



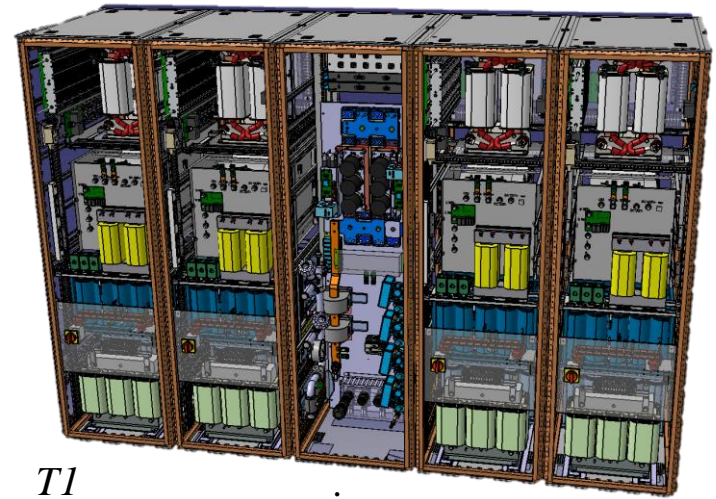
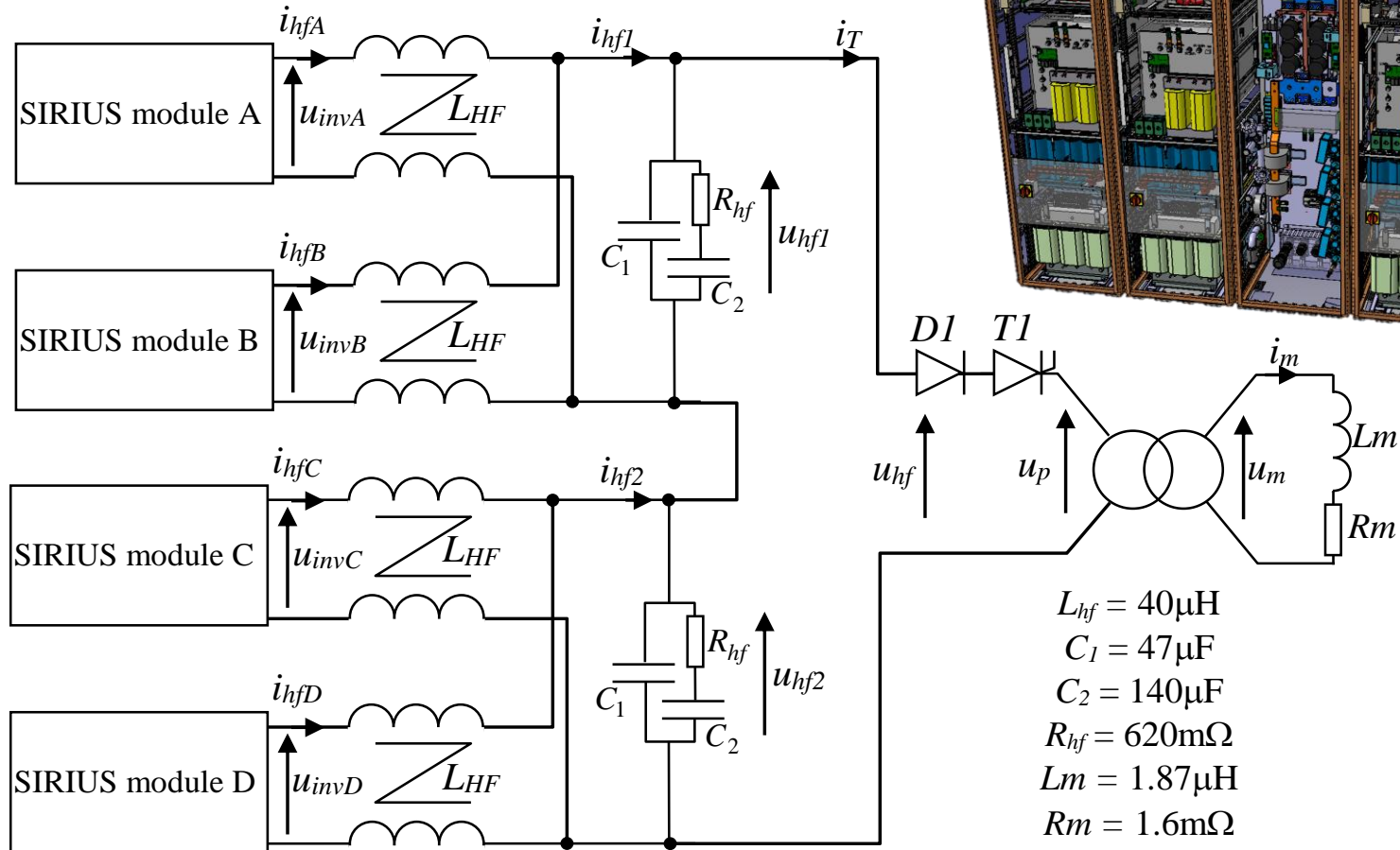
**Ludovic HORREIN**  
**SY - EPC - FPC**

