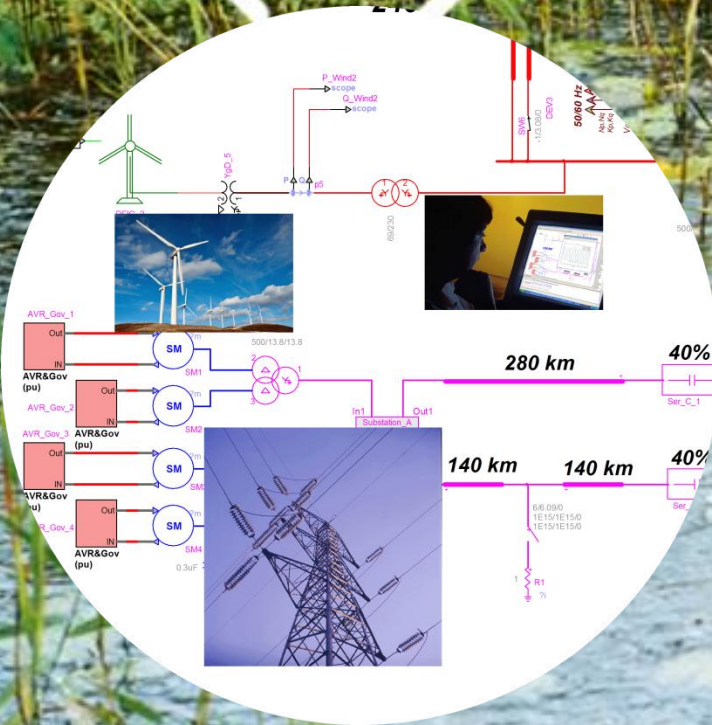


Usage of EMTP-RV for Nuclear Power Plant Studies

Ali El-Akoum, Alain Xemard



CHANGER L'ÉNERGIE ENSEMBLE

Schedule of the presentation

- 1. Introduction**
- 2. Qualification of the software**
- 3. The preparation of models for nuclear plants system modelling**
- 4. Perspectives**

Introduction

Nuclear plants include a huge number of very different and complex electrical components.

Most of these components interact together.

Stakes are very high in terms of availability, reliability, life span and safety.

It is necessary to prove that software programs used for numerical simulation work adequately. This is the role of the qualification.

The Qualification of EMTP-RV

The **qualification** is to be conducted field of application by field of application.

Or

for each study which is not part of a field of applications already covered by the **qualification**.

Performance of the qualification : the results of the software are compared on test cases with :

- field measurements,
- results from other software programs,
- analytical calculations, etc.

