



EMR'22
HES-SO Sion
June 2022



EMR'22 Summer School
“Energetic Macroscopic Representation”

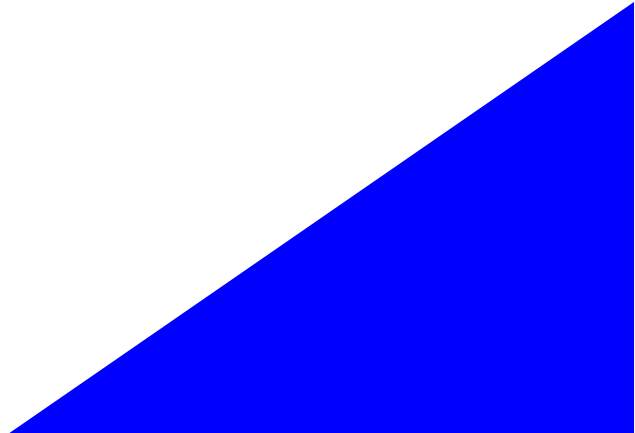
« EMR-based control of a particle injector »

**Gabriel GODART, Dr. Philippe DELARUE,
Prof. Alain BOUSCAYROL**

University of Lille, France



In collaboration with:



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Context and Objective

2

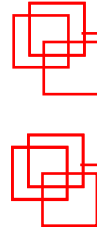
EMR and MCS of the System

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Simulation of the System



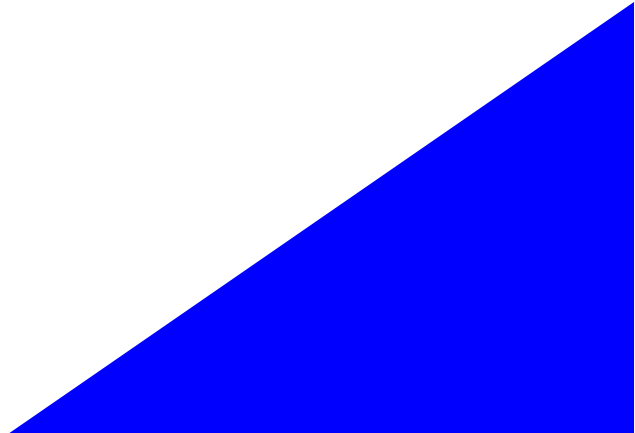
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« Context and Objective »



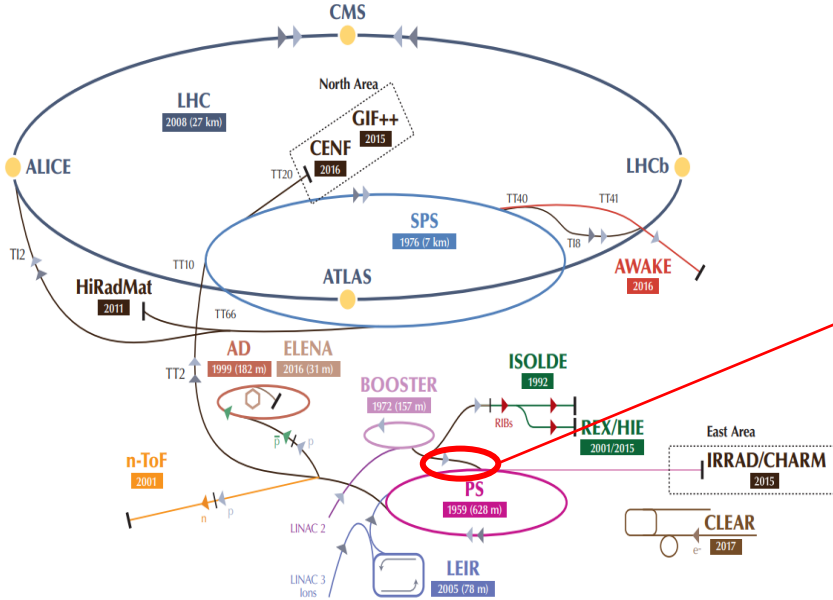
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- Context -