# Control structure design of SIRIUS FP2P2S using EMR approach

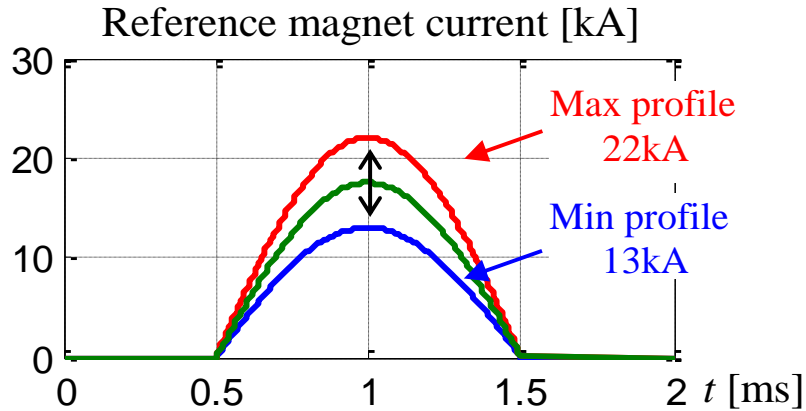
# System

# Specific structure of SIRIUS FP

BSW 42

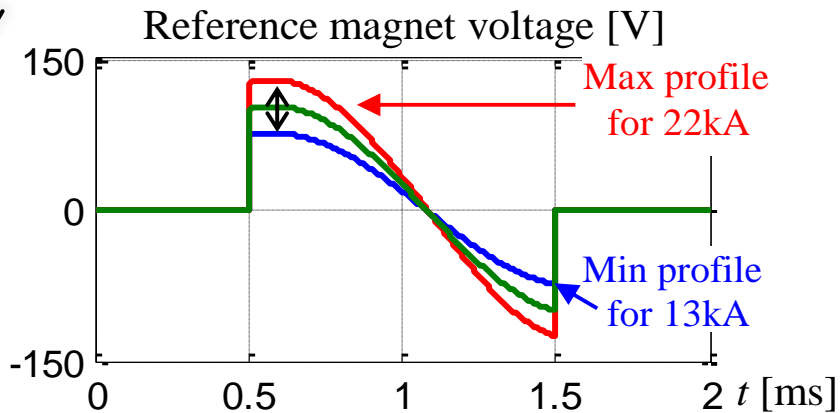


# Output Diode-Thyristor



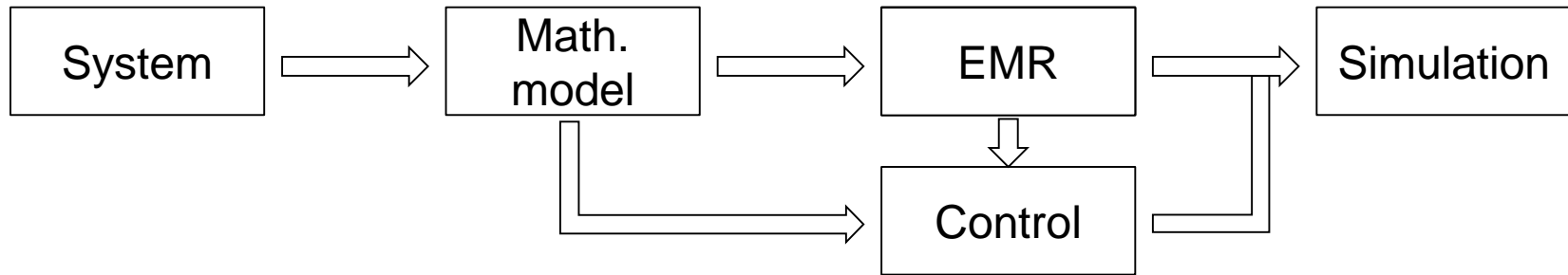
Thyristor: Allows voltage step

Diode: Avoid negative current during the opening time of the thyristor



# EMR and Control

# Description tool and EMR



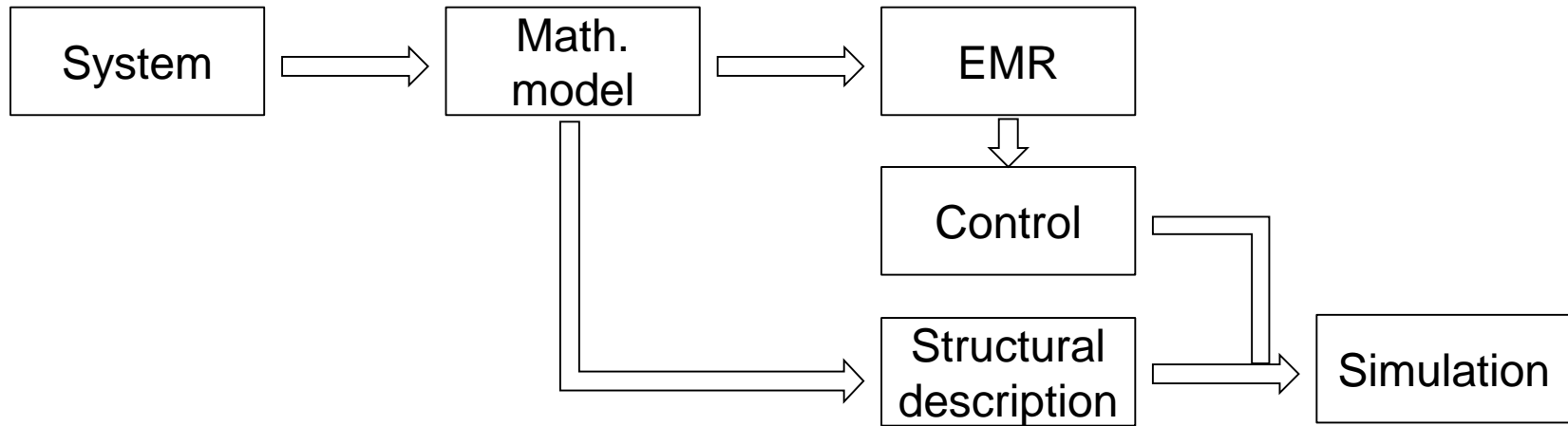
Description tool =>

- Simplify the interconnection between sub-models
- Analyse state variables / energetic flows...