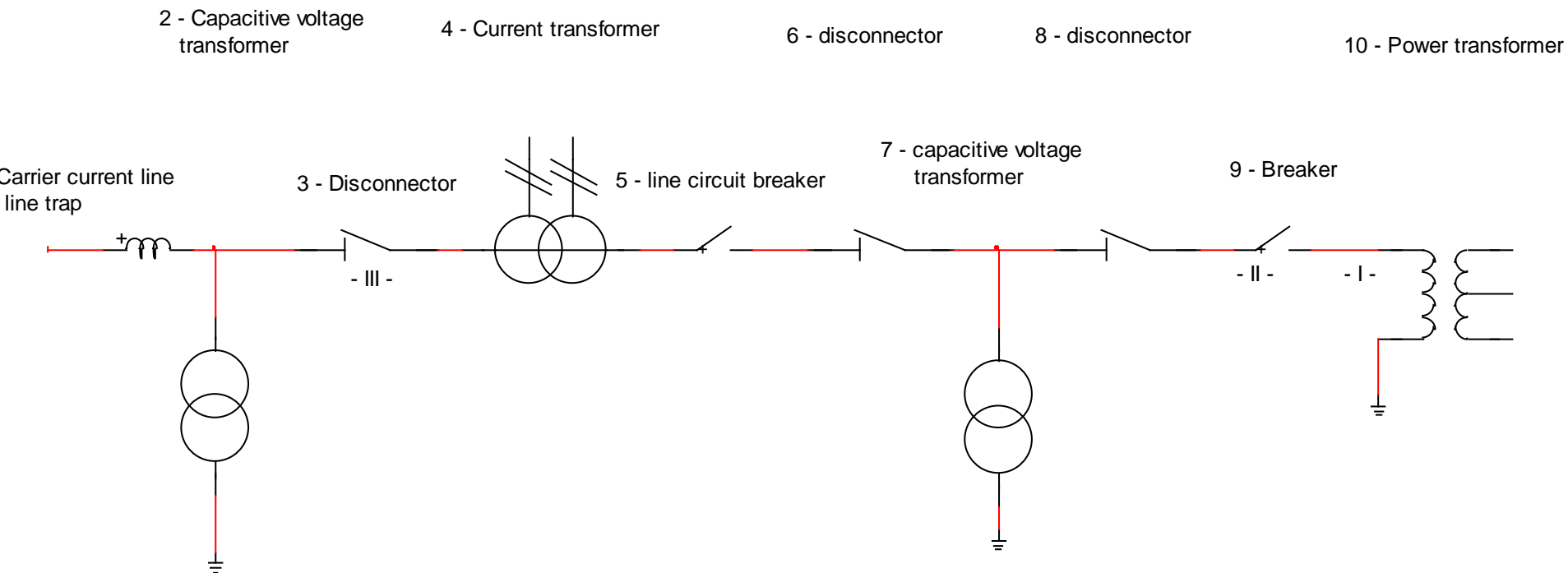
The qualification of EMTP-RV

In 2011, EMTP-RV version 2.1 was qualified for **fast-front-overvoltage** studies (lightning) ;

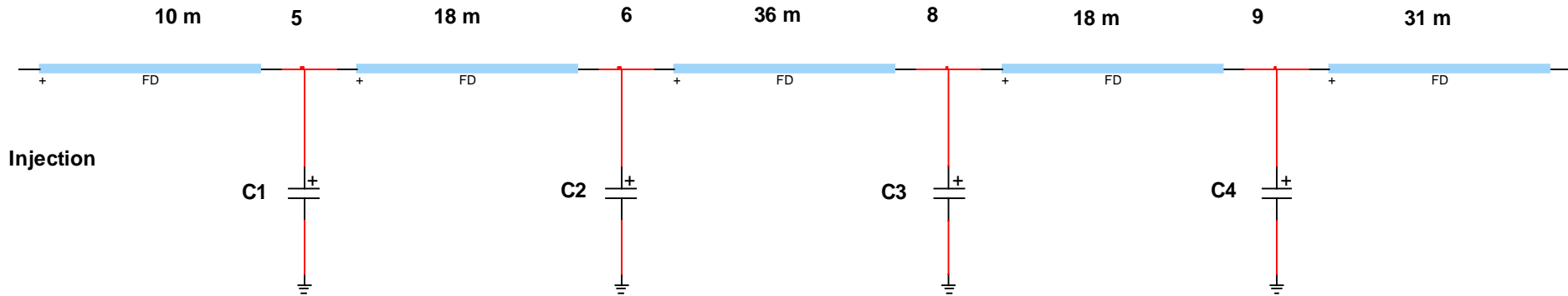
In 2012, the qualification of the **low frequency transformer models** of EMTP-RV is in preparation.

Example of Test Case – FFO measurements in the substation of Avalon

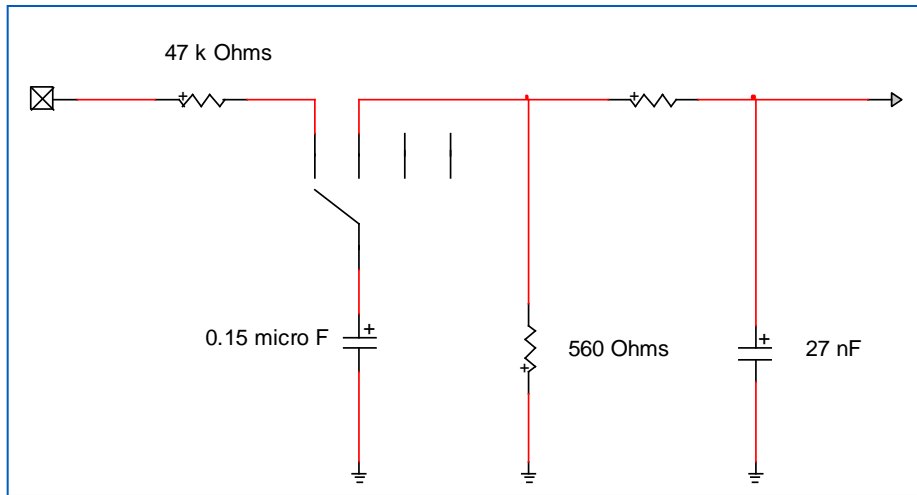
This is an outdoor substation 245 / 63 / 20 kV. This is a 2-busbar substation. When the tests are performed only one line and one transformer are available.



