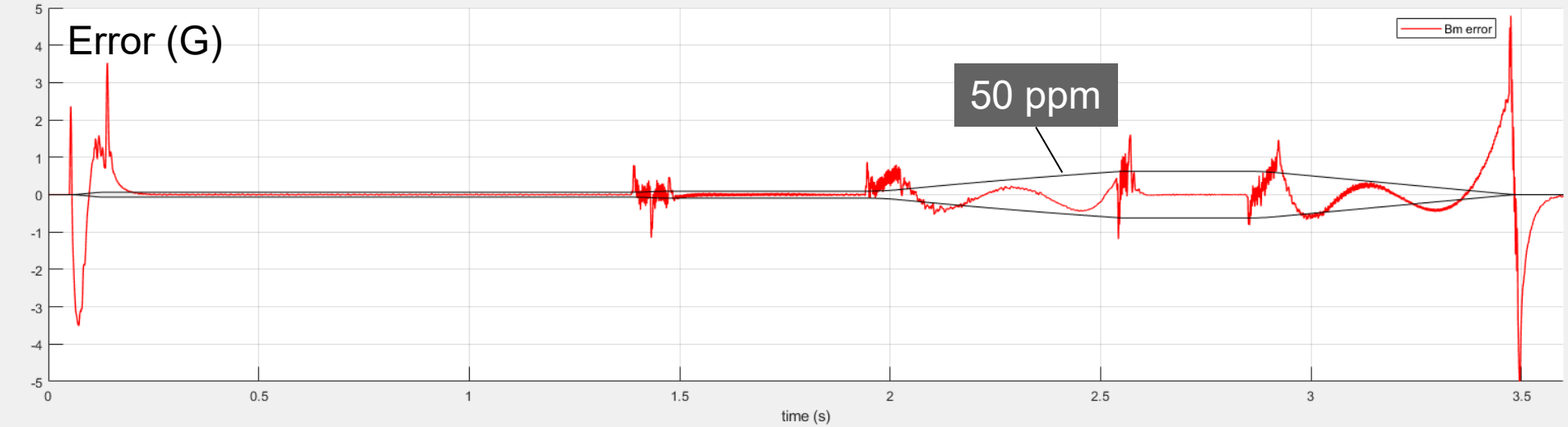
« RESULTS OF THE SIMULATION »