EMR Description tool =>

- Allow interconnection following causality principle
- Highlight action/reaction principle (energetic flows)
- Systematic control structure design

# Structural / Functional description



Structural description

=> organisation following real structure

Functional description

=> organisation following energetic function

With current simulator based on 'structural description' (Simplorer, SimPowSyst)

=> Fast simulation files design, Large components library available,  
Easy to modify models (add phenomena)

EMR is a functional description tool



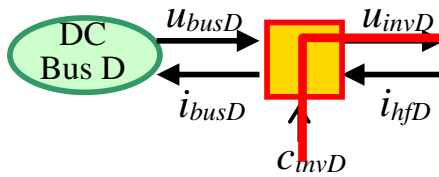
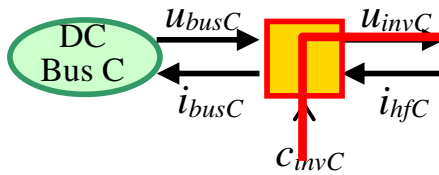
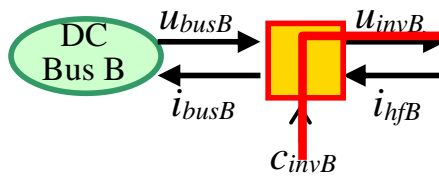
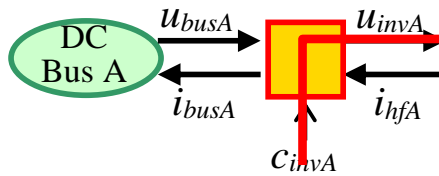
# EMR pictograms

	<p>Power Source</p>		
	<p>Power conversion</p>	<p>Direct inversion</p>	$\begin{cases} U_{sec} = K_t U_{prim} \\ I_{prim} = K_t I_{sec} \end{cases}$ $U_{prim\_ref} = \frac{1}{K_t} U_{sec\_ref}$
	<p>Energy accumulation</p>	<p>Closed-loop control</p>	$I_L = \frac{1}{L_m \cdot s + R_m} (U_1 - U_2)$ $U_{1\_ref} = \left( k_p + \frac{k_i}{s} \right) (I_{L\_ref} - I_L) + U_2$
	<p>Power distribution</p>	<p>Inversion with distribution criteria</p>	$I_1 = I_1 + I_2$ $\begin{cases} I_{2\_ref} = k_d I_{1\_ref} \\ I_{3\_ref} = (1 - k_d) I_{1\_ref} \end{cases}$

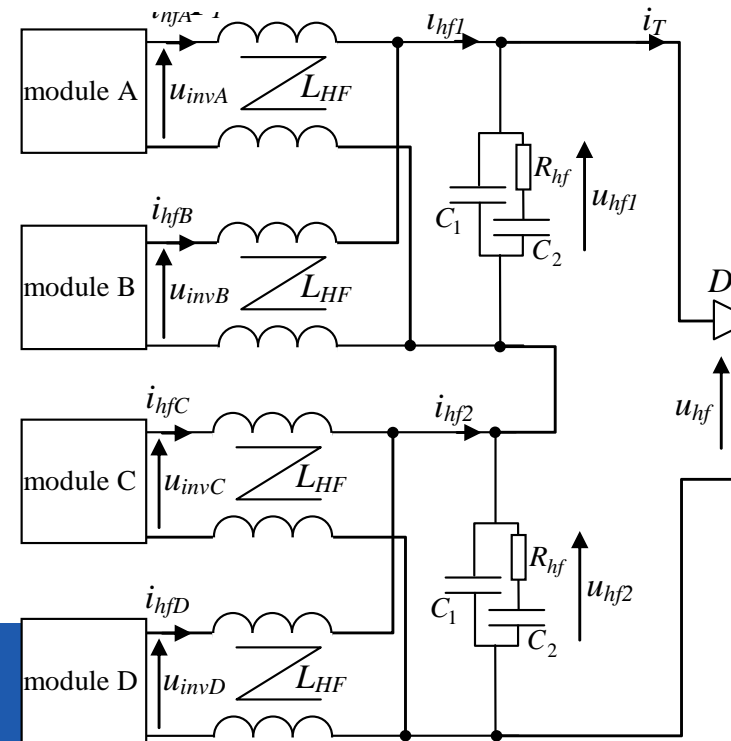
# Modelling, EMR and Control (IBC)