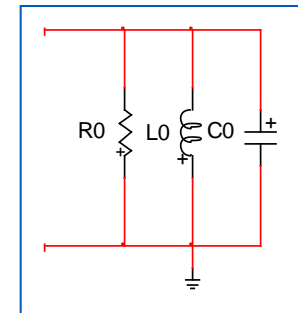
Modeling of the substation



Capacitance	value (pF)
C1 – circuit breaker at 5	100
C2 – capacitance of the disconnector at 6	50
C3 – capacitance of the disconnector at 8	100
C4 – capacitance of the circuit breaker at 9	50

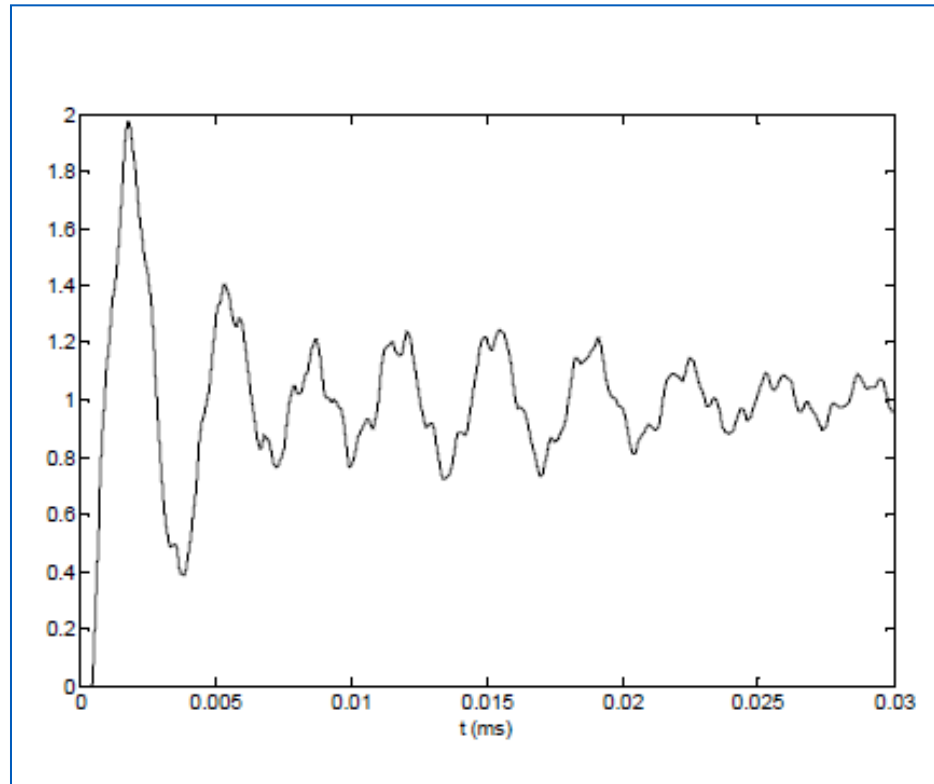


Representation of the pulse generator



Representation of the transformer

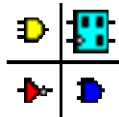
Injection of an homopolar pulse at point 3



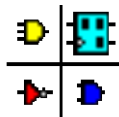
	EMTP-RV	Measurements
Pseudo-frequency	289 kHz	296 kHz
Crest value	2 pu.	1.9 p.u.