EMR-based Control of POPS

- Results of the simulation -

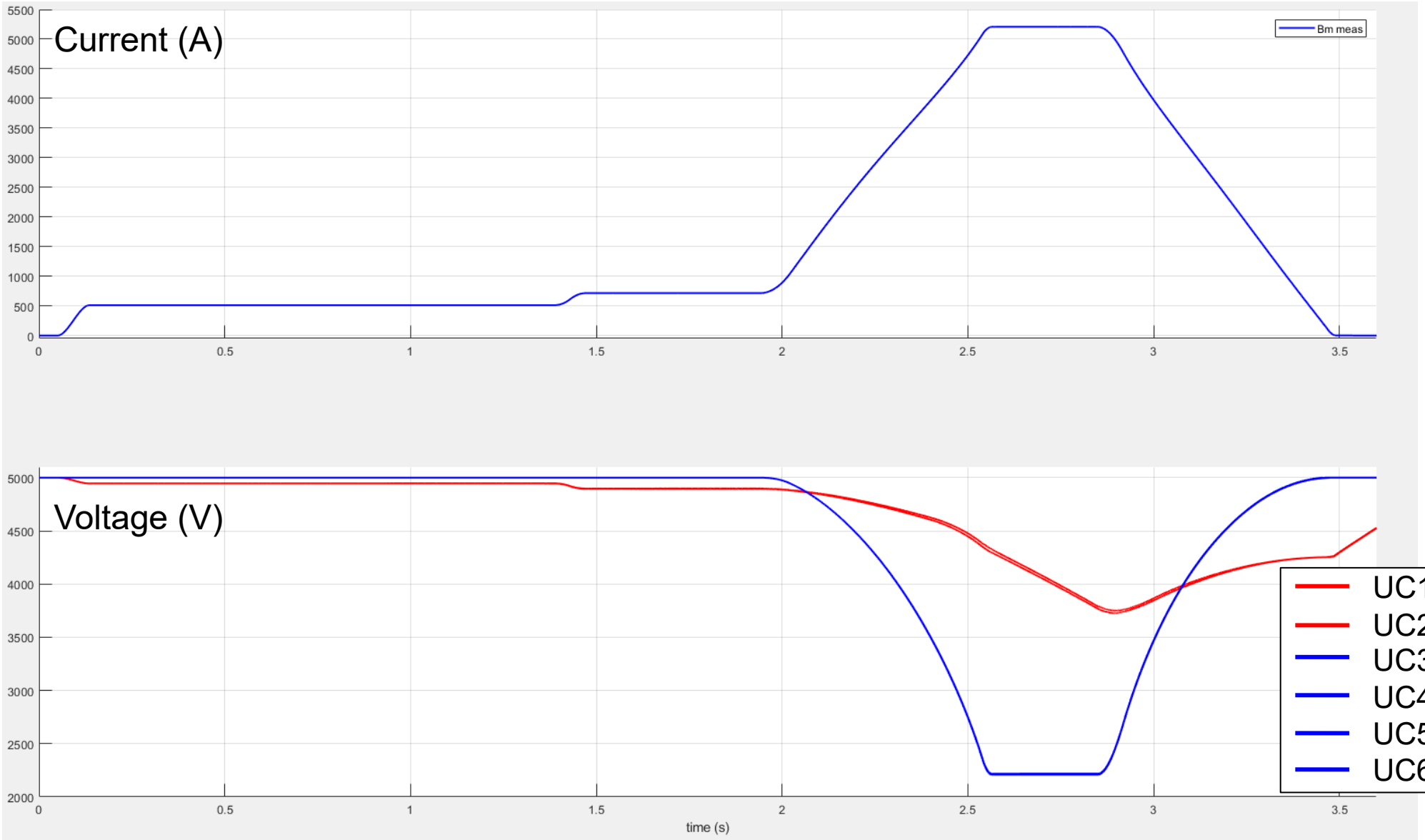
EMR'25, Lille, July 2025



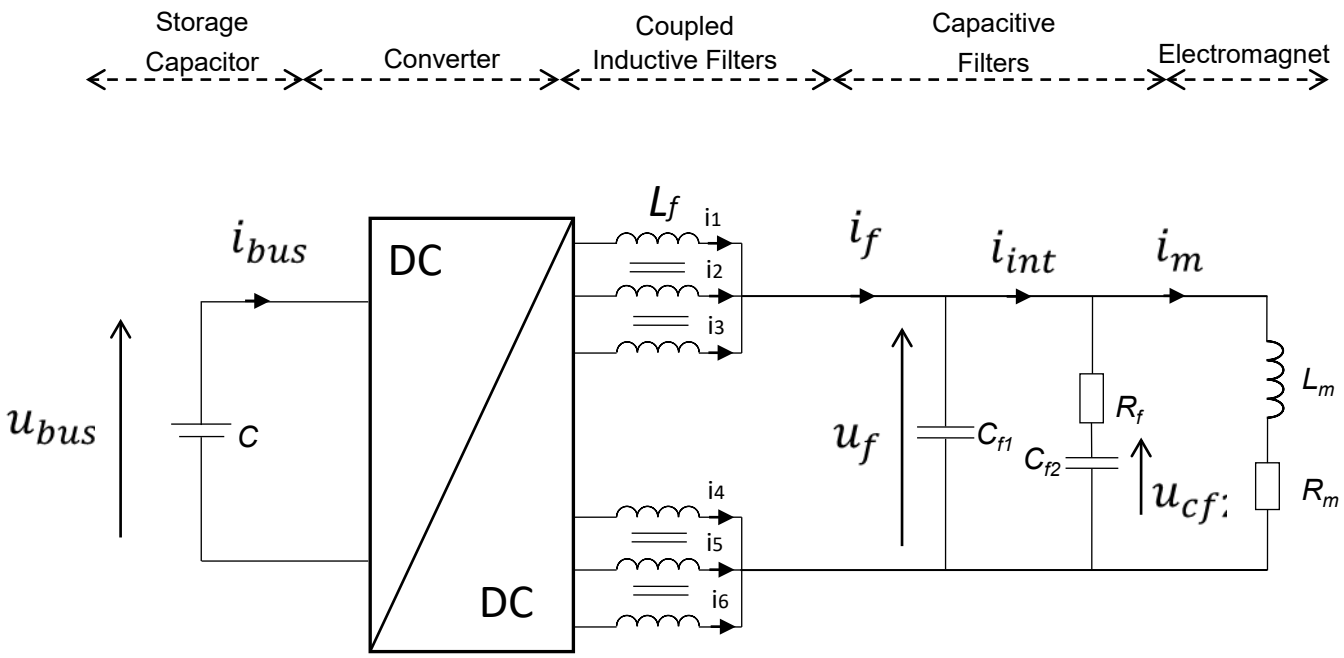