# EMR

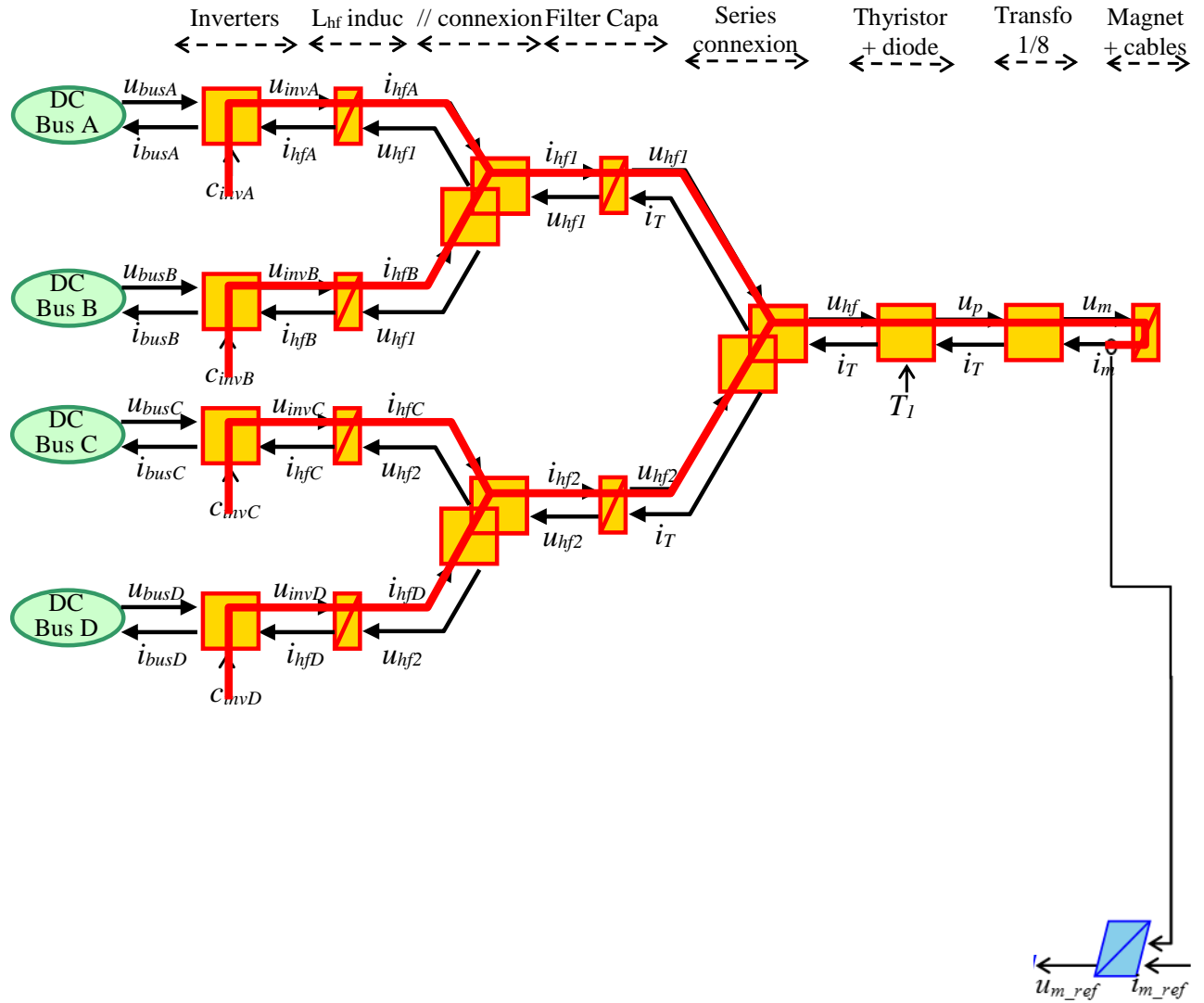
Inverters  
←-----→



 Tuning path



# IBC



# Control IBC

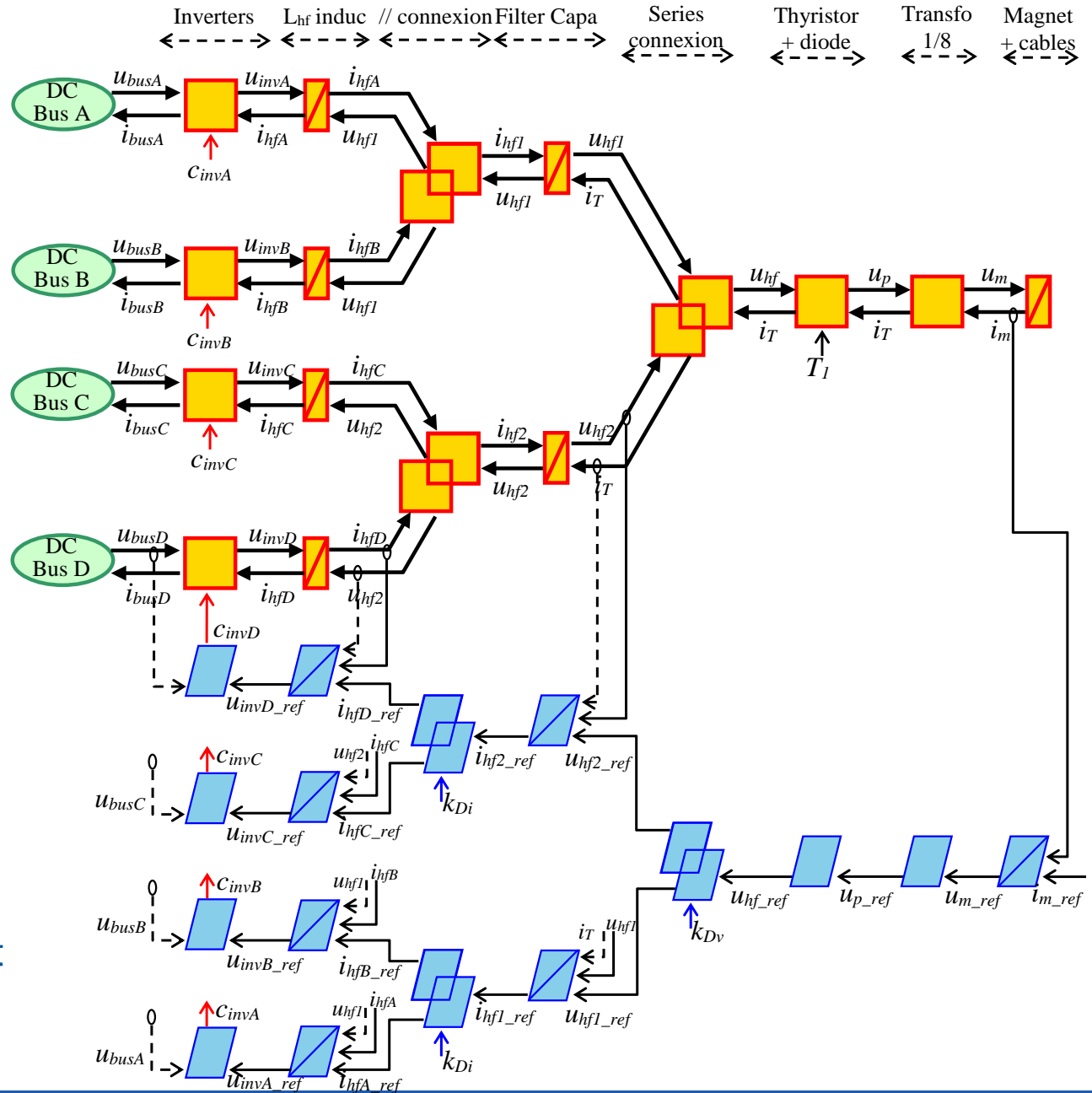
All control loops are designed independently