3 – Models for nuclear plants system

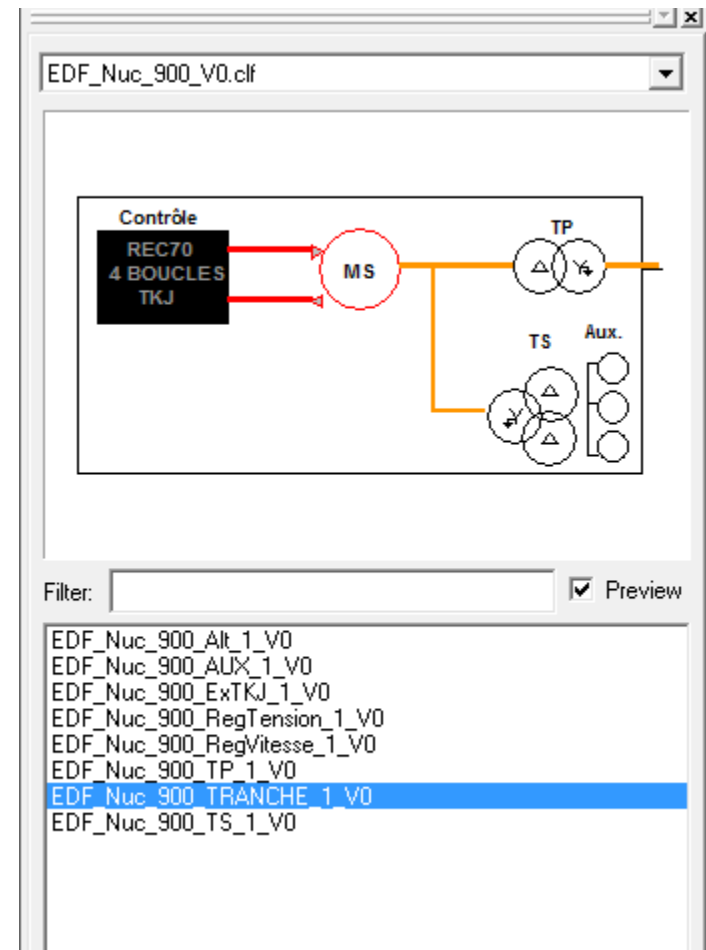
▶ Libraries



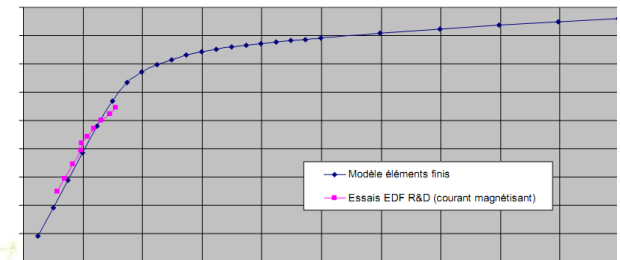
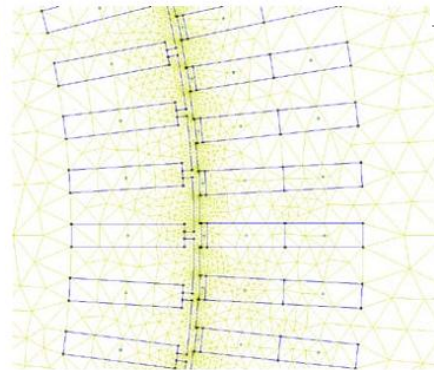
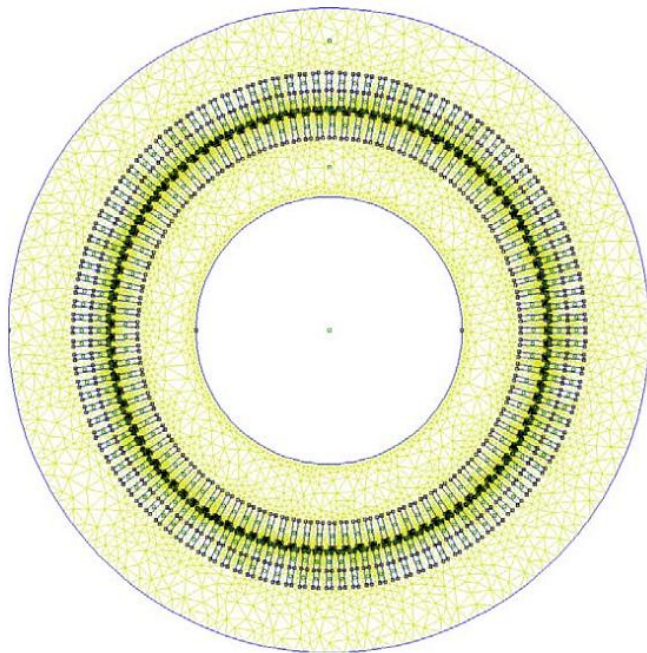
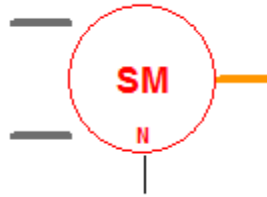
EDF_Nuc_900MW.clf



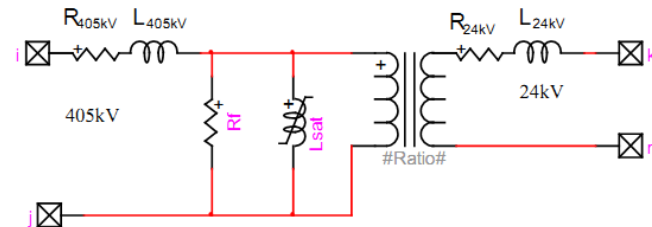
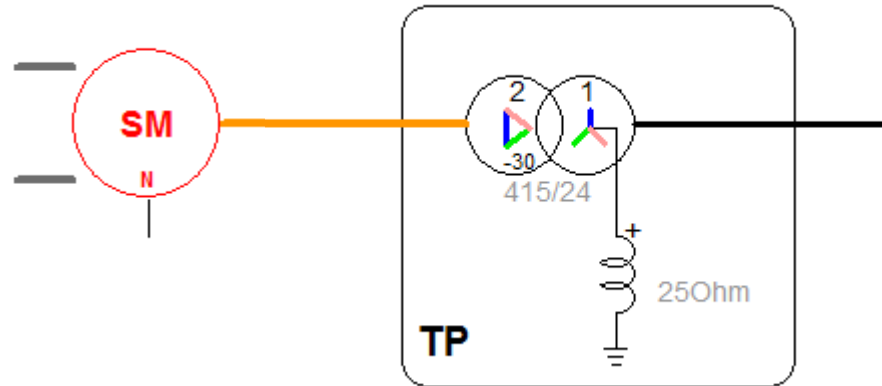
EDF_Nuc_1300MW.clf