EMR-based Control of POPS

- Results of the simulation -

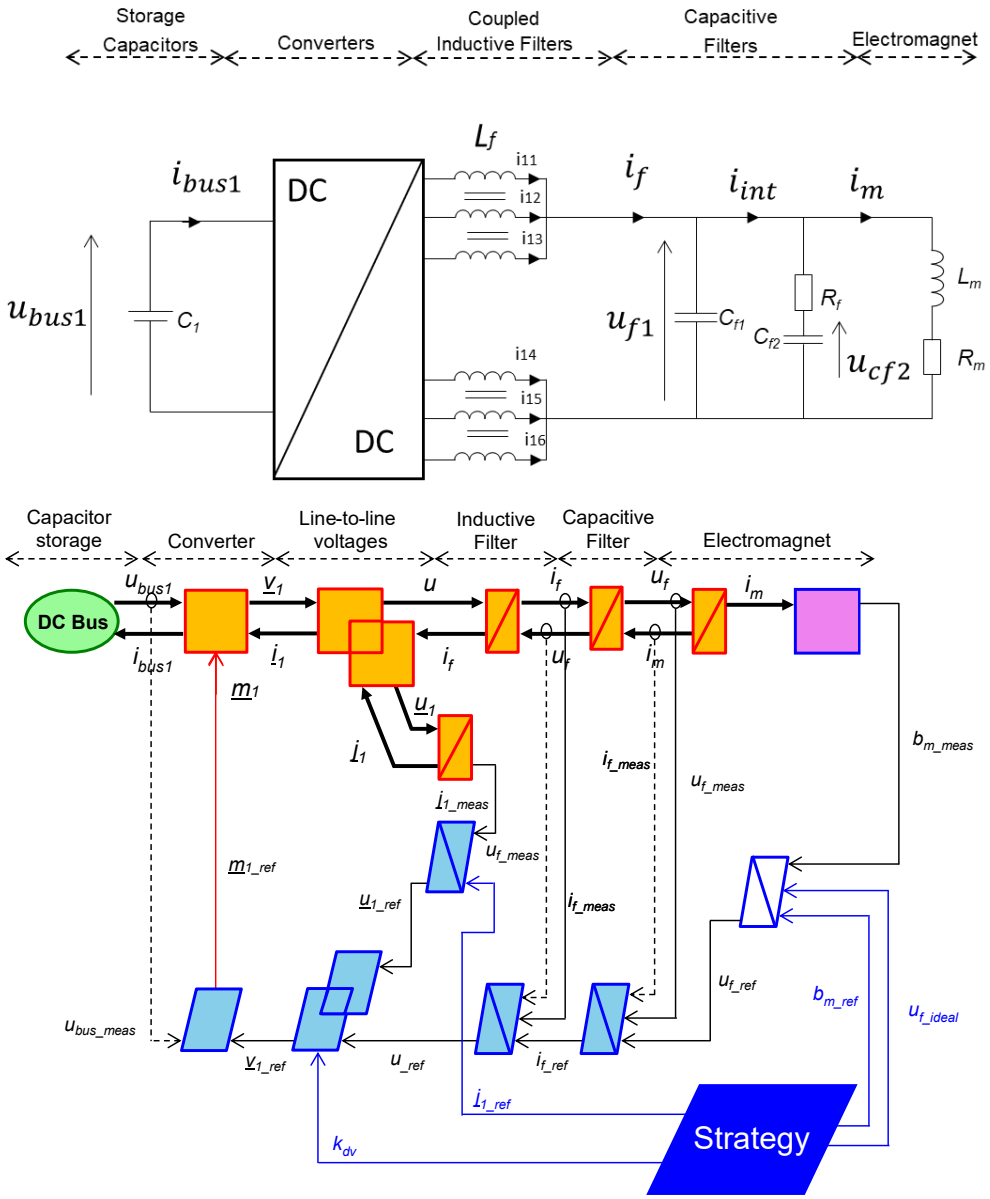


« RESULTS OF THE EXPERIMENTATION »