Param of inversed model

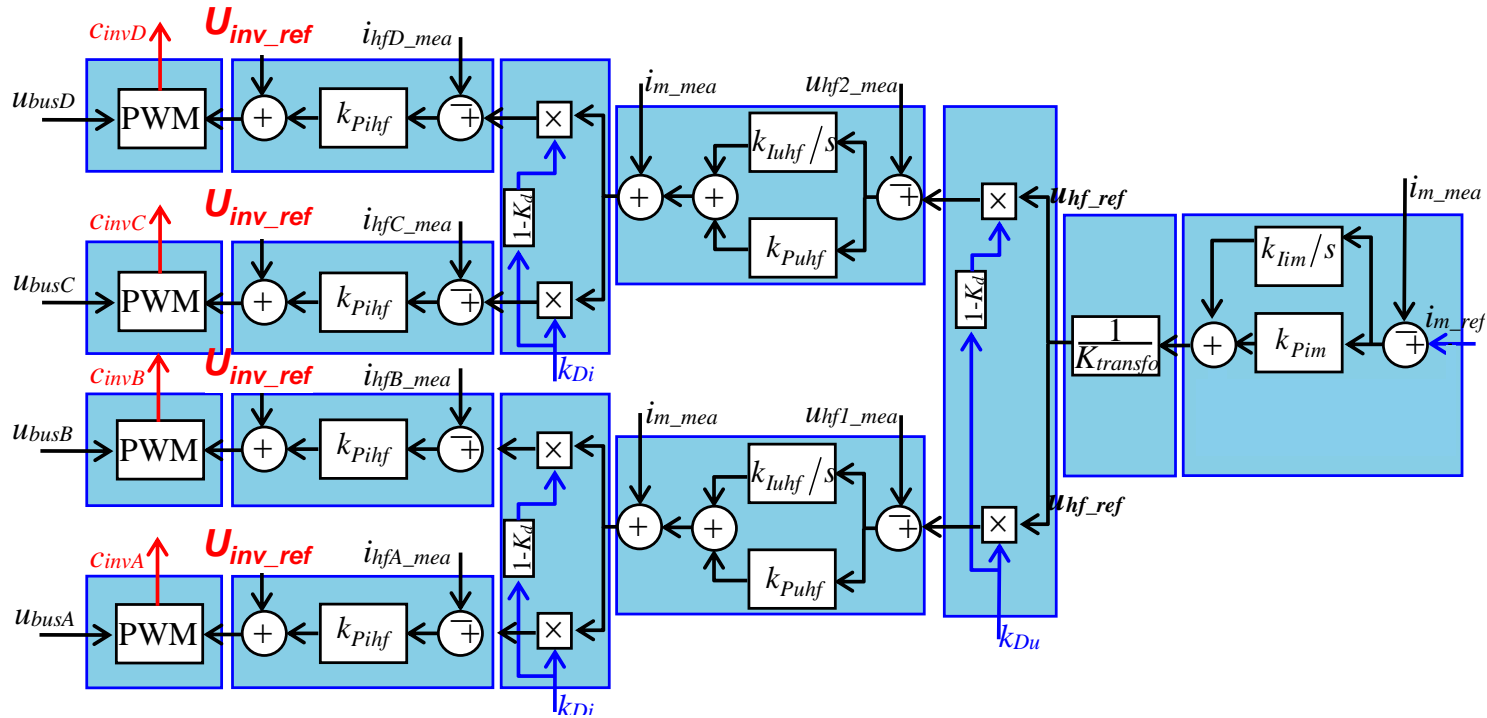
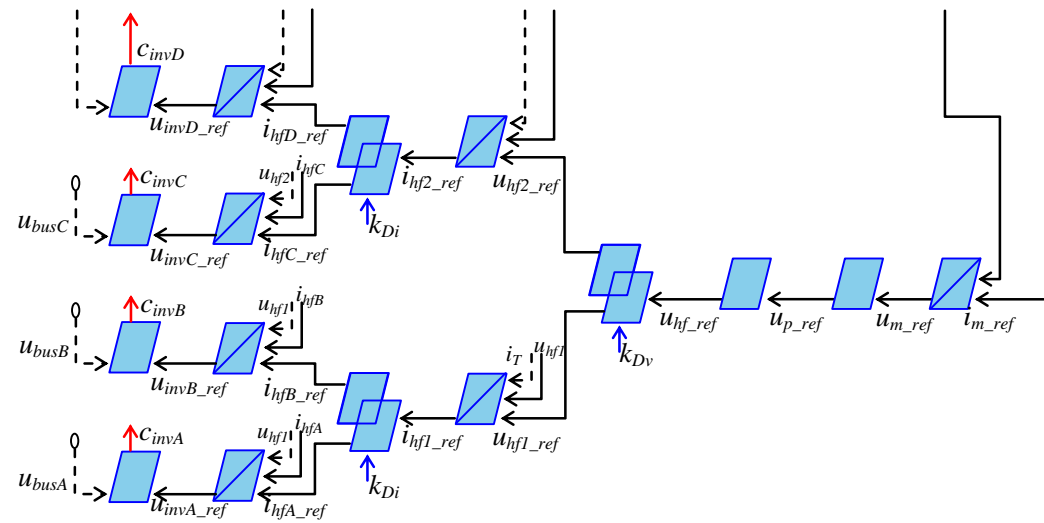
Desired local performance