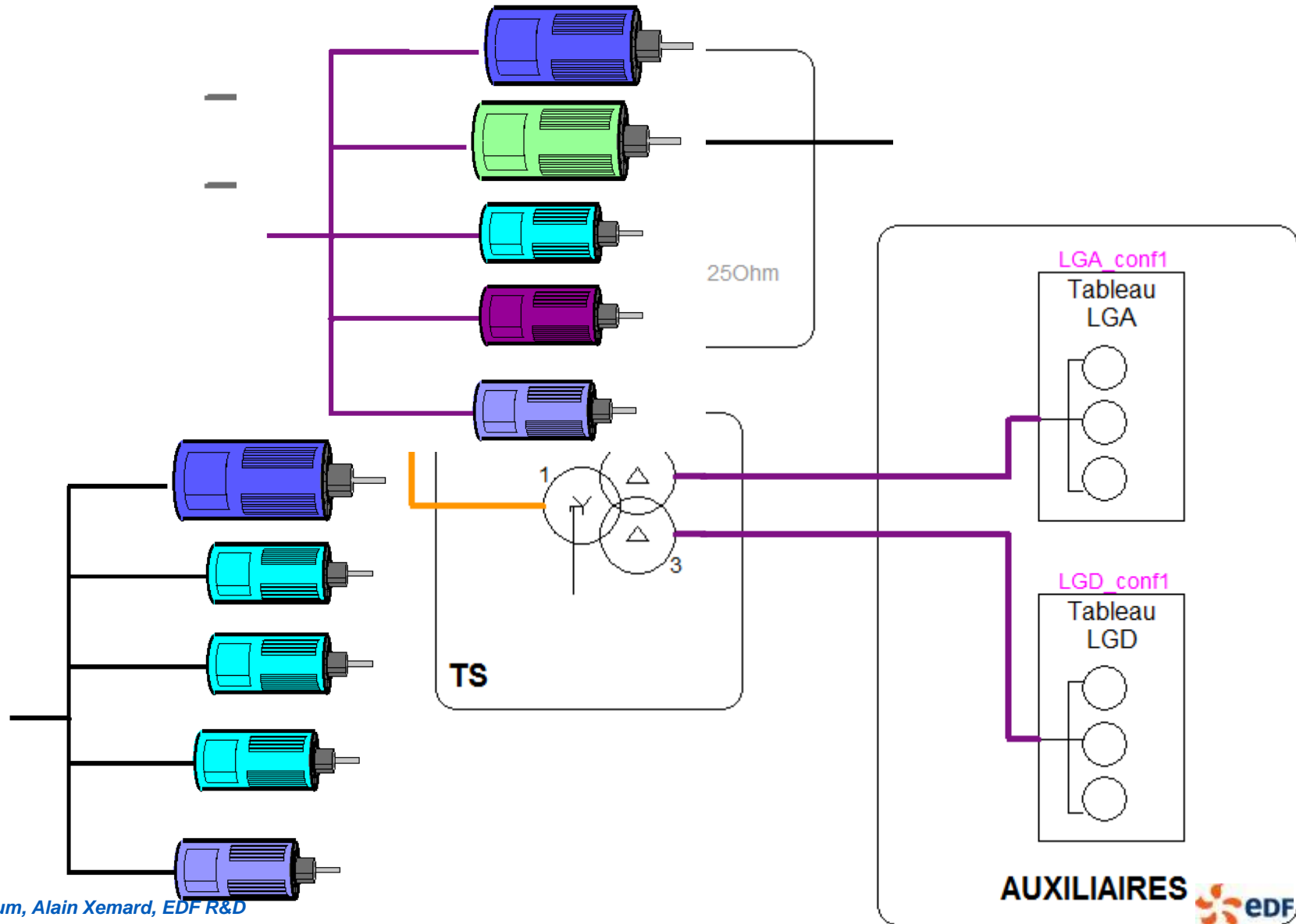
3.1 – Turbo-generator



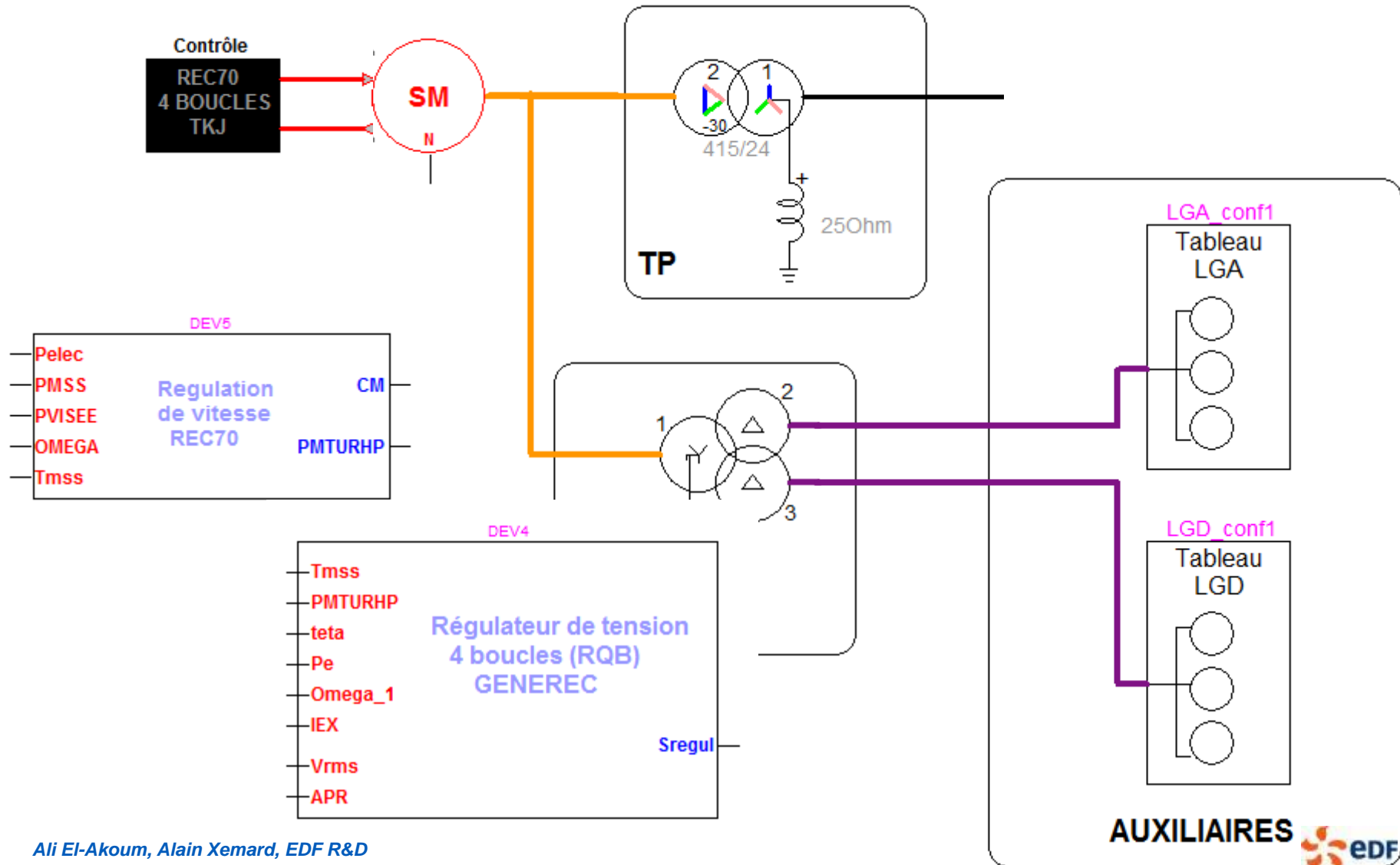
3.2 – Main transformer