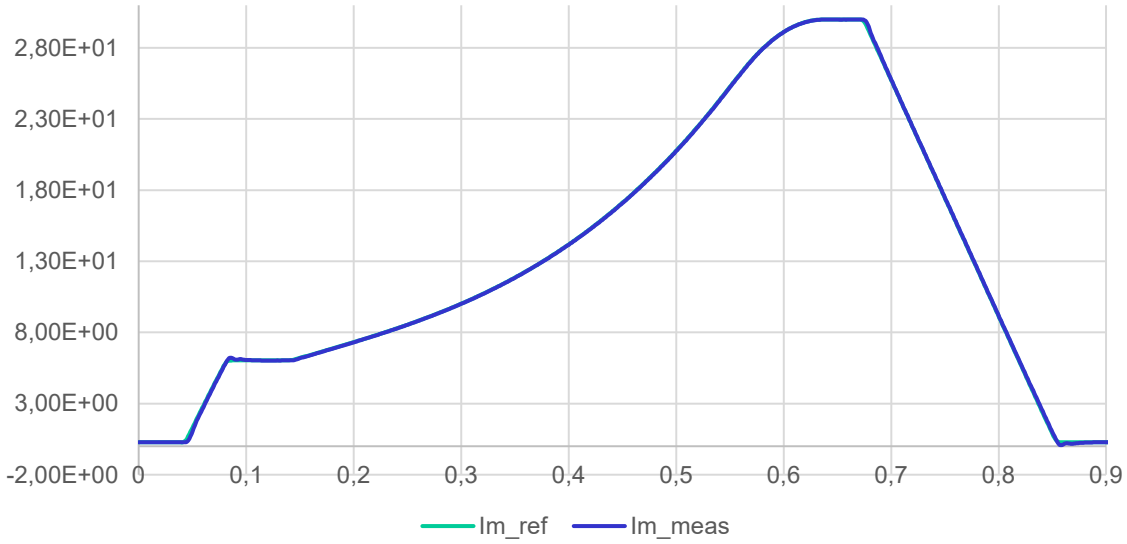
mini POPB = reduced power experimental set-up for first tests.