Possibility to test each loop progressively

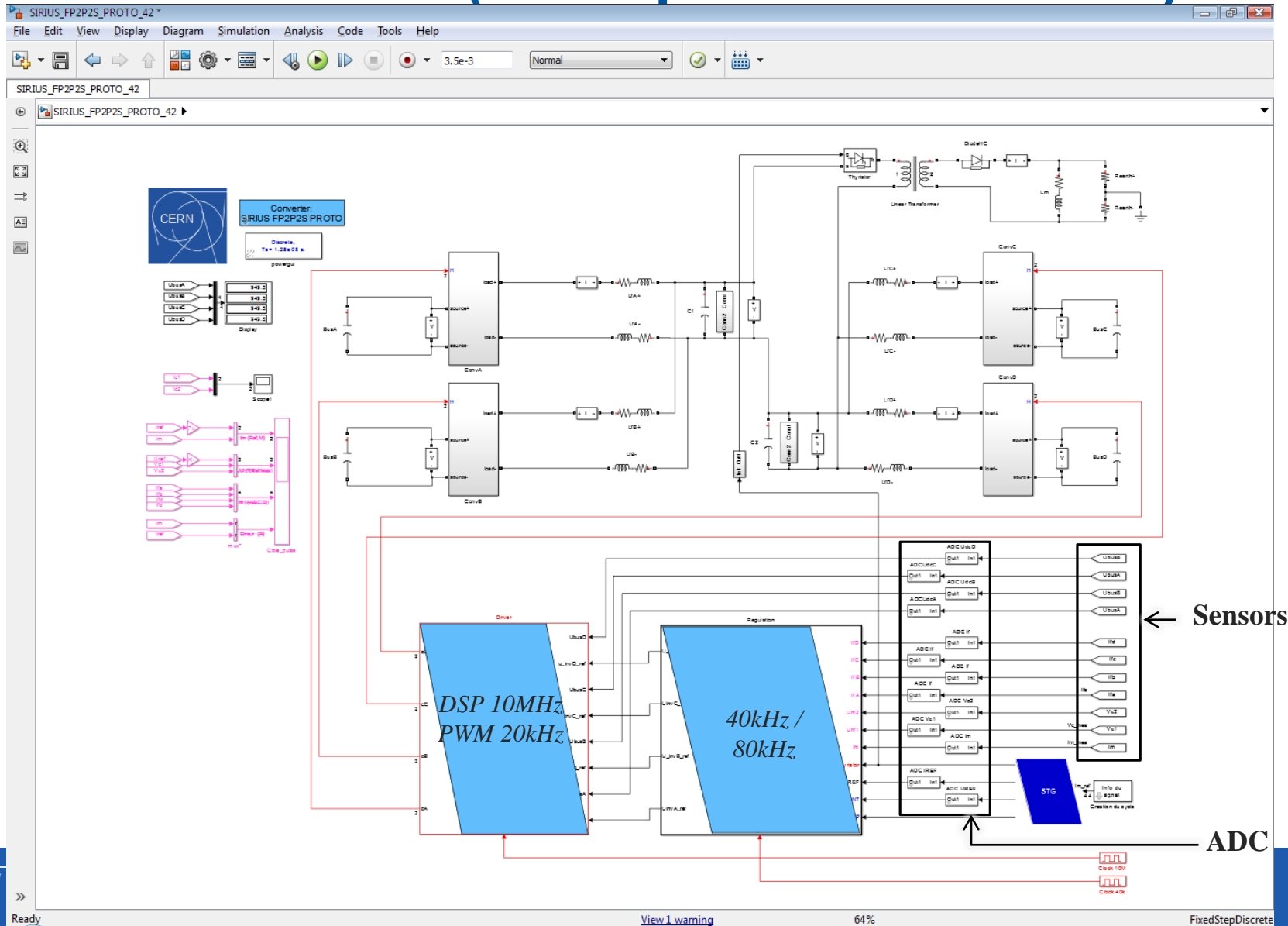
Constraint: Each loop must respects the dynamics separation criteria