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CERN accelerator complex

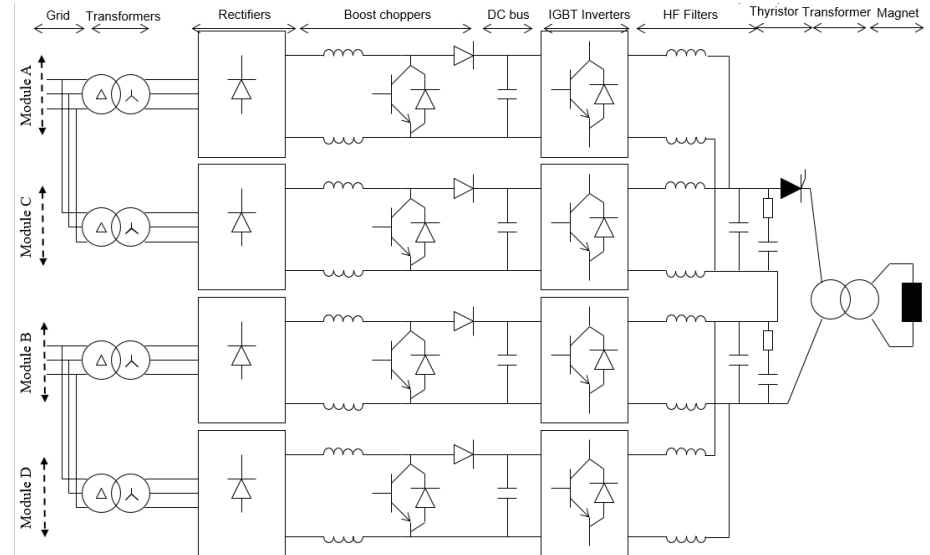


PS beam injection



4 classical magnets + 1 with pulsed transformer

supply system for each bumper:
SIRIUS FP2P2S
power converter



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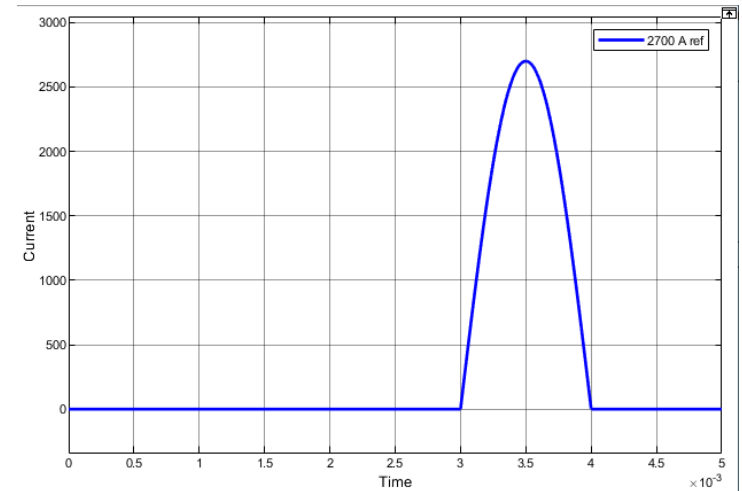
- Objective -

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Bumper magnets control requirements:

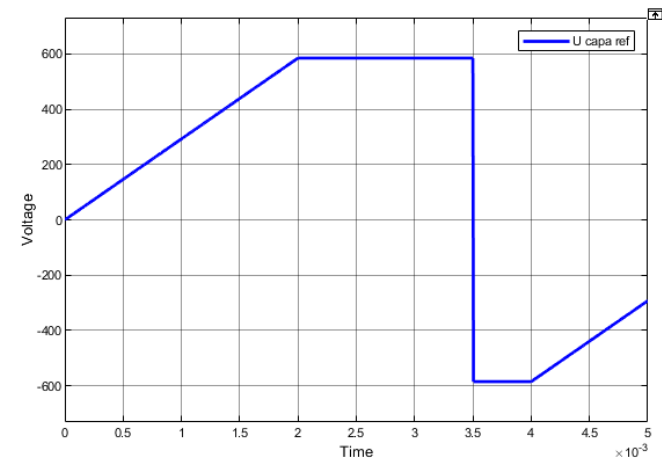
- complex supply system
- $\frac{1}{2}$ sine wave up to 2.7 kA
and 20 kA with transformer
- 1ms period
- repetition every 1.2s 24h/24h
- instantaneous error $< \pm 3.1$ A



High current / High dynamics
Ultra-high accuracy

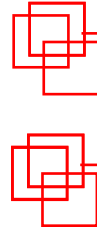
Require charge of the filters:

- Needs 2 controls





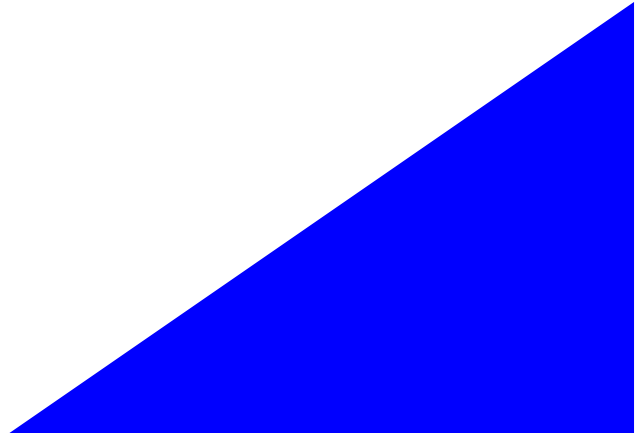
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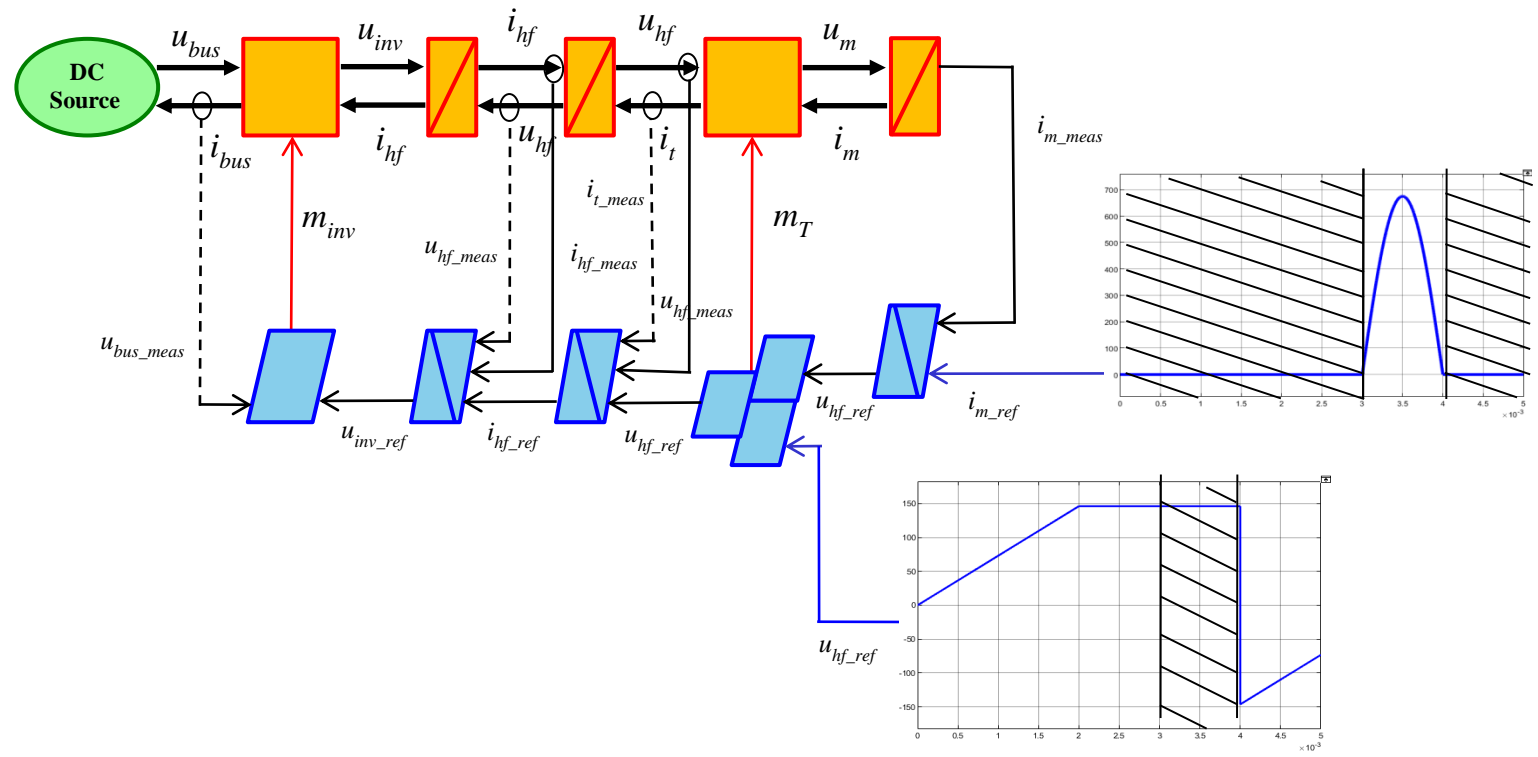
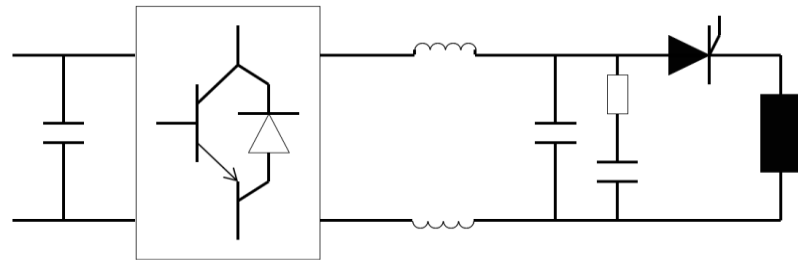
« EMR and MCS of the System »