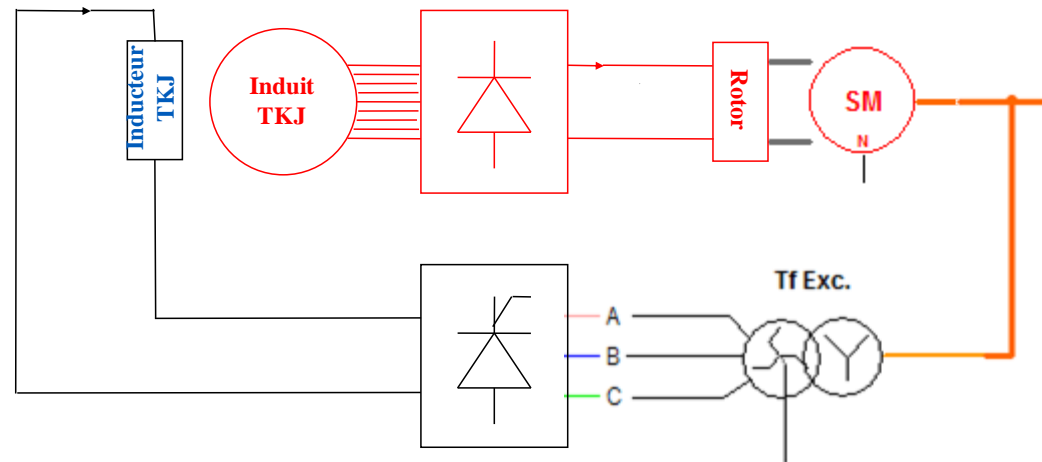
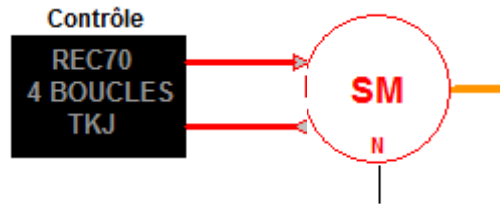
3.3 – Auxiliary systems