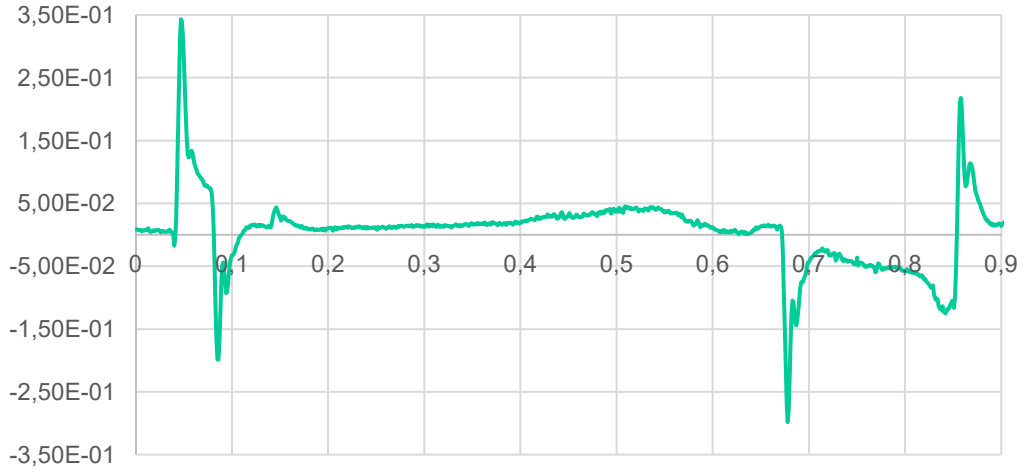
- EMR of MiniPOPSB -



- First Experiments results -

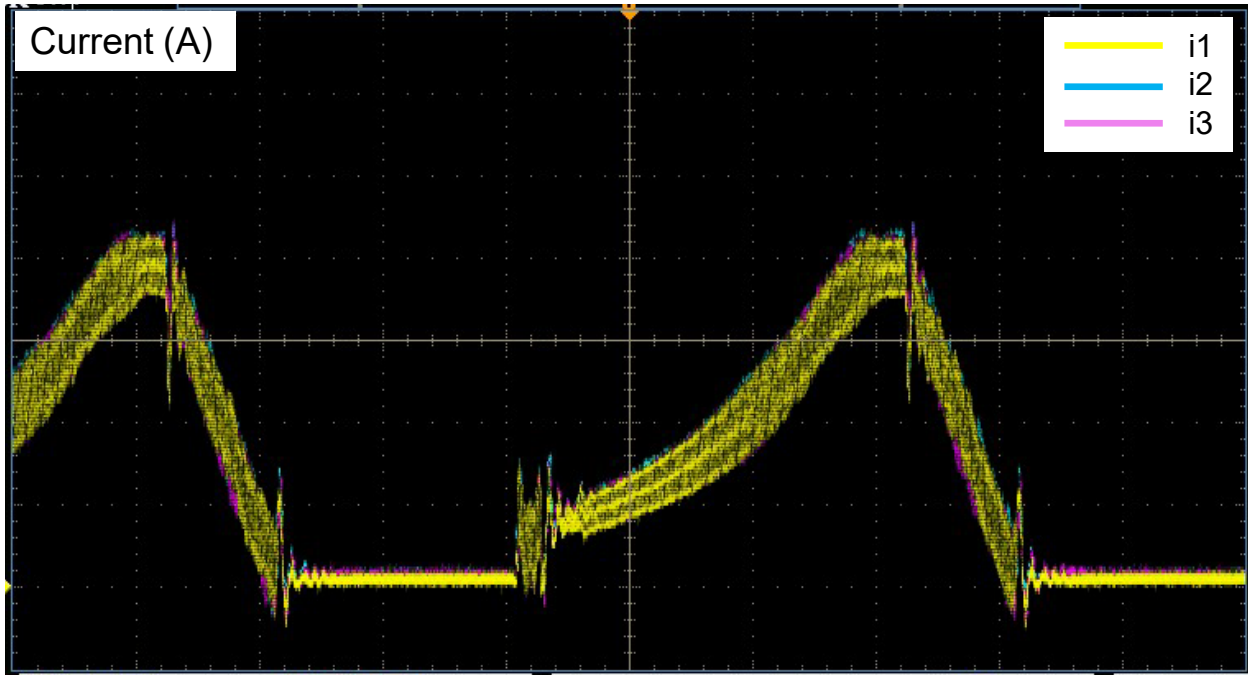
Current measurement, its reference and error