EMR-based control of a particle injector

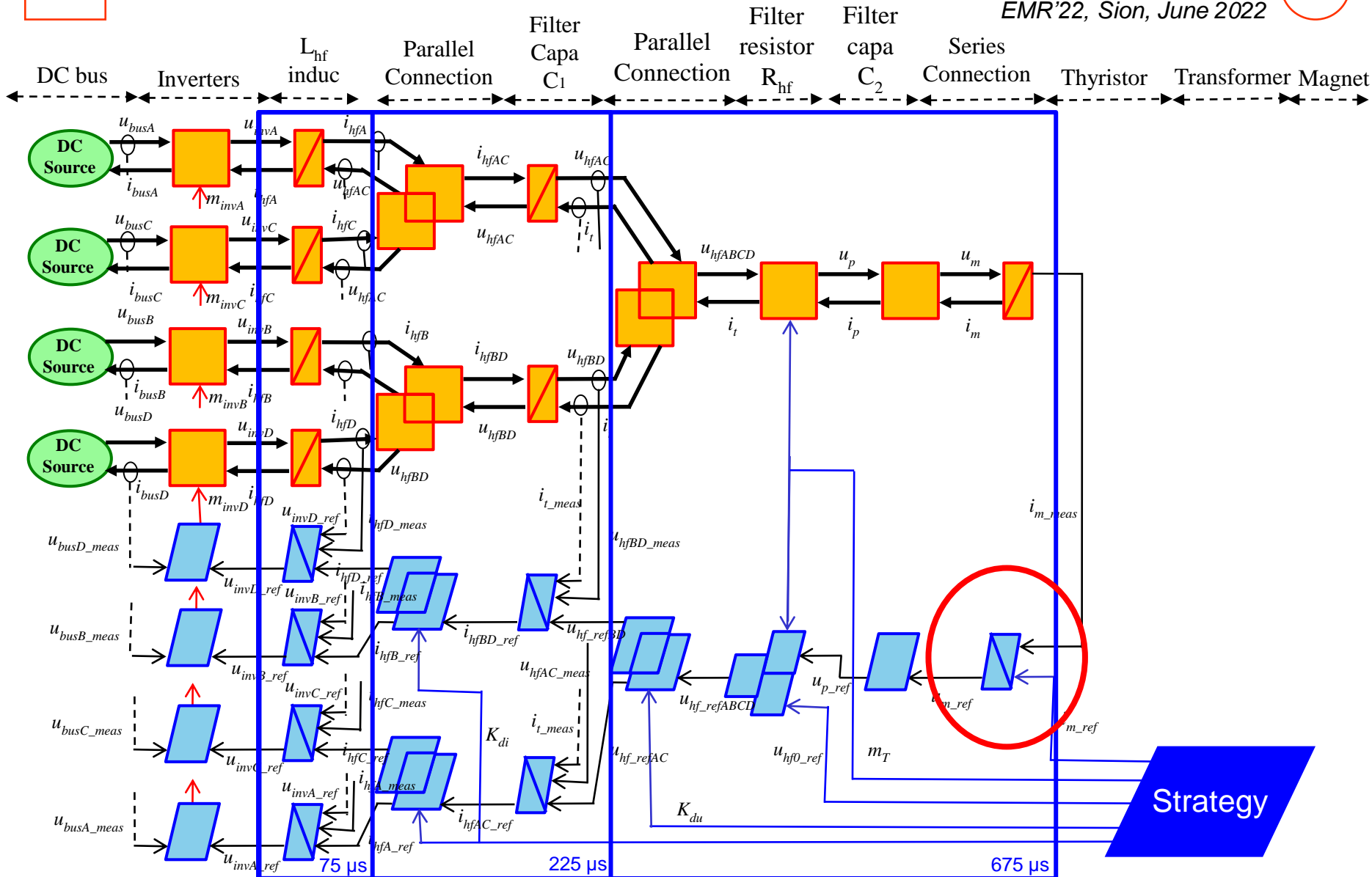
- EMR of the System -

DC bus IGBT Inverter HF Filters Thyristor Magnet



EMR-based control of a particle injector

- EMR of the System -