# Regulation



# Simulation (Simpower - IBC)

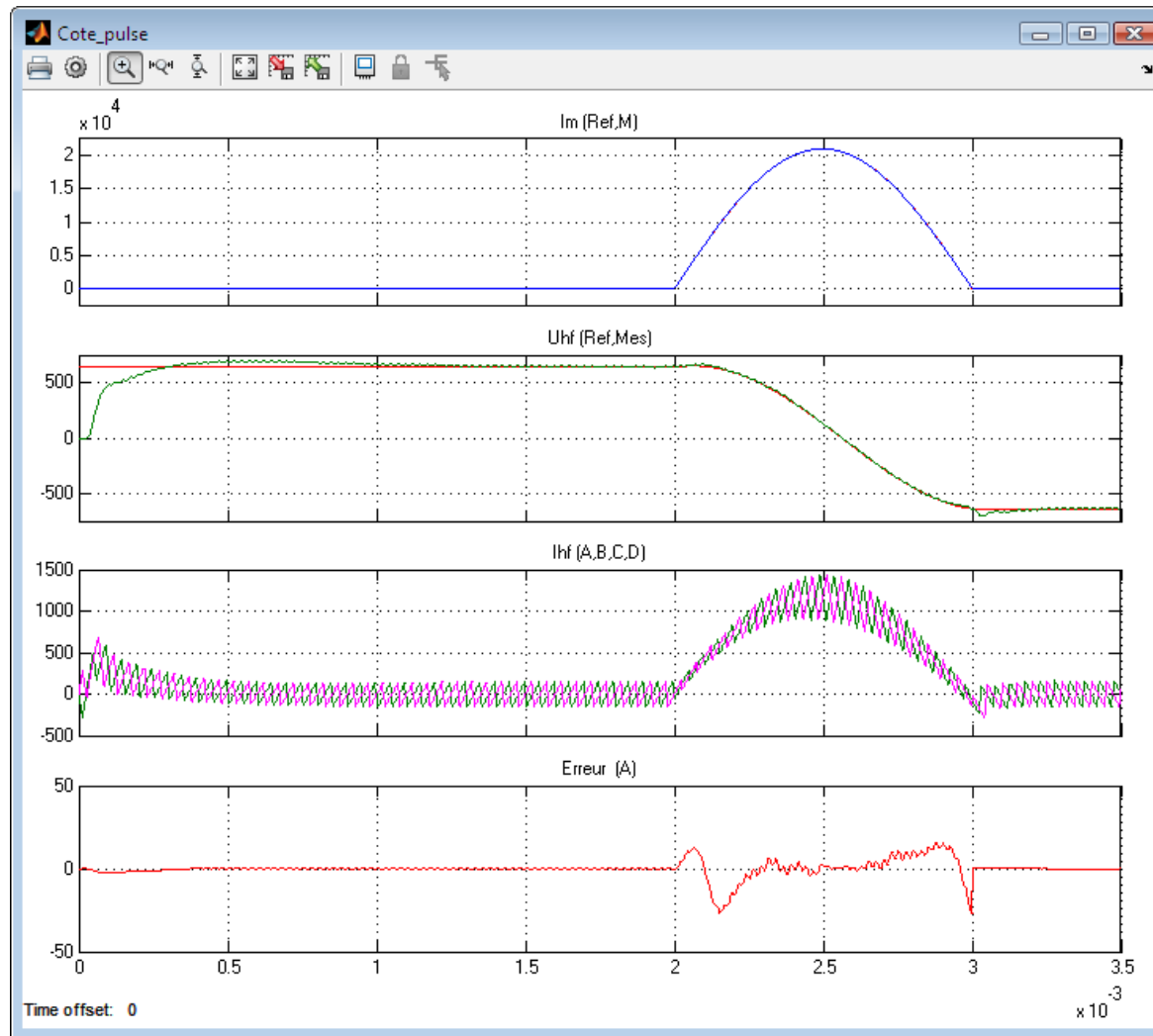


← Sensors

ADC



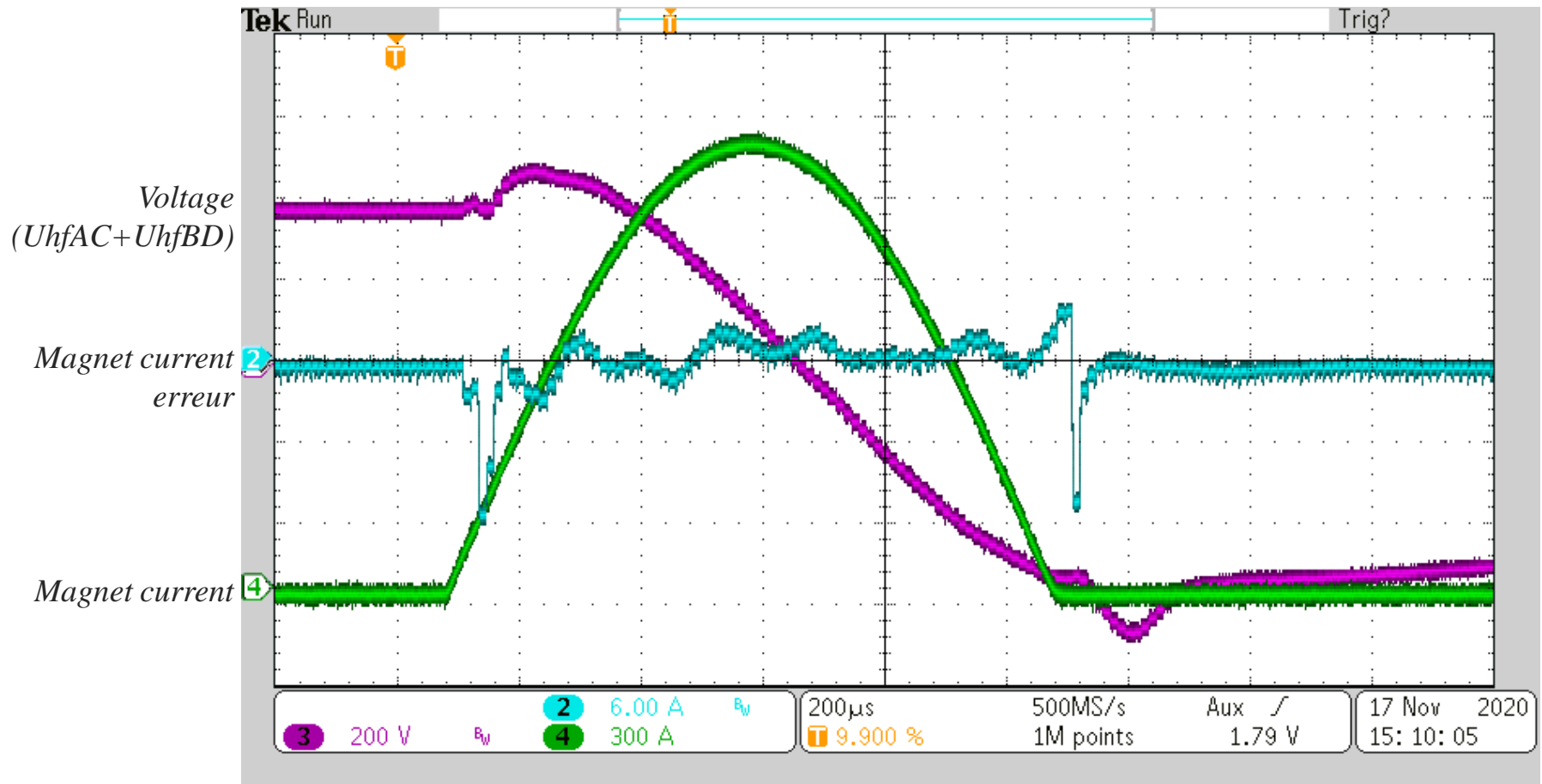
# Simulation results (Simpower-IBC)