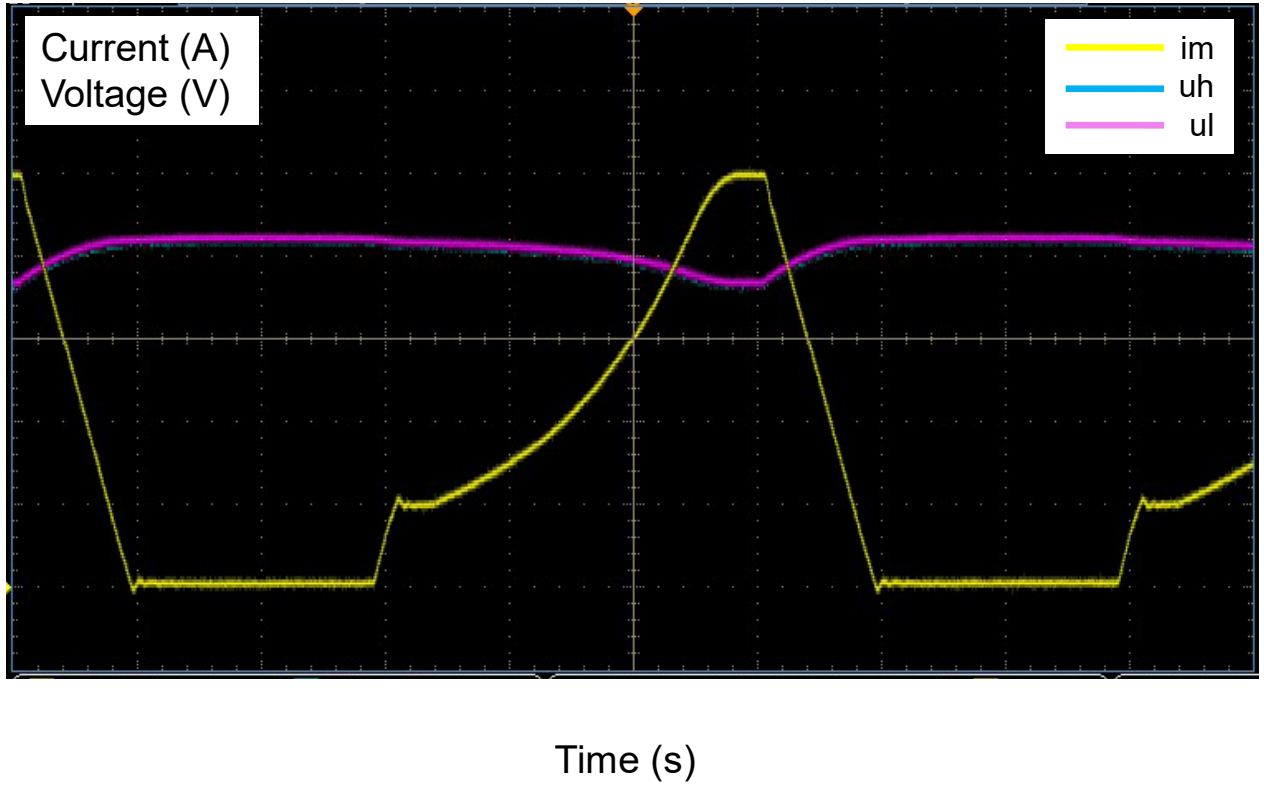


Time (s)

Current in the legs



Uh-Ul balancing



« CONCLUSION »

Realised work:
- Organisation of the model of the system
- Systematic organisation of the control
- High performances
- Experimental control validation on a part reduced-power system (miniPOPS-B)

Next step
- Real-time control of the full part of the reduced-power system (miniPOPS)

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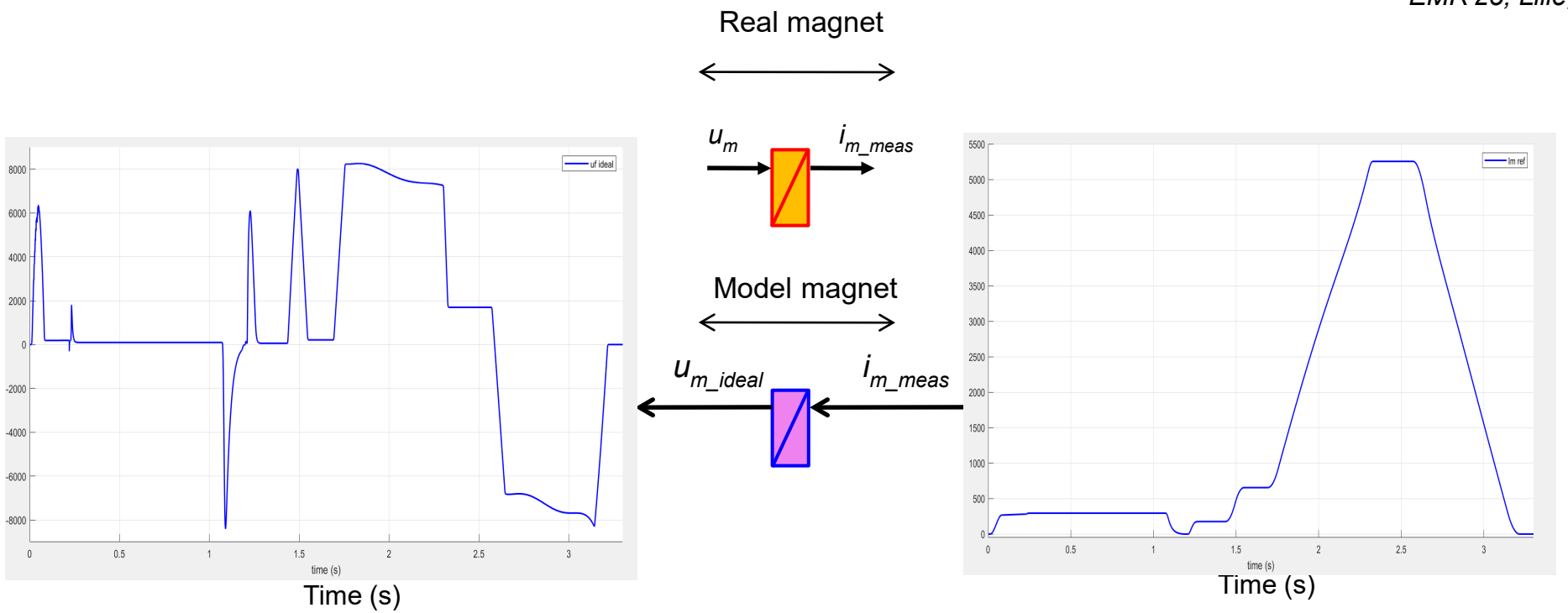
«Annexes »



True if we know the reference beforehand

$$u_{m\_ideal} = L_m \frac{di_{m\_ref}}{dt} + R_m i_{m\_ref}$$

- Flatness control -