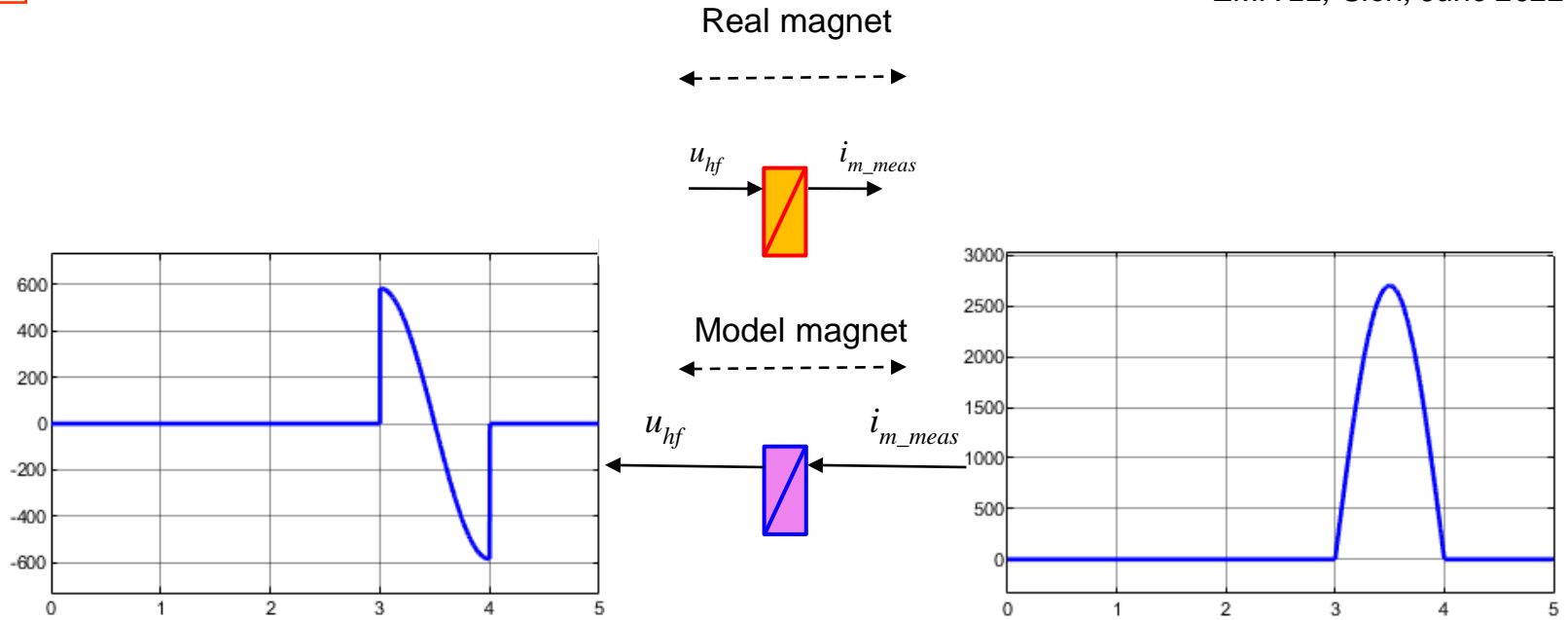


EMR-based control of a particle injector

- Flatness control -

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True if we know the reference beforehand