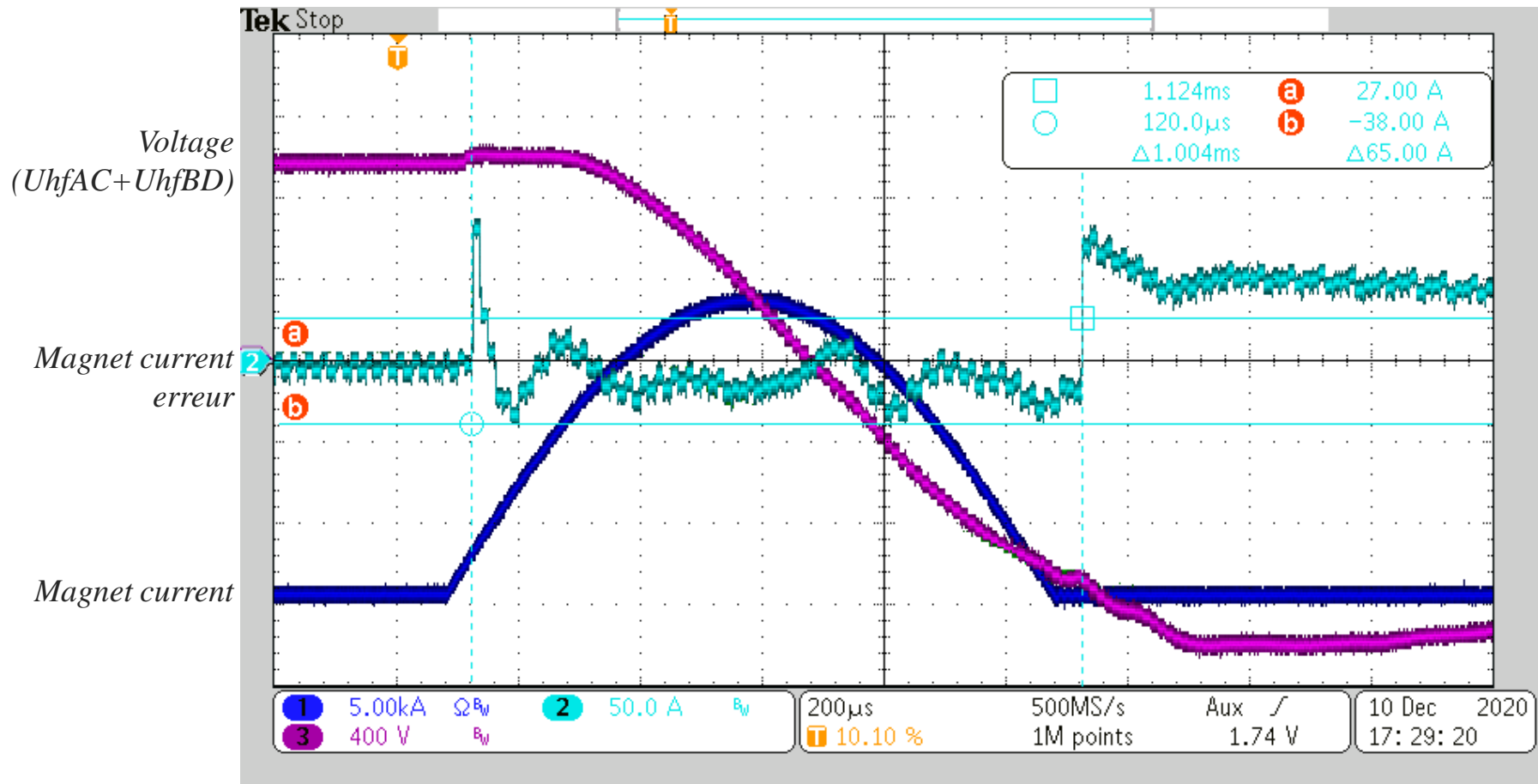


# Implementation

# Experimentation 1678A



# Experimentation 18 kA



# Comparisons

Amplitude	1 boucle	2 boucles	3 boucles
1750 A	1.54%	0.68%	0.28%
2000A	1.67%	0.72%	0.22%
2250A	2.08%	0.6%	0.25%
2500A	2.4%	0.736%	0.30%