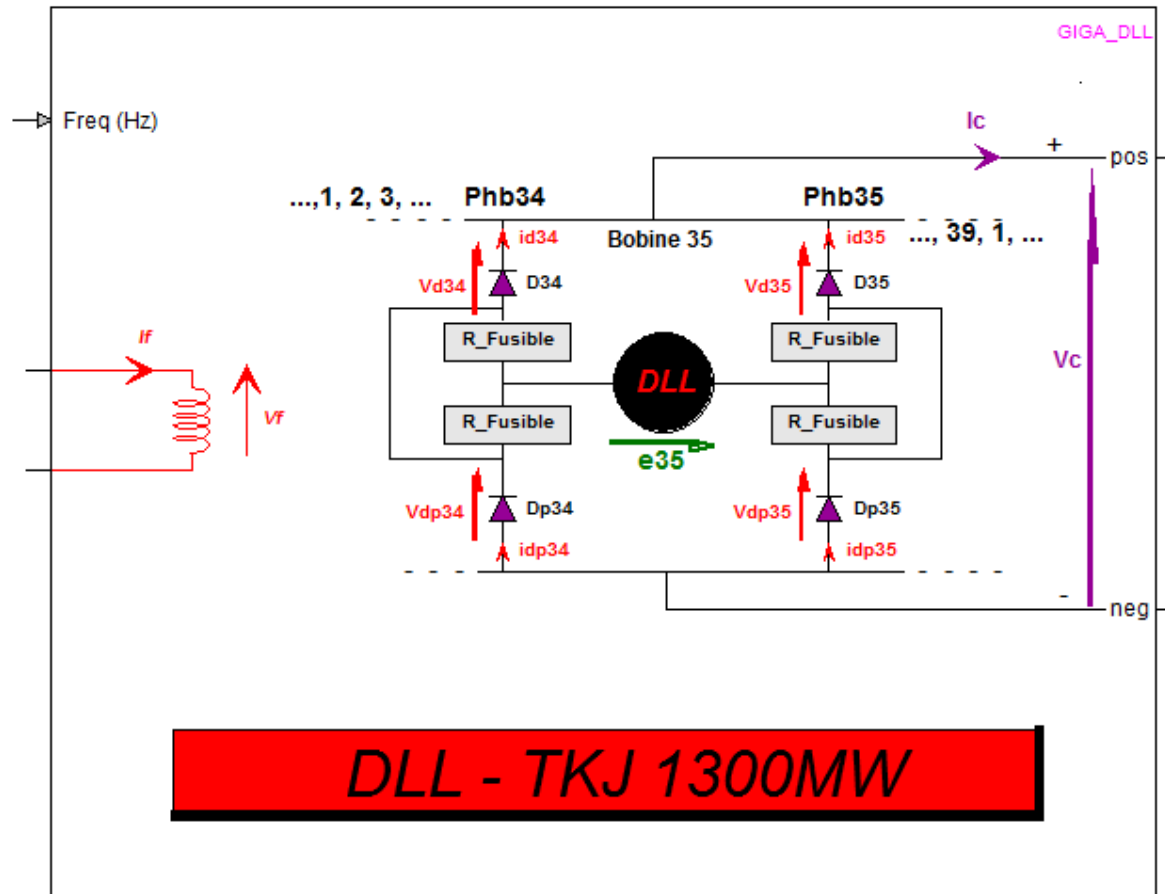
3.4 – Regulators and protections



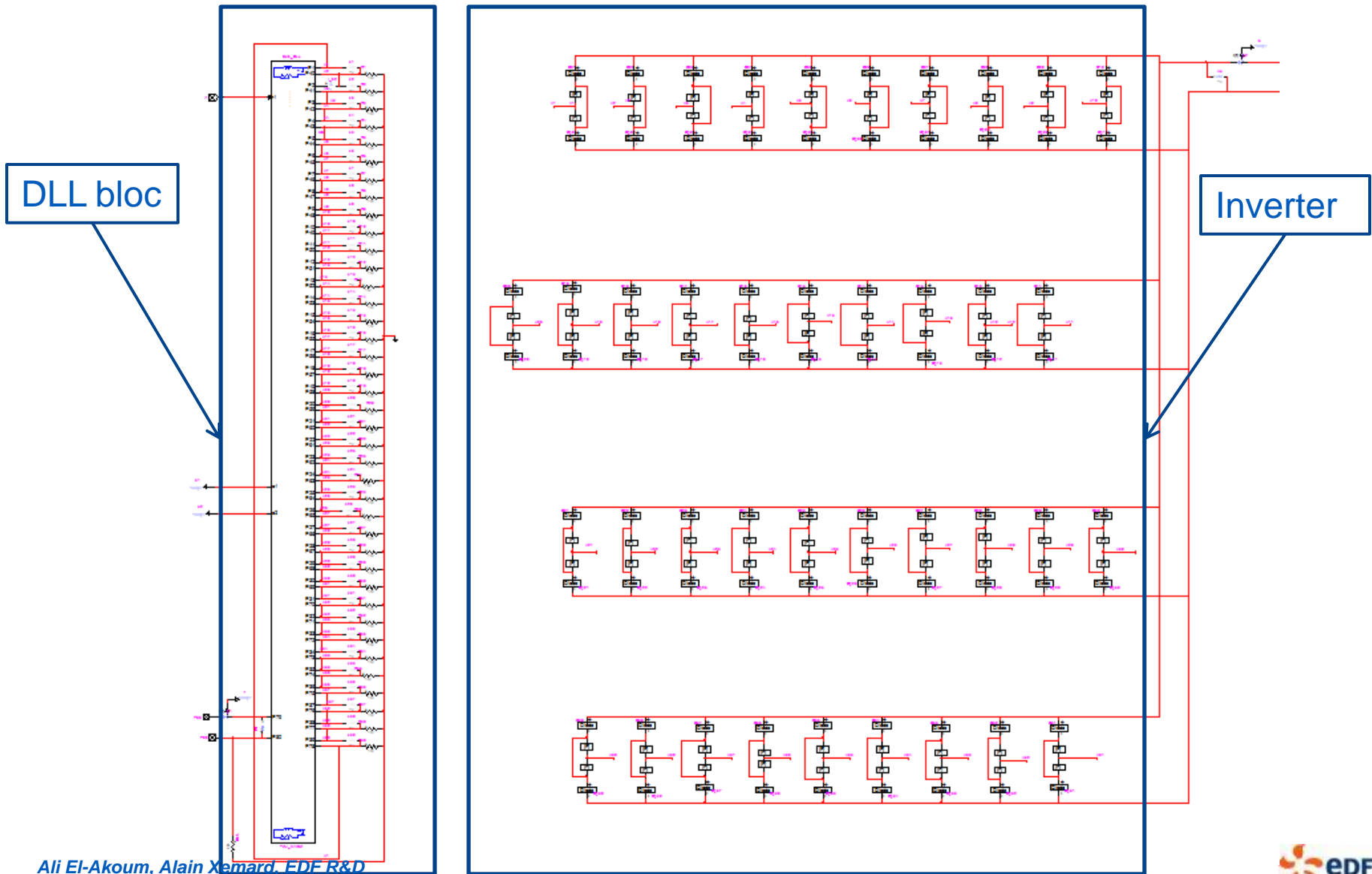
3.5 – Excitation system



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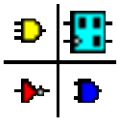
3.5 – Excitation system



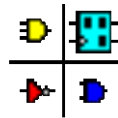
4 – Perspectives

▶ Work in progress / futur work:

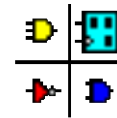
- New synchronous machine models (phasors domain approach);
- Co-simulation ;
- Finite elements methods (Saturation, self inductance ...);
- Libraries :



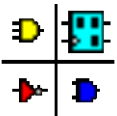
EDF_Nuc_900MW.clf



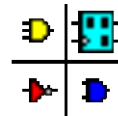
EDF_Thermal.clf



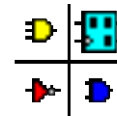
EDF_Wind_Power.clf



EDF_Nuc_1300MW.clf



EDF_hydroelectric.clf



EDF_solar.clf



Questions ?

Thank you for your attention!



On peut **sou**haiter
des solutions
énergétiques d'avenir.