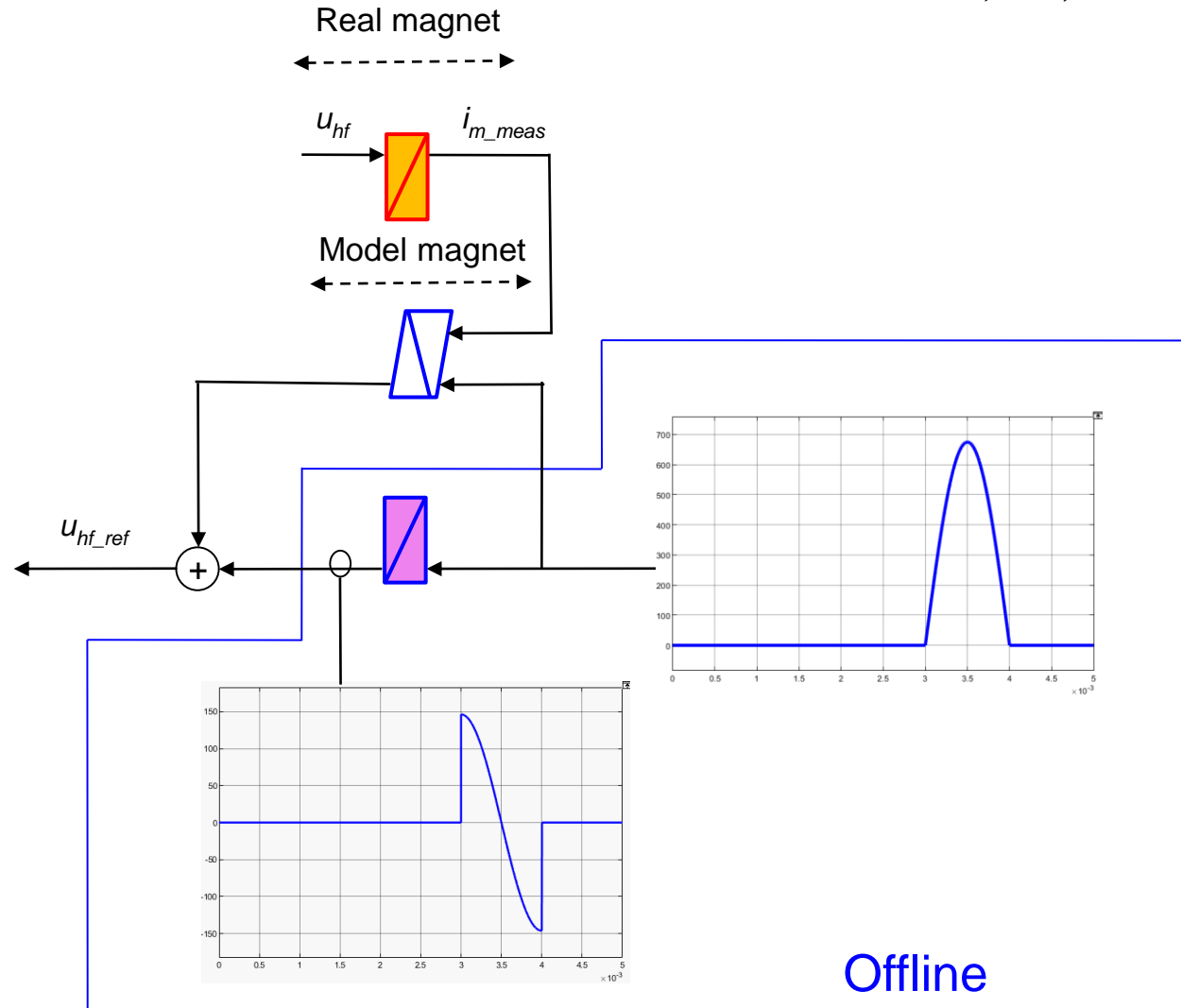
$$u_{hf_ideal} : L_m \frac{d}{dt} i_{m-ref} + R_m i_{m-ref}$$

EMR-based control of a particle injector

- Flatness control -

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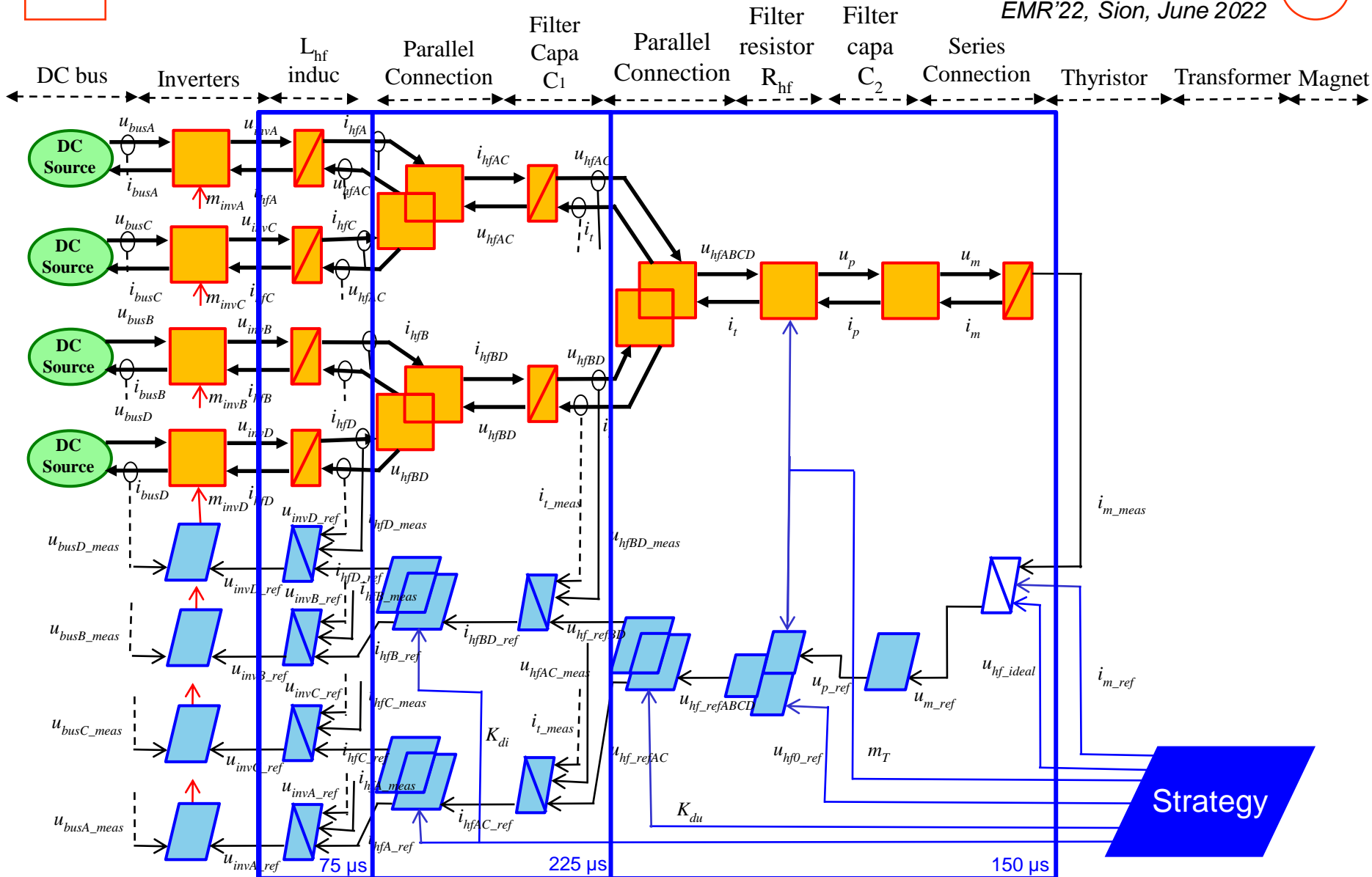


EMR-based control of a particle injector

- EMR of the System -

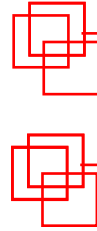
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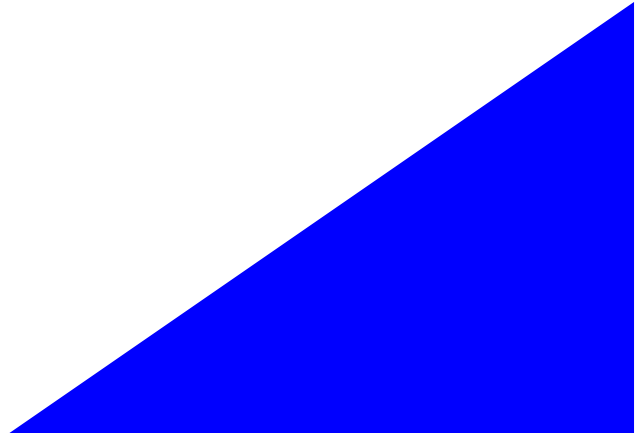
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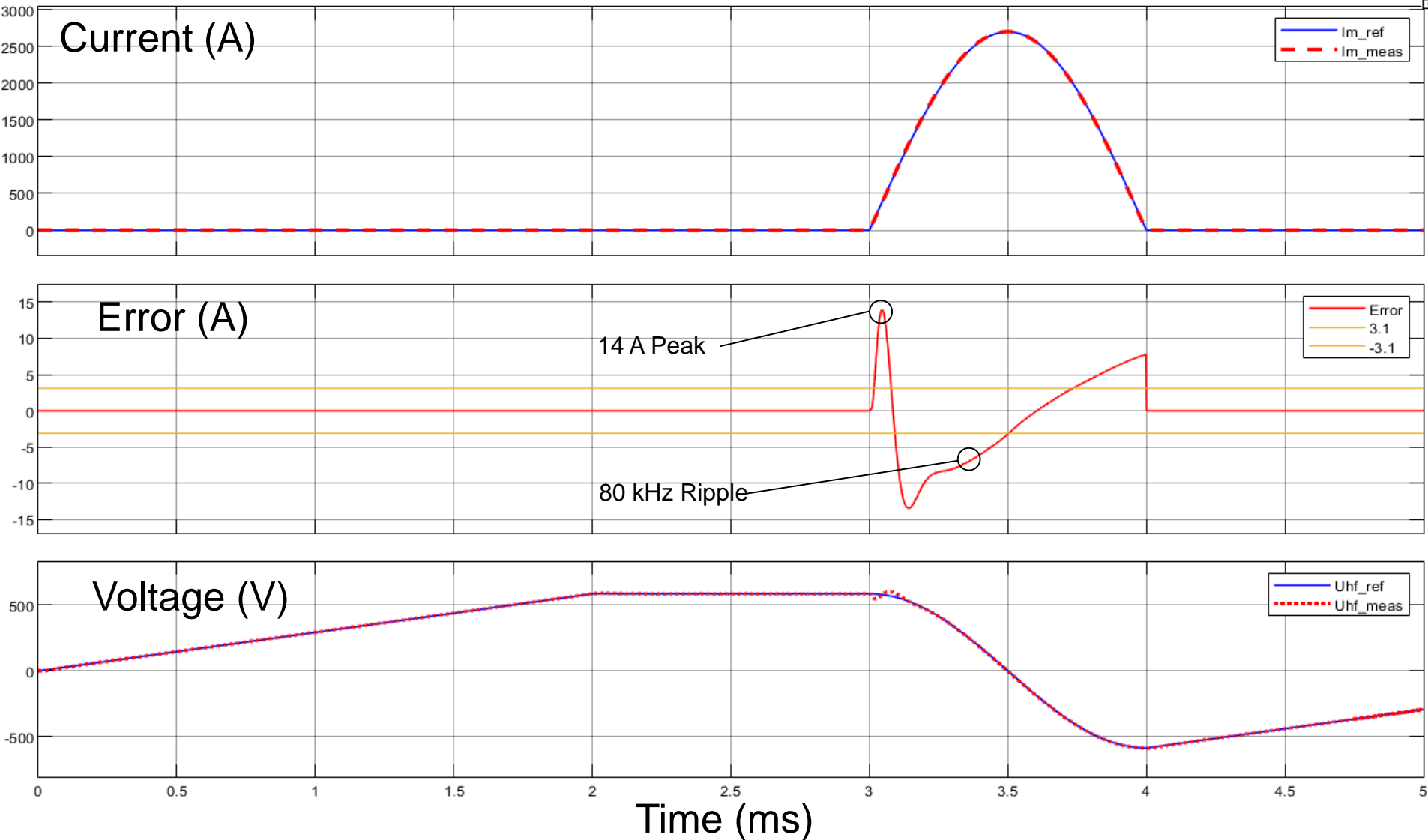
EMR-based control of a particle injector

- Simulation of the System -

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Reference and measure of the current its error and the voltage



EMR organize well the system

Allow the implementation of different strategies

Improving discrete response time should be done

In the process of comparing with state feedback control